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Girls' Education and Climate Resilience in Sub-Saharan Africa's Agricultural Sector

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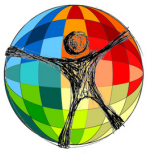

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ABSTRACT

This paper explores the impact of investment in girls' education in Sub-Saharan Africa's agricultural sector on global climate resilience. Sub-Saharan Africa is one of the world's most at-risk regions for climate disasters. Agricultural communities are particularly at risk when climate disasters occur, and a significant proportion of the region's population depends on agriculture for livelihood. Yet investment in education and climate resilience strategies tends to focus on urban rather than rural areas and to employ a generalized approach that is not adapted for agricultural communities.

This paper shows that by increasing girls' school attendance and adapting curricula to focus on gender-mainstreamed and climate-smart agricultural practices, greater proportions of Sub-Saharan Africa's population can adapt and maintain stability when climate disasters occur. The paper focuses on three of the greatest risks of climate change within agricultural communities: loss of food, loss of livestock, and forced displacement. It shows that educating girls in STEM subjects, literacy and numeracy, management, agricultural-based rights, lifesaving techniques, and traditional knowledge mitigates the probability of all three risk factors. Finally, the paper explores the history and context of girls' education in Sub-Saharan Africa, analyzing the role of governments and NGOs in improving education access.

CONTENTS

ACRONYMS

CSA: Climate-Smart Agriculture

FAO: Food and Agriculture Organization of the United Nations

GDP: Gross Domestic Product

INGO: International Non-Governmental Organization

NGO: Non-Governmental Organization

SACMEQ: The Southern and Western Africa Consortium for Monitoring Educational Quality

SDG: Sustainable Development Goal

SSA: Sub-Saharan Africa

STEM: Science, Technology, Engineering, and Mathematics

TVET: Technical and Vocational Education and Training

UN: United Nations

UNESCO: The United Nations Educational, Scientific and Cultural Organization

1. Introduction

Sub-Saharan Africa's agricultural sector is particularly vulnerable to the effects of climate change due to complex biophysical, economic, geographical, and socio-cultural conditions that reduce farmers' adaptive capacity.[1] Evidence suggests that climate change is forcing large regions of marginal agriculture in Africa out of production and that women farmers are particularly affected.[2] This paper argues that investment in gender-equal education is required to strengthen climate resilience in agriculture. Several articles have been written on the

[1] See Mary Nyasimi et al, "Evidence of Impact: Climate-Smart Agriculture in Africa" (2014) CGIAR Research Program on Climate Change, Agriculture and Food Security Working Paper 86 at 3.

[2] See Ariel Dinar et al, *Climate Change and Agriculture in Africa*, 1st ed (London: Routledge, 2008).

broad connection between girls' education and climate change;[3] yet studies on the specific connection between gender-equal education and climate resilience in agriculture are limited. On close examination, the greatest climate risks to farms in SSA—loss of food, loss of livestock, and forced displacement—could be mitigated by investing in girls' education. Climate change disproportionately impacts women farmers and female-headed farms due to women's lack of access to climate-smart resources, technology, land, information, and leadership opportunities. Investing in girls' education expands access to resources within the agricultural sector which in turn strengthens climate-adaptive capacity. The paper is divided into two sections: first, it provides an overview of climate resilience and agriculture in Sub-Saharan Africa, with a specific focus on gender. This section examines the differences between climate vulnerability, resilience, and mitigation, analyzes the gendered dimensions of climate-smart agriculture, and outlines ways to mitigate loss of food, loss of livestock, and forced displacement. The paper's second section examines the important role of girls' education in strengthening resilience. This section provides background on the state of girls' education in Sub-Saharan Africa, outlines education interventions that have had positive impacts in agricultural communities, and examines the role of governments and NGOs in strengthening girls' education.

2. Climate Resilience and Agriculture in Sub-Saharan Africa

2.1 Climate and Agriculture in Sub-Saharan Africa: A Brief Overview

Approximately 950 million people, 13% of the global population, live in Sub-Saharan Africa (SSA). This number is

[3] See e.g. "Three platforms for girls' education in climate strategies" (2017), online (pdf): *Global Economy and Development* at Brookings <www.ungei.org/sites/default/files/Three-Platforms-Girls-Education-Climate-Strategies-2017-eng.pdf>.

expected to increase to 2.1 billion by 2050.[4] There is great diversity across SSA, although all sub-regions have experienced, to varying degrees, political instability, civil strife, high population growth, diminished agricultural resources, and extreme climate events in recent years, contributing to an overall struggle to meet sustainable development goals.[5] Poverty rates are on a downward trend in most countries in SSA, although the region continues to have the largest proportion of people in the world below the poverty line.[6] In particular, the prevalence of undernourishment is rising at a higher rate than any other region in the world. The FAO estimates that 22% of the world's undernourished population, approximately 235 million people, lives in SSA, and that the proportion of the population experiencing severe food insecurity is rising.[7]

The agricultural sector plays a key role in food security and maintenance of livelihood across SSA. Agriculture contributes 15% of total GDP across the region[8] and employs more than half the total labour force. Small-scale farms employ about 175 million people, approximately half of whom are women.[9] The UN's *Sustainable Development Goal* (SDG) 2 identifies sustainable agricultural productivity as key to ending global hunger and improving livelihoods through food security and improved nutrition,[10] and the development of subsistence farming has become a policy focus for many African governments in recent years.[11] Still, agricultural production across SSA is low compared

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[4] See OECD-FAO, "OECD-FAO Agricultural Outlook 2016–2025" (2016) at 60, online (pdf): *FAO* <www.fao.org/3/i5778e/I5778E.pdf>.

[5] See *ibid* at 60.

[6] See World Bank Group-Poverty & Equity, "Sub-Saharan Africa" (2020), online (pdf): *World Bank Data Bank* <databank.worldbank.org/data/download/poverty/33EF03BB-9722-4AE2-ABC7-AA2972D68AFE/Global_POVEQ_SSA.pdf>.

[7] See FAO, "Africa Regional Overview of Food Security" (2020) at 6, online (pdf): *FAO* <www.fao.org/3/cb4831en/cb4831en.pdf>.

[8] See OECD-FAO, *supra* note 1.

[9] See *ibid*.

[10] See "2: End hunger, achieve food security and improved nutrition and promote sustainable agriculture" (last visited 9 July 2022), online (pdf): *UN Department of Economic and Social Affairs, Sustainable Development* <sdgs.un.org/goals/goal2>.

[11] See Vibeke Bjornlund, Henning Bjornlund & Andre F Van Rooyen, "Why agricultural production in sub-Saharan Africa remains low compared to the rest

to other developing regions[12] and its yield potential is higher than achieved.[13] Low productivity is due to many factors, including interference by external forces focusing on export crops, an overall lack of government support to facilitate farmers' transition from subsistence to commercial farming, neglected public infrastructure, lack of crop rotation, and, importantly, climate change.[14]

Climate variability is a major threat to agricultural development and a driver of food insecurity and poverty in SSA.[15] Climate change projections for SSA demonstrate warming temperatures, particularly in sub-tropical regions, increased frequency of extreme heat events, increased aridity, changes in rainfall, and as much as a one-metre sea-level rise.[16] Such changes have a direct and immediate impact on the agricultural sector, forcing farmers to quickly adapt to temperature changes to protect their crops. In recent years, the region has faced several extreme climate emergencies, regular food crises and water scarcity, floods, droughts, reductions of cereal crop productivity, and surges in disease, pests, and weeds on crops and livestock.[17] Notably, rainfed agricultural systems, which account for approximately 96% of overall crop production, are particularly vulnerable due to an overall increase in floods and droughts.[18] Regarding immediate consequences, an increase in flood shocks in SSA has been associated with a 35% decrease in per-capita food consumption and a 17-percentage-point increase in extreme

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of the world – a historical perspective" (2020) 36 Intl J of Water Resources Development 520 at 520.

[12] See *ibid*.

[13] See FAO, *supra* note 7.

[14] See *ibid*.

[15] See *ibid*.

[16] See Olivia Serdeczny et al, "Climate change impacts in Sub-Saharan Africa: from physical changes to their social repercussions" (2017) 17 Regional Environmental Change 1585 at 1589.

