Understanding gendered preferences for Climate-Smart Agriculture adoption in Malawi

Meaghan Gallant
Supervisor: Chris Huggins
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School of International Development and Global Studies
Faculty of Social Sciences
University of Ottawa

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1 Introduction

One of the greatest challenges facing sustainable development and global food insecurity is the impact of climate change on global agriculture. In particular, those who rely on agriculture for their livelihoods, such as smallholder farmers, will experience these impacts acutely. With fewer resources and assets to adapt, they are most at risk of experiencing greater poverty and food insecurity as a result. These are challenges felt by millions, all around the world.

Despite gains made in other key development sectors over the past two decades, such as poverty reduction and improvements in global health, reducing food insecurity has been a challenge. Global hunger levels are now equivalent to what they were almost ten years ago, with climate change being one of the key drivers of this phenomenon (FAO, IFAD, UNICEF, WFP, & WHO, 2018). For those who rely on agriculture for their livelihoods, the impacts of climate change on agricultural productivity are a key cause of increased hunger. More intense and variable weather patterns are disrupting farmers' ability to produce effectively, improve their livelihoods, and feed their families. In Malawi, the country of focus for this research paper, smallholder agriculture is the backbone of the economy. Over 80% of the population relies on agriculture for their livelihoods, and it supports the country's food security (FAO, 2015). With climate change impacting yields and farm productivity, a policy and programming response in the country is necessary.

One of many responses in the agricultural sphere to the impacts of climate change has been the development and introduction of new practices branded as "climate-smart". Taking climate change mitigation, adaptation and resilience into account, Climate-Smart Agriculture (CSA) was developed by the Food and Agriculture Organization (FAO) and the World Bank. CSA proposes to help farmers and those who manage agricultural systems to effectively respond to climate change, while also boosting their productivity, reducing greenhouse gas (GHG) emissions, and enhancing their ability to achieve food security (Chandra, McNamara, & Dargusch, 2018). Thus, CSA appears to be a good option for smallholder farmers to respond to climate change. CSA has been implemented in many cases in Malawi, although uptake has been slow thus far.

To effectively equip smallholder farmers to respond to climate change, considerations of gender roles, responsibilities, and differences are necessary. Female smallholder farmers comprise a large proportion of the agricultural workforce in Malawi, and in developing countries in general. Despite this, they are often excluded from discussions and decisions related to climate change adaptation and agriculture. As women and men experience climate change impacts differently, and have varying priorities in farming contexts, understanding gendered differences is fundamental to supporting farmers' ability to effectively address climate challenges.

The issues of climate change, food insecurity, and incorporating gender into these considerations are extensive and significant. Understanding the intersections of these concepts is also crucial to understanding the complexities between them and how smallholder farmers might address climate challenges. Looking at CSA in this context is important to understand the options available to farmers. Thus, this major research paper (MRP) will seek to explore which CSA practices farmers prefer to adopt and why, taking into consideration the gendered differences that may appear in these answers, and framed by the context of climate change and food security. With negative impacts of climate change becoming more frequent and severe, smallholder farmers need to be able to adapt their agricultural practices in ways that are relevant to their particular contexts. To effectively support their efforts and promote improved food security, we must first understand the complexities of their particular contexts and priorities to provide the best possible opportunities for adaptation.

1.1 Research Question

This MRP explores the following research question: "Which CSA practices do women small-scale farmers prefer to use to bolster their household food security in the context of climate change, in Malawi, and how do these preferences differ from men's?"

1.1.1 Scope of Research

With the purpose of giving this MRP a sufficiently precise focus, the scope of the research was defined upfront. This involved deciding which aspects of smallholder farming, CSA, climate change, and food security would be covered. As such, the research scope focuses on the household level of food security; smallholder farmers (working on plots of 1 hectare or less[1]), and female smallholder farmers in particular, were chosen as the demographic of study; and only agriculture practices considered "climate-smart" were analyzed (as many agricultural practices could be analyzed in the context of climate change, only practices labelled under the CSA umbrella were considered). These preliminary decisions enabled a more methodical search for data, and ensured the literature reviewed and analyzed was relevant to the research question.

To ground the research in a particular geographical context, Malawi was chosen as the country of focus, for two primary reasons: first, the relevance of the country context to the research question, and second, the availability of data and information on this specific topic in the country. Malawi heavily relies on smallholder agriculture for economic growth and wellbeing, experiences high levels of poverty and food insecurity, and CSA has already been introduced in the country. Therefore, through initial research, it was determined that sufficient literature was already available on these topics in Malawi, that a desk study would be feasible.

The scope of this MRP therefore covers adoption and implementation of CSA in Malawi, use of CSA by female farmers, gender dynamics in the context of agriculture and food security, and preferences for CSA practices and how decisions are made. The research scope also includes understanding key concepts of food security, climate change, and smallholder agriculture, from a gender perspective and in the Malawian context.

