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Evidence of Gender Inequality in Agriculture Related to Climate Change: Specifically in Developing African Nations

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ABSTRACT

When considering the negative effects of climate change, its relevance to a person's socio-economic status and cultural background is often ignored. In other words, climate change affects everyone, but its effects on different individuals and groups differ due to long standing inequalities in human society. The importance of gender discrimination in particular is in deseperate need of additional attention during this unprecedented global environmental event. A plethora of research articles and data show that women are affected disproportionately by climate change. To expand, sexism in relation to climate change is especially evident in agriculture. In this case, negative impacts of climate change are further intensified due to the industry's close connection with the environment. Therefore, additional research should be dedicated towards understanding the discrimination against female farmers, and thus it is the focus of this essay. The essay focuses on developing African nations where conventional agriculture is the main source of income. By using previous research and database searches from scientific journals, governmental websites, and international organizations, the increasing burdens on female farmers in climate crises will be analyzed. Throughout the investigation, it was discovered that African rural women are excessively exposed to climate change threats and lack adaptability. When viewing this through a holistic lens– acknowledging the cultural and historical backgrounds of Africa–it was concluded that subordination of rural women in all contexts is responsible for their predicament in climate crises. To address these issues, the essay proposes potential solutions from educational, economics, and political perspectives.

Introduction

The Relationship between Climate Change and Agriculture

To start, agriculture by definition is the practice of cultivating the soil, growing crops, or raising livestock for human use (Oxford dictionary, n.d.). Although it has a variety of branches, the environment is the branch that unites all aspects of agriculture. While agriculture is constantly under the risk of natural disasters since humans entered the agrarian era, modern climate change – the result of immoderate fossil fuel combustion - has not only raised the severity and frequency of extreme weather events but has also permanently altered farming conditions worldwide (Trinh, 2020). Taking soil quality as an example: fluctuation in rates of rainfall and evaporation can alter soil moisture, leading to erosion or cracking. Moreover, acid rain – the product of gasses from fossil fuel combustion reacting with atmospheric oxygen and water vapor, catalyzed by sunlight – is responsible for soil acidification and altered nutrient components. Such disturbances are destroying the required conditions for the cultivation of crops (Aydinalp and Cresser, 2008).
While agriculture has globally become the industry most directly and most negatively affected by climate crises, the degree of its impacts on different regions varies vastly. For example, In Africa – especially Sub-Saharan Africa –

agriculture accounted for 16.5% of GDP and 53% of total employment in 2019 (statistics in the United States in the same year were only 0.9% and 27%) (Worldbank, 2019). As is evident from this statistic, economies there rely heavily on agriculture. Such reliance increases a population's susceptibility to the volatile and negative effects of climate change. Moreover, the relatively primitive farming methods and technologies further place local farmers at risks under these worsening environmental conditions. For instance, 95% of agricultural water in Africa is supplied by rainfall, making farmers extremely vulnerable to climate change leading droughts and abnormal precipitation patterns. (Munang and Andrews, 2014).

Climate Change in Africa

While Africa is paying the price for a changing climate caused by the entire world, a certain group of people receive the heaviest burden. African female farmers account for approximately 40% of total crop production while also shouldering domestic works. Today, the depletion of resources and harshening farming conditions led by climate change has placed African female farmers in an unprecedented disadvantageous position (Palacios-Lopez et al., 2017).

To begin, the work partition between genders has been shaped adversely towards women during a long history of agricultural development in Africa. The influence of climate change exacerbates the disadvantages of women. For instance, women are traditionally responsible for water collection, which has now become more time-consuming and difficult due to massive water shortages (Medagbe et al, 2020). In addition, in recent decades the out-migration trend – in other words, the trend of household heads moving into cities for work – has further increased the burden on female farmers when males leave the household/farm for work in cities (Worldbank, 2018).

More specifically, female farmers in Africa are treated unfairly in society, at market, by their government, and in relation to their families. They face discriminations at every stage of their agricultural production process – ranging from obtaining land and seeds, to the prices they receive for their hard-produced crops. (Muzari, 2014). To give more detail, under the rule of male-dominated government and market, most female farmers can only farm on inferior lands and with uneven distribution of resources. Not to mention, they also have less access to advanced modern technologies. Furthermore, lack of educational opportunities and scientific knowledge delay their response to the changing climate and local weather conditions. This has restrained their capacity to adjust their agricultural methods with persisting abnormal climate patterns (Muzari, 2014). Issues such as these will be discussed in greater detail throughout the research paper.

Although a plethora of scientists and organizations have provided strategies for the agricultural industry to address problems brought by climate change, most of them failed to consider these African female farmers separately and their special situations. For instance, genetically improved seeds that are resistant to pests and drought – which are mentioned most frequently in related articles – are not easily accessible to smallholders mainly made up by women due to high seed costs and competition with large farms (Hlatshwayo et al., 2021). Thus, the adaptive seed strategy struggles to solve problems faced by African female farmers thoroughly if deeper, more fundamental social and financial restraints to women are not eliminated.

In order to promote improvements of female farmers' condition in climate change, equality should be achieved in political, social, and family levels. Moreover, economic empowerment and female-held leadership in government with participation in the decision making of related crises are essential in strengthening their robustness to unstable environments. (Mokoena and Dolan, 2020).

Part A：Disproportional Exposure to Climate Change's Negative Impacts

In part A, the reasons behind the over exposure and vulnerability of female farmers in climate crises and related disturbances will be explained. The causes mainly include lower yields, natural disasters, and unfavorable hydrolog-

ical conditions. Complex issues such as gender roles, farming scales, human demographics, and the legacy from colonial history in Africa will be explored. The discussion will cover the entire African continent, but mainly focus on Sub-Saharan Africa, considering the particularly important role of agriculture and especially severe gender inequality in this area (Hakura et al, 2016).

