

## **Enhancing Food Security By Fostering Gender Equality In The Context Of Climate Change Variability In Tanzania: A Review**

**Mwanaisha S. Mkangara<sup>1\*</sup>, Anne M. Mnabe<sup>2</sup>, Never M. Zekeya<sup>3</sup>, Ernest Mbega<sup>4</sup>,  
Musa Chacha<sup>5</sup>, Tatu M. Nyange<sup>6</sup>**

<sup>1</sup>*\*Faculty of Science, Technology and Environmental Studies, The Open University of Tanzania, P. O. Box 23409, Dar es Salaam, Tanzania*

<sup>2</sup>*Department of General Studies, Dar es Salaam Institute of Technology, P. O. Box 2958, Dar es Salaam, Tanzania.*

<sup>3</sup>*Department of Wildlife Management, College of African Wildlife Management Mweka, P. O. Box 3031, Kilimanjaro, Tanzania.*

<sup>4</sup>*Nelson Mandela African Institution of Science and Technology, P. O. Box 447, Arusha Tanzania.*

<sup>5</sup>*Arusha Technical College, P. O. Box 296, Arusha, Tanzania.*

<sup>6</sup>*Department of Gender Studies, the Mwalimu Nyerere Memorial Academy, P.O. Box 9193 Dar es Salaam, Tanzania.*

*\*Corresponding author: mkangaram72@gmail.com*

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### **ABSTRACT**

Gender equality in agricultural productivity has boosted food security in this era of climate change dynamics. The equal treatment of women and men in resource allocation, access to credit, education and leadership minimizes the gender gap and increases women's representation in coping with climate change impacts. Focusing on equal rights for women in resource utilization to enhance food security and addressing mitigations and adaptation measures minimize the exacerbation of greenhouse gas (GHG) emissions. The review identified the role of climate-smart agriculture (CSA) for farmers to increase productivity with minimum GHG emissions and how understanding resource-smart production and consumption chains contributes to reducing production footprints.

The mitigation measures discussed to reduce climate change variability are education, implementing treaties and agreements, agriculture and food systems, carbon credit, urban planning and building designs. The climate change adaptations highlighted are adapted crops, ecosystem restoration, early warning systems, climate-resilient infrastructure and national adaptation plans.

Therefore, addressing climate change challenges and gender inequalities through climate action's innovative strategies is vital for food security.

**Keywords:** Gender Equality, Food Security, Climate Change, Adaptations, Mitigations.

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## INTRODUCTION

Several factors engineer the inadequate of food around the global. Climate change variability fired by industrialization and agricultural investments to comply with the needs of the rising population are among the factors of food insecurity (Ngangnchi *et al.*, 2024). Increasing greenhouse gases (GHG), warming of the earth, drought, bushfires, tree line shifting, floods, coral bleaching, glacier melting, and sea level rising are consequences of climate change impacts (Chakraborty *et al.*, 2014). Lessening the climate change impacts by empowering women to own and use natural resources has been realized in agricultural productivity, biodiversity and environmental conservation (Mulneh, 2021). The conservations reduce carbon footprint, minimizing GHG emissions and saving the earth from global warming. Women continue to be a significant factor in ensuring that societies use natural resources to manage food security and sustain their livelihood. However, most of them have limited ownership and control over the resources and thus suffer disproportionately in gaining benefits (Pratley, 2017). In the majority of African societies where the patriarch system has dominated for centuries, the land and other agricultural investments, in most cases, are owned by men due to deeply rooted and persistent gender inequality (Glazebrook *et al.*, 2020). Gender inequality emasculates the contribution of women to food security, income generation for household resources mobilisation, and biodiversity and environmental conservation. On the other side, climate change dynamics escalates the efforts of women to ensure food security for all. Contrary to that, gender equality and women's empowerment will raise agricultural productivity, promote nutrition levels to improve people's lives and enhance food security in societies (Nyasimi and Huyer, 2017).