1.2 Methodology

This MRP was conducted using a content analysis to understand the implementation of climate-smart agricultural practices in Malawi. As a desk study, this paper uses information gathered through examining projects and studies conducted by others. Thus, the analysis in this paper is based on a literature review and examination of sources that cover the key themes of the topic, and that provide practical data on implementation of CSA in Malawi.

The methods used in the analysis were qualitative and inductive. Primarily qualitative sources were used, describing key topics, themes, and findings from projects and research conducted in Malawi and other African countries. Minimal statistics and other quantitative data were used, simply due to the nature of the topic and information available. An inductive approach was used, starting with the research question and using that to guide the discovery of

[1] There is no standard definition of a smallholder farmer, and definitions in the literature varied from 2 hectares or less (Murray, Gebremedhin, Brychkova, & Spillane, 2016) to up to 10 hectares (FAO, 2012). In Malawi, landholding size was described as being close to 0.5 hectares, on average (CIAT & World Bank, 2018; FAO, 2018b; Government of Malawi, 2017; IFPRI, 2018). As such, the figure of 1 hectare or less was chosen to define smallholder farmers in Malawi for this paper, as this is both close to the average reported figure and encompasses the range of smallholder farm sizes generally found in the country.

patterns and themes in the literature. This approach allowed me to explore the available literature with an open mind and develop findings iteratively, rather than commencing the research with preconceived notions.

To start, over 70 sources were consulted to determine their relevance to the research question. There were finally 46 sources selected for their utility, breadth of information on the topic, and specificity to helping answer the research question. A variety of sources were used, and attention was given to ensure an appropriate balance of source types. While the majority were peer-reviewed studies, grey literature sources were also required to fill the gaps of practical implementation of CSA. In total, 29 sources were academic peer-reviewed journal articles or book chapters; 7 were NGO reports and briefs; 7 were reports, information sheets, and policy briefs from international organizations; 1 was Government of Malawi survey results; 1 was a conference paper; and 1 was a news article.

Sources were organized according to their key components and themes, using the program Zotero. Subsequently, in order to streamline the analysis, the sources most specifically related to the research question (i.e. those directly to related to decision-making around adoption of CSA practices) were included in the coding process. While other sources certainly provided relevant background information, the sources chosen for coding all made reference to specific CSA practices and detailed why they were chosen. In total, 19 sources[2] were coded.

An initial list of codes was developed based on preliminary thinking about the research question, and was iteratively developed as the analysis progressed. The final list of codes covered preferences for CSA practices, including split by gender, impacts of climate change, CSA adoption, gender dynamics and roles, and dimensions of decision making, including farmer characteristics and other imposed factors[3]. The codes that were most relevant to the analysis (and used most often) were the "preferences" and "dimensions of decision-making" codes.

This coding, in addition to notes from all of the sources consulted, were used to analyze the literature and draw conclusions in order to answer the research question. After the literature was coded, the frequency of each code was tallied to help determine their importance in the literature. Coded passages were reviewed to understand content and context, and grouped according to findings about specific CSA practices and dimensions of decision-making. Simultaneously, the literature not coded was reviewed for background context and for additional information to supplement the coded findings. This standard review of the content grouped related information and sources to help finalize the analysis.

Although this approach worked well for this type of research and the research question, there were limitations. Geographically, while Malawi was chosen due to the availability of information on the country, there was still limited data about specific CSA practices in the country. As such, the analysis was supplemented with sources focusing on nearby countries, or on Africa more broadly. Thematically, there was a good level of existing literature on the intersections between climate change and gender, climate change and food security, and food security and gender, but little on the intersection of all three. The literature on CSA was also limited, with fewer academic peer-reviewed sources available regarding CSA application on the ground. More grey literature was relied on in this area. Overall, there was sufficient data and literature available on the themes, concepts, and geography of this research question, recognizing that some gaps remain. I also hit a saturation point with the research, where the addition of new sources was neither necessary nor helpful as I had already found most of the available sources

[2] See Appendix B for a summary of the coding.
[3] See Appendix A for the full list of codes.

that were useful for the topic. In general, I believe the approach taken was the best and most feasible way to conduct this desk-bound research within the time limitations.

1.3 Outline of the Paper

The following sections of this MRP will describe key themes, the country context of Malawi, and will discuss the research findings through an analysis and discussion.

In section 2, I present my literature review and contextual information, organized into the themes critical to the background of this study. These themes are climate change and agriculture, food security, gender and agriculture, and climate-smart agriculture. Section 3 presents the Malawian country context. This section outlines important background information about Malawi, namely a country overview, economic and agricultural context, the experience of climate change in the country, and the application of CSA.