[17] See Carlos Pérez et al, "How resilient are farming households and communities to a changing climate? A gender-based perspective" (2015) 34 Global Environmental Change 95 at 95.

[18] See FAO, *supra* note 7.

poverty.[19] A 2006 study of 9,000 farmers across 11 African countries demonstrated that warming temperatures immediately reduced incomes on dryland farms.[20] Moreover, recent research suggests that relative poverty in rural areas, most poignant in highland temperate, pastoral, and agro-pastoral regions, tends to limit adaptive capacities.[21]

2.2 Vulnerability, resilience, and mitigation

Climate discussions related to agriculture tend to centre on three key terms: *vulnerability*, *resilience*, and *mitigation*, definitions of which vary greatly across secondary literature. Pérez et al offer a concise definition of *vulnerability*: "a dynamic 'space' bounded by historical and socially constructed sociopolitical and economic processes and structures that are negotiated."[22] In other words, a region's climate vulnerability is affected by its resources and assets, labor power, technology, access to education and information, decision-making power, and adaptive capacity regarding climate issues. These indices include exposure to climate risk, sensitivity to such risks, and capacity to adapt. Discussions of vulnerability are key to understanding recent studies exploring the intersection of climate and agriculture. For instance, the 2020 *Sustainability and Development Conference* paper "Climate and poverty in Africa South of the Sahara" argues that "SSA is one of the most vulnerable regions to climatic shocks, since it is home to the bulk of the world's extreme poor." The paper suggests that SSA's population below the poverty line is unlikely to rise above it in the coming decades because of the effects of climate on agriculture.[23] Through a detailed sub-regional poverty analysis, the paper's authors examine the ways in which factors contributing to poverty make regions more *vulnerable*—more susceptible to dynamic and multi-layered consequences—to variations in climate.

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[19] See Carlo Azzarri & Sara Signorelli, "Climate and poverty in Africa South of the Sahara" (2020) 125 World Development 1 at 9.

[20] See Pradeep Kurukulasuriya et al, "Will African Agriculture Survive Climate Change?" (2006) 20:3 The World Economic Review 367 at 367.

[21] See FAO, *supra* note 7.

[22] Pérez, *supra* note 17 at 96.

[23] Azzarri & Signorelli, *supra* note 19 at 2.

Resilience is often defined in opposition to vulnerability,[24] where resilience is the strength of a community to cope with climate shocks, or, in other words, to reduce vulnerability. Yet as Dixon and Stringer point out, the relationship between vulnerability and resilience is complex, as a single community may be vulnerable to a particular climate event, such as a flood, and resilient to another, such as a drought.[25] Mikulewicz and Taylor are highly critical of the term *resilience*, arguing that in the context of Africa, it has been used so abstractedly as to become meaningless.[26] Perez et al address the opacity of the term *resilience*, arguing that vulnerability and resilience must be examined "from a multi-layered and multidimensional perspective of 'concentric' social spaces (household, community, region) akin to a set of Russian dolls."[27] Resilience includes many factors, including exposure to specific shocks; a generalized understanding of past exposure to shocks; the capacity to deal with change in the short-term; and the ability to build new systems for the future. Resilience is not the same as development—in fact, resilience may undermine development objectives—nor is it equal to poverty reduction.[28] Instead, climate resilience in agriculture is the capacity to respond immediately and over the long term to climate variability, taking into account social, financial, political, and institutional adaptive capacities, and in particular perceiving farming systems as complex social-ecological systems that comprise both biophysical and human components.

Finally, in discussions on climate, *resilience* is often in conversation with *mitigation*. While resilience is the capacity to respond to environmental threats, mitigation aims to reduce the likelihood of those threats, principally through reducing

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[24] See Jami L Dixon & Lindsay C Stringer, "Towards a Theoretical Grounding of Climate Resilience Assessments for Smallholder Farming Systems in Sub-Saharan Africa" (2015) 4:1 Resources 128 at 130.

[25] See *ibid* at 130–31.

[26] See Michael Mikulewicz & Marcus Taylor, "Getting the resilience right: climate change and development policy in the 'African Age' " (2020) 25:4 New Political Economy 626 at 626.

[27] Perez, *supra* note 17 at 97.

[28] See Dixon & Stringer, *supra* note 24 at 130.

greenhouse gas emissions.[29] In the context of agricultural communities in SSA, mitigation strategies tend to centre on transitioning to clean power technologies in farming, making land available for reforestation, and reducing population growth.[30] Some of these strategies will be further explored in the section on climate-smart agriculture; however, this paper principally focuses on vulnerability and resilience rather than mitigation. Climate mitigation strategies tend to place responsibility on low- and middle-income countries rather than on wealthy ones for reducing carbon emissions even though wealthy countries have significantly higher levels of carbon emissions per capita.[31] Moreover, reducing carbon emissions through managing population growth is a complicated and sensitive issue that engages the ethics of population control, particularly in the context of international or Western organizations implementing population reduction strategies in developing nations.[32] Mitigation is important in relation to vulnerability and resilience, but in the context of climate issues in SSA, raises complicated ethical issues that are beyond the scope of this paper.

2.3 What is Climate-Smart Agriculture?

Several recent studies have demonstrated that developing climate-smart agriculture (CSA) is one of the most effective methods of countering the impacts of climate change.[33] The FAO defines CSA as "agriculture that sustainably increases productivity, resilience (adaptation), reduces/removes greenhouse gases (mitigation), and enhances achievement of national food security and poverty reduction."[34] The aim of CSA is to transform Africa's

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[29] See Bruno Merven et al, "Climate Mitigation in South Africa" (2021) SA-TIED Working Paper 174.

[30] See Cheryl A Palm et al, "Identifying Potential Synergies and Trade-offs for Meeting Food Security and Climate Change Objectives in Sub-Saharan Africa" (2010) 107:46 PNAS 19661 at 19661–62.

[31] Kate Sims, "Education, Girls' Education and Climate Change" (2021) K4D Emerging Issues Report 29 at 5.

[32] See RA Price, "The linkages between population change and climate change in Africa" (2020) Institute of Development Studies K4D Helpdesk Report 900 at 3.

[33] See e.g. Nyasimi, *supra* note 1 at 3.

[34] *Ibid* at 8.

agricultural landscape to optimize climate-related risk management processes, meet increasing food demand, and research and develop technologies that effectively respond to climate variations.[35] CSA is being implemented across agricultural systems, including in crops, livestock, fisheries, aquaculture, agroforestry, and forestry.[36] Major CSA strategies in SSA include: improving irrigation systems to maximize dryland area that could be converted to irrigated cropland;[37] integrating traditional and indigenous knowledge and practices into farmland production systems; crop diversification and soil fertility management; sustainable livestock feeding practices;[38] incorporating climate variability into agricultural planning; improving access to technologies that strengthen climate resilience; mapping climate-smart practices of rural women; and mitigating institutional and financial barriers to CSA implementation.[39] Because of wide socio-political, cultural, and environmental diversity across SSA, it is important for adaptation strategies to be local-specific for change to be sustainable.[40]

2.4 Gender and Climate-Smart Agriculture

As a key target in ending global hunger, *Sustainable Development Goal* 2.3 highlights the importance of strengthening the capacity of women farmers:

> By 2030, double the agricultural productivity and incomes of small-scale food producers, in particular women, indigenous peoples, family farmers, pastoralists and fishers, including through secure and equal access to land, other productive resources and inputs, knowledge, financial

[35] See *ibid*.

[36] See FAO, "Climate-Smart Agricultural Case Studies 2021" (2021) at 1, online (pdf): *FAO* <www.fao.org/3/cb5359en/cb5359en.pdf>.

[37] See Kurukulasuriya et al, *supra* note 20 at 380.

[38] See Sophia Huyer et al, "Expanding Opportunities: A Framework for Gender and Socially-Inclusive Climate Resilient Agriculture" (2021) 3:718240 Methods 1 at 1.

[39] See FAO, *supra* note 36 at 4.