Food security is when every community member has access to adequate food that supports a healthy life. On the contrary, failure to access and utilize the nutritious daily caloric requirement means food insecurity. According to Alphonse (2017), food insecurity in Tanzania is elevating, with 39.3% of the population undernourished, 33.9% taking low dietary energy, and 26.7% living in poverty. Concurrently, over 34% of the population in 16 Arusha, Tanga and Manyara districts faced severe food shortages from 2019 to 2020. The highest reported food-insecure regions were Dodoma, Singida and Manyara, with 45-55% of households needing livelihood support (Kazungu and Kumburu, 2023). From 2023 to 2024, approximately 900,000 people, equivalent to 13% of a population of 7.1 million, in 21 district councils of Mainland Tanzania reported severe acute food insecurity in the IPC phase 3 (Nyange *et al.*, 2024). Tanzania's heightened food insecurity levels are linked to continuing climate change dynamics and gender inequality (Randel *et al.*, 2022).

Climate Change (CC) is a global phenomenon with no boundaries and affects all nations, from developed to developing countries. The population

increase leading to changes in land use patterns for industrialization, urbanization, deforestation and agricultural activities accelerate climate change disasters at a high pace compared to natural phenomena. Globally, approximately 68.5 million people were affected by extreme weather events, amounting to \$131.7 billion loss, of which storms (\$70.8B), floods (\$19.7B), wildfires (\$22.8B) and droughts (\$9.7B) all together accounted for approximately 93% of the total loss (Fawzy *et al.*, 2020). The increasing anthropogenic activities have caused about 1.0 °C of global warming above the pre-industrial level, and the trend is expected to reach 1.5 °C between 2030 and 2052 if the current emission rates persist (Warren *et al.*, 2021).

Concurrently, the global surface temperature increased by 0.74 C in the late 19th century and is expected to rise by 5.8 C in 2100 (Fawzy, 2020). The climate models all indicate a rising trend in temperature with decreased rainfall over South and Southeast Asia, revealing more prolonged droughts since the 1970s. Perpetual snow cover has declined in Antarctica, and the depth of snow cover has been reduced with a projection of the global sea level rise by 0.18 to 0.59m by the end of the 21<sup>st</sup> century (Mahato, 2014). According to 1912, 1899 and 1906 data, Mount Kilimanjaro constituted 11.40 km<sup>2</sup> of snow cover, while 1.64 km<sup>2</sup> was for Mount Kenya and 6.51 km<sup>2</sup> for Rwenzori Range, respectively. Recently, reports observed an over 80% reduction in snow cover on Mount Kilimanjaro, Kenya and Rwenzori compared to what was experienced in 1900 (Prinz and Molg, 2020). Furthermore, about one-fifth of Bangladesh's population would be displaced due to the farmland loss caused by an estimated 1.5 m sea-level rise. The sea level along the Indian Ocean has been observed to increase by 2.5 mm yearly, with a projected temperature rise of 2.5-3.5 °C by the end of the 21<sup>st</sup> century. Sea level rise will create a habitat loss for about 7.1 million people due to the area loss of 5764 km<sup>2</sup> (Chauhan, 2009).

Food security and gender equality are sides of a coin in the sustainable development of any country. However, the impacts associated with CC persistently affect the levels of food security in societies and poor societies are the most affected group. Most women and girls in Tanzania are engaged in agricultural activities to ensure commercial and household food security. Despite the contributions of women and girls in ensuring societies are constantly fed well, WHO (2019) identified 55% of Tanzanians experienced moderate to severe food insecurity, 31% were undernourished, and 35% of children were stunted. The scenario is highly linked to climate change variability experienced around the globe that adversely impacts water resources, species composition, biodiversity, agriculture production, human and animal health, forest cover and socioeconomic sectors (Syed *et al.*, 2022). Concurrently to what is happening in Tanzania, over 60% of Southern America and Asia's population are supported by women working in agricultural sectors

(Nhamo *et al.*, 2019). Over 95% of Southern Africa's agriculture is rain-fed (Nicholson *et al.*, 2018). Thus, the changes in rainfall and temperature patterns worsen water availability vital for life and negatively affect crop production in food-insecure African regions. These extreme weather events offset women's contributions to the economic developmental plans specified in the Sustainable Development Goals (SDGs). These include SDG 1 (poverty alleviation), SDG 2 (zero hunger), SDG 3 (good health and well-being), SDG 5 (gender equality), SDG 6 (clean water and sanitation) and SDG 10 (reduced inequalities) (Hope, 2009; Nhemachena *et al.*, 2020). The review explains why breaking the gender gap ensures full participation in implementing climate actions and representation of women to achieve the SDGs are essential for food security in Tanzania.