Gender Role in Africa

To start, traditional African farming families generally have a clear division of labor between men and women. In specific, women typically balance between agricultural production and domestic work while men specialize in farming activities (Medagbe et al., 2020). To recognize the challenges of household chores, the harshness of natural conditions and primitiveness of local resources supply networks should be considered in the first place. Responsible for food preparation, African rural women devote massive time in water collection and firewood fetching since undeveloped pipeline and transportation systems enormously magnify the difficulty of those tasks (Medagbe et al., 2020). For example, the collection of water that can be easily achieved in most parts of first world countries by simply turning on a faucet requires on average two hours each day from African rural females while carrying a heavy five gallon container (Gross et al., 2018).

Moreover, such challenges have long existed in African agricultural society, but the impacts of climate change in recent decades place women in an even worse condition. Rising temperatures caused by increasing levels of greenhouse gasses in the atmosphere have changed the atmospheric circulation and precipitation patterns, leading to higher frequency of drought. For instance, in Eastern Africa, the occurrence of drought has doubled from one in every six years to one in every three years (Ofori et al., 2021). Moreover, scientific models have also predicted the drop in discharge and water level in major African surface water supplies across the whole African continent, from the Northeastern Nile river to the Breede River in South Africa (Ofori et al., 2021). At the same time, groundwater is also depleting due to the decline in recharge and years of overexploitation. In most affected regions, the groundwater level has decreased approximately 30m since the 1950s (Oiro, 2020).

Under this situation of water shortage, female farmers in Africa have no choice but to expand their range of water collection. This not only demands more time and energy, but also exposes them to additional risks. Without modern transportation systems, most women commute between their house and water sources by walking on primitive bumpy roads under the threat of wild animal attack. Physical injuries happen frequently, especially when carrying heavy water vessels. In a survey of water fetchers, 85% have experienced injuries during the water collection process (Venkataramanan et al.,2020). Commonly this results in fractures, dislocations, pain, and lacerations. Falling is considered the leading cause of such body damages, followed by traffic accidents and handling water containers. Moreover, the research discovered a positive correlation between water insecurity – one of the major effects of climate change – and the possibility of physical injuries in water fetching (Venkataramanan et al.,2020). However, female water fetchers have to overcome more than physical challenges. Sexual violence and conflicts occur frequently in water collection paths and at water points. Further extended water journeys measn women and girls are exposed to threats of rape and sexual harassment for a longer period. In addition, the water shortage in the family caused by natural water depletion can also trigger potential domestic violence against women in punishing their dereliction of duties (Allen et al., 2020).

Furthermore, climate change not only increases the difficulties and dangers of the water fetching process, but also expands the spread of water borne diseases. This is due to warmer temperatures and changed rainfall patterns that create more bacterial and virus friendly environments (Giesen et al., 2020). Situations are especially poor in rural Africa where sanitation and waste disposal systems have not been implemented. For example, scientists predicted that the West Nile Virus – symptoms including fever, headache, and vomiting – will spread to highlands and deserts of South Africa driven by climate change (Paz, 2015). Having the most direct contact with untreated water, female farmers are threatened by the increased possibility of such diseases, indirectly caused by climate change.

Out Migration of Men

Rural to urban migration, driven by the pursuit of opportunities and living quality, has become a trend in modern, African agricultural communities. To be noted, the pattern and timeline of this population mobility varies slightly in each region based on the local social, economic, and historical backgrounds. But for example, the population movement in Zambia follows the recession and expansion of the local mining industry, while the internal relocation in Senegal is highly coincident with the pattern of the country's oversea migration. However, under the continental economic transition and the legacy of colonization and apartheid, the general disparity between urban and rural is expanding. In this case, such gaps promote a massive shift of agricultural productivity to cities and a lack of labor in the countryside (FAO, 2017).

Although the mobility of rural residents is not modified depending on gender, the destination of relocation demonstrates significant distinctions among men and women. For example, in the survey of migration patterns in rural KwaZulu-Natal, 19.4% of all adult women experienced a type of migration between 2001 and 2003 – nearly consistent with the same statistic for adult male (19.1%). Nevertheless, within those female migrants, 50.4% of them actually moved within rural areas, compared to 64.8% of male migrants dislocated from rural to urban. Moreover, the survey also showed the domination of men in long distance migration crossing provincial or national boundaries (Camlin et al., 2013). According to this phenomenon, we can reasonably hypothesize that urbanization is further accelerating the loss of male labor force in farming while transforming more agricultural responsibility to females. Both North and Sub-Saharan African countries demonstrated that an increasing share of the agricultural labor force was by women from 1980 to 2010 (FAO, 2011).

In addition, gaps between different age groups are also notable. More specifically, the out-migration rate of men in 2001 was constantly above that of women through the majority of age groups. The only exception is for subjects aged 15-19: in this case, relocation was slightly more common within the female population (Camlin et al., 2013). To speculate reasons behind this phenomenon, the influence of marriage cannot be ignored. In Sub-Saharan Africa, the average age for women to enter their first marriage is between 21 to 22 – about 5 to 6 years earlier than men's (UN, 2015). This coincidence may suggest the connection between women's stability and their marriages, promoting the role of women as housekeepers.

As mentioned frequently in this essay, agriculture is one of the industries most negatively impacted by climate change. Thus, the situation of female farmers is further deteriorated due to the increasing burden of farming and impediments brought by the absence of male representatives of the family. Some articles have pointed out that the out-migration of men is a potential opportunity for women by empowering them in family or local decision making (Worldbank, 2018); however, such thoughts might be too idealistic under the political and social context of sexism. For instance, due to cultural constraints and the public disapproval of women's capacity, female farmers usually lack access to large markets and have difficulty in applying for loans. Similar situations can also be applied to resource distribution and access to agricultural related information (Muzari, 2016). Thus, the out-migration of men in the family can result in the instability of women's production and economic state, especially during climate change when agriculture is vulnerable.

