Using economic empowerment as a tool to increase women's resilience to climate change and disasters

uOttawa

École supérieure d'affaires publiques et internationales

Graduate School of Public and International Affairs

Sawadee Adhikari

Student ID: 7315336

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Supervisor: Professor Nicholas Rivers

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Abstract

As the effects of climate change continue to intensify, it is important to acknowledge that women disproportionately suffer the impacts. This is due to existing inequalities and multidimensional social factors in many developing countries, such as the unequal distribution of roles, resources and power. These barriers prevent women from being able to fully participate in economic activities and thus they are unable to be empowered economically, which is one of the prerequisites to enhance resiliency to cope with climate variability and change. This paper explores how increasing access to certain economic tools, such as access to credit, access to market and access to climate information, can empower and position women to better manage the effects of climate change on their livelihoods as well as those of their families and communities. Access to credit, markets, and climate information were among the most cited in literature as being the main barriers for women to fully participate in local-level economic and income generating activities. This paper defines the concepts of women's economic empowerment and climate resiliency by drawing on literature and when linked together, these two concepts are a necessary step to take in the fight against climate change to build women's resilience. The analysis concluded that access to credit builds resiliency of women by providing them with the financial capacity to adapt to and cope with climate shocks; accessing markets ensures that women are able to sell their products for a fair price and thus are able to generate higher income to sustain their livelihoods in the face of climate change; and receiving timely and accurate climate information empowers women to make informed decisions related to agricultural activities and avoid loss of income in light of unpredictable climate and weather-related events at the local level.

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1. Introduction

Over the last decade, climate change has impacted a wide range of human and environmental systems and has affected the livelihoods of people across the globe. From increasing temperatures, frequent droughts and heatwaves to rising sea levels, changes in rainfall patterns and the melting of the Arctic, climate change is oblivious to boundaries and does not discriminate in its impacts toward different ecosystems, peoples, or cultures. Although the effects of climate change can be felt in every corner of the world, the severity of these effects is strongly dependent on the actions that societies and countries take to respond to them. Because different societies have different sets of capabilities, some will have weaker or lower-capacity responses to adapting to the effects of climate change. This opens up space for inequality and will therefore result in certain individuals or groups becoming extremely vulnerable due to the already pre-existing inequalities they face in day-to-day society. A report by the Intergovernmental Panel on Climate Change (IPCC) on impacts, adaptation and vulnerability notes that individuals who are marginalized on the basis of social or economic class, culture, or otherwise are especially vulnerable to climate change. This heightened vulnerability is not due to a particular or single cause, but rather inequalities that exist in society due to certain forms of discrimination, such as on the basis against gender, class, ethnicity, or age (IPCC, 2014). The negative effects of climate change tend to exacerbate the unequal conditions that certain groups already struggle with.

Studies have shown that the effects of climate change are felt differently by men and women. Women disproportionately suffer the impacts of disasters and climate change events due to cultural norms such as the inequitable distribution of roles, resources, and power (Yavinsky, 2012). It is important to note that the heightened impacts faced by women are due to these existing inequalities and multidimensional social factors, rather than solely biological sex (UNFCCC

Synthesis Report, 2019). This is particularly true in developing countries where existing gender inequalities are caused by unequal power structures, discriminatory laws and customs, and unequal access to and control of resources. This creates vulnerabilities for women that arise from non-climatic factors but are further compounded by climate change.

This paper explores the question of whether economic empowerment can be used as a tool to increase women's resilience to climate change and disasters and thus reduce their vulnerability, with a focus on women and women farmers in the agriculture industry due to this sector's extreme sensitivity to climate change. Because women play a significant role in the agricultural labour force[1], they will have to disproportionately bear the burdens of climate change on farms (Food and Agriculture Organization (FAO) of the UN, 2011). The purpose of this research is to examine whether providing women with the additional resources needed to level them with their male counterparts in the agriculture sector can in turn aid them in building resilience against climate change.

This paper will analyze how increased access to certain economic tools, such as microcredit, markets, and climate information, can empower and position women to better manage the effects of climate change not only on their own livelihoods, but also those of their families and communities. Through an examination of the challenges to women's economic participation, this paper will demonstrate how overcoming the socioeconomic inequalities women face can in turn help them to reduce their vulnerability to climate change and instead build resilience. The paper argues that climate change exacerbates existing biases against women and women farmers, who continue to face discrimination in accessing credit, markets, and climate information, and

[1] Women are responsible for 60% to 80% of food production in developing countries (FAO, 2011).

increasing access to these services aids in building their resilience because they will have the necessary resources to adapt their livelihoods to the adverse effects of climate change and disasters.

This paper is divided into six sections, the first section serving to introduce and establish the research question. The second section of this paper will define several factors that can contribute to women's economic empowerment, and explain why this paper chooses to focus on these factors (namely access to credit, markets, and climate information) as the economic tools for empowerment. It will also define climate resiliency and how it is linked with women's economic empowerment. This section of the paper aims to serve as a conceptual framework to better understand the linkages between discrimination against women, women's economic empowerment, and the importance of building climate resilience.

The third section of this paper reviews insights from the literature on the topics of women's vulnerability to climate change and economic empowerment. This section provides an overview of what has been researched on the subject and how this paper aims to contribute to ongoing discussions. The fourth section outlines the methodology for choosing the regions and case studies in this paper.

The fifth section provides context around the various barriers women face to accessing credit, markets, and climate information. 2-3 case studies are used in each subsection to showcase examples of overcoming these barriers through providing training and additional resources to women. The sixth section concludes with a reflection on these challenges and also provides recommendations on how governments can mainstream gender perspectives in their national policies and strategies to ensure that climate change initiatives actively include women's participation in all stages.

2. Economic Empowerment and Climate Resilience

Economic Empowerment

Around the world, women are disadvantaged in relation to men due to reduced economic opportunities and as mentioned, many structural inequalities that increase their economic vulnerability. Biases exist against women in many sectors, including the economic sector, health, politics, education, agriculture, among others (BBC, 2020). The focus of this paper will be on economic aspects in the agriculture sector. Climate change further exacerbates biases in this sector and because many women do not have the capacity to deal with these extra burdens, government and/or non-governmental interventions are needed to address the existing inequalities and prevent future ones that may be created as a result of climate change. For women to be able to participate fully in economic and agricultural activities, they require the same level of access to resources and the same protection of rights as their male counterparts. However, this is not the case since women do not always enjoy the same rights as men. It is crucial that women receive adequate support to increase their economic empowerment and participation in order to be provided with the resources and knowledge needed to adapt to the risks and effects of climate change.

The term "empowerment" has been defined in various spheres. It can be defined as a "multi-dimensional social process that helps people gain control over their own lives" (Page and Czuba, 1999). Women's empowerment refers to "women's ability to make strategic life choices where that ability had been previously denied them" (Malhotra et al., 2009). Malhotra at al. (2009) also note that empowerment is central to creating and maintaining the benefits of women at individual, household, community, and broader levels. Thus, women's empowerment is about allowing and equipping women to make important choices. This definition can be expanded further into the sphere of women's economic empowerment.

The Swedish International Development Cooperation Agency (SIDA) defines women's economic empowerment as:

> "The process that increases women's real power over economic decisions that influence their lives and priorities in society. Women's economic empowerment can be achieved through equal access to and control over critical economic and financial resources and opportunities, and the elimination of structural gender inequalities in the labour market, including a better sharing of unpaid care work" (SIDA WEE Series, 2013).

Further, The UN defines women's economic empowerment as:

> "Women's ability to participate equally in existing markets; their access to and control over productive resources, access to decent work, control over their own time, lives and bodies; and increased voice, agency and meaningful participation in economic decision-making at all levels from household to institutions" (UN Women, 2018).

Both definitions highlight the importance of equal access to and control over economic resources and opportunities, access to the labour market, as well as increased voice and participation on economic decision-making. Additionally, the director of the United Nations Environment Programme (UNEP), Inger Anderson, has stated that "unequal access to land tenure, financial resources, and decision-making power can create economic stress for households in times of crisis, leaving women disproportionately exposed to climate-related security risk" (UNEP, 2020). These definitions commonly signal that equal access to i) economic and financial resources; ii) fair labour market opportunities; and iii) decision-making powers are all vital to achieve women's economic empowerment.

To this end, this paper explores how increased access to land and credit (i. economic and financial resources), access to market (ii. fair labour market opportunities), and access to climate

information (iii. decision-making power) can be used as tools of economic empowerment to provide women farmers with the necessary resources they need to continue making a living in the face of climate change. UN Women emphasizes that women's economic empowerment is about rights and equitable societies. Enhancing it can lead to increased economic growth and sustainable development, promotion of social development for women, and reduced poverty levels, thus providing women with resiliency against climate change (UN Women, 2014).