### ***Methodology***

Searching for published articles describing food security in the era of climate change variability and the contribution of gender equality was done using academic journal articles and ebooks. The relevant information was analysed using keywords such as climate change, food security, gender equality, global, Africa, and Tanzania, and synthesis of the information was due to the article's topic. The desk review literature assessed the scientific quality of information from ebooks and journal articles from 1981 to 2024. Professional sites including Food and Agricultural Organization (FAO), World Health Organization (WHO), Intergovernmental Panel on Climate Change (IPCC), Clean Development Mechanism (CDM), and United Nations Framework Convention on Climate Change (UNFCCC), Organization for Economic Cooperation and Development (OECD), Conference of the Parties 28 (COP 28), International Food Policy Research Institute (IFPRI) were used to collect information on climate change impacts on food production. The consequences of gender inequality and the contribution of gender equality to the sustainability of food security in societies were also identified. The abovementioned sources also gathered the mitigation and adaptation measures for extreme weather events to improve food security and reduce greenhouse gas (GHG) emissions.

### ***Nexus of Resilient Food Systems Theory and Gender Equality***

Resilient food systems theory focuses on the ability of food systems to withstand and recover from shocks, such as climate change, economic crises, and environmental stressors. In climate change variability, a theory emphasizes the importance of adaptability, diversity, and sustainability in food production and distribution. Gender equality plays a crucial role in enhancing the resilience of food systems, as gender dynamics influence access to resources, decision-making power, and the division of labour in agricultural activities. Research has highlighted that climate change exacerbates gender inequalities, particularly in agricultural communities where women are often responsible for food

production and household security (Quisumbing, 2014; Doss *et al.*, 2011). Women, especially in rural and developing regions, are frequently disadvantaged in terms of land ownership, access to credit, and agricultural technology, which reduces their capacity to adapt to climate-related changes such as droughts, floods, and temperature shifts (Meinzen-Dick *et al.*, 2014). This imbalance undermines the overall resilience of food systems, as the contributions of women in ensuring food security and sustainable agricultural practices are not fully recognized or supported.

Resilient food systems theory, however, underscores the importance of inclusive decision-making and gender-responsive approaches. Integrating gender equality into the food system and resilience strategies can lead to more equitable and effective adaptation measures. Empowering women, for instance, by ensuring access to land rights, financial resources, and education can enhance their capacity to implement adaptive practices, improve food security, and build resilience to climate impacts (FAO, 2011). Studies have shown that agricultural productivity increases when women access resources equally, leading to greater food system stability and community resilience (Goldstein and Udry, 2008). The link between resilient food systems and gender equality to enhance food security in the face of climate change is not only about improving agricultural techniques and systems but also addressing gender inequalities that affect the sustainability and adaptability of these systems. By fostering gender equality in food systems, social and ecological resilience can be enhanced, ensuring long-term sustainability in a changing climate. Among others, the technological innovations in climate-smart agriculture (CSA) projects essential for food and nutritional security resilience are agroforestry, adapted crop varieties, efficient water use techniques, integrated soil fertility, and rangeland management.

### ***Agriculture and climate change***

The agriculture sector is essential in providing food for humans and animals. However, industry is one of the factors that impact and are impacted by changing climatic conditions. The projected global population of 9.7 billion people by 2050 will increase global food demand, which is linked to agricultural expansion (Gu *et al.*, 2021). Deforestation reduces forest cover, causing forest fragmentation to provide human needs for settlements, industrialization and commercial agriculture. However, creates a vicious circle, leading to emissions of greenhouse gases (GHG). The food system relates to all activities involving food production, processing, distribution, preparation, and consumption, adding GHG emissions (Naheed and Rukhsana, 2024). The food system uses 70% of the fresh air and is the leading source of methane (CH<sub>4</sub>) emissions and biodiversity loss. For instance, 37% of all emitted GHGs in Asia are associated with agricultural practices (Fahim, 2011). The use of commercial

