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Responses of Local Government Authorities to Climate Change Impacts in Agro-pastoral Communities: The Case of Bahi District, Tanzania

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Abstract

Climate change remains one of the most critical development challenges of the twenty-first century, with agro-pastoral communities in Tanzania experiencing disproportionate impacts due high dependence on climate-sensitive livelihoods. This study examined LGA responses to climate change impacts on agro-pastoral livelihoods in Bahi District, focusing on the effectiveness of adaptation measures and the constraints affecting implementation. A mixed-methods design was employed, integrating quantitative and qualitative approaches. Two villages were randomly selected, and a sample of 78 households was drawn from a population of 385 using Yamane's (1967) formula. Stratified random sampling targeted households engaged in both crop and livestock production, while purposive sampling guided the selection of participants for key informant interviews and focus group discussions. Four gender-disaggregated FGD groups (8–12 participants each); and interviews with district officials, extension staff, village leaders, and experienced farmers provided rich qualitative insights. The quantitative data were collected through structured questionnaires, and analysed descriptively using IBM SPSS (V20) and Excel, while qualitative data were examined through content analysis in NVivo. The findings show that despite having implemented several adaptive measures, LGAs face persistent limitations, particularly inadequate technical data, shortages of skilled personnel, and insufficient financial resources: all of which constrain effective planning, implementation, and monitoring of climate initiatives. The study recommends long-term institutional capacity-building, increased integration of gender-responsive approaches within climate governance frameworks, and enhanced extension service delivery to bolster resilience and adaptive capacity among agro-pastoral households.

Keywords: *agro-pastoral communities, Bahi district, climate change impacts, local government, Tanzania*

1. Introduction

Climate change is poised to exert profound impacts on arid and semiarid rangelands, which constitute nearly two-thirds of the African continent (Galvin et al., 2001). Due to its limited adaptive capacity, Africa remains the most vulnerable continent to the effects and fluctuations associated with climate variability. A significant portion of the population already resides in drought-

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prone regions, with approximately 220m people experiencing drought annually, thereby increasing their susceptibility to food insecurity (Mung'ong'o et al., 2019). Moreover, climate change and variability have exacerbated poverty levels among rural populations (Helmuth et al., 2007). Given the continent's diverse climatic zones—ranging from tropical to semi-arid and arid (WFP/ICPAC, 2014)—the impacts of climate change are not uniformly distributed, and will affect different regions in varied ways. These communities are compelled to adapt their agricultural practices to cope with decreasing precipitation and other climate-related challenges. Africa boasts some of the world's most diverse production systems, mixed farming, and agro-pastoral and pastoral systems.

On the other hand, agriculture remains the cornerstone of Africa's economy, contributing approximately 23.7% to 24.3% to the continent's GDP; and accounting for about 55% of the total export value. Furthermore, around 70% of the population depends on agriculture for livelihoods (OECD, 2014). However, the sector's productivity has been significantly undermined by unpredictable rainfall patterns and temperature fluctuations, leading to reduced yields. Consequently, Africa is increasing susceptible to the adverse effects of climate change; a vulnerability compounded by the region's projected environmental warming (Lyimo & Kangalawe, 2010). Projections by Nelson et al. (2009), as cited by Cooper et al. (2016), estimate that climate change and variability could decrease agricultural output by 10–20% by 2050, driven by shifting precipitation regimes and more frequent extreme weather events.

Moreover, in Tanzania, agriculture sustains over 65% of the population, providing livelihoods, income, and employment. The sector contributed approximately 56% of the national GDP, and accounted for about 60% of total export earnings over recent years; underscoring its critical role in the economy (URT, 2021). The Tanzanian government aims to enhance rural productivity and income through the National Strategy for Growth and Poverty Reduction (NSGPR), among other policies. Nevertheless, climate change present significant challenges to agricultural development, impeding progress despite strategic efforts. Tanzania's climate has already experienced notable changes, with a documented increase of 1.0°C in mean annual temperature since 1960; and a decline in average monthly precipitation by 2.8mm per decade (TCAR, 2016; Magita & Sangeda, 2017). Climate models project an increase of 3–5°C by 2075 (VPO, 2003), with ongoing impacts already affecting rural livelihoods across diverse regions (Sangeda & Malole, 2013; Magita & Sangeda, 2017; Kangalawe & Lyimo, 2010).

Local government authorities (LGAs) in Tanzania are strategically positioned to address the causes and effects of climate changes. Being closest to affected communities, they can provide effective leadership and foster behavioural changes necessary for building resilience (Deri & Alam, 2008). However,

existing centralized planning systems have limited the capacity to support local adaptation efforts; which are characterized by rigid and top-down approaches that are often fragmented across sectors. These systems frequently lack an understanding of local adaptation strategies, fail to consider gender-diverse impacts, underutilize climate data, and have limited capacity to access and disburse climate finance effectively (URT, 2012).

Therefore, this paper seeks to address the studied gaps by: (i) assessing local government responses to climate impacts on agro-pastoral communities; (ii) evaluating the capacity of LGAs to integrate climate issues into their planning and budgeting processes; (iii) capturing the perceptions of agro-pastoral communities regarding climate change impacts; (iv) examining the socio-economic implications of climate change on these communities; and (v) identifying the challenges faced in combating climate change impacts. The findings are expected to contribute to the existing body of knowledge; and also inform policymakers, non-governmental organizations, and other stakeholders in designing responsive strategies. This research aligns with Tanzania's Third Five-Year Development Plan (FYDP III, 2021/22–2025/26), particularly its objectives aimed at enhancing the quality of life and human development, including expanding social services and strengthening human capital, as well as promoting inclusive planning through increased participation of local and non-state actors in development processes (URT, 2021).