Climate Resilience

The Centre for Climate and Energy Solutions defines climate resilience as "the ability to anticipate, prepare for and respond to hazardous events related to climate change" (C2ES, n.d.). Moreover, Adger et al. define resilience as "the ability to absorb perturbations without changing overall system function, the ability to adapt within the resources of the system itself, and the ability to learn, innovate, and change" (Adger et al., 2011). Building women's resilience to climate change is especially crucial given the fact that many of their traditional roles revolve around agricultural production and procuring water, cooking fuel, and other household resources – all of which are negatively impacted by climate change. Therefore, an important step in tackling the challenges of climate change is empowering women to build their resilience and safeguard the environment.

Women are particularly vulnerable not only due to the direct effects of climate change (i.e. natural disasters), but also to the indirect effects. Research has shown that in Chad, gender-based violence and structural inequalities limit the capacity of communities to respond to climate shocks. Many men migrate away from local villages in search of alternative livelihoods in farms or mines far from home, leaving women with greater economic burdens (UNEP, 2020). Therefore, interventions around natural resources and climate change are necessary to provide women with

significant opportunities for economic leadership and empowerment, thus strengthening and building their resilience to climate change.

Women are said to be powerful agents of change, particularly in developing countries where they play significant roles in supporting their households as caretakers and providers of food and water, and they can play an important role and be strong advocates for climate action and sustainability in the agriculture sector (UNDP, 2020). This entails building the capacity of women farmers to fully participate in the economic sector in order for them to successfully act against climate change.

For successful action on climate change and disaster resilience, women need to be able to withstand the additional shocks and burdens brought about by climate change and disasters. To accomplish this, it is integral that women have equal access to and control over the resources that they will need to adapt to the effects of climate change (Ibid). This requires securing women's rights to land as collateral so that they are able to access credit, while also ensuring that microfinance options are accessible to rural women. To ensure that vulnerable women farmers are able to cope with the effects of climate change on their homes, crops, or land, they must be able to sell their goods and make a decent living, thus displaying the need for equal access to markets. Increased access to climate information, including information on weather patterns and new climate-smart technologies, are necessary to provide women farmers with the same level of information that many of their male counterparts receive.

Increased access to microfinance strengthens climate resilience by helping households overcome the financial barriers to implementing adaptation options that reduce exposure or sensitivity to natural disasters (Fenton et al., 2017). Household adaptation is when households adjust to changing conditions, hazards, risks, and opportunities posed by climate change. This need

to adapt stems from existing vulnerability to climate hazards. Fenton et al. note that adaptation is distinct from coping. Coping refers to immediate household responses to environmental and climate hazards when they occur, such as obtaining credit or selling assets, while adaptation consists of reactive changes that reduce long-term vulnerability (Fenton et al., 2017). In order to cope with adverse effects of climate change by selling assets, women must have fair access to labour markets. Therefore, accessing credit and labour markers is crucial for women to adapt to and cope with climate change and is necessary to build their resiliency in the long-term.

The UNDP notes that women's involvement is key in disaster risk reduction and that further down the line, strengthening the participation of women in decision-making processes builds their capacities to participate in the formulation and implementation of policies and programs of relevant institutions to ingrate gender perspectives (UNDP, 2020).

3. Insights from the Literature

There is a broad range of literature on the topics of climate change and gender equality. Some of it encompasses ways to promote women's economic empowerment while reducing vulnerability to climate change, while others solely focus on the barriers to women accessing certain economic resources that are necessary to combat climate change, such as access to credit.

A UN report on the differentiated impacts of climate change on men and women cites the following as the most frequent reasons for women's increased vulnerability to climate change impacts when compared to men: discriminatory and patriarchal laws and institutions that exclude women from participating in decision-making and community processes; limited awareness of legal and human rights; limited or no access to or control over resources and assets; unequal burden

of unpaid domestic and care responsibilities; and increased exposure to gender-based harassment and violence (UNFCCC Synthesis Report, 2019). These issues demonstrate that the economic playing field is not as open for women to perform, due to the fact that they are unable to access loans, political offices or land ownership. Since women are unable to fully participate economically, 50% of the population is left out of the workforce, which prevents economies from flourishing (Breland, 2020). If policies are in place for women to better participate economically while having their rights protected, they can work and acquire more resources to fall back on in the wake of a climate disaster.

Women are evidently an integral component of agriculture in developing countries, and due to their specific roles in food production, they are the repositories of knowledge on cultivating, processing, and preserving nutrients and locally adopted crop varieties (Tripathi et al., 2012). Given the right opportunities, women can become innovative leaders in sustainable agriculture. The UN FAO says that increasing women's contribution to food production and enterprise by providing equal access to resources and opportunities could reduce the number of hungry people in the world by 12-17%, or by 100 to 150 million people (FAO, 2011). This demonstrates that if given the proper resources, women can become empowered and build resilience for themselves, which in turn can help their families, communities, and more broadly, their countries. However, women face various barriers in accessing these resources.

In her book *Gender and Climate Financing* (2016), Mariama Williams discusses the different gender biases that operate in global financial markets and prevent women from accessing climate finance as they need. She notes how the participation of women's organizations within the United Nations Framework Convention on Climate Change (UNFCCC) has historically been weak, making women underrepresented in boards and delegation. Because women as a group did

not have a significant and organized presence at climate change policy gatherings until fairly recently, policies are created without the appropriate gender considerations in mind.

Moreover, women in developing countries are less likely to have a formal bank account. The World Bank's Global Findex show that in developing countries, women are 20% less likely than men to have an account at formal financial institutions[2]. Williams discusses the different forms of discrimination as a key barrier to women trying to access credit or finance. She notes how although international institutions such as the World Bank have clear gender policies and women's empowerment as a goal in their organizational frameworks, these tend to diminish when it comes to climate change finance. Due to this, many regional and local banks are emerging to bridge the gap between gender and climate finance. It is imperative that regional banks use climate financing to ensure that the concerns and priorities of women are sufficiently met (Williams, 2016).

Although this book provides insight on how financial resources are generated, managed and distributed, and how certain gender discriminations act as a barrier for women to access finance, it does not explore how women have benefit from this increased access to finance. The impact that local banks have on women's economic activities is not clear, so this paper aims to fill this gap and provide examples of women using microcredit to better deal with the risks and costs associated with climate change.

An article in the *Journal of Agricultural Extension* discusses ways to promote women's economic participation while simultaneously counteracting climate change (Anjani et al., 2013). It notes the many ways in which climate change increases women's burdens[3], and how

[2] For example in South Asia, 41% of men have a formal bank account compared to 25% of women (Williams, 2016).

[3] Droughts, flood and deforestation can change how far women need to walk to collect water and wood, thus leaving them with less time to earn an income. Girls regularly drop out of school, more so than boys, to help their mothers gather these resources (Anjani, Onwubuya & Mgbenka, 2013).

communities can deal better with natural disasters if women play a leadership role. Similar to the previous literature, this article also mentions how women are consistently underrepresented in policy and decision-making processes about climate change at all levels – local, national and global. This needs to change because not only are women more vulnerable to climate change, they can play a pivotal role in counteracting it.

Anjani et al. (2013) argue that there should be greater decision-making powers for women at both the family and community level with regard to agriculture. Moreover, they provide four ways to strengthen economic empowerment of rural women for climate change adaptation: access to education and training, access to and control over productive resources, access to services, and access to markets. However, the way these are described tend to overlap and do not provide a clear picture. Access to markets in this context includes land, labour, financial and product markets, while access to control over resources also includes land rights, and access to services also includes financial resources. If these categories were further fleshed out, perhaps the distinction would be clearer.

A few authors (Hill, 2011, Doss et al., 2012, Fontana and Paciello, 2010) have explored multiple avenues to empower women socially and economically through improved agricultural practices. Proposed interventions include access to credit, savings and financial services, women's access to land and tenure security, market access, access to other productive resources, and technology (Doss et al., 2012, Hill, 2011). These articles also outline some of the key issues around women farmer's economic empowerment within the context of their multi-dimensional roles and responsibilities. However, the link between empowerment and climate change is not made clear by the authors. For example, Hill (2011) focuses on the empowerment of rural women to aid them out of poverty, rather than to build their resilience to climate change. Doss et al., (2012) also

explore economic empowerment and supporting women farmers in the agriculture sector. The arguments made in these articles are relevant to the research undertaken in this paper, but this paper approaches the economic empowerment of women as a tool for them to reduce their vulnerability to climate change, which in turn encompasses the arguments of reducing poverty and other socioeconomic barriers for women through this empowerment.