fertilizers such as nitrogen (N) is also responsible for more than 30% of agricultural-related N<sub>2</sub>O emissions, making agriculture the major source of global N<sub>2</sub>O emissions. While CH<sub>4</sub> is produced mainly in animal husbandry, it accounts for 37% of all the CH<sub>4</sub> emitted worldwide (IPCC, 2007). According to the International Fund for Agricultural Development (IFAD) report, agriculture and land use contributes approximately 24% of global GHG emissions. Half of it (12%) is from agriculture involving artificial fertilizers in producing plant-based food such as wheat, sugarcane, maize, and cassava and wastes from ruminant livestock. Another half is from forest and other forms of land use (Richards *et al.*, 2019). In Tanzania alone, the GHG emissions as the result of agricultural activities calculated from all Eastern and Southern Africa (ESA) countries account for 10.2% (29.7/290.9) (Branca and Chileshe, 2023). The unusual agricultural practices in using nitrogenous fertilizers contribute to the leaching of N and the contaminated groundwater, cause eutrophication of freshwater bodies and estuarine ecosystems, and finally cause soil acidification and degradation. Furthermore, leaching is responsible for toxic aquatic causing algal blooms, fish death and biodiversity loss.

Climate Smart Agriculture (CSA) is a strategy to sustainably improve agricultural productivity and enhance food security for farmers while increasing resilience and adaptation to climate change and reducing and/or removing greenhouse gas (GHG) emissions (FAO 2013). The unacceptable levels of GHG emissions worldwide make CSA an obligatory task to manage food insecurity of the anticipated over 9 billion people by 2050 (Israel *et al.*, 2020). The practices and techniques in CSA have to achieve the three pillars considered in climate-smart: (1) boosting productivity and maintaining the sustainability of food security for both present and future needs, (2) enhancing resilience and long-term adaptation to changing climatic conditions, and (3) reducing GHG emissions associated with agricultural production, i.e., CO<sub>2</sub>, CH<sub>4</sub>, and N<sub>2</sub>O and short-lived climate pollutants ((Israel *et al.*, 2020; van Wijk *et al.*, 2020). The interventions identified in the three pillars will contribute positively to drought-tolerant crops, managing and maintaining soil fertility, water conservation techniques, and better integration of livestock in smallholder, mixed crop-livestock farms and land restoration in rangelands. Cutting off the anticipated decline of world agricultural productivity at 3 to 16% by 2080, joint efforts to formulate and implement policies emphasizing climate-smart agriculture will be mandatory (Chaudhary, 2017). The CSA recognizes a gender-responsive approach to addressing the gender gap and improving the lives of farmers, fishers and foresters for more sustainable agriculture. Closing the gender gap in accessing resources over the next 10 years is expected to change the population below the poverty line by 80,000 people in Tanzania, 119,000 people in Uganda and 238,000 people in Malawi and ensure food security (Daramola and James, 2021). Therefore, promoting

CSA and gender quality in Tanzania and the rest of Eastern and Southern Africa (ESA) countries is the realization of the SDGs.

### ***Gender gap***

Gender roles define women as subordinate to males in most cultures we inherit from our ancestors, thus significantly affecting them in resource gathering (Helgeson, 2020). Factors such as socio-economic inequalities also prevent women from owning resources such as land, products, and credit in various organizations such as Savings and Credit Cooperative Society (SACCOS), Banks, etc. The gap between men and women regarding resource ownership, division of labor, access to education and decision-making creates inequality, which continues to marginalize women in leadership to speak for themselves (Genda, 2024). According to the United Nations (UN) Food and Agricultural Organization (FAO), about half (45%) of the global population (about 3.1 billion) live in rural areas (FAO, 2012). Of every 1.4 billion of 2.5 billion women, 500 million are farmers without land and receive only 5% of agricultural resources (Kyei-Baffour, 2023; FAO, 2012). In the Global South, women constitute 43% of the workforce; half of it, 21.5%, is from sub-Saharan Africa (FAO, 2012). However, much would have been done if women had been given a full mandate to access land and other resources to realize their human rights to adequate food, energy shortage and water. Despite the circumstances involving women in agricultural activities, their substantial contributions to the national food basket are crucial for food security. Empowering women and routine functioning of extension officers in the agricultural sector is a way to minimize food insecurity around the globe. Globally, in 2017, one in nine people was hungry, and of the world's 795 million who went hungry in 2015, 780 million, equivalent to 98%, were in the global South (FAO, 2015). Food security globally is no longer safe, as the United Nations (UN) Food and Agriculture Organization and health agencies estimated the number of hungry people worldwide to rise by 60 million over the coming five years after it increased by 10 million in 2019 (WHO, 2021). The projection is that 660 million people will go hungry by 2030 (WHO, 2021).