[40] See Azzarri & Signorelli, *supra* note 19 at 2.

services, markets and opportunities for value addition and non-farm employment.[41]

Women provide more than 80% of farm and domestic labour in Africa[42] yet control less land than men; moreover, the land they control tends to be of poorer quality, and women's land tenure is insecure.[43] Women have less access to resources, less decision-making capacity at the household and community levels, and less access to the services they need to maximize productivity. These disadvantages make women farmers particularly vulnerable to climate change and more at risk when disasters occur.[44] The African Development Bank found women 14 times more likely than men to die in natural disasters, attributing this difference to women's poorer health, nutrition, and living and working conditions.[45] During extreme climate events, women and girls are less likely to have lifesaving skills such as the ability to swim; they may not be permitted to evacuate their homes without the consent of men in their family or community; dress norms may inhibit their mobility; and they are more likely to be subject to intimidation, gender-based violence, harassment, assault, and trafficking.[46] Because women are less likely to own land due to land tenure systems based on male inheritance,[47] when disasters occur women have less capacity to make decisions about the land. Women tend to have lower education levels, affecting their skills and knowledge, resources access, and leadership opportunities.

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[41] *Supra* note 10.

[42] See Nyasimi, *supra* note 1 at 26.

[43] See Perez et al, *supra* note 17 at 105.

[44] See Nyasimi et al, *supra* note 1.

[45] See Alice Nabalamba, Maurice Mubile & Patricia Alexander, "Climate Change, Gender and Development in Africa" (2011) 1:1 AfDB Chief Economist Complex 1 at 18.

[46] See C. Nellemann, R Verma & L Hislop, "Women at the Frontline of Climate Change: Gender Risks and Hopes" (2011) at 4-5, online (pdf): *United Nations Environment Programme Rapid Response Assessment* <file:///Users/claramcgaughey/Downloads/rra_gender_screen.pdf>.

[47] See Chidiebere J Onwutuebe, "Patriarchy and Women Vulnerability to Adverse Climate Change in Nigeria" (2019) 9:1 SAGE 1 at 4.

CSA technologies do not benefit women and men equally; [48] yet CSA recommendations are rarely gender-mainstreamed. Unterhalter and North define gender mainstreaming as "an organizational strategy developed to prevent or overcome the neglect, or side-streaming, of women's issues, and to ensure that these become the concern of whole organizations that set out to structure their major goals around gender equality." [49] The FAO notes that the task of making agricultural practices both climate-smart and gender-responsive is site-specific: it requires knowledge of gender gaps and relations within each community as well as locality-specific projections for climate change impacts. When site-specific information is not available, the FAO recommends a "no-regrets" approach, in which general CSA practices such as "rainwater harvesting techniques and water reservoirs, increase in soil organic matter, and improved access to weather information" are applied.[50] Yet such a generalized practice is unlikely to close the gender gap in climate impacts.

Gender-mainstreamed CSA begins with CSA education, wherein agricultural education considers the different resources available to men and women in the community, knowledge gaps, infrastructure and market access, and access to control of land to ensure women's participation in agricultural development. [51] Because climate shocks disproportionately impact women, the impact of CSA is greater when strategies take into account gender gaps—from education, age, employment, and marital status of women in agriculture, to social norms, leadership, and access to land and other resources. Education is key to reducing gaps in other areas: it lessens likelihood of child marriage, and increases women's employment, leadership, and resources access. The

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[48] See Sibyl Nelson & Sophia Huyer, "A Gender-responsive Approach to Climate-Smart Agriculture" (2016), online (pdf): *FAO* <www.fao.org/3/be879e/be879e.pdf>.

[49] Elaine Unterhalter & Amy North, "Girls' Schooling, Gender Equity, and the Global Education and Development Agenda: Conceptual Disconnections, Political Struggles, and the Difficulties of Practice" (2011) 23:3 Feminist Formations 1 at 3.

[50] FAO & World Bank, "Training Module: How to Integrate Gender Issues in Climate-Smart Agricultural Practices" (2017) at 9, online (pdf): *FAO* <www.fao.org/3/i6097e/I6097E.pdf>.

[51] See *ibid* at 10.

FAO rightly notes that "closing the gender gap in agriculture produces significant gains not only for women but for society as a whole, by increasing agricultural productivity, reducing poverty and hunger, and promoting economic growth."[52] The following sections will explore the ways a gender-mainstreaming approach to CSA strategies and education could strengthen climate resilience when it comes to three major risks of climate change: loss of food, loss of livestock, and forced displacement in the agricultural sector.

2.4.1 Loss of food

Food insecurity is arguably the most immediate and major risk of climate change. Long-term projections predict a 3.2% yield decrease in cereal crops across Africa by 2050,[53] as well as a 17% decrease in wheat, 5% in maize, 15% in sorghum, and 10% in millet. [54] Changes in precipitation and temperature, floods, droughts, and pest attacks all threaten food production.[55] Soil is becoming increasingly infertile due to deforestation and overgrazing. Most food production in Africa comes from smallholder farms, which have less access to innovative farming technologies, pesticides, herbicides, quality seeds, and fertilizers.[56] The rural locations of many smallholder farms and the particular cultures and social norms of each farming community make the sustainable introduction of CSA strategies challenging. Furthermore, high poverty levels among small-scale farmers lowers adaptive capacity.[57]

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[52] *Ibid* at 9.

[53] See Linus M Nyiwul, "Climate Change Mitigation and Adaptation in Africa: Strategies, Synergies, and Constraints" in Tiago Sequeira & Liliana Reis, ed, *Climate Change and Global Development: Markey, Global Players and Empirical Evidence* (2019) at 219, online (pdf): <link.springer.com/content/pdf/10.1007%2F978-3-030-02662-2.pdf>.

[54] See Jerry Knox et al, "Climate Change Impacts on Crop Productivity in Africa and South Asia" (2012) 7 Environmental Research Letters 1 at 1.

[55] See *ibid* at 2.

[56] See Charles Onyutha, "African Food Insecurity in a Changing Climate: The Roles of Science and Policy" (2019) 8:1 Food Energy and Security 1 at 5.

[57] See Byela Tibesigwa et al, "Gender Differences in Climate Change Risk, Food Security and Adaptation: A Study of Rural Households' Reliance on Agriculture and Natural Resources to Sustain Livelihoods" (2015) Environment for Development Initiative at 2.

Climate-driven food insecurity disproportionately affects female-headed households. Approximately 80% of small-scale subsistence farmers in SSA are women.[58] This is largely due to farming activities being a viable financial option for women with household duties such as raising children.[59] Research from South Africa shows that women are less mobile than men, resulting in less ability to search for alternate employment beyond the farm. As a result, women farmers tend to be poorer and less able to invest in new seeds, fertilizers, and pesticides to enhance resilience.[60] Moreover, because women heads-of-house divide their labour between family care, household duties, and working on the farm, their produce yields tend to be lower, increasing risk of food insecurity.[61]

Leadership opportunities for women narrows the male-female gap in food productivity. In particular, to ensure food security, it is critical for farmers, both men and women, to have secure tenure to the land they farm.[62] Yet due to male inheritance rights, it is challenging for women to possess land—though sex-disaggregated data on land is extremely limited, and what is meant by tenure, ownership, and management varies greatly across studies.[63] In any case, women appear to control substantially less land than men across SSA.[64] As a result, female-headed households often depend on common property resources such as communal land.[65]

With less control over land than men—whether in the form of less ownership, tenure, or rights—women are discouraged from adopting modern technologies that could enhance adaptive capacity.[66] Evidence suggests that women with secure land tenure,

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[58] See *ibid* at 4

[59] See *ibid* at 5

[60] See *ibid*.

[61] See *ibid* at 4-5.

[62] See Cheryl Doss et al, "Women in Agriculture: Four Myths" (2018) 16 Global Food Security 69 at 71.

[63] See *ibid*.

[64] See *ibid*.

[65] See Tibesigwa et al, *supra* note 57 at 4.