Similar to Hill (2011) and Doss et al. (2012), this paper will focus on women's lack of access to credit and markets, which are commonly cited as hampering women from being fully able to participate in the economy. Women in developing countries have less access to credit, or financial services. According to the World Bank, women make up 40% of the world's workforce and account for 30-37% of small and medium-sized, female-owned enterprises in emerging markets. The biggest barrier to growth and development is the fact that these women-owned business have unmet financial needs of USD $260 billion to USD $320 billion a year (Isaac, 2014). Increasing women's access to credit can create new economic opportunities for them, but women employers face significantly greater challenges to access financial services than men. This could be due to the fact that women are less likely than men to have formal bank accounts and access to other financial services such as savings and insurance, or they are unable to access credit due to the fact that many of them are responsible for land or other property that is not under their own name, but rather a male relative (Ibid). In addition, a World Bank study found that 155 out of 173 countries currently have at least one law impeding women's economic opportunities, including access to credit (World Bank, 2016).

Lack of access to markets can impede on women's abilities to sell their goods and services. Women can add value to the goods they produce by trading or selling in local markets or as a vendor along different value chains. However, they face certain barriers in accessing these

markets, such as physical difficulty accessing markets due to limited transport opportunities in more rural areas, as well as challenges in negotiating prices with buyers (UN Women Watch, 2012). Furthermore, women face constrains from the supply side, including a lack of access to information. Women may not be able to access information on price differences at different locations, or different points in the value chain. They also do not have access to timely and accurate information on quality or quantity requirements, nor have the capacity to know about let alone meet increasingly stringent food safety standards (Ibid). All these factors put women at a disadvantage and prevent them from fully participating in markets, thus preventing them from making an income to support them in times of disaster and increasing their vulnerability. It should be the norm for women to having equal access to markets, but this is especially true in the face of climate change, where women will need additional income and resources to adapt.

Lastly, access to climate information is an important tool for women farmers to understand weather patterns and better manage climate risks (Diouf et al., 2019). Climate information services (CIS) include the production, translation, transfer and use of scientific information for decision-making (Ibid). A study by CGIAR's Climate Change, Agriculture and Food Security research program suggests a few ways in which women have less access than men to climate information and climate decision-making: financial power decides who buys new crops and fertilizers, and because men are usually the ones responsible for their household finances, they decide which crops and fertilizers to farm. Men could also travel more easily to markets to purchase needs than the women, who stayed home to take care of household needs (Schubert, 2013). Other reasons why men are found to be more receptive to adopting CIS use to manage climate risks is because they are more likely to access mobile phones than women, while women generally access their

husband's phone (Dembele, 2018). These barriers prevent women from accessing timely information that could help adjust their behaviour to better mitigate the risks of climate change.

4. Methodology

The purpose of my research is to use available literature to explore how providing women with better access to the economic tools of credit, markets, and climate information can be a vital step in reducing their vulnerability to climate change. I explain the current barriers to each of these three tools and then use 2-3 case studies in each section to showcase examples of programs being implemented to overcome these barriers through providing training and additional resources to women. I selected the case studies based on the key words of the research purpose – "access to land", "access to credit", "access to market", and "access to climate information". As suggested by Tsang (2013), in selecting these case studies, I paid attention to whether the findings can be generalized in several important aspects of my research on access to credit, markets, and climate information.

The case studies I use include programs implemented in Mali, Niger, Uganda, India, Bangladesh, and Southeast Asia (Laos, Cambodia, Vietnam). Mali and Niger are located in the Sahel region of West Africa which is one of the poorest parts of the world. 40% of the population across the 5 Sahel countries live on less than $2 a day (Bodewig, 2019). This is exacerbated by the fact that temperatures in the Sahel are expected to rise 1.5 times faster than the global average (Ibid), thus putting poor and vulnerable women at an even greater risk. South Asia is also home to some of the world's most vulnerable countries to climate change. Due to rising temperatures, more than 25,000 glaciers in the Hindu Kush Himalayas are retreating fast. This proves a big challenge

since they provide water and energy to 1.9 billion people (Fallesen et al., 2019). Bangladesh is particularly vulnerable to floods due to its low elevation, high population density and inadequate infrastructure. As sea levels rise, storms, cyclones, droughts, erosion, landslides and salinization are displacing a large amount of people (Environmental Justice Foundation, n.d.). These conditions are also reflected in Southeast Asia, where countries face catastrophic consequences as a result of rising sea levels. Long coastlines are regularly victims to natural disasters like typhoons and tsunamis (Kurlantzick, 2019). I chose to examine these regions due to the extreme nature of climate change and due to the fact that women in these countries are disproportionately affected by these disasters.

The research and case studies revolve around women smallholder farmers and workers in the agricultural sector. This is due to the fact that most countries depend heavily on agriculture and the effects of global warming on productive croplands threaten the welfare of not only women but of the population as a whole, as well as the economic development of the countries (FAO, 2011).

5. Economic Empowerment Tools: Access to Credit, Access to Market, Access to Climate Information

Access to Credit

The costs of climate change are more difficult to bear for women in developing countries. Many women are responsible for land or other property that is not under their own name, but rather a male relative, so they are unable to access credit or finance. Access to and control over economic and financial resources is necessary to enable women's economic empowerment, improve food security, and improve general livelihood conditions, especially in rural communities (Hill, 2011). Because women are less likely than men to own land and livestock, they are unable to access credit

or other financial services from local financial institutions as needed. Property rights need to be addressed because women's ownership and control of land can determine other factors such as housing quality, security, and broader possibilities for livestock-keeping, small-scale enterprise development, access to water, wood, and most importantly in this case, credit (Ibid). Many women face gender disparities in accessing credit because of their lack of access, control and ownership of land or other collateral. Therefore, access to property and land is an important consideration for women to access credit or financial services. For that reason, this section will be divided into two sub-sections: access to property and access to finance.

Access to Property

In many developing countries, especially rural areas, customary practices and norms contradict policy and legislation that are meant to protect women's right to land and other protective resources (Hill, 2011). Social norms and laws, or lack thereof, allow women to be excluded from decision-making on their own land and the crops that it yields. According to the Landsea Center for Women's Land Rights, women's rights to access, use, and manage land in Africa and South Asia are often denied and they are rarely allowed to control the land where they raise crops (LCWLR, n.d.). In many of these countries, women's ties to land is often dependent on their relationship with male family members. Because women own less land than men overall, or own land legally under the name of a man, they have fewer assets to sell when crops collapse due to climate change, and they are unable to continue farming. Effective policy and legislation is needed to affirm women's rights to land and property. One way to do this is to separate men and women's rights from their civil or marital status, thus allowing women to register land under their own name rather than the name of their husband or son (Hill, 2011). As traditional leaders and

heads of communal land groups, men also need to be engaged to help build an improved understanding of the need for a change in gender and power dynamics when it comes to the use of resources. Communities need to come together to achieve this, as demonstrated in the Niger case study below.

Case Study: Bioreclamation of Degraded Lands in Niger

The Sahel region in Africa has a hostile environment that has further been compounded by climate change. The region is suffering from extreme temperatures, fluctuating rainfall and droughts, which are degrading land, changing grazing patterns, and reducing water supplies (Penney, 2019). This in turn jeopardizes food security. The soil is sandy and acidic, very poor in nutrients, and has low organic carbon content. The harsh conditions degrade the soil, but in this region, 60 million poor people need to live and grow food (ICRISAT, 2009). With other effects of climate change and widespread degradation, environmental migration is also on the rise. This is particularly true in Niger, which is fast becoming a migration hub towards North Africa and Europe. Niger also has the fastest growing population rate in the Sahel, with an annual growth rate of 4% (ICRISAT, 2017). Because the widespread soil degradation and climate variability can make it difficult to sustain a family year-round, increased investment in agriculture and food security is necessary, especially for women and their children who are at a disadvantage due to less access to productive land to produce food (Ibid).