Additionally, over 3 billion people (38.3% of the world's population) cannot afford a healthy diet, and more than 90% are from sub-Saharan Africa (Fears and Canales, 2023). Viewing food insecurity through the lens of gender roles of women and their contributions to society is crucial. Thus, promoting women's equality as men in owning land, credit, education, and other resources remains a significant business in this era of climate change variability. The benefits of empowering women and breaking the gender gap have been realized by agricultural produce rising by 2.5 to 4 % and the number of malnourished people being reduced by 12 to 17 per cent (Njuki *et al.*, 2019). A

comparative study by Mukasa and Salami (2015) identified countries yield production gained by 2.8 per cent, 8.1 per cent, and 10.3 per cent for Nigeria, Tanzania, and Uganda, respectively, when gender productivity gaps are closed, and women are treated as men.

### ***Gender inequality***

Gender inequality refers to the gaps between men and women regarding resource ownership, division of labor and decision-making power (Helgeson, 2020). Gender inequality, an antonym of gender equality, refers to the equal rights, responsibilities, and opportunities of women and men, girls and boys, in all aspects of their livelihood without considering whether they are born male or female (Otieno, 2019). In areas where gender inequality exists, women and girls are, in most cases, marginalized in various aspects. For example, in Tanzania, like the rest of developing countries, women are more likely to be displaced by climate-related disasters, and they are less likely to have access to resources and decision-making power. The climate-related disasters exacerbate the existing gender inequalities in Tanzania, making it more difficult for women to achieve their full potential. For instance, during times of water scarcity, women are more than twice as likely as men to walk several hours to collect water and search for food for children and graze animals, as reported by Edward (2020).

Gender inequality was the reason for the 1995 Beijing Platform for Action for all governments to break the gender gap, make women implement policies, and participate fully in political empowerment (Tambe and Jormfeldt, 2024). Women were low-represented in all sectorial agendas and programs. The Beijing platform for action empowered women in levels of decision-making, education, policy implementation, health/survival, and leadership (Sweetman, 2015). Tanzania developed gender mainstreaming strategies and applied them to integrate gender issues in all sectorial policies and programs (Ampaire *et al.*, 2020). Gender inequality, mostly in terms of access, use, and control over crucial resources, has existed in developing countries as a result of deeply rooted patriarchal values and beliefs. Women and girls, to some extent, are excluded from important decision- and policymaking forums. The tribal beliefs deliberately or unknowingly create a situation that makes women and girls vulnerable in accessing family resources (Abebe, 2014). For example, restrictions on land ownership for rural women may prevent them from having access to productive land for agricultural activities (Nadasen, 2012). The International Food Policy Research Institute (IFPRI) urged that the control over assets is highly influenced by gender inequality; therefore, understanding the gender dynamics of CC adaptation and using resources to strengthen women's control over critical assets is indispensable (Ringler *et al.*, 2014). Thus, the CC responses through the lens of gender inequality must consider the different

treatment and needs of women and men in a specific community. Even though Sustainable Development Goal 5 (SDG 5) insists on promoting gender equality and women's empowerment, the recognition of how climate change affects men and women differently is limited, thus substantially widening the gender gap.

### ***Strategies for Climate Actions***

Strategies to address climate change are mitigations and adaptations. Mitigation focuses on all possible ways of reducing greenhouse gas (GHG) concentrations. Reducing GHG emissions ranges from investing in clean energies to forest conservation. Other mitigation strategies include:-

#### ***1. Education***

The education systems offered worldwide have to change societies' lifestyles by attracting clean energy for domestic and industrial activities to minimize GHG emissions. Implementing curricula on the advanced technologies of clean energy to humankind and the consequences of GHG emissions to biota and abiotic as components of the environment is essential. Researchers and academia at all levels of education systems have to play their roles in teaching innovative technologies of zero emissions to mitigate climate change. Integrating risk reduction in policies as the result of research findings on climate change variability provides space for academia and researchers to pay back to the communities. For instance, as per the 2018 record, power production identified that renewable energy accounted for approximately 26.2% of global electricity production (Couture *et al.*, 2019). Hydropower accounted for 15.8%, while wind power's share was 5.5%. Photovoltaic solar power accounted for 2.4%, bio-power 2.2%, and geothermal, concentrated solar power and marine power accounted for 0.46% of the electricity generated in cities (Couture *et al.*, 2019). Therefore, investing in renewable energy will significantly reduce GHG emissions and save the world from climate change disasters.