2. Context and Methods

2.1 Study Area

The study was conducted in Bahi District (Figure 1), one of the six administrative districts of Dodoma Region in central Tanzania. The area was purposively selected due to its high concentration of crop-growing households, and the predominance of agro-pastoral livelihoods, which make it highly vulnerable to climate variability and change (URT, 2008; URT, 2011). Agriculture is the mainstay of the district's economy, engaging over 80% of the population; and contributing substantially to household income and food security (URT, 2017; URT, 2021a). Because farming is largely rain-fed, the sector is particularly sensitive to rainfall fluctuations, prolonged droughts, and rising temperatures that have become more frequent in the semi-arid zones of central Tanzania (Lyimo & Kangalawe, 2010; Mary & Majule, 2009). Geographically, Bahi lies between latitudes 4° and 8° South, and longitudes 35° and 37° East; covering an area of about 5,948km^2. It is bordered by Chamwino District and Dodoma City to the east, Kondoa District to the north, Iringa Region to the southwest, and Singida Region (Manyoni District) to the west. The climate is semi-arid tropical, characterized by a unimodal rainfall pattern with a short wet season from December to April, and a long dry season from May to November, averaging 500–700mm of rainfall annually; and a mean temperature of 22.6 degrees Celsius (Mdemu et al., 2020; URT, 2021b).