The International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) has developed a system for rain-fed horticulture production adapted to semi-arid land, called the Bioreclamation of Degraded Lands (BDL). The BDL is an integrated system aimed at increasing food production and income of poor farmers, mainly women, through using degraded lands to

produce rain-fed fruit trees and vegetables (ICRISAT, 2009). A hard red lateritic layer prevents water from seeping into the degraded soil and prevents plants from growing, so traditional water-harvesting planting techniques are used (ICRISAT, 2017). Micro-catchments called demi-lunes (half-moon structures) are built to catch runoff rainwater, where it is stored to irrigate trees. They are spaced at 5m x 10m and trees are planted in them. The area between demi-lunes are occupied by planting pits called "zaï" holes, where compost or manure is placed at the bottom and covered with soil. Traditional vegetables are planted here and the zaï holes are also used collect runoff water. The deeply placed manure allows for extensive root growth, giving the plant both water and nutrients (Ibid). The process is pictured below (ICRISAT, 2009):

A single tree is planted in each demi-lune (half-moon)

Manure is placed in zaï holes, which are dug between the demi-lunes

Historically, women have been denied the right to own cropland in Niger and other parts of the Sahel, but now they are able to cultivate vegetables on this new "reclaimed" land. A village chief allots degraded lands to women. The women form associations that are legally registered, and the land is allotted to them for 15 years. The land does not belong to an individual woman, but to the association. If an individual man wants to take land from his wife, he must go through the

women's association and the Chief who legally issued the land, thus protecting the women's right to that land. Using the BDL system, 241 hectares of degraded land was converted into productive farms for 10,770 women, which resulted in an agri-income increase of 50% (ICRISAT, 2016). Women were trained in BDL, planting nutritional vegetables such as okra, and using drought-tolerant trees. In addition to food, trees were also used for firewood, fodder, shade and live fencing to protect farming plots against animals (ICRISAT, 2016).

The initial results from a mid-term evaluation in 2016 showed that the BDL system positively affected women by giving them access to land and increasing their income – there was an average increase in household income of women participants by about USD $26, which is approximately a 50% increase over non-BDL farmers. ICRISAT research found that a 200m^2 BDL plot could yield an annual income of approximately USD $100, which is equivalent to what men usually earn from lower levels of production, but shows an improvement in women's wages (ICRISAT, 2017). Household nutrition was also shown to have increased – vegetable and trees brought essential nutrients and improved diet diversity. Women could also save up dried okra for up to 5 months, ensuring that their families continued to have nutritious food during the dry season (Ibid).

This example showcases how increased access to land can provide women with the necessary economic resources to adapt to the adverse effects of climate change. The women who were trained in BDL previously did not have access to land and were suffering from food insecurity, and the effects of climate change further exacerbated it. These findings are in line with a UN Committee on the Elimination of Discrimination against Women (CEDAW) report, which suggests that efforts to tackle climate change are more successful when women hold secure rights to land, and that responsibilities and benefits associated with climate response programs are more

equitably distributed (CEDAW, 2016). This is because if women do not hold effective legal control over the land they farm on, they lack the incentive, security, opportunity and authority to make decisions on how to sustainably develop the land for long-term productivity.

The BDL case study shows that secure rights to land and natural resources prove an incentive for women to invest in its conservation. If the reclaiming land for agriculture is practiced in other developing countries, it can benefit women, their families, and their communities in many ways. The women's association is also a key legal stipulation because it protects their right to own and control land. With secure access to and control of their own land, women will have a better chance at receiving credit or financial assistance.

Access to Finance

Without access to credit, women will lack the capacity to deal with the risks and costs associated with climate change, nor will they be able to improve or increase their agricultural productivity. Credit can also strengthen climate resilience by providing financial coping and adaptive capacity (Fenton et al., 2017). As mentioned, barriers to women's access to financial services[4] include policy constrains and cultural norms that keep women from having bank accounts, or from entering into contracts without their husbands or with other men (Hill, 2011). Credit, savings and loans are integral to creating long-term achievements for women in the agriculture sector. However, there is a gendered aspect to receiving loans – an important issue is whether individual loans will be given to women, or if they can only get joint loans with men (Doss et al., 2012). Because of the land and asset ownership issues discussed previously, the

[4] Rural finance includes retail and wholesale institutions that offer financial services to the poor and extremely poor (microfinance) including formal private sector providers, informal mutual financial mechanisms, formal sector providers, specialist microfinance institutions, and membership-based financial organizations (World Bank/FAO/IFAD, 2009, p. 85)

question of whether to provide a loan to a women or issue her a joint loan with her husband is intensified in the context of women in the agricultural supply chain. There are various reasons for this: as mentioned, even if women are in charge of land, they cannot use it for collateral if it is not registered under their name. Additionally, there have been instances where men took out loans without telling their wives, leaving the family in debt (Ibid). Because of these issues, many projects prefer to issue joint loans, or at least require family knowledge. BRAC Uganda, a credit institution in Uganda, allows women to take out smaller loans by themselves, but requires joint loans for larger amounts (Whisson & Coppel, 2017).

Moreover, it is important that women who receive loans also receive financial education and business planning. This is particularly true for women with lower literacy skills who need to be taught how to keep significant records in their bankbooks (Doss et al., 2012). Projects should provide women with the necessary tools to budget, record and manage their finances so that they may take full advantage of a microloan.

Women are less likely to get credit to buy drought-resistant crops, and they are more likely to be allocated marginal lands that are at a heightened risk of climate impacts such as flooding or downpours (Habtezion, 2013). Women farmers in South Africa reported that lack of access to credit was preventing them from adapting to increased temperatures and variability of rainfall (Gbetibouo, 2009). Therefore, an increase in access to credit and finance is necessary for women to adequately adapt to the effects of climate change, both for their land and for their livelihoods.

Case Study: BRAC Uganda

BRAC Uganda began its operations in 2006 as a subsidiary of the Bangladesh Rehabilitation Assistance Committee in order to help reduce poverty and empower poor and

marginalized populations. The organization has a core microfinance program that is complemented by agriculture, food security, health, and livestock programs, among others (BRAC International, n.d.). BRAC organizes women's groups in the area it serves – larger groups of 20 to 30 women are divided into groups of 5, including an elected leader. Microloans are distributed through these groups, and members can take co-responsibility for loans, providing a solution to peer repayment. This method also encourages group savings (Doss et al., 2012).

In their agriculture program, BRAC aims to increase the productivity of women farmers at the subsistence level. BRAC Uganda provides training to community agriculture promoters, who then deliver lessons to microloan groups on new technologies for improved cultivation methods, seed sowing and selecting, pest and disease management, and climate-smart agriculture (CSA). This training can aids in agricultural activities and is also necessary for climate change adaptation. This agriculture program is targeted exclusively to women due to the fact that women tend to be the primary farmers at the subsistence level in Uganda (Ibid). BRAC Uganda's loan programs are designed to better serve women farmers and has adjusted the repayment term to allow time to accommodate growing seasons and conditions in Uganda.

BRAC Uganda's holistic approach is responsible for its success – rather than having a single strategy, flexible microloan programs are coupled with agriculture, health, and other programs to empower women to become successful farmers and businesswomen. According to BRAC's vision, they aim to address climate change adaptability in all programs. This program adapted an integrated approach to addressing climate change impacts, and used adaptation measures throughout the development initiative. The project helped women farmers to access the necessary tools to adapt and respond to adverse climatic impacts and adopt sustainable practices to combat impending climate impacts (BRAC, 2020). An integral part of the project was that it

provided women receiving loans for agricultural activities with additional training and tools required to make correct and climate-aware decisions.

Case Study: Grameen Bank, Bangladesh

According to recent evidence, Bangladeshi families in rural areas have been spending approximately 12 times more each year than the foreign aid Bangladesh receives to adapt climate change (Karim, 2019). A report from the International Institute for Environment and Development notes that households headed by women are under even greater pressure because they earn less than men and spend a larger share of their earnings on dealing with climate-linked disasters (Ibid), which shows that the poorest households in Bangladesh are bearing the brunt of climate change. This is especially true due to the fact that rural areas in the country are extremely flood-prone and will face additional impacts of rising temperatures and sea levels.

Research has found that rural households in Bangladesh spend $2 billion per year (about $79 per family) to prepare for and deal with storms, floods, and repairing homes. The government increased spending to aid rural areas with climate impacts from $884 million in 2014 to $1.46 billion in 2018, but according to the data, this is not enough to help sustain the families (Karim, 2019). These issues are exacerbated in female-headed households, but poor women are vulnerable regardless. Poverty is prevalent amongst both men and women in rural Bangladesh, but women suffer far more due to low socioeconomic status, social customs and religious beliefs (Momtaz and Asaduzzaman, 2018). Therefore, institutions such as the Grameen Bank are integral to provide support to poor and rural women to help them better leverage their resources and empower them to benefit themselves, their families, and their communities.