Section 4 presents the analysis and findings of this research. The analysis first explores the dimensions of decision-making, outlining factors that may influence a farmer's decision to adopt CSA, and then reviews the data on the adoption of five CSA practices, chosen due to their popularity in the literature. Section 5 presents a short discussion of the findings and analysis. Finally, Section 6 concludes the MRP.

2 Context

The following literature review focuses on the key concepts and themes critical for this research. For the purpose of this research, and to better situate the later analysis, the primary geographical focus of the literature reviewed is Africa, with much of the literature focusing on Malawi. Fundamental concepts reviewed include climate change, agriculture, food security, gender dynamics, and climate-smart agriculture. The linkages between these themes are also important to understand how each affects the other and how impacts can be compounded in various circumstances.

2.1 Climate Change and Agriculture

Climate change is one of the greatest challenges facing the world today and is a significant threat to achieving sustainable development. While the changing climate is a natural process, global warming has accelerated over the past several decades. This is largely attributed to human activity and industrialization causing increased GHG emissions in the atmosphere (FAO et al., 2018). Long-term global warming has caused an increase in average Earth surface temperatures of approximately 0.85^{o}C over the last century, and temperatures are expected to continue to rise (FAO et al., 2018). In Africa, it is estimated that temperatures will increase by 0.2-0.5^{o}C every decade (Challinor, Wheeler, Garforth, Craufurd, & Kassam, 2007). This surface temperature warming acts as a catalyst for other climatic changes, including rainfall and weather pattern variability, increased frequency of extreme weather events, and dramatic temperature fluctuations (FAO et al., 2018; Muller, Cramer, Hare, & Lotze-Campen, 2011).

One sector that is particularly negatively impacted by climate change is the global agricultural system. Direct impacts on the sector include lowered productivity and yield losses, crop failures, and spikes in food prices, resulting in further knock-on effects such as food insecurity, impacts on livelihoods, and negative economic effects (CIAT & World Bank, 2018).

Africa is one of the regions that will be hardest hit by climate change, with African smallholder farmers considered particularly vulnerable. African agriculture is predominately rain-fed, making these systems susceptible to rainfall variability (Altieri & Koohafkan, 2008). Too much or too little rain can damage crops, and greater variability in the arrival of rains makes planning for these impacts far more difficult. Extreme weather events like hurricanes, droughts, and floods are major causes of crop failures. In fact, Africa is projected to have the highest prevalence of drought-caused yield reductions (Muller et al., 2011).

As many African countries and economies are dependent on agriculture, these impacts will be felt fairly widely and across many populations (FAO et al., 2018; Muller et al., 2011; Ncube, Lufumpa, Vencatachellum, & Murinde, 2011). Although estimates vary, expected yield losses of key crops include up to 35% for rice, 20% for wheat, and 60% for maize, depending on the region (Khatri-Chhetri, Aggarwal, Joshi, & Vyas, 2017; Muller et al., 2011). The severity of impacts range across sub-regions and depend largely on the vulnerability of the local population to climate shocks and stressors. Thus, each country, and each farm, may experience and react to climate change differently (Muller et al., 2011).

Poor, smallholder farmers in developing countries are expected to experience the greatest damage caused by climate change, despite the fact that they have contributed the least to it. Their geographic location, low incomes, and reliance on rain-fed agriculture as (often) a sole livelihood option make them vulnerable to acute shocks, and less able to adapt their practices to longer-term trends in weather patterns and seasonal variations (Altieri & Koohafkan, 2008; Challinor et al., 2007). A climate justice perspective is important in this regard, as smallholder farmers emit almost no GHGs and have contributed the least to climate change, but are forced to adapt as a result of the impacts they experience. Building this adaptive capacity will therefore be critical for smallholder farmers if agricultural production is to become resilient to climate change and expand at a rate sufficient to meet rising demands for food and combat hunger (FAO, 2012; Lipper et al., 2014).

2.2 Food Security

Food security is defined by the Food and Agriculture Organization (FAO) as "a situation that exists when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life" (FAO et al., 2018, p. 159). Food security is defined by four dimensions: availability, access, stability, and utilization. Food availability refers to the quantity, quality, and diversity of food available, and is measured by indicators such as where calories are derived from (Stringer, 2016). Food access refers to both physical and economic access to food, and is measured by food prices and undernourishment levels. Stability looks at exposure to food security risk and incidence of shocks, and determines how stable one's access to food is over time (Stringer, 2016). Finally, utilization of food refers to the ability to effectively utilize food, and is measured with indicators like undernourishment, wasting, and stunting (Stringer, 2016). These four components are hierarchical, with sufficient food availability and accessibility necessary before stability and proper utilization are possible.

Food security is defined at many levels, from global, to regional, to household, and prevalence can vary across these levels. As this paper focuses on the household level of agriculture, food security will be referred to at the household level as well. Household food security can be determined by a variety of factors that fit into the four key dimensions. Food availability and access, for example, can be determined both through food that a household grows for its own consumption as well as purchased foods (IFPRI, 2018). Household income strongly influences food security, and the distribution of decision-making power and income control within the home can influence who in the household is more food secure, or if money is allocated for food consumption and nutrition (Stringer, 2016).