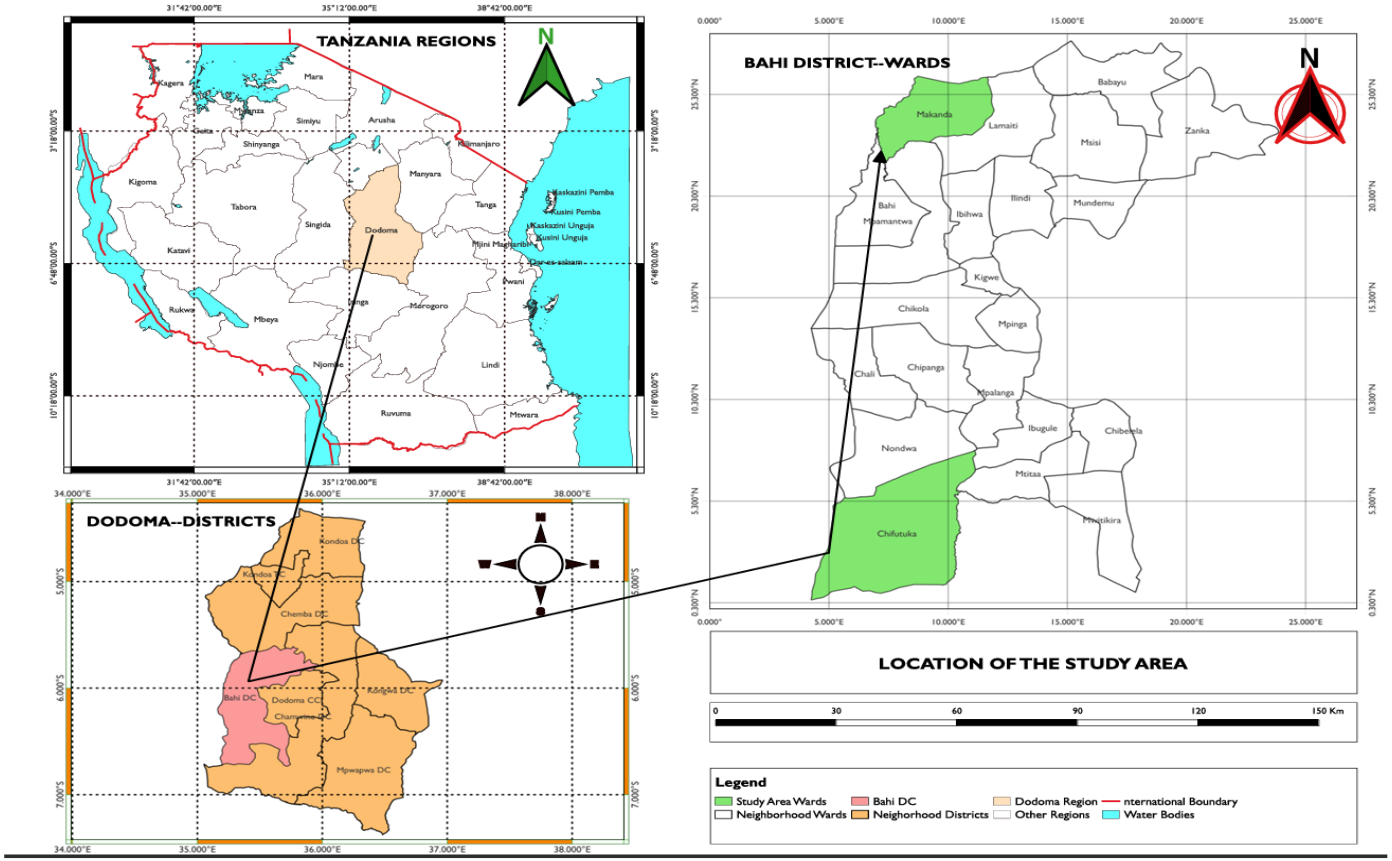

Figure 1: Location of the Study Villages in Bahi District, Dodoma Region

Source: GIS Lab, UDOM, 2025

The study focused on two villages—Makanda and Chifutuka—located in Makanda and Chifutuka wards, respectively; which represent distinct agro-ecological and socio-economic settings within the district. Agricultural production is dominated by drought-tolerant crops such as pearl millet, sorghum, paddy, and groundnuts; alongside livestock keeping involving cattle, goats, and sheep (URT, 2017; URT, 2021b). These livelihoods are highly climate dependent and increasingly exposed to risks associated with rainfall variability and warming trends reported across the central plateau (IPCC, 2021; URT, 2021a). The area's recurrent droughts, declining soil fertility, and water scarcity underscore the importance of examining how local government authorities and agro-pastoral communities respond, and adapt, to changing climatic conditions. Thus, Bahi District provides a relevant empirical setting for assessing climate change impacts and adaptation dynamics within Tanzania's semi-arid agro-pastoral systems.

2.2 Research Design

This study is an output of a cross-sectional research design that include agro-pastoral communities in Bahi District, Dodoma Region. The district was chosen because it is semi-arid, making it more susceptible to the effects of climate change than other regions of the country (Shemsanga, 2010). The area also provides a unique context for understanding the responses of local government authorities to climate change impacts in agro-pastoral communities.

2.3 Sampling Process

The sampling process was designed to ensure a representative and robust selection of participants from the target population in Bahi District. The study initially involved a random selection of the study villages from the official district village registry. A stratified random sampling technique was employed to select participating households (HHs) from the sampling frame, which consisted exclusively of farmers engaged in both crop production and livestock keeping. Stratification was necessary due to the heterogeneous distribution of the target population across the two selected villages, ensuring proportional representation of each village (stratum) in the final sample to enhance external validity.

The total population of eligible households across the two villages was 385. The required sample size (n) was determined using the formula by Yamane (1967):

$$n = \frac{N}{1 + Ne^2} \qquad (1)$$

Where: N is the total population (385 HHs), and e is the pre-specified level of precision (0.10).

Substituting the values, yielded:

$$n = \frac{385}{1 + 385(0.10)^2} \qquad (2)$$

$$n = 79$$

The computation resulted in approximately 79 households, which was rounded to 78 (the nearest whole number) for practical purposes. This sample size was considered adequate to provide reliable and representative information from the two study villages. Also, the sample size of 78 households was adopted for the quantitative survey, representing approximately 20.3% of the total eligible household population. The sample was proportionally allocated across the strata (villages) based on the number of eligible households in each village, utilizing the official village household registers as the sampling frame. This resulted in the selection of 35 households from Makanda, and 43 households from Chifutuka.

Purposive sampling was used to select participants for the focus group discussions (FGDs) and key informant interviews (KIIs). This non-probability technique ensured the inclusion of individuals with specialized knowledge, relevant experience, and decision-making authority to provide rich and in-depth qualitative data. The key informants included the District Agriculture, Livestock and Fisheries Officer (DALF), ward executive officers (WEOs), village executive officers (VEOs), agricultural and livestock extension officers, members of village government committees, and four elderly farmers (two men and two women).

2.4 Data Collection

Primary data collection utilized a mixed-methods approach, employing both qualitative and quantitative techniques. The quantitative data were gathered using a structured questionnaire administered to a sample of 78 household heads to ensure systematic collection of numerical data. For the qualitative data, KIIs were conducted using an in-depth interview checklist; and this targeted individuals with specialized knowledge. Additionally, FGDs were organized, specifically establishing 4 gender-disaggregated groups (one male group, and one female group in each of the two villages), guided by a focus group interview guide. This approach of separating groups by gender allows for richer and more candid discussions, and minimizes power dynamics; which is consistent with the literature (Mfungo et al., 2020; Msilu et al., 2024). The size of the groups ranged from 8 to 12 participants, which falls within the optimal range suggested for effective group interaction and comprehensive data generation (Kothari, 2004). The secondary data, which was sourced from relevant published reports and online databases, supplemented the collected primary data.

2.5 Data Analysis

The analysis of qualitative data was done using the NVivo software, whereby the data were analysed in three stages: first, line-by-line coding of field notes and transcripts (unpacking of text into discrete elements to expose underlying thoughts and meanings); second, an in-depth examination and interpretation of the resultant codes into descriptive themes; and third, the interpretation of the descriptive themes into more abstract analytical themes. The quantitative data was based mainly on descriptive statistics; including frequencies, means, percentages, and cross-tabulations. The Statistical Package for Social Science Research (IBM SPSS, version 20) was employed to analyse the quantitative data. The involvement of agro-pastoral communities in LGA plans and budgets, as a response to climate change impacts, was measured using five indices ('to a great extent', 'to some extent', 'to a small extent', 'not at all', and 'don't know') formed from Likert items (Marshall & Marshall, 2007).

3. Results and Discussions

3.1 LGA Response in Supporting Agro-pastoral Communities to Adapt to Climate Change Impacts

Climate change demands coordinated global action, yet its impacts are most intensely felt at the local level, positioning local government authorities (LGAs) as central actors in climate governance and community resilience. Literature identifies LGAs as frontline implementers of adaptation and mitigation due to their close engagement with communities (Agrawal & Lemos, 2007; UN-Habitat, 2015), a role that is especially critical in climate-sensitive agro-pastoral societies (IPCC, 2019). Local government responses to climate change in the study area include taking various measures as discussed below.