The Grameen Bank is a micro-credit institution in Bangladesh that lends small amounts of money to poor people who are unable to access conventional banking systems due to their lack of collateral. It was founded in 1976 by Mohammed Yunus when his country was stricken with famine. He lent money out of his own pocket to poor village women so that they could invest in livestock and other resources. He then received sponsorship from the central bank of Bangladesh as well as other commercial banks, and the Grameen Bank became an independent entity in 1983. Women make up more than 96% of its customers and use loans to invest in business ventures such as small-scale agriculture and mat-weaving. Despite a national illiteracy rate of 78% for women, rural Bangladesh has seen a significant increase in economic activity since the inception of Grameen Bank (BBC World Service, n.d.).

This case study was selected from *Journal of South Asian Studies* and explored how female Grameen entrepreneurs can use microcredits to build empowerment and help them to adapt to local-level extreme climate events such as flooding. The author surveyed 25 women in rural areas of Bangladesh based on the dynamics of their microcredit history and their eligibility to receive a loan (Morshed, 2014). Dula Barua, a poor woman in her fifties, lived in a dilapidated hut with mud walls and a thatched roof, similar to other huts in her small village of Boalkhali, many of which were exposed to the elements due to improper roofing. Her husband was a labourer and when he died, she was left to provide food for herself and her two children. Because did not possess any marketable skills and was illiterate and virtually unemployable, she reached out to the Grameen Bank and received a microcredit of about USD $35. Dula invested this credit in weaving, making floor mats, and stitching fabric decorations. She sold her products in a nearby village market and after saving up for a few years, she reinvested her money to enlarge her operations of making homeware. The microcredit loan helped alleviate her from the severe impoverished state that she

had previously faced in rural Bangladesh. The credit also turned out to be a safety net during the time of local disasters such as flooding and loss of property in her village.

In another poor village called Bhaluka, a women named Sharifa was landless and essentially destitute. She also became a Grameen borrower and used the credit to buy two cows, and with help from her children, she milked the cows and employed her husband to carry and sell the dairy product in the mostly male-dominated local market. Sharifa was barely educated and married at a young age due to cultural norms, and her employment prospects seemed very weak. Due to Grameen's microcredit loan, she was able to build and manage a business that produced significant results.

Morshed notes that all stories of micro-borrowing are not as successful as these two (Morshed, 2014). A few women out of the 25 he surveyed were not successful in their microcredit-based businesses, and there had also been increased marginalization due to debt crises and gender prejudices that restricted women's access to finance. Nonetheless, the success stories of Dula Barua and Sharifa represent a broad pattern of economic empowerment for women through access to credit. Their income-generating capacity greatly increased, which is a fundamental requirement for economic and social growth. Both women saved enough to move out of their mud huts, which were extremely vulnerable and easily destroyed by floods and heavy rains, into houses built on brick foundations with concrete pillars (Morshed, 2014). This is an example of using adaptation (households adjusting to changing conditions posed by climate change) to build climate resiliency. Dula and Sharifa were able to reduce the vulnerability of their homes to local disasters such as floods and heavy rainfall by saving enough to move to homes that were more resistant to the elements. With a more secure home, both women will incur less costs on damage to property as a result of the effects of climate change.

Women in many small villages in Bangladesh have asserted that floods and droughts continually lead to destroyed crops, property and economic loss, and most severely, to their families' food insecurity. Changes in rainfall patterns have forced women to change the timing of sowing and pumping river water to their plots or bucket irrigating (Caretta, 2014). These strategies can be categorized as reactive adaptation measures, and women must be able to access finance for this reason. With the risk of climate change, savings and loans coupled with training activities provide women with extra means and practices to plan ahead of time and adapt to climate variability (Ibid). Therefore, increasing access to credit can build the resiliency of women by providing them with the capacity to adapt to climate shocks. This finding is in line with arguments in the literature that state credit acts as an ex-post source of capital when environmental and climate hazards occur (Fenton et al., 2017) and that credit is an important coping mechanism more generally (Banerjee et al., 2015).

Potential problems with microfinance

Daas and Leuven analyze the microcredit sector in Andhra Pradesh, India, which recently saw a series of challenges and mishaps as a result of extensive and uncontrolled lending (Daas & Leuven, 2018). They report that lending institutions undertook unethical financial practices for recovering loans, such as confiscating property or socially shaming the default borrowers. These actions resulted in widespread cases of suicide by microfinance borrowers. The crisis faced widespread coverage by global media, which reignited discussions on the best microfinance strategy for alleviating poverty.

Furthermore, Bateman and Chang support the view that microcredit institutions have ignored the basic economical aspect of scale in agriculture (Bateman & Chang, 2009). They note

that many microfinance terms and conditions do not support the objective of sustainable agriculture, which results in the proliferation of overly unsustainable agriculture entities. Most of the largest commercial banks in India focus their lending strategies on the agriculture sector, which employs about half of the labour force of the country (Mader, 2013). These ill practices cause a huge burden to poor borrowers, especially women. Therefore, financial interventions aimed at spurring economic growth should follow a community-based approach to better understand local needs, and measures need to be put in place to protect borrowers if they are unable to repay on time, such as climate-proofing loans.

Climate-proofing loan products

Because destructive effects of climate change can wipe out assets that poorer and vulnerable people build up over time, microfinancing institutions must take the appropriate steps to adapt to climate change and ensure that their clients are able to maintain their income and assets in spite of the adverse effects of climate change (Dowla, 2009). Dowla suggests that in order to climate-proof loan products, microfinance institutions should be made more flexible. Loan repayment schedules are fixed over the duration of the loan, but it may be difficult for borrowers to repay if they lose their income opportunities during natural disasters such as floods. This is why most microfinance institutions in Bangladesh have started allowing their clients to reschedule installments during times of flooding, similar to BRAC Uganda's adjusted repayment term to allow time to accommodate growing seasons and conditions (Doss et al., 2012). Grameen Bank also allows its borrowers to negotiate their loan contracts if they are unable to complete their repayments on time (Dowla, 2009). These schemes help women to cope with local climate-related natural disasters and sustain their livelihoods.

Access to Markets

Many women in developing countries are involved in the production of agricultural and value-added goods that are traded in local and export markets. Small rural entrepreneurs, women in particular, face barriers to competing in domestic markets (which often sell cheaper and imported foods) as well as accessing wider export markets (Fontana and Paciello, 2010). Although women are increasingly providing national and international markets with high-value produce, they face various disadvantages that men may not, such as lower mobility, less access to training, and less access to market information (Hill, 2011). Evidence from the World Bank suggests that women tend to lose income and control over their agricultural products when they are marketed (World Bank, IFAD, FAO, 2009). This loss of income places women farmers in vulnerable positions, especially when coping with climate change, which signals that access to markets must be the norm for women so that they are able to generate a fair income to sustain their livelihoods.

Moreover, smallholder women farmers are negatively impacted by global markets that allow free entry of agricultural producers into domestic markets. For example, when pre-cut fries entered the Philippines' market, potato farmers (who are mostly women) were put at a disadvantage (Hill, 2011). This displays the vulnerability of women farmers face when they are not able sell their products in markets. Market access is a crucial method for women to generate income, but women are less likely than men to have access to all levels of market – local, regional, and international (Doss et al., 2012). In order to combat this, women farmers should be taught the necessary marketing skills to negotiate sales. Access to markets is an important consideration to build women's resilience to the effects of climate change because women working in agriculture are particularly sensitive to natural disasters and they require the means to reduce the risks they

face, adapt to change, cope with the aftermath of disasters, and rebuild their lives and livelihoods (Tripathi et al., 2012).

Tripathi et al. (2012) discuss how collective action is a powerful tool for women to increase productivity and access markets while sharing information and knowledge with each other. The use of farmer's groups is a common method to link small farms to markets – groups can create marketing strategies and acquire necessary technology if they pool together their surpluses and funds, which benefits even individuals with few resources. The pooling of resources is a crucial step in connecting smallholder farmers to larger markets. Once these groups establish a minimum volume of a good, they can reach various buyers such as supermarkets, processors, and even international buyers (Ibid). Due to the fact that women are involved in many aspects of agriculture[5], farmer's groups work especially well for them.

Doss et al. (2012) propose three ways to effectively engage smallholder farmers in markets to better foster economic success: i) facilitate connections between small farmers and large buyers; ii) provide training in marketing; and iii) foster local partnerships. In the first method, programs facilitate connections between smallholder farmers and larger buyers with the aim of creating deals with companies in other countries to export high value crops such as cotton, honey, and coffee. An example of this is SIDA's agricultural development fund program, FondeAgro, which facilitated a deal between Nicaraguan coffee farmers with several Swedish companies. The overall objective of this project was to alleviate poverty through increasing income in the rural parts of northern Nicaragua, with the main targets being smallholder female coffee and dairy farmers (Development Aid, 2018). This made Sweden the number one importer of Nicaraguan coffee.