[66] See *ibid* at 4.

information, and other resources are more likely to adopt climate-smart agricultural practices.[67] When women's land rights were formalized through certification in Ethiopia, for example, women were found to be more likely to lease parts of their land, improving household welfare.[68] Another study found that security of land tenure increased women's likelihood of planting trees and adopting other CSA practices.[69] Yet importantly, targeting women in CSA development could lead to increasing women's workload and placing the burden on them to improve farming. As Doss et al note: "Working toward joint resource management groups where both men and women have voice and leadership and toward ensuring that both men and women have secure tenure, information, and other complementary resources is needed to achieve sustainable food security."[70] In short, diversifying economic opportunities for female-headed households and securing land tenure for women farmers encourages the adoption of CSA practices, which are likely to decrease climate-driven food insecurity in the long term.

Education is a major contributor to the food security gap,[71] with male heads of house having higher education levels than women. Several issues resulting in climate-driven loss of crops—namely, farmers' mobility, capacity to diversify crops, and access to land—could be mitigated by improving girls' education. Skilled TVET (Technical and Vocational Education and Training) for women and girls strengthens women's capacity to find employment beyond the farm. Moreover, as noted by the Solidaridad Network, women need education to "[transition] towards more resource-efficient, circular, and regenerative production methods."[72] These methods include helping farmers "to decrease their dependency on pesticides and antimicrobials,

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[67] See Doss et al, *supra* note 62 at 69.

[68] See *ibid* at 72; Stein T Holden, Klaus Deininger & Hosaena Ghebru, "Tenure insecurity, gender, low-cost land certification and land rental market participation in Ethiopia" (2011) 47 Journal of Development Studies 31.

[69] See Doss et al, *supra* note 62 at 72; AR Quisumbing & N Kumar, "Land Rights Knowledge and Conservation in Rural Ethiopia: Mind the Gender Gap" (2014) IFPRI Discussion Paper 1386.

[70] *Supra* note 62 at 73.

[71] See Tibesigwa et al, *supra* note 57 at 13.

[72] "What We Do," online: *Solidaridad Network* <www.solidaridadnetwork.org/what-we-do/>.

reduce excess fertilisation, increase organic farming, improve animal welfare, and reverse biodiversity loss." [73] Providing women with the education to implement resource-efficient technologies on their farms gives them more time to spend on household tasks so their labour is less divided. Education also gives women more access to finance, clients, and business knowledge, to make their farms more profitable and sustainable in the face of climate change.

Education is also key to women gaining land rights. When women lose access to land—for example, if their husband dies and through inheritance laws the land is passed to a brother-in-law; if a corporation takes the land; if a neighbour imposes on the land—women typically must go through an official legal process to reclaim the land. As Glazebrook, Noll and Opoku explain, "Women have little ability to seek remedy through the courts in the official legal system that is expensive and hard to navigate for village women who have limited education and literacy, and may not speak the language of the court."[74] It is extremely difficult to claim land rights through legal remedies without language, reading skills, and knowledge of rights, which are typically acquired through formal education. It is also important for women to be educated on how to maintain income while they wait for a court's decision on their lost land; in such cases, it is helpful to have diverse skills training to sustain a diversified income. Agricultural cooperatives could improve the capacity of women farmers by providing community-specific and gender-sensitive basic skills training to farmers. Within higher education, Glazebrook, Noll, and Opoku recommend courses on "agricultural ethics on gender sovereignty and other issues, as well as education in indigenous and traditional ecological knowledge and agricultural practices" [75] to make diverse agricultural knowledge and land rights more accessible to women. They also recommend integrating women's knowledge of local

[73] *Ibid*.

[74] Tricia Glazebrook, Samantha Noll & Emmanuela Opoku, "Gender Matters: Climate Change, Gender Bias, and Women's Farming in the Global South and North" (2020) 10:7 Agriculture 1 at 12-13.

[75] *Ibid* at 17.

ecological systems into higher education, as knowledge on harvesting is traditionally passed down through women.[76]

2.4.2 Loss of Livestock

A significant component of food security is livestock. Africa holds approximately a third of global livestock, accounting for about 40% of Africa's agricultural GDP, ranging from 10–80% of agricultural GDP country-to-country.[77] Demand for livestock is expected to increase with population growth. Estimates from 2021 predict that low- and middle-income countries will demand 107 million tons more meat and 5.5 million tons more milk by 2050 than they did in 2005/2007.[78] Particularly in arid regions where crops are challenging to maintain, livestock is a major provider of employment and revenue.[79] It also serves social functions: as Zougmoré et al explain, "Livestock provide draft power, skins, transport and manure, and fulfill various sociocultural functions such as payment of dowry, establishment and reinforcement of relationships and source of prestige within the pastoral society."[80] Climate change poses a major threat to livestock, with climate shocks such as droughts and floods causing food crises and revenue shortages and forcing farmers to develop new strategies to remain productive.

Developing CSA technologies for livestock has been a focus of studies on climate *mitigation* because its production is a major contributor to global greenhouse gas emissions.[81] Less has been written on climate *resilience* in livestock farming. Climate risks include droughts and reduced access to water leading to animal mortality due to water scarcity; rangeland degradation; reduced feed production; variability in resources to maintain animals; changes in breeds of livestock that can be kept; and animal

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[76] See *ibid*.

[77] See Mulubran Balehegn et al, "Livestock Sustainability Research in Africa with a Focus on the Environment" (2021) 11:4 Animal Frontiers 47 at 47.

[78] See *ibid* at 47.

[79] See Robert Zougmoré et al, "Toward Climate-Smart Agriculture in West Africa: A Review of Climate Change Impacts, Adaptation Strategies and Policy Development for the Livestock, Fishery and Crop Production Sectors" (2016) 5:26 Agriculture & Food Security 1 at 2.

[80] *Ibid*.

[81] See Balehegn, *supra* note 77.

disease.[82] These factors are exacerbated by little incentive to breed endemic species, human migration into grazing areas, low capacity to diversify livelihoods, and land insecurity.[83]

There is a dearth of gender-disaggregated data on livestock holdings in SSA.[84] Evidence shows that although women are involved considerably in livestock husbandry—it is estimated that out of 600 million poor livestock farmers worldwide, two-thirds are rural women[85]—gender differences in ownership and rights to livestock vary greatly across countries.[86] In many countries, livestock is a valuable asset that women can acquire more easily than land.[87] Ownership may be informal, however, whereas all countries in SSA have formal systems of animal ownership for men. In some communities, women are involved in the selling and pricing of livestock, although historically excluded from its farming.[88] In others, women have control over animal products used for the home but are excluded from selling them for income.[89] Men are more likely to own large animals such as cattle herds while women tend to own smaller animals like poultry and goats.[90] Women across the region, moreover, tend to have less access to information, resources, and technologies for sustainable breeding practices.[91]

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[82] See Zougmoré et al, *supra* note 79 at 3–4.

[83] See *ibid* at 4.

[84] See Patti Kristjanson et al, "Livestock and Women's Livelihoods: A Review of the Recent Evidence" (2010) International Livestock Research Institute Discussion Paper 20 at 2.

[85] See *ibid*.

[86] See *ibid* at 7.

[87] See *ibid* at 3.

[88] See Leon Gwaka & Job Dubihlela, "The Resilience of Smallholder Livestock Farmers in Sub-Saharan Africa and the Risks Imbedded in Rural Livestock Systems" (2020) 10:7 Agriculture 1 at 6.

[89] See Michael O'Sullivan, "Gender and Property Rights in Sub-Saharan Africa: A Review of Constraints and Effective Interventions" (2017) World Bank Policy Research Working Paper 8250 at 6.

[90] See *ibid* at 7.

[91] See Kristjanson, *supra* note 84 at 4.

Diversifying animal breeds and diversifying crops with livestock both appear to strengthen resilience.[92] Yet combining livestock with crop production is uncommon amongst female-headed households.[93] The reasons for this disparity are multi-faceted and under-researched, but, in addition to socio-cultural impacts and less access to livestock assets, are due in part to organizations that foster livestock production providing support primarily to men.[94] Other recommendations for improving climate resilience in livestock farming include improving feeding efficiency and manure management efficiency (particularly to rely less on water); developing varied CSA resources to maintain animals; developing preventive treatments for emerging animal diseases; and keeping animals that require less natural resources.[95]

Women are at an advantage in one important area when it comes to climate resilience in livestock agriculture: they are less likely to farm large, non-local animals, which tend to be less adaptable to climate change because they require more land and water resources to survive. Smaller animals such as sheep and goats are more adaptable since they require less water and can accommodate heat stress.[96] Research suggests communities are also more likely to perceive climate-smart breeds as suitable for husbandry when owned by women.[97] Climate resilience strategies could benefit from taking advantage of the knowledge and expertise of women farmers, re-orienting livestock husbandry to further reflect the ways it already exists amongst rural women: namely, raising smaller, local animals using local resources. Providing women with more leadership opportunities—with more access to decision-making roles where their expertise on small, local animal breeds could be used, more resources from organizations that foster livestock productivity, and more access to livestock markets where women could generate income and

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[92] See Tibesigwa, *supra* note 57 at 8.