3.1.1 Provision of Farm Inputs and Implements

The study results indicate a gradual shift from traditional hand-hoe cultivation toward more efficient tillage technologies among agro-pastoral households in Bahi District. Although all respondents continued to rely on hand hoes, a notable proportion reported transitioning to ox-ploughs and tractors; reflecting early-stage mechanization that supports labour efficiency and timely land preparation under climate stress (Diao et al., 2016; Mrema et al., 2018). However, limited and irregular use—particularly among women, 60% of whom could not afford annual hire—highlights persistent socioeconomic and gender barriers. This aligns with broader evidence showing that women farmers across Sub-Saharan Africa (SSA) face restricted access to credit, land, and productive assets; resulting in reduced adaptive capacity relative to men (FAO, 2011; Quisumbing et al., 2014).

Farmers also reported using ox-ploughs or tractors for deep tillage, approximately once every three years; citing improvements in soil moisture retention and yields, consistent with studies showing that periodic deep tillage

enhances infiltration, breaks hardpan layers, and supports crop performance in semi-arid regions (Thierfelder & Wall, 2012; Giller et al., 2015). Furthermore, subsidized fertilizers and seeds, provided through LGAs, played a critical role in strengthening resilience during prolonged droughts; echoing the literature demonstrating that input subsidy programs enhance food security and adoption of stress-tolerant varieties (Jayne et al., 2013; Lunduka et al., 2013). While LGAs effectively identified household needs and ensured transparent distribution through *vitongoji* leaders—reflecting principles of effective decentralized governance (Ribot, 2014)—some households were unable to meet co-payment requirements. This challenge is consistent with SSA-wide evidence that such subsidy schemes often exclude the poorest, thereby reinforcing inequalities in access to essential adaptation resources (Chirwa & Dorward, 2013; Mason & Ricker-Gilbert, 2013).

3.1.2 Developing and Implementing Local Climate Action Plans

Developing and implementing local climate action plans is essential for strengthening community level responses to climate change, as such plans provide structured strategies for mitigation and adaptation tailored to local vulnerabilities. Evidence from Bahi District indicates that LGAs have begun operationalizing these plans through community awareness initiatives on energy efficiency, the promotion of renewable energy transitions, and the introduction of green infrastructure, such as rain gardens. These efforts align with global findings that localized climate planning enhances institutional preparedness, reduces emissions, and builds adaptive capacity by integrating community knowledge with scientifically informed interventions (UN-Habitat, 2015; IPCC, 2022). Moreover, the emphasis on renewable energy and the nature-based solutions correspond with the literature highlighting their effectiveness in reducing environmental degradation, improving water management, and enhancing resilience in resource-dependent rural systems (Smit & Wandel, 2006; Chu et al., 2017).

However, the partial and emerging nature of these interventions underscores the need for sustained financial, technical, and institutional support to ensure that local climate action plans move beyond planning toward fully implemented, long-term adaptive systems; a challenge commonly documented in many SSA local governments (Ayers, 2011; Nkiaka et al., 2020). One of the key informants at a district level pointed out this thus:

> *"It is important for local leaders to engage with the community in the development of these plans, to ensure that the actions reflect the needs and priorities of the people who live and work in the area. Once the plan is in place, it is equally important to follow through on its implementation, monitoring progress, and making adjustments as needed. By taking action at the local level, communities can make a significant contribution to the global effort to combat climate change"* ***(Informant 1, DALF Officer, face-face interview, February, 2025).***

3.1.3 Budget Allocations

The results reveal that budget allocations for climate change in Bahi District remain limited, fragmented, and insufficient to support comprehensive adaptation and mitigation efforts. Although the 2023/2024 and 2024/2025 budgets included funding for clean energy technologies, renewable energy programs, and community-level adaptation initiatives, these expenditures were embedded within broader sectoral budgets rather than presented as a dedicated climate finance line. This pattern reflects a wider challenge across SSA, where climate expenditures are often dispersed across departments, thereby obscuring transparency and complicating systematic tracking and evaluation (Bird, 2015; Allan et al., 2020). The absence of explicit climate budget tagging not only constrains accountability, but also perpetuates institutional fragmentation; hence hindering the mainstreaming of climate priorities in planning and budgeting processes (Trærup & Olhoff, 2015; Tenzing, 2020). These findings align with global assessments indicating that substantial and sustained financing is needed to limit global warming to 1.5°C, and adequately support local adaptation pathways requirements that remain difficult to meet in fiscal environments marked by resource scarcity and competing development demands (IPCC, 2018; Pauw et al., 2020).

Critically, the inadequate funding observed in Bahi District significantly limits the implementation of district climate action plans, and weakens the adaptive capacity of agro-pastoral communities. Respondents noted that insufficient financial allocations restrict agricultural extension services, delay the dissemination of climate-smart technologies, and impede investments in key interventions such as water harvesting, rangeland restoration, and climate-resilient livestock systems. This reinforces findings in the broader literature: that underinvestment in adaptation heightens socio-economic vulnerability in climate-dependent rural areas; where recurrent drought, heat stress, crop losses, and livestock diseases already undermine livelihoods (Smit & Pilifosova, 2003; Fankhauser & McDermott, 2014; IPCC, 2022). Furthermore, inadequate climate financing diminishes the ability of LGAs to leverage external climate funds, many of which require co-financing and evidence of institutional readiness. As a result, the district risks becoming trapped in a cycle of chronic under-resourcing, limited adaptation action, and escalating climate vulnerability. Addressing these constraints will require improved climate-budget tagging, strengthened intergovernmental coordination, adequate fiscal transfers, and institutional capacity building to ensure that adaptation priorities receive consistent and predictable funding.