Farming Scale

The distribution of resources is the most direct manifestation of social and institutional inequalities. Furthermore, the consolidation of wealth and opportunities in a small percentage of a population will result in the class stratification and insuperable constraints of disadvantaged communities. Africa, as the second most unequal continent in the world, harbors a large gap of resource inequality. For instance, the African rich class – occupying only 4.8% of the population – dominates 18.8% of total income, while 60.8% of Africans live with salaries less than two dollars per day. (AfDB, 2022). The general situation of uneven allocation of resources in Africa can be applied to various local industries, including agriculture.

In this case, female farmers have become one of the main victims due to gender discriminations in the acquisition of resources. For instance, land – the basis of all agricultural resources – is under men's sole control for the majority of situations in Africa. In Sub-Saharan Africa especially, women own only one percent of land while contributing to approximately half of agricultural production (Muzari, 2016). In detail, although many African governments have been committed to land reform based on fighting against sexism, the effects of related policies are diminished by regional inveterate patriarchy during actual enforcement (Akinola, 2018). To explain, in most traditional communities and families in Africa, female farmers' qualifications are commonly doubted, and they must rely on their male relatives for accessing land and resources (Muzari, 2016). For example, in Kenya, women's tenure rights are legally promised, but in reality, only an extremely small proportion of land is actually registered under the name of women (Worldbank, 2013).

Because of the uneven distribution of resources and the general underestimation of women's abilities (at least on the surface) in African social and cultural perceptions, the scale of agricultural production of female farmers is significantly restricted. In fact, the majority of rural females in Africa are smallholders or subsistence farmers, focusing on the family-oriented cultivation and breeding in limited areas (UN, 2014). Driving a vicious circle, smallholders are not favored in the market and the loan application process. For example, in South Africa, credit for small-scale farmers was constantly below one percent of national GDP between 1992 to 2012 (Chisasa and Makina, 2012).

Predicaments as smallholders not only restrains female farmers' productivity and income, but also further exposes them to the hazards brought by climate change. In a case study of agriculture in Madagascar, researchers found that smallholder communities often lack adequate transportation systems and solely rely on natural ecosystems to fulfill fundamental survival demands – increasing their vulnerability under the capricious environment. Moreover, in the studied region, smallholders are facing additional financial pressure from more frequent natural disasters and the depletion of already scarce resources (Harvey et.al, 2014). Furthermore, due the added anxiety that climate change's instabilty can have on farmers, severe mental health issues are more likely to develop – namely depression, sleeping disorders, PTSD, and even suicidal ideation (Talukder et al., 2021).

Finally, because of limited access to market and lack of funding, farming related products available for female smallholders are limited and inferior in most situations, some of which are even detrimental to health. In specific, fungus, bacterias, and pathogens thrive on agricultural products more easily under warmer and more humid environments created by climate change. In this case, additional threats to their physical conditions are also posed as female smallholders are main consumers of such contaminated products (Talukder et al., 2021).

Legacy of European Colonization

As repeatedly mentioned in this essay, the widespread gender discrimination among African society is the foundation of female farmers' disadvantage position in climate change. Although their plight is commonly recognized, the public's cognition of sexism's root is often misled by histories and literature written from a Western perspective. To start, in order to understand the detailed history of the development of gender disparity in Africa, its complexity should be acknowledged in the first place. As the second largest continent and oldest origin of humankind, Africa has always possessed diverse cultures, customs, and social structures. Different from today's general image of African women as the oppressed, in the past, females actually occupied dominant positions and held superior powers in many African indigenous agricultural societies (Sudarkasa, 1986). In such institutions, women – especially female elders – controlled the majority of resources and were treated with respect as decision makers and military leaders (Sudarkasa, 1986). Nevertheless, instead of being the reversal of a patriarchy, the status of women was not based on the abuse and disempowerment of men (Sudarkasa, 1986). In many matrilineal societies in West Africa, the authorities of women and men were parallel to each other (Sudarkasa, 1986). A typical structure of leadership, for example, would be a joint management by a queen mother and a monarch son (Sudarkasa, 1986). In contrast, in modern Africa, constituting only 24% of parliamentarians (IDEA, 2021), women have low participation and discourse power in discussions of major

affairs – including climate crises. Such political disadvantages and inequality result in underrepresentation of women's interest and indifference to their predicament.

Colonization is primarily responsible for the transformation of once thriving matrilineality to the commonly male dominated regimes of Africa still seen today. To explain, brought by european, market development and globalization fundamentally shifted the economic structure in Africa. In this western pattern of production and marketing, women were pushed away from the core of power due to a variety of factors (Jaiyeola and Isaac, 2020). For example, western religion brought by european missionaries have spread rapidly among african women and greatly influenced their views on gender role and marriage(Fofack, 2014). In specific, instead of persisting with independence, a lot of them became the "subordinate" of their male relatives to obtain materials and protection(Fofack, 2014). This established the commonly inferior position of the majority of African women in the family and society, which also explain their reliance on men in the acquisition of resources previously mentioned(Fofack, 2014).

In addition to the reduction in women's political and social status, the legacy of colonization also includes disputes over land. As discussed in the previous part, farming scale limited by the uneven distribution of land and common inability in formal land registration is one of the main reasons of womens' susceptibility to climate change. Specifically, because of the expropriation of the land by colonists and the industrialization under global context, a large portion of indigenous farming lands was transited to foreign capitals or for other purposes, resulting in agricultural land shortage. Thus, under the extension of prevailed and strengthened patriarchal consciousness in agricultural society, women, being in an inferior position, became the worst victims during the land competition intensified by resource scarcity (Akinola, 2018).

Part B: Lack Of Adaptability To The Climate Change And The Inapplicability Of General Responsive Strategies

As climate change has gradually gained more attention in the twentieth century, various corresponding adaptation strategies have been proposed by scientists and politicians to neutralize its negative effects. For example, in an article titled "Adapting Agriculture to Climate Change," schemes based on weather forecasts, genetically improved seeds, pest management, irrigation systems, and income diversification were suggested for farmers to increase their resistance and resilience in the face of climate crises (Howden et.al, 2007). However, in **Part B**, the feasibility of these suggestions for African female farmers will be analyzed. This part draws on concepts of African women's vulnerability and disadvantaged positions explained in **Part A**, discussing the barriers in implementing such strategies through the analysis of their cultural, social, and financial plights.