[93] See *ibid*.

[94] See Perez et al, *supra* note 17 at 102.

[95] See Zougmoré et al, *supra* note 79 at 4.

[96] See *ibid*.

[97] See Nicola JC Chanamuto & Stephen JG Hall, "Gender equality, resilience to climate change, and the design of livestock projects for rural livelihoods" (2015) 23:3 Gender & Development, online (pdf): <doi.org/10.1080/13552074.2015.1096041>.

share their practices with other farmers—could help to strengthen adaptability across the board.

Kristjanson et al propose a three-pronged path to improving women's livelihoods in livestock husbandry: "securing, building and safeguarding livestock assets; increasing and sustaining livestock productivity; and enhancing participation in and benefits from livestock markets."[98] These strategies require securing girls' education. Like land, it is important for women to be educated on their rights to livestock to be able to navigate their community's dispute resolution system should a legal issue arise. Women also need agricultural education so they can participate in livestock cooperatives to gain more control over selling animal products.[99] Waters-Bayer and Letty explain that it is not enough for women to be trained through second-hand information passed through the family: training needs to be direct, "in literacy and numeracy, small-enterprise management, and group management and leadership."[100] Incorporating livestock knowledge and skills in school curricula gives orphan children and children not raised on a farm the opportunity to gain knowledge others may acquire through family. It also gives girls an opportunity to acquire knowledge boys may be learning at home on the assumption boys will take over the farm. Furthermore, if female extension agents[101] who usually focus on home economics were trained in livestock and agriculture, they could mentor rural girls on how to sustain resilient livelihoods on the farm.[102]

2.4.3 Forced Displacement

Climate-driven displacement has become a major global issue, with a steep rise in climate refugees and domestic migration

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[98] *Supra* note 84 at 1.

[99] See A Waters-Bayer & B Letty, "Promoting Gender Equality and Empowering Women through Livestock" in Frans Sanepoel, Aldo Strobel & Siboniso Moyo, ed, *The Role of Livestock in Developing Communities: Enhancing Multifunctionalit* (Bloemfonteni, South Africa: The Technical Centre for Agricultural and Rural Cooperation, 2010) 31 at 37.

[100] *Ibid* at 43.

[101] Extension agents are personnel who visit farming communities to deliver educational workshops.

[102] See Waters-Bayer & Letty, *supra* note 99 at 43.

to escape slow-onset change and sudden disasters. The World Bank predicts that in SSA, South Asia, and Latin America, slow-onset environmental stressors could force 143 million people to migrate within their countries by 2050.[103] Displacement caused by sudden-onset disasters is increasing, with an estimated 24.9 million people displaced by disasters in 2019, the highest number since 2012.[104] SSA has the highest number of internally displaced women and girls worldwide, at about 8.2 million or 40 percent of the global number.[105] Smallholder agriculture is a major source of climate displacement in SSA because it is particularly vulnerable to rainfall variability and temperature changes, and smallholder farms are typically located in poorer, more rural areas, with less access to adaptive technologies.

Importantly, migration is sometimes considered a positive method of climate adaptation. Successful climate-driven migration in the agricultural sector typically involves men migrating to surrounding regions to find alternate sources of income, often leaving a wife behind to tend crops and livestock and care for the family. Yet there is little reported evidence of this form of adaptation being successful for the family or the farm. Research from Burkina Faso reported a general perception that migration is an ineffective form of adaptation for both men and women. In this study, men experienced "lack of economic gain, continued food insecurity, harsh working conditions, and health problems during migration" while their wives experienced "continued food insecurity, lack of money to buy food, and other necessities as well as the burden of caring for children alone."[106] Thus, because

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[103] See Kanta Kumari Rigaud et al, "Preparing for Internal Climate Migration" (2018) at 111, online (pdf): *World Bank* <file:///Users/claramcgaughey/Downloads/WBG_ClimateChange_Final.pdf>.

[104] See Internal Displacement Monitoring Centre, "Global Report on Internal Displacement" (2020) 1, online (pdf): *Norwegian Refugee Council* <www.internal-displacement.org/sites/default/files/publications/documents/2020-IDMC-GRID.pdf>.

[105] See Christelle Cazabat et al, "Women and Girls in Internal Displacement" (2020) at 5, online (pdf): *Internal Displacement Monitoring Centre* <www.internal-displacement.org/sites/default/files/publications/documents/202003-twice-invisible-internally-displaced-women.pdf>.

[106] Kira Vinke et al, "Is Migration an Effective Adaptation to Climate-Related Agricultural Distress in Sub-Saharan Africa?" (2021), online: *Population and Environment* <link.springer.com/article/10.1007/s11111-021-00393-7>.

there is little evidence to support the theory that migration is an effective form of climate adaptation, more investment is required into building resilience to mitigate the need for migration.

When climate disasters displace girls and women, employment opportunities are scarcer and risks higher than they are for men.[107] In the aftermath of climate emergencies, girls are at an increased risk of violence, exploitation, sexual and physical abuse, and trafficking.[108] Moreover, when women do not have equal economic and social rights, their mortality rates in climate-related disasters are higher.[109] Migrant girls may be prevented from attending school because it is not safe and costs are high.[110] In Save the Children's report on child climate migrants, in reference to a Mozambique climate refugee camp, one interviewee stated: "Girls and women who are in refugee camps always feel harassed by authorities or NGOs. They isolate themselves to avoid exposure. They stop going to clinics for prenatal care and don't access other basic care and services."[111] To compensate for lost family income, minor migrants may be forced into child labour, where girls are particularly vulnerable to risks such as violence, assault, and commercial sexual exploitation. Displaced women and girls have less access to healthcare, education, and employment, and are less able to participate in decision-making processes that affect them.[112]

Save the Children importantly notes that "there is not enough gender-disaggregated data to draw concrete conclusions

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[107] See *ibid*.

[108] See Alexander Vu et al, "The Prevalence of Sexual Violence among Female Refugees in Complex Humanitarian Emergencies: a Systematic Review and Meta-Analysis" (2014), online: *PLoS Currents* <10.1371/currents.dis.835f10778fd80ae031aac12d3b533ca7>.

[109] See "Women, Gender Equality and Climate Change" (2009), online (pdf): *UN WomenWatch* <www.un.org/womenwatch/feature/climate_change/downloads/Women_and_Climate_Change_Factsheet.pdf>.

[110] See Sarah Selby et al, "Walking Into the Eye of the Storm: How the Climate Crisis is Driving Child Migration and Displacement" (2021) at 59, online (pdf): *Save the Children* <s3.savethechildren.it/public/files/uploads/pubblicazioni/nellocchio-del-ciclone.pdf>.

[111] *Ibid*.

[112] See Cazabat et al, *supra* note 105.

on gender, disability, or age-related vulnerability to climate-related migration risks to inform policy and programming."[113] Evidence on the success of gender-mainstreamed programming for migrants is mostly anecdotal. As discussed, it is important to first improve CSA strategies on farms so that the agricultural sector is more resilient in order to minimize the risk of forced displacement. The implementation of these strategies should be gender-mainstreamed to reduce the disproportionate impact of climate change on women: diversify crops and livestock, implement land and family laws that protect women's rights, provide women with resources to invest in climate-smart seeds and fertilizers, and enhance women's participation in markets. When displacement occurs, gender-mainstreamed safeguards must be put in place to protect migrants, including preparedness activities, development of evacuation routes, risk-awareness raising, distribution of disease-preventive measures such as mosquito nets, communication on employment opportunities, and legal measures to prevent abuse and exploitation.[114]

Education is key to implementing these strategies, including educating girls on life-saving techniques such as swimming, disease prevention, and evacuation routes, and educating older girls and women on CSA strategies to improve farm resilience, women's rights as agricultural workers and migrants, and the risks associated with migration. Importantly, evidence shows that countries that have invested in female education and leadership suffer fewer losses from climate disasters.[115] When women and girls are forced to migrate, availability of education in rural areas improves capacity to capitalize on employment opportunities.[116] Without education, girls and women are more likely to be forced into vulnerable work where risk of exploitation is high. Research

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[113] Selby et al, *supra* note 110 at 33.