3.1.4 Extension Services

Agriculture and livestock extension officers are central to facilitating climate adaptation among agro-pastoral communities, as they serve as intermediaries for disseminating knowledge, technologies, and practices that reduce vulnerability to

climate stressors. Numerous studies show that extension services significantly enhance farmers' adaptive capacity by providing timely information on climate-smart agriculture, improved livestock management, and risk-reducing technologies such as drought-tolerant crops, pasture management techniques, and early warning systems (Anderson & Feder, 2007; Kristjanson et al., 2012). However, the findings from Bahi District reveal that many wards suffer from a shortage of extension officers; hence limiting households' access to technical guidance, and constraining the spread of effective adaptation practices. Similar shortages have been documented across SSA, where understaffing and under-resourcing of extension systems are recurrent challenges hampering rural resilience (Davis et al., 2020). The implications are significant: without adequate personnel, agro-pastoral households continue to rely on traditional knowledge alone which, though valuable, may be insufficient in the face of increasingly unpredictable climatic conditions.

The study results further demonstrate that the existing extension officers in Bahi District lack adequate training and opportunities for professional development; echoing findings from broader research indicating that weak capacity within extension systems undermines the quality of advisory services delivered to rural communities (Rivera & Alex, 2005). Inadequate or non-existent training programs reduce the pool of qualified candidates for extension positions; and impede the ability of current officers to remain informed about emerging technologies, climate adaptation strategies, and innovations in sustainable livestock and crop production (Birner et al., 2009). This capacity gap has far-reaching consequences: poorly trained extension officers are less able to translate scientific research into actionable guidance; thereby inhibiting the mainstreaming of climate-smart agriculture, and constraining the district's overall institutional readiness for climate adaptation. Therefore, strengthening training systems, expanding in-service professional development, and improving resource allocation to extension departments: all are critical steps for enhancing local adaptive capacity, and ensuring that agro-pastoral communities in semi-arid regions can respond effectively to accelerating climate risks.

4. Capacity of LGA in Mainstreaming Climate Change Issues in their Plans and Budget System

The study findings indicate that LGAs in the study area experience persistent challenges in effectively mainstreaming climate change considerations into their planning and budgeting frameworks. Although local adaptation plans have been formulated, their operationalization remains limited due to the absence of clear implementation pathways, insufficient specification of responsibilities, and the lack of defined resource requirements. The plans were often presented in generalized formats, with weak or missing monitoring and evaluation (M&E) structures, which constrained their applicability at the execution level. These observations align with wider empirical evidence

showing that adaptation plans at the subnational level in many African contexts tend to be generic and lack actionable components, thereby limiting their potential to drive meaningful adaptation outcomes (Ford et al., 2022; NAP Global Network, 2023; Ayers et al., 2021). As a result, LGAs in the study area struggled to translate policy intentions into practical interventions such as early-warning systems, climate-smart agriculture, and sustainable rangeland management.

Interviews with council officials further revealed institutional and capacity-related barriers that hinder the implementation of climate-related priorities. Respondents consistently cited shortages of technical expertise, inadequate access to localized climate information, limited staffing, and insufficient financial resources as the major constraints. These problems were intensified by administrative expansions that increased the councils' jurisdiction without accompanying increases in staff or budget allocations. Additionally, misalignment between the council's planning and budgeting cycles and climate-sensitive decision-making periods was reported to impede timely adaptation actions. These barriers are consistent with findings from other SSA contexts, where subnational governments frequently face resource constraints and governance limitations that restrict their ability to operationalize adaptation strategies (Carter et al., 2023; UNFCCC, 2024). A recurrent theme emerging from the interviews was the limited political prioritization of climate change within the councils. Some councillors and senior officials perceived climate issues as secondary to immediate service delivery concerns, a perception that reduced the visibility of adaptation needs in council agendas. Respondents also cited inconsistent policy direction from the central government, noting that existing guidance is fragmented and insufficiently integrated with local planning processes. These challenges collectively reduce the capacity of LGAs to respond effectively to climate risks, and limit opportunities for harmonized planning across districts despite the presence of shared and transboundary climate vulnerabilities (IPCC, 2022).

5. Perception of Agro-pastoral Communities on Climate Change Impacts

The findings reveal notable gender-based differences in how community members perceive the impacts of climate change, reflecting variations in livelihood roles and exposure to climate-related risks. The male respondents expressed heightened concern about livestock losses, with 68% identifying animal mortality—particularly from emerging diseases such as the East Coast Fever—as the most severe climate-related impact. The participants explained that such diseases were less prevalent in the past, and their rising occurrences signal a significant shift attributed to changing climatic conditions. These results align with broader evidence showing that men in agro-pastoral

communities often exhibit greater sensitivity to climate impacts on livestock because livestock herding and management are traditionally male-dominated responsibilities in many rural African contexts (Bryan et al., 2009; Ngigi et al., 2017). As climate variability increases the frequency of vector-borne livestock diseases, men's concern for cattle survival reflects their direct dependence on herd productivity for income, status, and household security.