[5] Women's agricultural activities range from growing home gardens to processing agricultural goods (Tripathi et al., 2012)

The second method, marketing training, focuses on teaching smallholder women farmers marketing and negotiation techniques so that they can use these skills to negotiate with local middlemen or other buyers. Marketing relationships in rural areas are dominated by middlemen, which is partly due to the fact that women farmers face a lack of market information which results in lack of opportunities to sell elsewhere, so they sell to middlemen. These middlemen can set any price they desire and smallholder women farmers lose a large amount of potential income due to this (Doss et al., 2012). Furthermore, majority of buyers are men who tend to take advantage of social and cultural norms to pay women lower prices, putting them at a significant disadvantage. This makes it clear that it is important for women to receive information and training to ensure they receive a fair price for their produce.

An example of this is the Shea butter project in Ghana which teaches women about contract agreements, conflict resolutions, and other skills to help them negotiate effectively with buyers. More than 600,000 women in Northern Ghana depend on the sale of shea butter and other shea-related products to generate an income (UNDP Ghana, n.d.). Income generated from shea butter production and sales significantly contributes to improve the living standards of local women and their households, providing them resilience to the effects of climate change. This project resulted in an annual increase of USD $250 in women's incomes (Ibid), showcasing that women lose less potential income if they are properly trained with negotiation skills and equipped with essential market information.

The last method is to foster local partnerships through creating a local demand for products. This is similar to the first method but at a much smaller scale, and involves two variations: i) establishing local buyer partnerships, such as with schools to buy local produce, and ii) creating a project-associated market, such as the one created by Sunhara India. This project developed an all-

women farmers market with women-owned shops, which bought and resold the produce of the aforementioned women's groups (Doss et al., 2012). This method empowers women in local markets and assists in raising their income. This form of economic empowerment is a vital step to enhance the resilience of local women to climate change through access to markets, as displayed in the case study below.

Case Study: Sunhara Prayas Project by Walmart, India

The Sunhara Prayas project was launched in Uttar Pradesh and Andhra Pradesh, India by Walmart in order to enhance the value chain of mango, banana and vegetable farmers, and ultimately economically empower women farmers and help them cope with climate-related economic shocks. This was a part of Walmart and the Walmart Foundation's training programs launched from 2011-2016 that were aimed at training more than one million women farmers worldwide (Walmart India, 2018). The project used a market-based approach to empower smallholder women farmers, and linked producer groups to large buyers such as Walmart locations in India and bigger farmer's markets. The project had three intervention strategies: i) form collective groups from villages, ii) start savings and credit practices within the groups, and iii) help build an understanding in communities on the importance of empowering women as economic agents (Doss et al., 2012).

The project called for women to form small groups across several villages, and these groups become a forum for receiving training and advice. The groups then join to form a federation, which collects produce from women farmers and negotiates deals with large-scale buyers. This system eliminates the need for middlemen and ensures that women receive a fair price. One year into the project, the federation had made more than USD $40,000 from vegetable and dairy sales.

Furthermore, the federation set up street carts and corner shops to sell 10% of the goods that did not go to large-scale buyers. The federation ensured that profits went back to women farmers (Ibid).

The Sunhara Prayas project also involved other forms of training such as literacy camps, where women were taught about their rights, how markets work, how to talk to buyers, and essentially how to become successful businesswomen (Doss et al., 2012). In addition, the project provided women farmers with information on climate-resilient farming techniques. Sadha Laxmi, a smallholder farmer, grew vegetables on her hectare of land in southern India but rarely made a substantial income from it. Training from the project encouraged her to grow tomatoes on half of her land using a new technique called "stacking". This simple shift in agricultural practice protected her tomatoes from heavy rains and improved productivity, thus increasing her income (ACDI/VOCA Annual Report, 2014).

By the end of its term, the Sunhara Prayas project successfully benefited around 5,000 women farmers and agriculture workers through empowering them socially and economically (Images Retail Bureau, 2014). The program brought about significant changes in the lives of women smallholder farmers in Uttar Pradesh and Andhra Pradesh. Through the three intervention strategies mentioned above, there was a 32% increase in the income of women farmers, 1,639 small farmers were linked to buyers, and 3,661 women reported increased access to credit and other financial services. Furthermore, the project led to a 20% increase in the production of five major vegetable crops and two major fruit crops (Ibid). The project also created social change by

creating the title “woman farmer” in the region, which is an important change since it recognizes that women do majority of the farm work[6].

The women involved in the Sunhara Project transcended from farmers to buyers and sellers as well, displaying how strengthened collective action and improved bargaining power can increase women farmers’ chances at receiving fair prices for their goods (Doss et al., 2012). They have been socially and economically empowered – many women reported increased decision-making powers in their households and communities. The project’s success hinges on the fact that it integrated women both horizontally in women’s groups, and vertically via federations to link them to markets (Ibid). This example encompasses the marketing methods proposed by Doss et al. above. It displays the positive impact of linking producer groups to large buyers, providing marketing and negotiation skills training, and fostering local partnerships.

The project also established 12 Farmer Resource Centres (FRCs) to offer services such as soil testing, information on good agricultural practices, equipment for irrigation, and pest and disease control for climate-smart agriculture (Images Retail Bureau, 2014). It introduced easy-to-adapt technologies such as harvesting and pruning equipment that are effective with regard to productivity and costs. This type of information is crucial for women farmers, especially when dealing with the effects of climate change. The Sunhara Prayas project is a great example of an integrated approach to economically empower women farmers while providing them with the necessary means, whether it be knowledge, training, or equipment, to build resilience against climate change and its effects.

[6] The concept of “woman farmer” did not previously exist in the region due to women being seen as “farmwives” rather than true farmers capable of sharing valuable knowledge about farming and agricultural practices (Abeka et al., 2012).

Case Study: Connecting women in Bangladesh to markets

Women in the Chittagong Hill Tracts (CHT) of Bangladesh, a mountainous region bordering Myanmar, are largely responsible for farming and other agricultural activities on communal plots. CHT is home to an ethnic Bengali tribe and has a temperate climate that is suitable for year-round agricultural growth (Kelly, 2012). Due to geographic isolation and ethnic discrimination, women were not able not access the markets, which are dominantly controlled by Bengali traders. To combat this, Hellen Keller International partnered with the UK Department for International Development (DFID) and the Government of Bangladesh to support the "economic empowerment of the poorest" program and to help farmers adapt climate-smart agriculture (CSA) practices. As part of the program, 45 women leaders carried out market surveys before the start of each growing season to identify products that are likely to yield the most profit. They interviewed suppliers, shop owners, consumers, and other market actors with the support of program staff in case any ethnically-driven discrimination occurred.

Survey results revealed that there was a scarcity of fresh vegetables being sold, with some venders purchasing from farms more than 600 kilometers away, and many restaurants reported that they could only obtain fresh vegetables on bi-weekly market days (which was not frequent enough to sustain their needs). This information allowed women farmers to target which vegetables to grow, what price to demand from buyers, and they were given the opportunity to sell their produce on days that the bi-weekly market was closed. This method of planning was a huge change from traditional strategies, where the same products were grown every year with little to no awareness of expected price or demand (Kelly, 2012). Conducting this survey was key to understand buying patterns, which is important market information for women farmers to have access to. Through the use this interview method, women farmers were able to adjust their

behaviours to meet market needs. Another example is spices – women farmers' interviews found that turmeric was highly profitable in the region in 2010, but the price decreased by 50% in 2011 and 2012. In the same time, the price of ginger and taro increased, so women were able to turn their attention to cultivating those. This allowed women the foresight to know which seeds and crops to purchase in advance as per the local climatic conditions and weather forecasts. The progress of monsoon rains plays a key role in deciding sowing trends and women farmers must be made aware of these patterns.

As part of the project, Hellen Keller International provided training on contour farming techniques to grow products prioritized in the market surveys, which produce higher yields but reduced input costs on water and fertilizer (Ibid). With the increased income from higher yields and the money saved from lower costs on water, women farmers are able to use their extra income to invest in climate-resilient crops and sustainable agricultural equipment. Training also included marketing skills such as information on how to determine sale price, negotiate, and bookkeep. To address geographic isolation, the program provided donkeys to women farmer groups as well as trainers that instructed women on the care and feeding needs. The donkeys saved a significant amount of labour and also eliminated the issue of middlemen taking advantage of lower prices and selling for higher, now that a selected "middle-woman" in each group could transport produce from several women farmers to markets and set their own prices.