Awareness/Forecast Of Climate Change

To start, environmental related education is the prerequisite in adapting to weather abnormalities caused by climate change. In specific, perception of climate change is especially important to farmers who rely on seasonal patterns for crop rotations and livestock migrations, which in certain degree determines their situation in this unprecedented environmental crisis. However, research indicated that African female farmers are disadvantaged in this regard. For instance, in a survey of Eastern Uganda suburbs, rural women showed obvious insufficiency of climate related knowledge. Compared to the statistic of men (90 percent), a smaller portion (60 percent) of surveyed women showed understanding of the causes of climate change. Moreover, in the survey specific to local household heads, female heads were approximately 11 times more ignorant and 3 times more likely to have misconceptions about climate related knowledge than male heads. According to this study, the cognition of humankind's role in driving climate change is directly linked to the farmers' motivation in addressing its impacts. And educational inequality is one of the main reasons for this cognitive disparity (Kisauzi et al., 2012).

Unequal access to education is the main reason for the gender based perceptual disparity to climate change. In the studied region, the average time of education for females was only half of that of men. Lack of scientific knowledge added to challenges in comprehending climate crises, delaying the response to environmental related disturbances (Kisauzi et al., 2012). Instead of being unique to Eastern Uganda, this phenomenon occurs across Africa. In Sub-Saharan Africa, in particular, the literacy rate for women aged 15 or above was only 59% in 2020, while 72% of men of this age group were literate (Worldbank, 2020). Moreover, this region contributes to 13 out of 18 countries in the world where fewer than 90 girls are enrolled in primary education for every 100 boys(UNESCO, 2015). Furthermore, the gender gap in acquiring academic support continues to expand with the progression of educational stages. The situation is especially examplified in rural areas where resources are already scare and gender discrimination is prevailing (UNESCO, 2015).

In addition to the perceptual differences of climate change, education is directly connected in accessing climate/weather forecasts. Advanced knowledge of weather and major environmental disturbances can provide farmers more time to scheme and implement responses to neutralize the negative impacts. For example, in a survey of farmers from nine Sub-Saharan African countries, education was found to have a positive correlation with the ability of extreme weather prediction. Specifically, relatively well-educated farmers demonstrated a statistically significant increase in their probability of acquiring and utilizing climate forecasts compared to those uneducated or less educated (Oyekale, 2015).

However, what limits African female farmers' access to environmental predictions is also their deficiency of information channels. A survey of south central Uganda revealed that the gender-based disparity of information attainability and variations in climate forecast sources is statistically disadvantageous for women in accessing both long-term and short-term weather forecasts. Compared to men, local women also had obstacles in obtaining information about natural disasters such as drought and pest or disease outbreaks. Moreover, the sources commonly utilized by local female farmers were also inferior in terms of credibility. In the studied region, men were able to receive relatively high-quality sources of information that were regularly inaccessible to women from government extension workers, community meetings, and TV. The difference was especially evident in the accessibility of the newspaper, which was approachable for thirty percent of men but only one percent of women (Kristjanson et al., 2015).

Therefore, without popularization of education and reliable information channels among African women farmers, sole development in weather forecasts cannot fundamentally change women's vulnerability to climate change, because they have neither opportunity to access nor ability to understand.

Accessibility To Improved Seeds

When traditional crop varieties are inadequate to thrive in abnormal environmental conditions, scientifically improved seeds are considered as a potential solution to reverse the decline in production. Advanced seeds are capable of increasing yields while being resistant to diseases and extreme weather (namely heat and drought). Nevertheless, this is often an inaccessible option for African female farmers. Regardless of the evident monopolies that already limit these improved seeds to developing countries, even those seeds that domanage to circulate in African markets are difficult for women to access (Puskur et al., 2021). With the expansion of pest season and their geographical range triggered by global warming (Skendžić et at., 2021), the disadvantage in the seed acquisition will pose a great threat to the financial situation of female farmers and further drive the gender disparity in adaptability to climate change. In the other words, even if improved seeds with more advanced environmental tolerance are developed, it's likely that African female farmers would have neither accessiblioty nor affordability.

For example, in a survey of an agricultural zone in Nigeria, only 26.6% of female farmers claimed their accessibility of improved seeds, which was not even one-third that of male farmers (Adeola and Ayoade, 2009). There are several reasons behind this phenomenon. First, as mentioned in the previous part, information channels not only restrain African female farmers' obtainability of climate forecast, but also contribute to their inferior position in the seed market. In contrast to female farmers with information sources limited by their neighborhood or community,

African men generally own a more extensive seed information network that increases their opportunity in accessing advanced seeds without regional boundaries. Research focused on farmers in Sub-Saharan Africa revealed that local female farmers' over rely on local networks for seed acquisition, while local men were able to establish relationships with the outside world. For example, in some studied areas, males that included expert consultants in their report of information sources were two to three times that of females(Otieno et al., 2021). Thus, seeds available to women were usually limited to local varieties, although men took advantages from their connections with outsiders in obtaining improved seeds. In addition to that, the study also indicated that women were more likely to trade seeds with the same sex in most studied regions, potentially constraining their engagement in seed programs led by male-dominated governments or organizations (Otieno et al., 2021).

Accessibility to Advanced Techniques to Address Agricultural Pests and Diseases

As a major obstacle to farmers throughout time, pests post threats to crop cultivation by damaging their physical structure and spreading plant pathogens. Nowaday, agriculture is under unprecedented insecurity from infestation as global warming and erratic precipitation patterns create an ideal breeding environment for insect pests and increase their over winter survival rate (Skendžić et al., 2021). Genetically improved seeds or GMO varieties mentioned in the last part are modern solutions to these problems;but, pesticides are actually the most widely used and traditional method in controlling the population of unexpected insects and minimizing their impacts on crop yield. However, many chemical substances such as Acetochlor, Glyphosate, and Metolachlor contained in pesticides can not only destroy pests, but can also have negative impacts on health and the environment (Pennstate Extension, 2022). In this case, African female farmers are especially disadvantaged by being in close contact and treating their land with these harmful products, or even misusing the pesticide products.