Conversely, a larger proportion of the female respondents (82%) identified declining crop yields as the most severe climate change impact. The women emphasized that the past three years had been characterized by unprecedented crop failure, with many farmers experiencing total harvest losses. This perception is consistent with findings from gender-focused climate studies, which document that women often bear primary responsibility for crop production, household food supply, and subsistence farming activities; hence making them more vulnerable to erratic rainfall and prolonged droughts (Jost et al., 2016; Partey et al., 2020). The divergence in perceptions observed in Bahi District, therefore, corresponds with gendered divisions of labour: men's concerns centre on livestock, while women's concerns focus on crop performance. These differentiated perceptions carry important implications for adaptation planning, as households may prioritize adaptation strategies according to gender-specific livelihood roles. Literature emphasizes that successful adaptation interventions must recognize gender-differentiated vulnerabilities and integrate both men's and women's climate risk priorities to ensure equitable and sustainable outcomes (Djoudi et al., 2016; IPCC, 2022).

In-depth interviews with key informants and focus groups also revealed that the current temperature is higher than it was thirty years ago, which is related to frequent shortages and recurring droughts:

> *"There is no doubt that the level of temperature in our village has increased dramatically in recent years as compared to thirty years ago. You know, the temperature used to be high mostly in November and early December; both at day and night. But nowadays the temperature has become unpredictable because even those months which we used to have low temperature—like January, April and May—the situation has changed; we are also experiencing high temperature in these months."* ***(Participant 4, FGD, in Makanda village, February, 2025)***

Moreover, the results show that people in the district overwhelmingly perceive significant long-term climatic changes, with 81% reporting rising temperatures over the past thirty years, 15% noting temperature fluctuations, and only 4% perceiving no change. Similarly, 78% perceived declining rainfall, 20% observed fluctuations, and 2% reported no noticeable changes. These perceptions align with studies across semi-arid East Africa areas, indicating that rural households commonly observe increasing temperatures and declining—or more erratic—rainfall, often corresponding with meteorological

records (Mkonda & He, 2019; Turner et al., 2017). Research from Tanzania and neighbouring countries similarly shows that farmers attribute reduced rainfall reliability and rising temperatures to worsening drought frequency, shortened growing seasons, and increased crop and livestock stress (Belay et al., 2021; Masaba-South Study, 2022).

However, scholars caution that while perceptions frequently reflect real climatic trends, they may also mirror recent extreme events rather than long-term climate trajectories (Sani & Chalchisa, 2024). In Bahi District, these perceptions carry significant implications: they shape household adaptation behaviours, influence agricultural decisions, and signal the urgency of strengthening climate information services and evidence-based planning. The strong alignment between local perceptions and broader regional climate patterns suggests that integrating scientific climate data with community knowledge can enhance district-level climate adaptation strategies, and support more resilient agro-pastoral livelihood.

6.1 Climate Change Impacts at the Household Level

The findings further show that climate change and the pressures associated with adaptation have generated substantial social and economic disruptions for households in the study area. A significant proportion of the respondents (72%) identified food insecurity, increased disease incidences, escalating resource-based conflicts, and rising household labour demands as the most severe impacts. These burdens have impinged household well-being and constrained socio-economic progress, particularly for women and children. Consistent with wider evidences from climate-affected regions of SSA, the respondents noted that declining agricultural productivity, longer distances required to fetch water and fodder, and heightened care responsibilities: all have disproportionately increased the workload of women, hence reinforcing existing gendered labour inequalities (Djoudi et al., 2016; Partey et al., 2020). As these domestic pressures intensify, girls are often compelled to withdraw from school to support household tasks, while other children migrate in search of alternative livelihood opportunities (Opiyo et al., 2018; Henry et al., 2020). These results underscore the far-reaching social consequences of climate change, highlighting how intertwined environmental and gendered vulnerabilities limit adaptive capacity, and exacerbate long-term development challenges. These fears impeded domestic advancement in numerous ways, as stated by one interviewee below:

> *"Young women and men migrated to Dodoma City and other towns; where they worked as bartenders, housemaids, and food and garden vendors. Due to their lack of education, they were unable to support themselves and their family back in their home villages. Allegedly, as a result, the majority of women became prostitutes and contracted HIV/AIDS and other sexually transmitted diseases"* ***(Informant 2, Chifutuka village, In-depth interview, January, 2025).***

The findings from FGDs and in-depth interviews in Makanda and Chifutuka villages indicate that migration has become a widely adopted coping strategy among young women and men responding to climate-related livelihood stresses. The participants reported that many youths relocate to urban centres in search of informal employment, while some men use migration as a means of avoiding increased domestic responsibilities that emerge when household workloads shift during periods of environmental stress. These findings echo broader evidence from other parts of Tanzania, and other SSA contexts, which show that climate-induced livelihood pressures frequently reshape gender roles and labour divisions, often intensifying women's workloads; while men migrate or disengage from household responsibilities (Swai et al., 2012; Yeboah et al., 2021). Women in the study area were reported to take on additional duties such as searching for casual labour, engaging in petty trade, and allocating a greater share of their time and limited resources to sustaining their families; patterns that are consistent with regional studies demonstrating that climate adversities disproportionately burden women due to socially constructed gender roles, and limited adaptive resources (Nyantakyi-Frimpong & Bezner Kerr, 2017; Rao et al., 2020).