The success of these case studies could be attributed to the fact that these initiatives were supported by NGOs and local champions who have extensive knowledge and skills in the field. Local agency is extremely important to achieve local-level change, especially with women working together. According to McKinsey, in a "full potential" scenario where women play an

identical role in labour markets to men, as much as $28 trillion could be added to global annual GDP by 2025 (McKinsey Global Institute, 2015). This is more than enough to bridge the climate finance gap needed for the battle against climate change, which stands at $585 billion in 2020 and is expected to be $894 billion by 2030 (Sinha, 2019). Evidently, increasing the participation of women in labour markets will not only build their own resilience to climate change, but will sufficiently increase the world's GDP for financing sustainable development.

As climate change intensifies, rural markets will expand for products and services that support climate resilience. It is crucial to understand and recognize women's roles and participation in value chains and ensure that both public and private sectors integrate gender concerns into market access and climate change initiatives (Huyer et al., 2015).

Access to Climate Information

Evidence suggests information on climate change adaptation strategies is not well-distributed to women farmers in developing countries, which hampers their adaptation efforts and increases their vulnerability (Global Gender and Climate Alliance, 2016). The 2014 IPCC report indicates that farmers in regions most vulnerable to the adverse impacts of climate change require the most recent climate information, products, and services (IPCC, 2014). Climate information is especially necessary in regions such as sub-Saharan Africa where majority of the agriculture industry is rain-fed. This information will aid farmers in achieving a sustainable level of food production by providing them with the knowledge needed to improve planning and decision-making on seed and crop variations and yielding. Without this information, farmers are unable to predict rainfall patterns which can damage crops, thus lowering food production and resulting in additional adverse effects such as loss of income and food insecurity (Ibid).

Climate information must be gender-sensitive in order to meet the respective needs of both men and women farmers. In calling for more gender-aware climate information, Bogdan et al. (2019) note that the agricultural sector is increasingly feminized. Feminization of agriculture is defined as: "An increase in women's participation rates in the agriculture sector, either as self-employed or as agricultural wage workers" (Katz, 2003), or as "an increase in the percentage of women in the agricultural labour force relative to men, either because more women are working and/or because fewer men are working in agriculture" (Deere, 2005). Due to an increase of women in the agriculture sector, gender-sensitive climate information is vital to support agribusinesses, the majority of which are run by women. Female farmers and agribusiness owners in sub-Saharan emphasized the need for women farmers to receive useful information such as where to buy the best seeds, when the best time to plant is, and how to get crops to markets (Bogdan et al., 2019).

Climate information also includes early warning and weather information systems, but evidence shows that women have lower access to both of these systems as well as to formal agricultural extension services (ASE) (Ibid). FAO defines ASE as a service that offers technical advice on agriculture to farmers and supplies them with the necessary inputs and services to support their agricultural production. Moreover, it provides farmers with information and new ideas developed by agricultural research stations. ASE also provide a broad range of training such as improved crop varieties, better livestock control, improved water management, and the control of weeds, pests or plant diseases (FAO, n.d.). Research has shown that these extension systems often perpetuate a male bias in agriculture, hence they predominantly reach and benefit men (Ahmed and Fajber, 2009). There are various reasons why agricultural extension programs fail to target women farmers, one explanation is that these programs lack female professional staff – only 15% of extension agents are women (World Bank / FAO / IFAD, 2009). Male extension agents

tend to target male-dominated farmer groups, perhaps due to the fact that it may not be culturally acceptable for them to interact with women in some contexts. Farmers and farming activities were continued to be seen as "male" activities by policymakers, despite the fact that women's presence in agriculture has rapidly grown (Gallina, 2010), thus ignoring the important and increasing role women have in agriculture.

Studies also suggest that limited access to climate information on climate-smart agriculture (CSA) practices tend to make women disproportionately vulnerable to climate change (Twyman et al., 2014, Abeka et al., 2012). CSA practices help smallholder farmers to adapt to climate change, but farmers need additional climate information from reliable sources and at correct times in order to adopt such practices (Twyman et al., 2014). Smallholder farmers find it difficult to know when to plant, apply fertilizers, and harvest their produce due to increased variability in weather patterns. To address this, climate information providers need to understand the different needs of men and women farmers across religious and ethnic groups. This is an important consideration to determine the type of information needed by smallholders and the best way to disseminate that information to them (Ibid). The study by Twyman et al. found that in Senegal and Uganda, men are generally more knowledgeable than women about CSA practices and tend to have access to better weather information that they can use to modify agricultural practices.

Another study undertaken in Uganda looked at men in a village and noted that they used fertilizers, mulching, and livestock manure to a much larger extent than women, which resulted in a yield gap of around 20-30% between men and women. If yields farmed by women increased to the same level as men, agriculture output would increase between 2.5 and 4% in developing countries (FAO, 2011). Moreover, gender also impacts how Ugandan villagers received their climate information. 80% of the men listened to the radio, as compared to only 20% of women,

therefore men were able to receive important climate data while women relied on indigenous knowledge (Schubert, 2013).

Furthermore, social norms constrain women but also showcase why women farmers are interested in differentiating climate information. For example, research in Senegal shows that women farmers are more interested in information on droughts and rainfall patterns because social norms in the region dictate that women work on men's plots before working on their own, and they must wait to use men's farming equipment. As a consequence, women tend to plant later on their own land and this may put them at a disadvantage (Gumucio et al., 2018).

These examples make it clear that there is a large disparity between men and women farmers when it comes to receiving climate information. Projects need to address this fact and use a gender-sensitive lens to ensure that women farmers receive the additional climate information needed to provide them with a level playing field with their male counterparts, as demonstrated in the case studies below.

Case Study: Enhancing the capacity of women farmers in Southeast Asia

In order to enable women and ethnic minority farmers to better anticipate and respond to risks and opportunities from changes in weather patterns, the Southeast Asian Climate Change, Agriculture and Food Security (CCAFS SEA) program of CGIAR implemented an agro-climatic information systems (ACIS) approach (Ferrer & Bernardo, 2020). The initiative aims to enhance the adaptive capacity of women and ethnic minority smallholder farmers by working directly with agricultural and meteorological service providers, who engage them in meteorological observations and decision-making in agricultural management options (CCAFS, n.d.). The ACIS system was demonstrated in Vietnam through a phased approach and is now being tailored for

Cambodia and Laos, all of which are countries extremely sensitive to climate change. The region is extremely prone to typhoons and floods, and long coastlines and heavily populated low-lying areas make this region one of the world's most vulnerable to rising sea levels and other extreme weather as a result of global warming (Prakash, 2018). The project integrates local knowledge with scientific knowledge and uses social learning processes (such as farmer-learning networks) to develop the capacity of smallholder farmers to better understand climatic variability. It has a strong gender focus and examines the question of whether this co-generated weather information can reduce yield variability and losses.

Meteorological offices and ASE will translate locally-relevant weather forecasts and agricultural information into languages and formats that make it easier for women farmers to understand and validate, which can then be used to make informed and proactive decisions about farming activities. To achieve this, the project facilitates dialogue and creates feedback loops amongst scientists, service providers, and farmers (CCAFS, n.d.). The project outputs will allow national agricultural research systems and farmer groups to have tailored access to agro-climatic information, and they will be able to use this to communicate effectively with farmers that may not get this information otherwise. By using ACIS, women farmers are in a position to make more educated plans and decisions to reduce crop failures and food insecurity that arise as a result of extreme weather related events and climate change. This project addresses how better preparedness and planning will benefit many women smallholder farmers (Ibid).

Outcomes of this work in Vietnam were published in January 2020. The report notes that ACIS increased the knowledge and enhanced the skills of multiple stakeholders involved in the project including weather forecasters, agriculture extension staff, farmer unions, and local authorities, amongst others. For women smallholder farmers, ACIS helped them gain access to

weather information and use it to inform their decision-making. This information was ultimately used to adjust rice planting times to avoid the salinity intrusion brought by the 2019 El Niño storm. This helped avoid major rice production loss by saving more than 200,000 hectares of land and more than one million tons of rice (Ferrer & Bernardo, 2020). Direct impacts on women are still unknown, such as the average increase in income per individual per year, but the project is still ongoing in Laos and Cambodia, with preliminary results expected later this year. This project has contributed to empowering women and enhancing the knowledge and skills of relevant stakeholders on climate change in Vietnam, and has been successful in promoting sustainable development and ensuring food security for vulnerable women and ethnic minorities in the face of climate disasters (Ibid).