Despite improvements in many domains of sustainable development, global hunger has been one issue where the numbers have deteriorated in recent years. Both the absolute number of food insecure individuals and the prevalence of food insecurity in the global population have grown since 2014, after years of improvements in this sector. In 2014, 784 million people (10.7%) were considered food insecure and undernourished worldwide, and in 2017, this number was 821 million people (10.9%) (FAO et al., 2018). Food insecurity rates in Sub-Saharan Africa are the highest in the world at close to one in four people, or 23% (FAO et al., 2018). Eastern Africa, which includes Malawi, has the highest regional prevalence of food insecurity at 31% (FAO et al., 2018).

Food security at all levels can be influenced by many external factors, including conflict, macro-economic trends, and climate change. Climate shocks and stressors have lasting effects on food security. Acute shocks can cause food crises, such as crop failures and severe price fluctuations, which can push households, especially those dependent on agriculture, into immediate and alarming states of food insecurity (FAO et al., 2018). Additionally, longer-term climate stressors like unpredictable and extreme weather patterns can make agriculture less productive and certain, resulting in reduced yields and limiting food availability. In Sub-Saharan Africa, a region already plagued with low yields and undernourishment, increasing temperatures are affecting yields of staple crops such as maize, sorghum, and groundnuts (FAO et al., 2018). The combined impacts of these changes can initiate a downward spiral in food and nutrition security.

On national and regional scales, aggregate impacts of climate change on food security may not expose the full reality of local level impacts and experiences. Locally, impacts may be more critically felt by some households than others, especially by those who rely on agriculture for their livelihoods. Hunger is found to be worse in countries and households with high reliance on rain-fed agriculture, as they may experience more acute negative impacts from climate shocks which drive down their food security (FAO et al., 2018). Thus, food insecurity may be more severe for smallholder farmers than for larger-scale farmers or those who do not rely on agriculture for their livelihoods, who may have more resources at their disposal to supplement their food security by other means. However, these local-level declines may not be reflected in national or global levels of food security. In order to reverse current food insecurity trends, smallholder agricultural productivity in the context of climate change will be a key issue to address.

2.3 Gender and Agriculture

Gender plays an important role in smallholder agriculture. While numbers vary, sources indicate that women account for 40-60% of farmers in Sub-Saharan Africa, and up to 80% of smallholder farmers in least-developed countries (Huyer, 2016; Ncube et al., 2011). In Malawi, women comprise just over half of the agriculture workforce, at about 54-59% (CIAT & World Bank, 2018; Ncube et al., 2011). Although women are responsible for much of Sub-Saharan Africa's farming, their productivity is far lower than that of their male counterparts. This is, in large part, due to pervasive gender norms and differences in power structures. In addition, women’s unpaid off-farm duties detract from the time they can commit to agriculture, further reducing their productivity.

Gender norms, such as social and cultural normative understandings of women’s and men’s expected roles, contribute to how the household division of labour is determined and affects access to resources and other productive assets. These norms inform the expectations and limitations placed on women in terms of their access, operations, and responsibilities. Such norms and expectations are developed over time, and are unique to each social, cultural, and historical context. Responsibilities and the division of labour between genders can vary across cultures, countries, and communities (Kakota, Nyariki, Mkwambisi, & Kogi-Makau, 2011; USAID, 2013). While it is difficult to generalize norms as they manifest differently in different contexts, it is clear that general normative understandings of gender roles across Sub-Saharan Africa assign responsibilities and power unequally between men and women, at the disadvantage of women (Fapojuwo, Ogunnaike, Shittu, Kehinde, & Oyawole, 2018; Ndiritu, Kassie, & Shiferaw, 2014; Perez et al., 2015).

Gender norms significantly inform expectations for responsibilities and the division of labour between men and women. While both men and women perform on-farm tasks, women are also typically expected to take care of additional household and off-farm tasks (Bezner Kerr, 2005; Collins, 2018; Glemarec, 2017; Nyasimi & Huyer, 2017; USAID, 2013). Traditionally female tasks in Sub-Saharan Africa include cooking, caring for children, caring for the sick, cleaning, and other activities required to take care of the home (Bunderson et al., 2017; Kakota et al., 2011; Murray, Gebremedhin, Brychkova, & Spillane, 2016). Women and girls also collect firewood and water, and travel long distances to do so, which can increase their potential of exposure to gender-based violence (Murray et al., 2016; Nyasimi & Huyer, 2017; Perez et al., 2015). These are all routine tasks, and add to women’s time burden. Men do not usually have the same responsibilities and are unlikely to take on “women’s” work under most circumstances, but take on additional tasks as needed. Men therefore tend to have more free time for other pursuits, and have more diversified livelihood activities as a result (Kakota et al., 2011; USAID, 2013).