Foremost, the effective use of pesticides requires certain scientific knowledge and professional skills. Thus, related training programs are essential to improve farmers' adaptivity in rapidly decreasing the range of infestation. Paralleling the trend of gender disparity in education, the availability of pesticide training programs exhibits an even larger gap between men and women. For instance, as shown in the research of an agricultural zone in Nigeria, in the previous five years before the survey, only 21% of female subjects had the opportunity to engage in formal training of pesticide application provided by science institutes, which were accessible by 78.1% of local men (Adeola and Ayoade, 2009).

A survey of South African women in small-scale farming revealed the enormous risks for women without the most basic expertise and safety awareness of pesticide use. In addition, it's difficult for the majority of women to obtain information from pesticide labels because of the low literacy rate –23.2% of subjects couldn't read English, and only 16.4% of them had attended pesticide training courses. Thus, female sprayers tended to ignore important cautions and preventions to potential risks. For instance, only 10.9% of women locked pesticides in places untouchable by children, 37.9% of women had used their hands directly in mixing pesticides, and only approximately half of them used some kind of PPE while spraying (Naidoo et al, 2010). Such long term exposure to pesticides not only results in minor symptoms such as skin irrigation, high fever, and low blood pressure, but also heightens the likelihood developing to major and even fatal issues such as seizures or cardiac and respiratory arrest (CDC, N.D). Today, pesticides are used more frequently to neutralize the impact of geographical expansion of pests and the extension of infestation season on crops during climate change, meaning that women sprayers' health is being further threatened.

Moving on, in contrast to the complete dependence on chemical pesticides, integrated pest management (IPM) is a more scientifically secure and diverse strategy. In specific, IPM controls pest populations with a combination of various ecosystem-based practices including biological control, habitat manipulation, and improved cultivation techniques (UC IPM, N.D). Nevertheless, IMP often requires a relatively deep understanding of surrounding biochemical contexts and accurate prediction of climate patterns. Too often, the general educational level of African women farmers does not allow them to implement complex pest management systems without significant outside aid and/or

funding. Although extension workers undertake the responsibility of disseminating IPM related information and training (Erbaugh et al, 2007), African women have unequal access to such services. In Sub-Saharan Africa, women only received 7% of extension services, making IPM an unrealistic solution in addressing their situation (Muzari, 2016).

Accessibility To Advanced Irrigation Systems

As mentioned previously in the essay, many African regions are under the threat of water shortage. For example, North Africa is experiencing unprecedented severe drought as global warming further intensifies heat and exacerbates evaporation rate, while sea level rise introduces sea water to coastal aquifers and wells (Wehrey and Fawal, 2022). With agriculture threatened by water scarcity, advanced irrigation techniques that can largely improve water efficiency are considered to be potential solutions. For example, drip irrigation has a 90% water efficiency and can reduce 60% of a farm's water consumption, while sprinkle irrigation on average loses 25-35% of applied water(URI, N.D) . However, like the pesticide management mentioned earlier, the advanced irrigation system also requires funding and training support, which in most cases are less allocated to women.

Starting with affordability, although advanced technologies on average cost less than conventional irrigation systems (due to increased water efficiency), their installation fee remains high. Take drip irrigation. Based on the estimation by the EPA, the initial cost of subsurface drip irrigation systems with rain shutoff devices ranges between 1,700 dollars to 2,000 dollars, while the average income of African farming households is 2,989 dollars in 2012 (Tortora, 2014). Unaffordability obstructed the popularization of irrigation. In North Africa, only 13% of the cultivated area is equipped with any kind of irrigation system, and in Sub-Saharan Africa, the number is only 4% (Burney et al., 2013). In this situation, female farmers are particularly disadvantaged due to the widespread economic inequality in Africa.

To explain the infeasibility of advanced irrigation, female farmers are commonly underpaid or even unpaid for their agricultural work (Muzari, 2016). In addition, although the African Green Revolution program has already mobilized 1.4 billion dollars in supporting agriculture–especially targeted in smallholders (AGRA, N.D)–women benefit less from both its financial and technological support (Pingali, 2012). Overall, only an extremely small portion of government funding specific to climate change is allocated to women. For example, the women ministry in Ghana only received 0.1 percent of climate change adaptation funding between 2010 to 2015 (Pearl-Martinez, 2017).

Similar to the pest management mentioned earlier, there is also a great demand for irrigation training among African females. In a research project for the female farmers of Kwara State, Nigeria, training on water and irrigation management was determined the most needed by subjects among a list of 23 farming activities conducted by women. Ranked first, third, and fourth respectively were “Recommendation of suitable profile and water conservation measures for specific farmland,” “Knowledge of the amount of water to use,” and “Irrigation scheduling and frequency”, (Tshwene et al., 2019). However, due to the generally unequal status of African rural women and their responsibility of child care and chores, the majority of them have no access nor time to attend related workshops or meetings, impairing their ability in understanding and implementing relatively complicated irrigation systems (Dlangalala and Mudhara, 2020). In a research in KwaZulu-Natal, South Africa, the acquisition of formal education and training demonstrated a statistically positive correlation with the awareness of the water institute and irrigation scheme, but that women have a very low status on the graph. This was believed to be a result of the low efficiency for women in accessing related information and difficulty in accepting innovations (Dlangalala and Mudhara, 2020).

In addition, investment for an irrigation system–a permanent fixture–is usually based on careful consideration of future prospects and depreciation. In Africa, however, a large portion of female farmers are chronically in a state of mentally and financial insecurity. Mentioned previously, as owning an extremely small percentage of land, female farmers in Africa generally obtain farming land from their male relatives, meaning their lack of absolute control towards agricultural assets (IFPRI, 2019). Without legal protection, divorce, death, or a man’s change of mind can deprive women of their land (IFPRI, 2019). In this situation, such instability reduces women’s motivation to upgrade agricultural systems and equipment for long term development (IFPRI, 2019).