[114] See IFRC, "Displacement in a Changing Climate: Localized Humanitarian Action at the Forefront of the Climate Crisis" (2021) at 29, online (pdf): *International Federation of Red Cross and Red Crescent Societies* <reliefweb.int/sites/reliefweb.int/files/resources/2021-Climate-Displacement-Report-Final.pdf>.

[115] See Malalafund, "A Greener, Fairer Future: Why Leaders Need to Invest in Climate and Girls' Education" (2021), online (pdf): *MalalaFund* <assets.ctfassets.net/0oan5gk9rgbh/OFgutQPKIFoi5lfY2iwFC/6b2fffd2c893ebdebee60f93be814299/MalalaFund_GirlsEducation_ClimateReport.pdf>.

[116] See Mary Nyasimi & Sophia Huyer, "Closing the gender gap in agriculture under climate change" (2017) 30 Agriculture for Development 37 at 39.

from Mali and Senegal shows that "motives for migration differ considerably depending on the amount of education received, suggesting that migration constitutes a livelihood strategy, particularly for the lower educated."[117] The correlation between displacement patterns and educational attainment is partly due to education improving the ability to cope with environmental stressors, reducing the likelihood of forced displacement.

3. The Role of Girls' Education

3.1 Background: Girls' Education in Sub-Saharan Africa

As discussed, girls' education is important to mitigate loss of food, loss of livestock, and forced displacement, three of the principal risks of climate change affecting agriculture. Accomplishing improved education access for girls will be examined in the following sections. First, however, it is important to understand the state of girls' education in SSA. As with the other topics, education access and quality vary greatly across Africa.

A 2019 UNESCO report estimates that SSA has the highest out-of-school rate in the world, with 52 million girls from primary to upper-secondary age who do not attend school, accounting for 33.6% of girls in the region compared to 28.9% of boys.[118] This number is estimated to have increased significantly due to the COVID-19 pandemic. In 2021, the World Bank identified five key factors contributing to gender disparity in education: gender bias, poverty, violence, child marriage, and COVID-19. [119] To summarize their findings, in low-income households, girls are more

[117] Victoria van der Land & Diana Hummer, "Vulnerability and the Role of Education in Environmentally Induced Migration in Mali and Senegal" (2013) 18:4 Ecology and Society, online: *Ecology and Society* <www.ecologyandsociety.org/vol18/iss4/art14/>.

[118] See UNESCO, "New Methodology Shows that 258 Million Children, Adolescents and Youth Are Out of School" (2019) at 4, online (pdf): *UNESCO* <uis.unesco.org/sites/default/files/documents/new-methodology-shows-258-million-children-adolescents-and-youth-are-out-school.pdf>.

[119] See The World Bank, "Girls' Education" (2021), online: *The World Bank* <www.worldbank.org/en/topic/girlseducation#1>.

likely to be pulled out of school than boys; for girls in poverty, child marriage is also a risk. Girls who marry young are more likely to leave school and are at a higher risk of violence and young pregnancy. For girls in school, teacher bias and stereotypes about girls can affect a girl's academic performance and later employment prospects. Finally, girls' heightened risk of violence at school and on their way to school reduces enrollment rates.[120] A 2017 report on violence in schools notably points out that "in some countries, [there is] a higher probability for a girl to experience sexual violence than to become literate."[121] All of these factors contribute to overall gender inequality in education, with girls across SSA less likely to attend school and more likely to leave than their male peers.

Another factor impacting girls' education is menstrual hygiene management. A 2017 study on menstruation and education among adolescent girls in SSA reported that "between 50% and 70% of girls miss on average 1.6–2.1 days of school every month due to menstrual-related issues" and that, when girls attend school while menstruating, their confidence is lower due to social shaming.[122] Unhygienic options for menstrual products expose girls to health risks, which further impact school attendance, academic performance, and extra-curricular activities. The study builds a comprehensive argument that girls and women require "sustainable, environmentally friendly, ecological and cost-effective options"[123] as well as social interventions to prevent menstruation from negatively impacting their education.

Finally, climate change is a major source of education disruption across SSA. According to Sims, "it is estimated that environmental threats, which include weather-related disasters, disrupt the education of approximately 37.5 million learners

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[120] See GWI, "Evidence Brief: School-Based Interventions to Prevent Violence Against Women & Girls," online (pdf): *The Global Women's Institute at The George Washington University* <www.ungei.org/sites/default/files/EVIDENCE-BRIEF-School-Based-Interventions-to-Prevent-Violence-Against-Women-_-Girls-eng.pdf>.

[121] Derrick Ssewanyana & Byron Kiiza Yafesi Bitanihirwe, "Mentrual hygiene management among adolescent girls in sub-Saharan Africa" (2017) 26:1 Global Health Promotion 105 at 106.

[122] *Ibid* at 106.

[123] *Ibid* at 105–106.

across the globe each year."[124] This is due to several factors including: infrastructure damage preventing children from accessing school; climate shocks affecting food security and household income, which can lead to child marriages, children sent away to work, or children kept at home to help with household or agricultural tasks; damage to water, sanitation, and hygiene facilities, affecting girls' willingness to attend school while menstruating; family displacement resulting in children removed from school; and malnutrition or trauma resulting in reduced capacity to learn.[125] Although climate shocks evidently impact the education of all children, studies show a disproportionate impact on girls. Sims' Emerging Impact Report attributes this imbalance to "an increase in household chores and responsibilities, which are typically allocated to girls in contexts where there are gendered norms; decisions to withdraw girls from education, prioritising their male siblings' education; and, in some contexts, difficulties in managing menstrual hygiene."[126] Thus, while the reasons for SSA's educational gender gap are complex and multi-layered, recent research suggests that climate plays a significant role, with short-term shocks and long-term changes displaying a negative correlation with girls' educational attainment.

3.2 Education in the Agricultural Sector

More research is required on whether educational gender gaps are higher in the agricultural sector than in other sectors across SSA. Baten et al's study on the colonial era (1920–1979) notably found no evidence that agriculture affected educational gender disparities.[127] Other studies, however, have found that distance to school, lack of water points, household poverty, lack of services, and cultural restrictions for women negatively affect girls' educational attainment, all of which tend to be more

[124] Sims, *supra* note 31 at 2.

[125] See *ibid*.

[126] *Ibid* at 3.

[127] See Joerg Baten et al, "Educational Gender Inequality in Sub-Saharan Africa: A Long-Term Perspective" (2021) 47:3 Population and Development Review 813 at 840.

pronounced in rural areas.[128] Moreover, the aggravating factors we have already examined—gender bias, poverty, violence, child marriage, and lack of menstrual hygiene resources—are also heightened in rural regions. Even COVID-19, which has especially affected Africa's urban centres, appears to have widened rural-urban inequalities in some countries, as rural areas, with less resources and services, were less prepared to cope with nation-wide lockdowns.[129] In 2000–2002, the Southern and Western Africa Consortium for Monitoring Educational Quality (SACMEQ) found that in SSA, there were significant urban-rural disparities in educational achievement, with urban children's mathematics and reading scores outranking those of rural children.[130] These findings suggest a similar disparity in the agricultural sector because of significant overlap between rural and agricultural populations. However, more extensive research on specific trends in educational gender gaps and agriculture in SSA is required to gain a more nuanced and up-to-date understanding of the issue.