In addition to household responsibilities, women hold a large share of agricultural responsibilities. Typically, African female farmers are responsible for cultivating crops that are intended for consumption, in line with women’s responsibility for ensuring the food and nutrition security of their households (Jost et al., 2016; Murray et al., 2016; Ncube et al., 2011; Ndiritu et al., 2014). In contrast, men are responsible for the crops which are meant for sale. Although women also cultivate these crops, they do not usually have control over the decisions made to sell said crops (Murray et al., 2016). Specific tasks women are involved in include land preparation, planting, weeding, and processing crops. Women tend to have responsibility for more labour-intensive farming tasks, such as weeding, and their lack of access to mechanized tools contributes to the intensity of their labour and time burden (Beuchelt & Badstue, 2013; Huyer, 2016; Murray et al., 2016).

In total, it is estimated that Malawian women spend approximately 8-10 hours per day on agricultural tasks, plus an additional 5-6 hours or more on household chores and other non-agricultural tasks (Bezner Kerr, 2005; Murray et al., 2016). This leaves less time for women to manage their various, and sometimes competing, responsibilities, and less free time overall (Bezner Kerr, 2005; Perez et al., 2015). Women and girls have generally heavier workloads than men and boys, disadvantaging them for other activities such as education or livelihood diversification (Nyasimi & Huyer, 2017). Reduced time can also undermine the quality or quantity of work women can contribute, making them more vulnerable to external shocks, and potentially compromising the food and nutrition security of women and their households (Kakota et al., 2011; USAID, 2013). Finally, this also limits women's availability to learn about and adopt new agricultural practices that could potentially increase their productivity and reduce their time burden.

Land tenure, or lack thereof, is an issue that affects many female farmers. In most cases, it is men who own and have access to land. Women disproportionately have less land tenure security, and often work on land owned by and allocated to them by their husband (which they still may have no autonomous control over) (Murray et al., 2016; Perez et al., 2015). These land tenure differences are a result of statutory and customary laws that systematically limit women's access to land, resulting from colonial or other historical norms and practices that favoured men (Huyer, 2016; Ndiritu et al., 2014). Of the land women do own, or work on exclusively, it is typically smaller plots that are closer to the home. Their plots are also of poorer quality in terms of soil nutrient density and fertility compared to plots that are male-owned or jointly-cultivated (Fapojuwo et al., 2018; Ndiritu et al., 2014; Perez et al., 2015).

Lack of land ownership can exclude women from accessing many services, inputs, technologies, and resources that would improve their agricultural productivity. For example, women have less access to credit than men do as extension services and off-farm employment are inclined to favour men (Bezner Kerr, 2005; Glemarec, 2017; Nyasimi & Huyer, 2017; Perez et al., 2015). Women also use more labour-intensive manual farming tools, perpetuated by a lack of access to mechanized tools and services that provide training on new farming practices (Murray et al., 2016). Women are reached less by extension services who provide these technologies, tools, and training, as they are not typically considered farmers, nor are they thought to have control of the farm or the decision-making power in the household (Huyer, 2016). While NGOs are now starting to recognize and address the gap in extension services for female farmers, funding for such services and programming is still largely insufficient, especially to Sub-Saharan Africa (Jost et al., 2016).

Gender norms also perpetuate an imbalance of decision-making and power between men and women in the household, which can result in an uneven distribution of labour and benefits (Bernier et al., 2013; Njuguna, Kihoro, Hickey, Brownhill, & Muhammad, 2016). As the household head and through their ownership of land, men are typically the main decision makers. Holding this power means they ultimately decide which crops are grown and for what purpose, which practices are adopted on the farm, and how income is used (Njuguna et al., 2016; Nyasimi & Huyer, 2017). Where women do have some decision making power is typically over the crops that fall under their purview – primarily those related to household consumption and food security (IFPRI, 2018).

This power difference also varies across households and may depend on whether the household is male- or female-headed. In some cases, women have more decision-making power as the household head compared to women within male-headed households. In other cases, women do not have as much decision-making power even as the household head, as they defer to other male authority figures in their lives. This also applies to situations where women may own the land they work, but their decision-making power over that plot of land depends on who the household head is (Murray et al., 2016; Njuguna et al., 2016).

With more responsibilities both on-farm and in the household, and less access to land and resources, female smallholders have less time and ability to adapt to climate change (Jost et al., 2016; Perez et al., 2015). These pervasive constraints have a detrimental impact on women's agricultural productivity, which is far lower than men's, despite contributing more daily hours to farming than their male counterparts. In Sub-Saharan Africa, the productivity gender gap, in terms of the value of product produced per unit of land, can be up to 25% depending on the country and crop, with this costing an estimated $100 million annually in Malawi (Huyer, 2016; Nyasimi & Huyer, 2017). Addressing these constraints and supporting women's adoption of CSA are important efforts to enhance their productivity and reduce burdens.