Case Study: Using climate-smart agriculture in rural Mali

In Mali, investing in agriculture is a key method to lift women out of poverty since half of the Malian population engaged in agriculture are female (UN Women, 2018). Climate change is making these women more vulnerable by degrading their land and natural resources. Extreme droughts and desertification pose immediate threats that need to be addressed in order to build the resilience of vulnerable populations, including women and their households, communities and systems (Climate Links, n.d.). To combat the negative impacts of climate change on Malian women's livelihoods, UN Women introduced a new program called *Agriculture Femmes et Dévelopment Durable* (AgriFed) and implemented it alongside the Malian NGO *Groupe d'Animation Action au Sahel* (GAAS). The program aims to work closely with farmers to modernize their techniques, enables increased access to climate information such as the latest

advancements in agriculture, and increases the value of their produce by improving their conservation methods (UN Women, 2018).

Fatou Dembele is a Malian smallholder farmer, and when her plants first started dying due to climate change, she believed that her plot of land was ruined and her livelihood was at risk. She did not know that there was an increased number of live parasites due to rising temperatures and humidity that attacked the roots of her plants and killed them (UN Women, 2018). To restore her plants, the AgriFed program taught Fatou how to use locally available biopesticides to get rid of the parasites. She was quoted saying "Thank goodness we learned that there are local plants whose extracts can fight this disease" (Ibid). AgriFed activities began in 2017 in the Segou region and helped improve water usage, crop scheduling, new cultivation techniques, and pesticide and fertilizer use, and has reached 247 women and 66 men (Ibid).

AgriFed training also helped women across the region to improve and increase production of shallots, but it became clear that women needed to learn how to conserve their produce better during harvest. Hayèrè Keita, a shallot producer and seller, informed AgriFed trainers that she grows shallots and onions because of their long shelf-life, but she did not know proper conservation techniques prior to the training. The rates of loss for produce can be very high by following traditional methods and disregarding conservation efforts. The program provided further training sessions on how to preserve products like shallots, onions, and potatoes. Preliminary results show that around 110 women farmers have managed to increase their revenue using these new modern production and preservation techniques (UN Women, 2018).

AgriFed has been successful so far in teaching women smallholder farmers how to diversify the products in light of a changing climate, which not only brings additional income, but also helps improve nutrition for their families and reduces malnourishment for children. Another

farmer, Alphonsine Dembele, says that the program has had a positive influence on social cohesion because women farmers from across ethnic communities now hold meetings with each other and have dialogues during training sessions (UN Women, 2018). The program runs for five years and we can anticipate that these positive results will be replicated in other areas of the country.

These two case studies demonstrate how programs can empower women by providing them with the necessary climate and weather-related information they need to become successful farmers. The climate information and training they receive from these programs grants them independence from men so that they can rely on their own knowledge and information to adjust their agricultural activities (such as changing crop varieties and planting times). This is a clear demonstration of using women's social and economic empowerment to reduce their vulnerability to the effects of climate change and building resilience instead.

6. Conclusion and Recommendations

Economically empowering women must be taken as a vital step towards building the resilience of women to climate change and reducing their vulnerabilities to disaster. It is necessary to remove certain structural and cultural barriers to increase women's access to to credit, markets and climate information. Subsequently, women are able to participate in economic activities and become economically empowered, which provides them with an increased income and the necessary means and resources to invest in climate-smart technologies and build their resilience to disasters and climate change. First, access to credit builds the resiliency of women by providing them with the financial capacity to adapt to and cope with climate shocks. Second, accessing markets ensures that women are able to sell their products for a fair price and thus they are able to generate a higher income to sustain their livelihoods in the face of climate change. Third, receiving

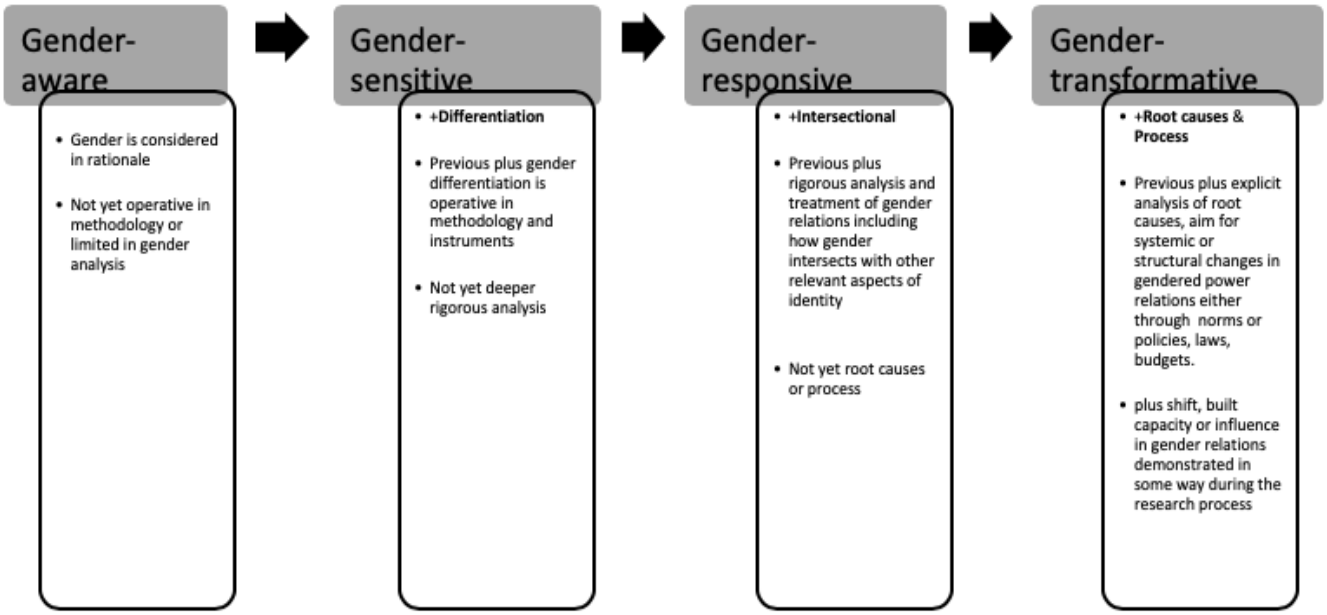
timely and accurate climate information empowers women to make informed decisions related to agricultural activities and avoid loss of income in light of unpredictable climate and weather-related events at the local level.

The selected case studies demonstrate different levels of information and training needed to address the various factors that have implications women farmers' livelihoods in developing countries prone to climate change. The success of the case studies could be attributed to the fact that these services were coupled with additional training and information for women. Without sufficient training, instances such as the Andhra Pradesh microfinance crisis may occur.

These case studies also highlight the importance of collective women's action – they involved a component that required women to form farmer's groups in order to strengthen action, provide material support for each other, as well as facilitate the exchange of information and knowledge. This supports findings from a study by the University of East Anglia (2019) which states that women's agency, or the ability to make meaningful choices and strategic decisions, can contribute to climate change adaptation. Women are forced to bear the burden of the consequences of climate change as they have been systematically excluded from decision-making, but collective agency can empower them to decide together when and how to overcome the vulnerabilities they face.

As a more general recommendation, governments should mainstream gender perspectives into their national policies, action plans, and other measures on climate change and sustainable development. This can be done through carrying out systematic gender analyses and establishing gender-sensitive indicators and benchmarks. Most importantly, establishment of climate change initiatives must include active participation of women, and the role of women's groups and networks must be strengthened in the climate policymaking sphere.

The International Development Centre has adopted a 4-step approach for projects to consider gender at all levels. Projects should aim to be: 1) Gender-aware: include local women in research; 2) Gender-sensitive: account for gender in the project design; 3) Gender-responsive: positively impact local women; and 4) Gender-transformative: contribute to a more equal society. The figure below demonstrates the process to include this in projects and programs (IDRC, 2019).



Projects with a gender-transformative aspect allow for the support of women's organizations and women-led collective initiatives. This in turn allows for the empowerment of women as key leaders in promoting community-based climate change adaptation and disaster risks reduction. Therefore, governments in developing countries should follow this approach when developing programs to support climate change adaptation efforts. Gender-transformative research studies gender relations (i.e. it does not look only at women, but rather the difference between women and men). This type of research is necessary to understand and address the various structural inequalities faced by women.

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