Disability in Income Diversification

For farmers, diversification in income usually refers to adopting alternative farming practices or engaging in non-agricultural production to neutralize the financial plight caused by the instability of agricultural yields under climate change. In this part, we will discuss the feasibility of this adaptive strategy for African female farmers from the perspectives of both non-farm and farm diversification.

Firstly, sources of income outside agriculture can generally be divided into two main categories: salaried or self-employed (Danso-Abbeam et al., 2020). In specific, salaried employment means receiving fixed and stable payment from a business or institute based on the time the employer spends working. In contrast, self-employment is entrepreneurial–and thus risky–in nature. Especially in developing countries, instead of aiming for long term development and expansion, the strategy of self-employment is generally based on the purpose of fulfilling an urgent need for money. Specifically, one might sell their services and homemade products in exchange for quick profit. However, the income from such transactions is usually insufficient and not secured by official sectors. In most cases, the adoption of self-employment is drived by resignation and the inaccessibility of other options (Fields, 2019).

In Africa, this phenomenon is especially pronounced among women farmers. Because of the difficulty for women to penetrate a male-dominated labor market, self-employment is often the only method of diversifying agricultural income. In a 1996 survey in rural Uganda, the main occupation of 66.8% of women and 53.8% of men was agriculture. Among them, 0.8% of women and 4.5% of men had wage employment as their second occupation, while 24% of women and 16.5% of men chose self-employment to be the subordinate source of income (Newman and Canagarajah, 2000). However, self-employment, as a flexible concept, can be implemented differently based on regional, social, and political variances. In detail, the root of the economic plight of the majority of self-employed African women farmers is the restriction of business development and formalization. In a research in Tanzania, 60.2% of surveyed females owned informal micro-enterprises operated with no employees, while there were generally more labor forces in male-owned businesses. Beside the limitation of productivity caused by the deficiency of the labor force, the lack of motivation in formailization cut off the possibility of business expansion. In specific, the fear of higher tax and more frequent scrutiny decreases owners' willingness of business registration, depriving them of access to larger markets and loans (ILO, 2013). In addition, the education level, social discrimination, and reproductive responsibility of Africa female farmers also reduce their opportunities in succeed within entrepreneurship (ILO, 2013). Back to agriculture, farm diversification can not only build harmonious ecosystems through mutualistic relationships between crops and livestocks which provide ecological services like reducing pests and nourishing soil, but it can also prevent income gaps due to the seasonally varied productivity of different varieties (Kremen et al., 2012). This strategy is especially significant under climate change in strengthening the stability of both productivity and income. However, the implementation of such schemes can be very time-consuming. As mentioned previously, African women farmers devoted a large portion of their time in firewood collection and water fetching. For example, according to statistics from a 1998 survey conducted by the UN in Benin, the ratio of time spent on water fetching of women to men is 3.88:1, and for firewood collection is 4.6:1 (Blackden and Wodon, 2006). Nevertheless, these are only part of their domestic duty. The majority of African rural women are also responsible for reproductive work and the upbringing of children. The fertility rate in Africa is 4.268 births per woman (MacroTrends, 2021), meaning that a large portion of female farmers' time is occupied by pregnancy and childcare.

Part C: Solutions

Through the discussion of Part A and Part B, we can find that the inferiority in climate change adaptation by African women farmers is not due to the lack of adaptation strategies or technologies to the related environmental crisis, but the general subordination of women in family, society, and politics. For instance, as mentioned previously, the high

illiteracy rate of rural women caused by the skewed educational resources increases the difficulty for women in obtaining information and understanding relatively complicated agricultural management systems. In addition, economic inequality negatively affects their financial means for advanced farming technologies and seeds; and the political underrepresentation results in the uneven allocation of government subsidies and supports. In this situation, the crisis facing African women farmers will not be eliminated if the most basic equality is not guaranteed.

Thus, in Part C, African female farmers' susceptibility to climate change will be analyzed while providing potential solutions from three major themes – education, politics, and financial conditions.

Education

Education is considered to be one of the most important tools to reverse the disadvantageous position of African rural women by the United Nations. Mentioned previously, difference in educational level drives gender-based disparity in the awareness of climate change and the flexibility in farm management. Thus, the promotion of both general education and professional skill training among African female farmers is essential in eliminating gender inequality in agriculture under global climate crises. The limitation in accessing education for African rural females is commonly the result of two significant restraints– culture and finances.

Starting with cultural restraints, the phenomenon of early marriage and early pregnancy prevailing in rural Africa is one of the main interruptions of females' education. Supported by the data from UNICEF, the literacy rate is positively correlated with the age of first marriage, in which only 29% of women married as minors are literate (UNICEF, 2014). In this case, Africa accounts for a large portion of child marriage in the world. For example, in just West and Central Africa, there were 59 million women married under the age of 18 between 2005 to 2017, and a considerable number of them were not even 15 years old (UNICEF, 2018). This phenomenon is particularly significant in rural areas, where the probability for rural women engaging in child marriage is twice those living in urban settings (UNICEF, 2018).

Although this issue is valued by most African governments and treaties, such as Dakar Outcome Document and AU Agenda 2063, there have also been inconsistent laws on the minimum age of marriage and child marriage laws are still missing in some countries (UNICEF, 2018). For example, child marriage is still legally approved in eight Sub-Saharan African countries including Zimbabwe, Gabon, and Malawi. As the average age of first marriage in those countries is below 18, related laws are in urgent need of being processed while respecting local cultures that may benefit women (Maswikwa et al., 2015). In this situation, both the African Union and international human right institutes have an obligation in promoting related improvements. In addition to that, more rigorous laws should be developed to fundamentally solve this problem and resources should be allocated to remote rural areas for enforcement and supervision(Maswikwa et al., 2015).