2.4 Climate-Smart Agriculture (CSA)

The relationship between agriculture and climate change is complex and reciprocal. While climate change shocks and stressors have an immense impact on the agricultural sector, agriculture is also one of the major contributors to climate change, through anthropogenic GHG emissions (Chandra et al., 2018). Due to the dual nature of this relationship, and based on the argument that the agriculture sector is a key component in the response to climate change, the concept of "climate-smart" agriculture emerged (Lipper & Zilberman, 2017). Climate-Smart Agriculture (CSA) was formally developed in 2010 by the FAO and World Bank, and touted as a new set of strategies to respond to farmers' need to adapt their practices to the context of climate change (Chandra et al., 2018).

CSA has three main objectives of productivity, adaptation, and mitigation. It aims to increase agricultural productivity and incomes, improve food security, adapt agricultural systems to improve their resilience to climate change, and mitigate the long term impacts of climate change by reducing GHG emissions (Chandra et al., 2018; FAO, 2018a). While an agricultural practice can be considered climate-smart if it achieves any of these three goals, achieving all three is considered a "triple win". However, achieving a "triple win" in every instance of CSA adoption is unrealistic, and instead the aim is to reduce trade-offs and promote synergies between the objectives through informed decisions and solutions at the appropriate scale (FAO, 2018a). Ultimately, CSA should "enhance the resilience of agricultural systems and livelihoods and reduce the risk of food insecurity in the present as well as the future" (Lipper et al., 2014, p. 1068).

The FAO notes that CSA is "not a set of practices that can be universally applied, but rather an approach that involves different elements embedded in local contexts" (FAO, 2018a). Elements of climate-smart systems include managing farms to balance the prioritization of immediate food security and long-term adaptation, managing to conserve ecosystems, services for farmers that enable them to better mitigate climate change, and changes in the wider food system (FAO, 2018a). Consideration of the local context is also very important. Certain practices have been identified as practical for farmers to integrate into their routines based on their ability to meet one or more of the CSA objectives. Some examples of these practices are: conservation agriculture, agroforestry, soil and water conservation, crop management, drip irrigation, rainwater harvesting, intercropping, fertilizer use, use of improved inputs like seeds, crop diversification, and others (Altieri & Koohafkan, 2008; Chandra et al., 2018; CIAT & World Bank, 2018; Khatri-Chhetri et al., 2017; Lipper & Zilberman, 2017; Schaafsma, Utila, & Hirons, 2018).

Following the development of CSA at the international level, its promotion became more widespread. CSA projects began to be implemented at the regional and national levels, often in partnership with the FAO, World Bank, or other climate change focused NGOs (Lipper & Zilberman, 2017). Now, CSA practices or principles have been adopted into many sustainable development, agriculture, and climate change programs, as well as into policies that promote sustainable intensification for agriculture and improved food security. Research shows that while there have been many successful case studies of CSA, adoption by farmers remains relatively low, due to a variety of factors including knowledge, access to resources, and government investment (Khatri-Chhetri et al., 2017; Nyasimi, Amwata, Hove, Kinyangi, & Wamukoya, 2014).

While CSA has been promoted on a relatively large scale by international organizations and governments, critiques from some NGOs and local organizations highlight an alternative view. Some have pointed to the re-branding of certain agricultural practices as climate-smart, even if they do not address climate change in reality, or worse, are damaging for the environment (Anderson, 2014; Chandra et al., 2018). This can be linked to the idea that CSA lacks clear principles and direction by which to define a climate-smart practice, opening the door to potentially brand anything as climate-smart (Lipper & Zilberman, 2017). Others see CSA as having the potential to undermine smallholder and poor farmers if applied as “one-size-fits-all”, which could justify large-scale agricultural practices and expand commercial production. Additionally, the inputs required for some CSA practices may further legitimize large corporations who produce items like genetically modified seeds or synthetic pesticides (Collins, 2018).

Other criticisms note the lack of focus on the nutritional quality of food, lack of transparency in governance, and a lack of consideration for issues specific to smallholders and their priorities. CSA has also been criticized for ignoring a transformation towards poverty alleviation or sustainable development (Chandra et al., 2018; Schaafsma et al., 2018). In addition, some have argued that CSA prioritizes mitigation over other aspects by mandating a link to carbon offsets. This may push the burden of climate change mitigation onto poor smallholder farmers and developing countries, an unfair expectation considering they have contributed the least to climate change. This can also remove the accountability for mitigation from the large polluters and rich countries who have primarily caused climate change (Lipper & Zilberman, 2017). Finally, CSA has long neglected gender considerations. Some integration of gender into CSA literature and programming has more recently emerged. However, there has traditionally been an absence of understanding of how the issues CSA seeks to address affect women differently, and the different realities women face that may affect their ability to adopt CSA (Collins, 2018). It is important to recognize these critiques of CSA when understanding its implementation.