The survey results further demonstrate that climate variability and climate change are severely undermining the community's primary sources of food and income, namely agriculture and livestock production. The respondents highlighted numerous climate-related stressors affecting household welfare and adaptive capacity, including increased drought frequency (54.6%), declining pasture and grazing areas (42.3%), rising incidences of crop and livestock diseases (39.1%), growing conflicts over scarce resources (35.1%), excessive heat (33.3%), livestock mortality (31.0%), and occasional flooding (9%). These findings align with existing literature documenting how climatic shifts in semi-arid regions accelerate environmental degradation, heighten competition over natural resources, and exacerbate health risks, thereby diminishing the ability of households to respond effectively to ongoing climate threats (Thornton et al., 2018; Serdeczny, 2019). Nearly all the respondents (97%) attributed the observed livelihood impacts to changing climatic conditions, reinforcing scientific assessments that communities dependent on rain-fed agriculture and extensive livestock systems are among the most vulnerable to climate-related shocks in East Africa. Collectively, these results highlight the compounding effects of climate variability on local livelihoods, social structures, and adaptive strategies; illustrating the multidimensional nature of climate vulnerability in agro-pastoral settings.

6.2 Climate Change Impacts on Crop Production

Additionally, the results show that both men (91.1%) and women (97.0%) perceived significant long-term changes in their local climate, which they associated with declining crop productivity. However, gendered differences

emerged in how these impacts were prioritized. The women most frequently identified increasing pest and disease outbreaks (54.5%), recurrent droughts (51.5%), deteriorating household health (42.4%), and extreme heat (39.4%) as the most critical consequences of climate variability. On their part, men listed similar stressors but ranked them differently, with droughts (54.6%) and livestock mortality (37.8%) ranking as their most pressing concerns. These gendered perceptions are consistent with wider research showing that men and women experience climate impacts differently due to distinct livelihood roles and responsibilities: with women often more attuned to household food security, pest pressures, and health burdens; while men prioritize stressors affecting livestock and field-based activities (Jost et al., 2016; Nnadi et al., 2019; Tavenner & Crane, 2019). The FGDs revealed that men viewed drought as their most severe challenge, given their direct involvement in livestock herding and land preparation; whereas women identified pests and diseases as the major threats due to their limited access to pest-control information, lower incomes, and heavier dependence on crop yields for household nutrition. These findings reinforce the argument that perceptions of climate risks are shaped by gendered divisions of labour, differential access to resources, and an unequal distribution of decision-making power within rural households.

Evidences from household surveys, key informant interviews, and field observations further demonstrated that crop yields have fluctuated markedly over the past decade, with the most severe declines occurring within the past three years. The majority of the key informants in Chifutuka reported minimal or complete crop failure in the season preceding data collection, attributing the losses primarily to prolonged dry spells and recurrent droughts; an observation supported by 82% of the surveyed farmers. These results mirror regional patterns in semi-arid East Africa, where climate change has intensified rainfall variability, elevated temperatures, and increased pest outbreaks: all of which have contributed to substantial yield reductions in smallholder systems (IPCC, 2022; Shikuku et al., 2017).

Moreover, farmers in the study area identified ants (70%), black soot (60%), and cutworms (32.8%) as the increasingly common pests, which are likely favoured by warmer soil conditions; a trend corroborated by other studies that link temperature rise to the proliferation of pests (Deutsch et al., 2018). Additionally, unpredictable rainfall patterns—such as early onset, but short-lived rains, followed by long dry spells—disrupted planting decisions and undermined crop farming. Field inspections confirmed widespread crop wilting and poor germination due to moisture stress. Several farmers reported that uncertainty about rainfall prevented timely replanting, illustrating how climatic unpredictability undermines adaptive planning. Collectively, these findings highlight the compounding effects of droughts, temperature rises, and pest outbreaks on agricultural livelihoods, underscoring the vulnerability of agro-pastoral communities to climate change impacts.

6.3 Climate Change Impacts on Livestock

The household survey findings revealed a marked decline in livestock ownership among agro-pastoral households, with 35.6% of the men and 21.2% of the women who owned cattle reporting reductions in their herds. Only a small proportion of the respondents—4% of the men, and fewer than 3% of the women—reported any expansion in herd size. Key informant interviews and FGDs corroborated these findings, noting that most herdsmen currently maintain fewer than 100 cattle, compared to substantially larger herds in the past: one wealthy herdsman reported a reduction from approximately 600 to 300 cattle over recent years. These observations align with regional studies showing that climate variability, rangeland degradation, and disease pressures have significantly reduced herd sizes among pastoral and agro-pastoral communities across East Africa (Nkedianye et al., 2020; Shemdoe & Saria, 2018). As livestock constitute both economic and cultural capital in pastoral systems, declining herd sizes not only weaken household income, but also reduce resilience to climatic shocks (Herrero et al., 2016).

The respondents attributed the decline in livestock populations primarily to worsening disease burdens and shrinking pasturelands. All female livestock keepers (100%) and the majority of their male counterparts (75%) identified pests and diseases as the leading cause of livestock loss. The most frequently cited diseases included tsetse-fly-borne trypanosomiasis (80%), East Coast fever (75%), Rift Valley fever (65%), and tick infestations (65%): all of which were perceived to be increasing in severity over time. These patterns are consistent with scientific evidence linking rising temperatures and altered rainfall patterns to expanded habitat suitability for vectors and pathogens affecting livestock health in East Africa (Nyamwaya et al., 2022; Munene et al., 2021). Respondents further noted that declining grazing lands, reduced water sources, and the escalating cost of veterinary treatment: all exacerbate livestock mortality challenges. This is similar to other documented results in studies of climate-impacted pastoral landscapes (Opiyo et al., 2015). Together, these findings highlight the compounding effects of climate-induced ecological change and disease pressure on livestock production, reinforcing the vulnerability of agro-pastoral livelihoods to ongoing climatic stressors.