In addition to cultural restraint, The cost of education is also an important factor deterring women from pursuing more advanced professions and knowledge. Although the tuition of primary education is abolished in most African countries, higher education, such as secondary and tertiary education, still requires it to be at households' own expense (Nir, 2019). In addition, the guarantee for tuition does not represent free education. In most parts of Africa, families still bear a large portion of the educational cost including books, uniforms, and school supplies. This phenomenon is especially significant in impoverished areas (UNESCO, 2022). For example, households are responsible for more than half of total educational costs in countries like Uganda and Zimbabwe (UNESCO, 2022). In the case that the national governments do not have the financial capacity of educational investment, international organizations, private donors, and other countries should be encouraged to support the popularization of education.

In addition to the general deficiency of educational funds in Africa, the constraint specific to women is the family's lack of emphasis on female education. Mentioned previously, in many parts of Africa, women's duties are limited towards procreation and household keeping, which are considered to have relatively low demand for knowledge and professional skill (Brookfield, 2013). Thus, guardians are generally reluctant to invest in their daughters' education (Brookfield, 2013). Highly dependent on their parents, especially their father, girls have neither the

ability to resist nor the access to school and often feel forced to accept their arrangements, including marriage (Brookfield, 2013). More financial support specific for women in their education is required to change this situation. Moreover, funding should be allocated directly to women instead of their families to ensure that the money is spent as expected. In this situation, only by getting rid of the dependence of their families, especially male relatives, can African women have greater potential and freedom to pursue higher education.

Financial Condition

Continuing on the discussion about the financial plight of African rural women, in addition to accessibility to education, financial competence is directly related with agricultural productivity. Specifically, expansion of farming scale and upgrade in previously mentioned agricultural equipment or management schemes – namely improved seeds, advanced irrigation system, and integrated pest management –utilized to neutralize negative effects of climate change, all require a considerable amount of long-term investment. In this situation, African female farmers are limited in development by their unbalanced status in the economy. To provide potential solutions for this issue, their financial condition will be analyzed based on two major economic sources – income and loans.

Because of the responsibility of domestic work, the crops cultivated by women are for the main purpose of self and family subsistence. In addition, these crops are often with low market value (UNWomen, UNDP, and UNEnvironment, 2018). On the contrary, men dominate the production of cash crops such as sugarcane, coffee, and tobacco, which results in economic imbalance between men and women (UNWomen, UNDP, and UNEnvironment, 2018). For example, according to the statistics from UN Women, the difference in crop values contributed to 13.3% of the gender productivity gap in agriculture in Malawi and 28.4% in Uganda(UNWomen, UNDP, and UNEnvironment, 2018). Thus, In order to achieve real economic equality, qualified seeds are required to be distributed by governments to women and their access should be established. Many African countries are currently operating seed programs to promote the cultivation of formal high-quality seeds. For instance, Ethiopia created "Quality Declared Seeds scheme and community based seed production directive" to assist smallholders in remote regions (Westengen et al., 2019). And the national seed policy in Malawi focuses on the sustainability and quality of seeds in order to improve agricultural productivity (Westengen et al., 2019). Moreover, in addition to national governments many international organizations also engage in this process. For example, the World Bank funded Agriculture Sector Wide Approach Support Project provides Eastern and Southern countries with funding for them to implement their schemes (Worldbank, 2018). However, seed programs focusing on empowering female farmers are missing in many regions, which leave the fundamental issue unsolved. Thus, governments and international organizations should design and launch more related seed schemes specifically concentrated on women to boost profits from farming.

In addition to the allocation of inferior seeds and prejudices towards "women crops", wage discrimination is one of the most significant factors in considering general low income for female farmers. Like previously mentioned, African women are often underpaid and unpaid in agricultural activities. Based on statistics from ILO, in South Africa, the wage for women in agriculture and fishery was 90% of the wage of men engaged in the same activities (2015), while in Namibia, the figure was only 80% (2016) (ILO, 2019). Nevertheless, these numbers are probably overestimations of authentic salary for African female farmers because the large population of unwaged or informal employed women – such as the self-employment mentioned in Part B – were not counted (ILO, 2022). Specific policies can include improvement in welfare and subsidies to stimulate female farmer's motivation to register in official sectors (ILO, 2022). Moreover, access to registration and related services should be promised (ILO, 2022). In addition, the minimum wage needs to be raised and its implementation should be strictly monitored in order to increase women's overall income. The establishment of a minimum wage is considered the most effective way to eliminate poverty. Using England as an example, the introduction of the minimum wage raised the salary of workers in agriculture by 13% in 1924 (Gowers and Hatton,2003). Although minimum wage is regulated in the majority of countries, it's not rigorously executed in many regions. For example, in 2007, 44% of covered workers in South Africa were paid below minimum wage, and this phenomenon is especially prevalent in agriculture sectors (Bhorat et al., 2012). Therefore,

governments should establish or expand relevant departments to monitor the implementation of the minimum wage and formulate relevant punitive measures against companies that do not cooperate.

In Part A, we already discussed the difficulty faced by women – commonly smallholders– during the loan application process. Moving forward, potential solutions for this issue will now be addressed. Banks' unfriendly policies towards female farmers are often based on concerns about their farming scale. For this situation, an effective solution is to promote female solidarity through the organization of cooperatives or associations. This is because groups are more advantageous than individuals in gaining credits (Ezeh and Anyiro, 2013). In addition to the efforts women themselves need to make, governments should also expand budgets specifically for female farmers to prevent them from competing with men for the same resources in a disadvantaged position. In this case, the popularization of micro-loans is a practical strategy in helping female farmers out of financial plight. Specifically, since the spread of messages in remote rural areas is limited and inefficient, a delay is likely to exist in receiving information about national and international loans (European Investment Bank, 2020). Moreover, such regions are commonly deficient in concentrated distribution of banks, thus, micro-loans provided by mobile, small banking or local financial offices are the most suitable option in addressing this situation (European Investment Bank, 2020).