Despite promotion of CSA, its application on the ground may differ from its portrayal in policy. However, when viewed from a local perspective, and when the needs and abilities of smallholder farmers are integrated into CSA planning, these climate-smart approaches have the potential to transform local agricultural systems, improve livelihoods, and increase food security for those most in need.

3 Country Context: Malawi

3.1 Overview

Malawi is a small, landlocked country located in South-East Africa, bordered by Mozambique, Zambia, and Tanzania. Despite being landlocked, approximately 20% of the country’s area is covered by water, mostly by Lake Malawi which runs along the country’s eastern border (CIAT & World Bank, 2018; World Bank, 2019). The country has experienced a significant and steady growth in population, rising to approximately 17.5 million people in 2017, 56% of whom are younger than 20 years old. The population is expected to double in the next twenty years (Government of Malawi, 2017; World Bank, 2019). Malawi is a predominately rural country, with 81% of the population living in rural settings (Government of Malawi, 2017)

Although gains in country development and economic growth have been made, Malawi remains one of the poorest countries in the world. Over 50% of the population is considered impoverished, half of whom live in extreme poverty (FAO, 2015). Poverty is driven by high population growth, low agricultural productivity and dependence on that sector, inconsistent economic growth, and poor policies and social safety nets (World Bank, 2019). Malawi is also highly food insecure, ranking at 105 out of 133 countries on the 2017 global food security index (CIAT & World Bank, 2018). According to the fourth Malawi Integrated Household Survey (IHS4), 61% of the population experienced low food security and failed to access sufficient calories in 2017, a number that grew from 37% captured in the 2011 survey (IHS3) (Government of Malawi, 2017; IFPRI, 2018).

In addition to poverty and food insecurity, Malawi faces many development challenges. The country has developed several policies and strategies over the years, starting with the Malawi 2020 Vision, which was adopted in 1998. This strategy outlined Malawi's long-term goals, and is guided and implemented through medium-term policy frameworks with five-year timelines (World Bank, 2019). These policies, titled the Malawi Growth and Development Strategy (MGDS), have shorter-term objectives and focus areas to promote sustainable development and economic growth (FAO, 2015). MGDS I and II, adopted in 2006-2011 and 2012-2016 respectively, aimed to "reduce poverty through sustainable economic growth and infrastructure development, focusing on agriculture and food security as a key priority area" (FAO, 2015, p. 2). The current strategy, MGDS III, runs from 2017-2022 and focuses on energy, education, agriculture, health, infrastructure, and tourism. It is advertised as the final strategy to fulfill the country's 2020 Vision (World Bank, 2019).

3.2 Economy and the Agriculture Sector

Malawi's economy is highly dependent on agriculture. The agriculture sector accounts for approximately one third of the country's GDP, and employs 80% of the population (FAO, 2015). Over 80% of the country's exports are agricultural commodities – the primary export crop is tobacco, accounting for 60% of Malawi's total exports, followed by tea and sugar (FAO, 2015, 2018b). Manufacturing is the second largest sector, followed by a variety of other small sectors such as retail, tourism, transport, and mining (Government of Malawi, 2017). The country's economic growth rate has varied year to year and is highly susceptible to changes in the agricultural sector. In 2017, the GDP growth rate was about 4%, dropping to 3.5% in 2018 due to dry spells that caused low agricultural productivity. In 2019, the growth rate is expected to reach 4.4%, with credit to a good overall harvest despite damages caused by Cyclone Idai (World Bank, 2019).

The agriculture sector is highly subsistence based, and largely managed by smallholder farmers. Of the 80% of the population that works in farming, 75% are smallholder farmers, disproportionately growing food for consumption and local sale. They produce approximately 80% of the total food consumed within the country (CIAT & World Bank, 2018; FAO, 2018b). Smallholder farmers in Malawi cultivate approximately 1 hectare of land or less, at an average of about 0.5 hectares. Most farms are male-headed, although Malawi has a relatively high proportion of female-headed households, at about 27% (Government of Malawi, 2017).

On smallholder farms, major crops grown include maize, rice, cassava, legumes, groundnuts, and potatoes. Maize is by far the major subsistence crop, grown by 95% of producers and occupying 60% of the country's crop area (CIAT & World Bank, 2018). The importance of maize as a staple food crop has led to its equation with the country's food security, particularly by the government: food security is largely considered in terms of having enough maize (FAO, 2015; IFPRI, 2018). This reliance on maize contributes to insufficient diversity in diets, including a lack of nutrient-rich foods like fruits, animal proteins, and other vegetables. This may mean that food security is compromised, particularly in terms of food quality (IFPRI, 2018).