#### ***.2 Treaties and Agreements***

Several treaties and agreements are involved in climate action for a healthy world. Among others, the United Nations Framework Convention on Climate Change (UNFCCC, 2021a) and the Kyoto Protocol called on governments to climate action to mitigate climate change (Campbell *et al.*, 2018). The UNFCCC (2021b), a multilateral treaty, encourage industrialized countries to negotiate plans agreed upon by each country to reduce GHG emissions. The negotiations aim at preventing dangerous human interference in the climate systems. The projection for recovery of biodiversity, responsible production and climate action at 90%, 94% and 84%, respectively, are for policies amended by nations to be environmentally friendly by 2100 (Moallemi *et al.* 2020). Several goals are determined to eliminate excessive CO<sub>2</sub> from the

atmosphere so that climate change disasters can cease and ecosystems can adapt naturally. The Kyoto Protocol stands for the commitment agreed upon by individual countries' targeting the reduction of GHG emissions in industrialized countries to reach 40–95 per cent by 2050 (Rosen, 2015).

The Paris Agreement is a legally binding climate change treaty addressing all nations' commitment to reduce emissions and work together to adapt the climate change variability. The EU is committed to lowering GHG emissions by 80–95% below 1990 levels by 2050 and replacing fossil fuels with natural gas, hydrogen and nuclear power. The Intergovernmental Panel on Climate Change (IPCC) provides policymakers with scientific evidence on climate change and finds solutions to adaptation and mitigation strategies. Among others, the mitigation strategies done by the IPCC are reducing global warming to 2 °C and lower yearly per capita global consumption growth by 0.06 per cent (Onencan *et al.* 2016). The Organization for Economic Co-operation and Development (OECD) anticipated an increase of 1% to 2.8% of GDP to G20 nations for 2021 and 2050, respectively, if climate change budgetary plans are considered for implementation. (OECD, 2017). With all these energy supply plans, obtaining high-energy efficiency for the end user to mitigate climate change is crucial.

### ***3. Transforming agriculture and food systems***

How we manage our food systems needs to be urgently changed if the goal is to achieve food security and sustainable development more quickly in this era of climate change variability. The existing agricultural and food systems practices contribute to GHG emissions, thus necessitating proper land use and reducing food loss and waste to lower the climate footprint. Global food loss and wastes are estimated to emit 9.3 Gt of CO<sub>2</sub>, equivalent to GHG emissions in the global food supply chain (Zhu *et al.*, 2023). Climate-smart agriculture (CSA) has a key role in the world's transformation of food systems. CSA is proposed as a solution to transform agricultural systems and support food security with the new realities of climate change mitigation. Proper land use is fundamental for agricultural specialists to change the agricultural system profoundly. The following will transform agriculture and food systems: 1) introducing a climate-smart village and using demo farms for farmers to learn 2) accessibility of digital devices such as smart mobile phones to farmers for weather and climate information services 3) Provision of policies and plans for CSA to limit global warming. Using the strategies above for small-scale agricultural producers can significantly minimize the agricultural production footprint (Cuaresma *et al.*, 2018). Among others, the adopted CSA options with more than 80% adoption rate are organic farming, intercropping, crop rotation, agroforestry, drip irrigation, organic/compost maturing, and early sowing/planting. The CSA increases productivity and resilience against climate

shocks, reduces/removes GHGs and enhances the achievement of national food security and sustainable development goals (FAO, 2010).

#### **4. Carbon credit**

Carbon credits are a prominent avenue for reducing emissions, as highlighted in the 2023 United Nations Climate Change Conference (Conference of the Parties 28- COP28) (Hayo and Hasegawa, 2024). It has been calculated the annual CO<sub>2</sub> emission per person ranged from 1 t CO<sub>2</sub> e in African nations to 30 t CO<sub>2</sub> e in Luxembourg and the US (Kohnert, 2024). Home consumption accounts for 72% of the total, government consumption is 10%, and investment is 18% of GHG emissions (KS and Thimmaiah, 2024). Forest covers have mitigated climate change since time immemorial, and in the early 1990s, documentation of the consequences of deforestation increased (Van der Gaast *et al.*, 2018). Forests increase carbon sequestration standards and benefit the world's growing carbon markets. Such projects address several challenges, including reforestation, afforestation on degraded islands, and long-term sustainable forest management significant for absorbing carbon dioxide (CO<sub>2</sub>) from the atmosphere (Trouwloon *et al.*, 2023). The emission trading system (ETS) stands for the carbon market, which assigns prices to each ton of CO<sub>2</sub> produced and turns it into a trading commodity. India's expected revenues from sales of voluntary carbon credits will reach US\$20-40 billion by 2030 (Jaspal, 2023). In Tanzania, 10 Clean Development Mechanism (CDM) projects have been implemented, costing US\$ 41 million, with a total of 180,583 Certified Emission Reduction (CER) credits issued (UNFCCC, 2021). The project Carbon Tanzania increased community income and reduced CO<sub>2</sub> emissions by 857,284 tones, receiving US\$ 2,041,638 from carbon credits (Carbon Tanzania, 2022). The sale of Carbon credits is voluntary and a means of generating income for individuals and private and public organizations benefiting from the carbon market. The profit earned through this business motivates communities to invest in afforestation and forest management for climate change mitigation (Lokuge and Anders, 2022).