Political Engagement

The underrepresented position in policy discussion and invisibility to decision makers are significant reasons behind the excessive vulnerability of African women in the face of climate change (Mokoena and Dolan, 2020). The root of such discrimination stems from common exclusion of women in formal sectors. In Africa, gender imbalance exists in both national and local governments. Mentioned previously, only 24% of parliamentarians are constituted by females (IDEA, 2021). Moreover, the influence of women is even more limited in local politics. To be specific, in the Sub-Saharan region, women currently account for 25% of the local deliberative bodies, and in Northern Africa, the number drops to eighteen percent, ranking lowest among the continent (UN Women, 2022). Women's deficiency in political engagement is mainly due to two reasons: the male-dominated political environment and low political ambition for the majority of females.

In addition to the women's relatively low level of education and their stereotyped perceptions of gender roles in male-dominated societies, lack of female role-models in their–especially rural women's–daily lives, diminishes their confidence in competing for government positions (Kovaleva et al., 2022). In fact, female representatives are not absent in African politics. Instead, throughout history, 22 women have served as heads of state, in which seven of them are currently running the country (AFJN, 2022). Achievements and visions of those female national leaders – from the first Slyvie Kining to the present Sahle-Work Zewde – are supposed to be the greatest stimulations in awakening African women's political ambitions (AFJN, 2022). Unequal access to media and information not only results in rural women's inferiority in acquisition of weather forecasts and securing for advanced technologies, but also blocks them from comprehensive understanding of the current political situation. For example, in a survey that spanned seventeen countries, it was noted that among traditional information acquisition channels, the share of the population (16 or older) that listen to radio was higher for males in all surveyed countries. Furthermore, while information and communication technologies are rapidly gaining popularity, only three of the studied countries had slightly higher rates of women internet users than men, and women were also less likely to own a mobile phone in thirteen out of the sixteen nations (Gillwald et al., 2010). In addition, the high illiteracy rate of women added to the challenge of spreading that information among women. Thus, one can reasonably infer that the influence and encouragement of African female role models on other African women are far from reaching their potential and expectations. To address this issue, governments and international organizations should actively promote the positive publicity of female leaders among women, especially rural women in order to enhance their political confidence. As for information channels that are most accessible and understandable to women, investment into television and radio programs should be de-

voted to in particular. In addition, The Orientations on mobile phone and social media – a newly emerging communication method in Africa – should also be widely implemented to prevent women from lagging behind in the transition to Information Age (Gillwald et al., 2010).

Instead of being unique to Africa, the disadvantages that women face in the political environment is a worldwide problem. In this situation, political institutions are closely linked to female representation. Based on a report by IDEA, women are better represented under the Proportional Representation (PR) system than the First Past the Post system (FPTP) (IDEA et al., 2021). To explain, the major distinction between these two institutes is that FPTP is simply based on absolute majority while PR allocates seats proportional to electoral strength (European Parliament, 1997). In other words, proportional representation prevents the monopoly of a single powerful group while providing more political opportunities for minorities (European Parliament, 1997). Of ten African countries with the largest proportion of women in their parliaments, six implement Proportional Representation, and two adopt a combination of PR and FPTP (IDEA et al., 2021). However, FPTP systems are still dominant in Africa as evidenced by being used in half of the countries (IDEA et al., 2021). Therefore, in order to promote women's representation in the government, the political system should be reformed in the direction of increasing participation for the minority and disadvantaged groups.

To illustrate how imporant female law makers can be in causing legistlative change: In Uganda, female parliaments promoted the death penalty for rape and in Mozambique, a family law considered as a milestrone in female empowerment passed due to the efforts of female government members (UN Women, 2022). Thus, women themselves are the most powerful drivers in achieving gender equality on all social levels. In this case, the increased engagement of women in government is necessary to win African females more attention to their plight and addressing these related issues.

Conclusion

Based on the analysis of surveys and data covering the extensive range of the African continent, this essay demonstrated the widespread vulnerability and disadvantage of African female farmers under unprecedented climate change. Thoroughly investigating different aspects, it was found that the fundamental promoter of this phenomenon is deeply rooted gender discrimination evident in all aspects of socity. Specifically, at the micro-level, women's division of labor within the household – namely domestic work and productive responsibilities - increases their exposure to the climate crisis while limiting their economic development. In addition, women's subordinate position in the family and their restrained resource networks in local communities block their access to outside information and larger markets. From a macro-perspective, women's general underrepresentation in African politics leads to the under consideration of their demands in climate-related policies and government funding programs. Moreover, discrimination in employment and high barriers of credit trap female farmers in small-scale farming, preventing them from upgrading agricultural system or diversifying income to compensate economic losses posed by more frequet natural disasters.

Among the many explanations of sexism in African agricultural society, the legacy of European colonization – namely patriarchy – is often ignored. In fact, the demise of matrilineality under rapidly rising Western religion contributes to the disadvantaged position of female farmers in long-term land disputes left over by European colonizers and climate change induced by industrialization in first world countries.

Due to the widespread financial predicament and high illiteracy rate, the role of climate-smart agricultural technologies and management is not evident in addressing female farmers' situation in Africa. Substantial evidence shows that in most cases, rural African women have neither affordability to advanced farming equipment nor the ability to understand complicated innovative cultivation systems such as integrated pest management.

To solve these issues, this essay considered potential solutions for education, economy, and political engagement. Starting with education, on the premise of eliminating child marriage and child pregnancy, both basic education and professional training need to be popularized among women. To achieve that, education should be affordable and

more financial support is required to be directly allocated to women, especially rural females. To improve their financial condition, female cooperatives should be encouraged to establish and provide micro-loans for smallholders. From the political perspective, empowering women in policy discussion and decision making is beneficial for addressing climate issues and earning attention for female farmers in distress. In this situation, political systems, such as Proportional Representation, can be widely used for underrepresented groups to gain electoral advantage.

To conclude, African women farmers are in urgent need of additional attention and support for their unique situation during the climate crisis. Their issues should be resolved specifically with comprehensive evaluations of regional economic, political, and cultural backgrounds.

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