7. Challenges facing Agro-pastoral Communities in Combating Climate Change Impacts

This study identified multiple constraints that hinder households' ability to adapt effectively to climate variability and change. The respondents were asked to list and rank the challenges they faced, and the results are as shown in Figure 2. From the figure, more than half (51%) identified limited capital as the primary barrier to adaptation. Also, they explained that improving agricultural and livestock productivity under changing climatic conditions requires financial

investments in improved seeds, fertilizers, veterinary medicines, and livestock equipment inputs; most of which many could not afford due to low and unstable incomes. High costs also prevented farmers from purchasing or renting improved agricultural machinery. These findings align with broader evidence from SSA, where limited financial resources have been found to significantly reduce smallholders' ability to adopt climate-smart agricultural technologies, and invest in adaptive strategies (Asfaw et al., 2019; Di Falco & Veronesi, 2013). Studies further show that inadequate access to credit and savings mechanisms amplify vulnerability by restricting farmers' ability to respond proactively to climatic shocks (Mpandeli et al., 2020), a dynamic clearly reflected in the study area.

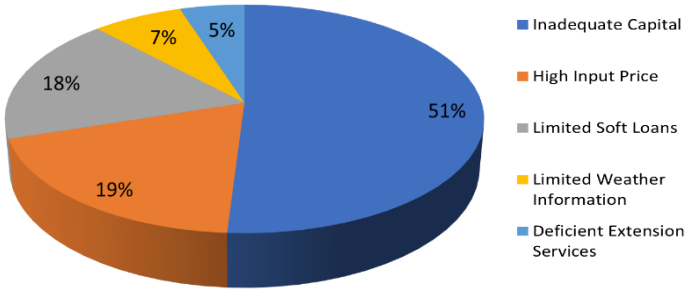

Figure 2: Challenges Facing Agro-pastoral Communities in Combating Climate Change Impacts
Source: Field data, 2025

Structural challenges in the local input supply system further compounded the financial constraints. The respondents reported that the lack of an efficient and regulated input distribution network had created opportunities for unverified traders to dominate local markets, supplying overpriced and poor-quality agricultural and veterinary inputs. Farmers frequently purchased these inputs on high-interest credit, with repayments deducted from future harvests: practices that exacerbate household vulnerability when yields decline due to droughts or pest outbreaks. Similar challenges are documented across East Africa, where weak quality-control systems undermine farmer confidence and reduce the effectiveness of adaptation interventions (Bold et al., 2017). In addition, the reliance on rudimentary tools—such as hand hoes—and the limited availability of local veterinary services: these have lowered agricultural productivity and delayed response to livestock diseases. According to the District Agricultural Officer, only a small proportion of agro-pastoralists had adopted improved machinery, echoing broader findings that low levels of mechanization continue to constrain climate resilience in semi-arid farming systems (Sims & Kienzle, 2017). Collectively, these constraints highlight how financial limitations, market inefficiencies, and technological gaps interact to weaken adaptive capacity among agro-pastoral households.

Moreover, the study revealed that Bahi District currently employs only 31 extension officers across village, ward, and council levels; a number insufficient to meet the climate adaptation needs of its agro-pastoral communities. This shortage match with broader national and regional patterns where understaffed and overstretched extension systems limit smallholder farmers' access to timely agricultural advice, climate information, and adaptation technologies (Kabote, 2018; Mutabazi et al., 2015; Nyasimi et al., 2017). Additionally, the problem is compounded by limited technical capacity among existing officers, many of whom lack updated training in climate-smart agriculture, early warning systems, and livestock disease management competencies that are increasingly essential under intensifying climate variability. Similar capacity gaps have been observed across other regions in SSA, where insufficient training and inadequate investment in extension services hinder the dissemination of climate-smart innovations, thereby reducing farmers' ability to respond effectively to droughts, pests, and emerging livestock diseases (Mwongera et al., 2017; FAO, 2021; Tesfaye & Seifu, 2022). Consequently, the constrained extension workforce in Bahi District impedes the implementation of adaptation strategies, and weakens the overall resilience of agro-pastoral households to climate change impacts.

8. Conclusion and Recommendations

This study has shown that LGAs in Bahi District have taken notable steps to support agro-pastoral communities in adapting to climate change. These steps include the provision of subsidized agricultural inputs (such as fertilizers and improved seeds), development of local climate action plans, and allocation of financial resources toward climate-related interventions. These efforts have helped households cope with climate change extremes, particularly recurrent droughts. However, several limitations persist: some households remain unable to afford their share of subsidized inputs; climate action plans lack comprehensive operationalization; and budgetary allocations remain insufficient to meet the scale of climate change risks facing the district. Hence, strengthening institutional capacity, securing predictable financing, and enhancing community-level engagement, remain crucial for improving adaptation outcomes.

Building on these findings, the study recommends increased and sustained climate financing at both national and local levels, accompanied by stronger policy leadership and accountability mechanisms to ensure climate change is prioritized across government structures. Innovative financing mechanisms, including carbon pricing and climate funds, can further bolster resource availability for adaptation initiatives. The findings also highlight the need to mainstream gender considerations within climate policies and adaptation programming, given the observed differences in the impacts and adaptive capacities between men and women. Moreover, local governments require consistent long-term funding to deepen their understanding of localized climate

change risks so as to effectively plan for future impacts. Finally, the study notes that climate extremes—although examined only briefly—represent a critical area for further research, as they may produce differentiated consequences for women, men, children, and the elderly in agro-pastoral settings. This will further offer important insights for targeted, equitable, and more effective adaptation planning.

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