In the agricultural sector, interventions to strengthen girls' education should be mainstreamed to protect girls' safety and specifically improve climate resilience. Importantly, attending school can be dangerous for girls, as school heightens risk of violence.[131] Interventions to improve girls' safety at school is beyond the scope of this paper, but numerous recent studies have found positive results with long-term culturally-specific gender-based sensitization training of teachers, students, and communities.[132] As discussed in the sections on food, livestock, and forced displacement, to maximize the difference education can make in climate resilience, girls' education should have a

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[128] See Hannah Dunga & Chengedzai Mafini, "Socio-Economic Factors Influencing the Education of the Girl Child in Zomba, Malawi" 11:2 International Journal of Social Science and Humanity Studies 20 at 21; Albert Novas Somanje et al, "Challenges and Potential Solutions for Sustainable Urban-Rural Linkages in a Ghanaian Context" (2020) 12:2 Sustainability 1 at 1.

[129] Justin Visagie & Ivan Turok, "Rural-Urban Inequalities Amplified by COVID-19: Evidence from South Africa" (2021) 6:1 Area Development and Policy 50 at 50-53.

[130] See Yanhong Zhang, "Urban-Rural Literacy Gaps in Sub-Saharan Africa: The Roles of Socioeconomic Status and School Quality" (2006) 50:4 Comparative Education Review 581 at 582-583.

[131] See GWI, *supra* note 120.

[132] See *ibid*.

disaster-risk-reduction focus. Primary-school-age children should learn life-saving skills such as swimming and first aid. Girls and boys should equally receive primary STEM education which acknowledges the historical exclusion of girls from STEM fields and equips girls with scientific and technological skills that translate to the workforce.[133] In agricultural communities, STEM education should include an introduction to CSA strategies, including information on climate-smart seeds, fertilizers, and animals.

Research has shown positive results with girls in secondary school taught community-specific entrepreneurship skills to lessen the income gap between male- and female-headed agricultural households. An FAO study from 2017 found that agricultural productivity for female farmers was 20–30% lower than male farmers.[134] To close the productivity gap, women need better access to financial and CSA resources. As Sakho-Jimbira and Hathie note, "education is key to facilitating women and youths' access to information and better technologies, which are critical to moving beyond production and running successful rural businesses."[135] Girls need gender-specific education on niche markets, including selling produce at a profit and participating in livestock markets. Negotiation training and information on policies that affect agricultural markets could help young women better participate in decision-making processes at the community level. Gender-mainstreamed TVET training could specifically develop climate adaptation techniques, educating girls and young women on technologies to improve efficiency on the farm, facilitate balance between farming and domestic responsibilities, and diversify income sources. While girls' education correlates positively with climate resilience, education programming that is

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[133] See UNICEF, "Towards an Equal Future: Reimagining Girls' Education Through STEM" (2020) at 17, online (pdf): *UNICEF* <www.unicef.org/media/84046/file/Reimagining-girls-education-through-stem-2020.pdf>.

[134] See FAO, "The Future of Food and Agriculture: Trends and Challenges" (2017) at 79, online (pdf): *FAO* <www.fao.org/3/i6583e/i6583e.pdf>.

[135] Suwadu Sakho-Jimbira & Ibrahima Hathie, "The Future of Agriculture in Sub-Saharan Africa" (2020) at 13, online (pdf): *International Fund for Agricultural Development* <www.ifad.org/documents/38714170/42030191/future_agriculture_sahara_e.pdf/1cb6b896-b9c1-0bb8-87b8-83df3153d0af?t=1597140766000>.

gender-mainstreamed and climate-specific could maximize women's climate resilience and by extension the resilience of entire communities.

3.3 The Role of Governments and NGOs

The connection between girls' education and climate response in agricultural communities brings together several Sustainable Development Goals (SDGs): Goal 2 (Zero Hunger), 4 (Quality Education), 5 (Gender Equality), and 13 (Climate Action). The nature of the SDGs is that they interact with and depend on each other: in the words of Nilsson, Griggs and Visbeck, "the agenda will be able to deliver on its potential" through "mutually reinforcing actions."[136] It takes a multi-level approach to tackle such a wide-ranging issue. SDGs are best implemented when governments, NGOs, communities, and individuals work towards common targets, with other interacting goals in mind. The following sections will explore the role of governments and NGOs in reaching these targets.

3.3.1 The Role of Governments

Governments play a significant role in driving gender inequity in schools. Many countries lack education policies that explicitly address gender inequity. Swainson et al found that in some countries in SSA "there was no overt attempt ... to address the serious gender inequities that existed in the educational system nor integrate gender into the education plans."[137] Part of the problem is a lack of government-commissioned research across SSA on the impact of educational interventions on marginalized learners. [138] Research from Malawi found that government resources allocated to post-primary education at the expense of primary education results in an overall deterioration of education quality and low primary graduation rates for girls. It also noted

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[136] Måns Nilsson, Dave Griggs & Martin Visbeck, "Policy: Map the Interactions Between Sustainable Development Goals" (2016) 534 Nature 320 at 321.

[137] Nicola Swainson et al, "Promoting Girls' Education in Africa: The Design and Implementation of Policy Interventions" (1998) Department for International Development Education Research Paper at 25.

[138] See Leon Tikly et al, "Supporting Secondary School STEM Education for Sustainable Development in Africa" (2018) University of Bristol School of Education Working Paper 5 at 8.

that lack of material and infrastructure resources in rural areas can result in girls not attending school due to distance. After the government of Rwanda attempted to implement a one-laptop-per-child program, results showed that lack of IT resources such as internet access inhibited STEM interventions in rural areas.[139] Research from Zimbabwe showed that teachers lack gender-responsiveness training to address educational challenges for girls.[140] Finally, supposedly gender-neutral policies such as school uniforms, school fees, and disciplinary policies related to pregnancy disproportionately affect girls.[141]

Several government interventions implemented across SSA have strengthened educational gender parity, leading to greater climate resilience for communities. Interventions include: (1) climate- and gender-sensitive curriculum development; (2) provision of free primary education; (3) development of fast-track teacher training programs; (4) and investment in agricultural TVET. First, it is common for schools to combine several ages and levels in co-educational classrooms, making it difficult for teachers to mould their lessons to specific learning styles. Research from Malawi showed positive results when math courses were streamed by gender and age.[142] The same study showed positive results when removing subject restrictions that prohibited girls from pursuing STEM subjects that could improve knowledge of climate technologies and removing aspects of curricula that reinforce negative gender stereotypes.[143]

Second, school fees are often cited as the principal reason for girls leaving school. Some countries have seen major enrollment increases in primary schools, particularly for girls, when the government waived fees for primary education.[144] When Uganda, for example, implemented a Universal Primary Education Program, schools saw a substantial reduction in gender

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[139] See *ibid* at 26.

[140] See *ibid* at 8.

[141] See Swainson et al, *supra* note 137 at 26.

[142] See *ibid* at 3.

[143] See *ibid* at 27.

[144] See Talan B Iscan, Daniel Rosenblum & Katie Tinker, "School Fees and Access to Primary Education: Assessing Four Decades of Policy in Sub-Saharan Africa" (2015) 24:4 Journal of African Economies 559 at 559.

inequality in primary school.[145] Notably, however, the increase in attendance was accompanied by a decrease in education quality, suggesting that fee waives should be complemented by policies to improve school programming.

Third, girls' lack of STEM education, which is especially important for climate resilience in agriculture, may be due to a lack of qualified teachers. STEM instruction falters when teachers trained to use equipment, materials, and textbooks are forced to rely on theoretical explanations. It is therefore important for teacher training and retention programs to be matched by resources.[146] Zambia and Côte d'Ivoire have had success introducing national fast-track teacher training programs to increase the supply of teachers trained in STEM.[147] Through gender sensitivity training, such programs can provide teachers with tools to address differentiated risks and challenges faced by girls.[148] Finally, Sakho-Jimbira and Hathie recommend major government investment in agricultural TVET to encourage young people to seize opportunities within agriculture.[149] When gender-mainstreamed, agricultural TVET training can call attention to rural women as key actors in climate-aware food security development.

3.3.2 The Role of NGOs

Non-governmental organizations (NGOs) are also key players in improving girls' education in agricultural communities. NGOs provide public-interest services, building community-oriented development strategies, lobbying the government, advocating for citizens' interests, and protecting human rights.[150] By working on-the-ground and building partnerships with the state, civil society, and international organizations, NGOs can accomplish a wide range of goals across communities. In some

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[145] See Klaus Deininger, "Does cost of schooling affect enrollment by the poor? Universal primary education in Uganda" (2003) 22:3 Economics of Education Review 291 at 291.