#### **5. Urban planning**

The urban population is expected to double by 2050, with a projection of 80% of global gross domestic product (GDP) contributing significantly to global GHG emissions. Building resilient and sustainable cities requires urban planners to integrate with experts from other disciplines to recognize the critical human need to avoid climate change variability. Creating green space, enhancing biodiversity, promoting energy efficiency and renewable energy, allocating spaces for public use, and developing sustainable transport solutions are important in planning cities. Laws and policies should explicitly define the community values (housing, commercial, agricultural, and industries) and plan for sustainable cities. Such approaches ensure the building of eco-friendly and

adaptive cities and play a pivotal role in reducing emissions and increasing resilience to climate shock.

### **6. Building designs**

Urban climate studies should be linked to architectural design. Urban and global climate, on the one hand, and urban planning and building design, on the other hand, are interconnected fields of research for climate change mitigation. Shaping sustainable cities for low-environmental-impact design should focus on energy and resource efficiency, safe waste generation and disposal, pollution reduction, biodiversity protection, and indoor environmental quality. The best alternative in building design is to reduce the excessive heat warming of the cities known as urban heat islands (UHI) and decrease the energy demand by air conditioning with decreasing GHG. Roof and wall color may increase or reduce urban structures from heating up. Walls and roofs in white and green for reflecting and transpiring prevent heating up and reduce air condition for cooling. The darker wall colors create heat conduction through the wall and airflow driven by natural convection transports, serving as a heat source in colder areas. Houses largely built of timber are carbon capture, helping to store carbon for a long time and reducing atmospheric CO<sub>2</sub> concentration. Among others, water fountains around parks also assist in cooling urban cities and planning for open spaces with trees, such as parks, is useful for people to have fresh air in a cooler area.

### **7. Adaptations**

Adaptation strategies differ between countries and require political commitments to formulate national adaptation plans to intermingle with the sectorial policies for climate actions. All the plans related to climate actions need monitoring, reviewing, and enforcement of policies to realize the best outcomes. For instance, monitoring and motivation for the carbon credit business encourage farmers in Tanzania to practice agroforestry to increase food security and monetary gain, restore the forest ecosystem and reduce carbon dioxide gas from the atmosphere. Reducing greenhouse gas (GHG) emissions using vegetation cover increases soil moisture, promoting productivity and enhancing community food security. However, forecasting risks and opportunities the weather offers farmers is done by making the proper selection of varieties of crops while minimizing the gender gap. In Ethiopia, the enhancement of climate change adaptation for female-headed households increased by 19% when the gender gap was reduced. According to Aryal *et al.* (2022), implementing adaptation strategies has been found to increase yields when the gender gap is minimized. Among the adaptation measures for climate action farmers have to observe are crop diversification, changes in the cropping pattern, calendar of planting, conserving soil moisture through appropriate tillage methods, improving irrigation efficiency, and afforestation and agro-

forestry (Ozor and Nnaji, 2011). The strategies are essential for adapting to short and long-term climatic changes and increasing food security in a country.

### **Conclusion and Recommendations**

Addressing gender inequality is crucial for sustainable food security in Tanzania. Enhancing food security and resilience, needs gender equality to be integrated into food systems strategies. Others promote women's access to education, land rights, and financial resources and ensure their participation in agricultural and climate adaptation decisions. Climate-smart agricultural practices increase produce and, ultimately, strengthen food systems and the representation of women in achieving sustainable development goals.

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