[146] See Tikly et al, *supra* note 138 at 25.

[147] See *ibid* at 8.

[148] See *ibid* at 8.

[149] See *supra* note 135 at 15.

[150] See Nitya Rao & Ines Smyth, "Introduction: principles and realities" in Nitya Rao & Ines Smyth, eds, *Partnerships for Girls' Education* (Oxford: Oxfam, 2005) 1 at 1–2.

countries, because of fundraising capabilities, NGOs have more financing power in their fields of activity than the state.[151] Notably, some countries in Africa receive more than 50% of their education budget through international aid, much of which is through International NGO (INGO) fundraising.[152]

Dozens of NGOs across SSA have had success in strengthening girls' education. Wiehe suggests that when examining NGOs it is useful to look at "exemplary practices" that can be used to understand techniques and strategies that have worked across Africa.[153] In Congo, for example, evaluation of the VAS-Y Fille! Programme showed positive results in training teachers, providing learning opportunities for out-of-school girls, initiating a reading club for community members, and developing a programme for parents to save school fees.[154] The Girl Child Network in Kenya had success in reducing school dropout rates by delivering awareness-raising workshops on children's rights, drug and substance abuse, child labour, child marriage, and female genital mutilation.[155] International fundraising initiatives such as Michelle Obama's "Let Girls Learn" program has paid school fees for hundreds of thousands of girls and provided funding to projects aiming to reduce risks such as child labour, poverty, and hunger.[156] Both girls' education and climate change have become popular initiatives for NGOs in recent years, with hundreds of non-government initiatives popping up across SSA that aim to increase girls' school enrollment, decrease the effects of climate change, and at times target both issues at once.

In the 1980s, international human rights initiatives expanded hugely in Africa. Since then, researchers have written

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[151] See Mike Powell & David Seddon, "NGOs & the Development Industry" (1997) 24:71 Review of African Political Economy 3 at 5.

[152] See Elsa Wiehe, "Rethinking African Educational Development" (2019) in Alan S Canestrari & Bruce A. Marlowe, eds, *The Wiley International Handbook of Educational Foundations* 47 at 56.

[153] *Ibid* at 60.

[154] See Laura Bolton, "Barriers to education for girls in the Democratic Republic of the Congo" (2020) Knowledge, Evidence and Learning for Development Helpdesk Report at 2.

[155] See "Education" (last visited 9 July 2022), online: *Girl Child Network* <girlchildnetwork.org/our-work/education/>.

[156] See Wiehe, *supra* note 152 at 60.

extensively on the negative impacts of NGOs and INGOs. Domestic NGOs may face several problems, including lack of fundraising, internal corruption, and lack of partnerships with existing community, civil society, and state initiatives. Domestic NGOs historically have less fundraising capacity than INGOs, which may raise huge amounts of money from the Western market. In relying on funding from Western states, however, INGOs may have an interest in advancing Western ideas of development. In doing so, INGOs risk enforcing a version of human rights in which, in the words of Mutua, "foreign policies become the conveyor belts of 'civilization.' "[157] Kennedy explains that it is important to avoid a version of international aid in which "development workers bring gifts of modernity and literacy to the African child, through strategies and skills that local teachers do not possess."[158] International approaches to development can result in colonial initiatives that do little to strengthen communities and contribute to discourse that celebrates Western states as saviours of Africa.[159]

Recent development work has focused away from international strategies and towards community-driven sustainable development. Mutua explains a new movement in Africa at the core of which is "intellectual originality and self-reliance, local and not Western foundation support, and a commitment to challenge all sources of violations, be they local or foreign."[160] In such initiatives, local organizations advocate for the rights and interests of their own communities, with local-specific ideals of development driving activism. Even INGOs are moving towards community-driven development. The UK-based INGO CAMFED (Campaign for Female Education), for example, has used a community-based, self-sustaining approach to fund the education of over a million girls in SSA, specifically developing a program to build climate resilience through girls' education. Another INGO, Solidaridad

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[157] Makau Mutua, "Savages, Victims, and Saviors: The Metaphor of Human Rights" (2001) 42:1 Harvard Intl LJ 201 at 239.

[158] Wiehe, *supra* note 152 at 47.

[159] One example of such a problematic INGO is Canada's WE Charity, which raised millions of dollars promising to build schools in Kenya and built less than was promised, instead funnelling money to administrative costs in Canada: see Matthew Pierce et al "WE Charity misled donors about building schools in Kenya, records show", CBC (18 November 2021), online: <www.cbc.ca/news/canada/we-charity-misled-donors-records-show-1.6251985>.

[160] Mutua, *supra* note 157 at 242.

Network, supports smallholder farms in rural communities through a community-focused approach with the needs of local farmers at the centre of strategy development. Within this movement, the aim of INGOs becomes the self-reliance of communities in which INGO work is no longer needed.

4. Conclusion

There is a plethora of recent studies suggesting that strengthening girls' education could improve climate resilience. Striessnig, Lutz and Patt's study from 2013 used a regression analysis to estimate that if, by 2050, 70% of young women in SSA completed secondary education, deaths due to natural extreme events could be reduced by 60%.[161] A more recent study from 2017 found that on the ND-GAIN index, which measures vulnerability to climate disasters, girls' education was inversely correlated with vulnerability to climate disasters, suggesting that each year of schooling a girl receives increases her overall climate resilience.[162] A third study, which examined 72 countries during 1971–2012, found a positive correlation between women's political empowerment (closely entwined with education) and reduced CO2 emissions. [163] These findings support the Malalafund's argument that "education increases women's socioeconomic power in households and wider society relative to men. This, in turn, reduces gender disparities in mortality rates from climate-related extreme weather events."[164] These studies are wide in scope, but all point to the conclusion that broad investment in girls' education improves climate resilience.

More quantitative research, however, is required on the specific relationship between girls' education and climate

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[161] See Erich Striessnig, Wolfgang Lutz & Anthony G Patt, "Effects of Educational Attainment on Climate Risk Vulnerability" (2013) 18:1 Ecology and Society 1 at 6.

[162] See Christina Kwauk & Amanda Braga, "Three Platforms for Girls' Education in Climate Strategies" (2017) 6 Global Economy and Development at Brookings at 19, online (pdf): <www.ungei.org/sites/default/files/Three-Platforms-Girls-Education-Climate-Strategies-2017-eng.pdf>.

[163] See Zhike Lv & Chao Deng, "Does women's political empowerment matter for improving the environment? A heterogeneous dynamic panel analysis" (2019) 27:4 Sustainable Development 603 at 603-604.

[164] Malalafund, *supra* note 115 at 19.

resilience in SSA's agricultural communities, as well as which educational interventions best strengthen community resilience. A preliminary literature review shows that a major proportion of SSA's population relies on agriculture and that their livelihoods are under threat due to climate change. Communities that have implemented CSA strategies have seen improvements in resilience. In particular, CSA strategies mitigate three of the greatest risks of climate change on farms: loss of food, loss of livestock, and forced displacement.

If CSA had a gender focus, those most affected by climate change would be better equipped to adapt. Climate change has the greatest impact on women, demonstrated by women's increased mortality rate in climate disasters and their increased vulnerability to food insecurity. Gender-mainstreamed CSA strategies include improving women's access to CSA resources and information, providing CSA technology to female-led farms, capitalizing on women's traditional knowledge of local plants, seeds, and livestock, and securing land rights for women. Importantly, strengthening girls' education to prepare girls for work in agriculture is key to gender-smart CSA.

For CSA to be implemented effectively, it is important to not only increase female enrollment in primary and secondary schools but to adapt curricula to recognize challenges girls face in school. Children require lifesaving skills to respond to climate emergencies. Gender-sensitive STEM learning that includes agricultural TVET could also improve children's climate resilience. Teachers need gender-sensitivity training and to be equipped with materials and resources to teach in rural communities. Finally, governments and NGOs are key actors in school reform. When governments, NGOs, and communities form partnerships towards common targets, change can occur at the individual, community, and national level.

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