Agriculture in Malawi is primarily rain-fed, with less than 5% of the total crop area irrigated. This makes the agricultural sector especially vulnerable to decreased yields as a result of climate shocks and risks, including droughts, floods, and rainfall variability (CIAT & World Bank, 2018). In response, the government has implemented a series of agricultural subsidy programs for smallholder farmers, including the well-known Farm Input Subsidy Program (FISP) (FAO, 2015; Kassie, Teklewold, Jaleta, Marenya, & Erenstein, 2015). The FISP distributes vouchers to smallholders with which they can collect fertilizers and improved seeds of specific crops (primarily maize, as well as some legumes) to help improve yields and promote food self-sufficiency. Through the FISP, 76% of farmers have access to these improved inputs (FAO, 2018b). Results of the FISP have been varied, showing significant maize yield increases and crop income, but less impact on household food consumption and quality of life (FAO, 2015; IFPRI, 2018). Despite this government investment in the agriculture sector, Malawi still faces many challenges with the sector and as a result, in the economy.

3.3 Impacts of Climate Change

As noted, Africa is one of the regions that is most susceptible to the impacts of climate change (Muller et al., 2011). Malawi is one country that will be the worst affected by climate change in the region (Kakota et al., 2011). Data over the last four decades shows that weather patterns in Malawi have become increasingly variable, with more frequent droughts and floods and an increase in average temperatures. These trends are expected to continue, with average temperatures increasing by 2°C and average precipitation decreasing by 3% by 2050 (CIAT & World Bank, 2018). As the country's agriculture sector is primarily rain-fed and specialized on a few key crops, changes in precipitation patterns and increased extreme weather events have a direct impact on crop yields, failures, and overall productivity (FAO, 2018b). There are also fewer alternatives for farmers to fall back on if maize or other staple crop yields are especially compromised (FAO, 2015).

When agriculture is affected by climate shocks, the economy is equally as affected due to the heavy reliance on this sector. For example, in 2015-2016, Malawi was hit with heavy floods followed by a period of drought, which combined caused a loss of US $700 million for the economy (CIAT & World Bank, 2018). The lack of diversification and vulnerability in the economy affects the whole country, and is further exacerbated by a lack of significant government investment in climate change adaptation policies and programs and a high level of poverty resulting in lower local adaptive capacities. The primary dependence on one sector makes the impact of shocks far more severe and widespread (CIAT & World Bank, 2018; FAO, 2018b). As a result, loss of yields of most crops may cause Malawi to become far more dependent on imports of food commodities, and the value of exports will change (CIAT & World

Bank, 2018). Agricultural production in the country will therefore need to shift if these impacts are to be mitigated effectively.

3.4 Application of Climate-Smart Agriculture

In response to climate change impacts, the Malawian Government has made an increasingly concerted effort to incorporate climate change considerations and goals into many of their national strategies, although there are still gaps. For example, Malawi's Vision 2020 and MGDS highlight the importance of sustainable development and natural resource management. Malawi has also developed strategies and policies that more directly target natural resources and climate change management, such as the National Environment Policy, National Adaptation Program of Action to Combat Climate Change, and the National Climate Change Management Policy (CIAT & World Bank, 2018; FAO, 2015).

Agriculture is also understandably at the centre of many of the country's policies and strategies. As the largest employer and economic contributor in the country, improving agricultural productivity, and subsequently increasing economic outcomes and food security, are key government priorities. The MGDS incorporates the Agriculture Sector Wide Approach, which is a tool for operationalizing the MGDS in the agriculture sector. It promotes increasing agricultural productivity and improving food security through mechanisms such as the FISP and through promoting improved crop varieties and diversification (CIAT & World Bank, 2018). With a focus on these priorities, the integration of CSA into the Malawian agriculture sector seems to be a natural fit.

CSA has been promoted and implemented in Malawi with some success. For example, a National Climate-Smart Agriculture Framework was developed in 2018 in partnership with the United Kingdom. The FAO conducted a large CSA project from 2012-2015, focused on capturing synergies between the three CSA pillars, under their Economics and Policy Innovations for Climate-Smart Agriculture (EPIC) program (Asfaw, 2015; CIAT & World Bank, 2018). Many of the country's national policies and strategies also directly integrate CSA or promote work towards its pillars, such as the National Climate Change Management Policy and National Agriculture Policy (Rosenstock, 2019). Despite this relatively strong policy environment and support for CSA, implementation is still primarily driven by international NGOs rather than internally by the government, and challenges remain in terms of funding and application on the ground (CIAT & World Bank, 2018).

Where CSA is adopted in Malawi, projects tend to focus on the adaptation and productivity pillars of CSA, rather than mitigation, as Malawi's GHG emissions are among the lowest in the Sub-Saharan African region (CIAT & World Bank, 2018). The low level of emissions compared to other countries in the region (and the world), coupled with a need and desire to increase agricultural productivity for poverty reduction and improved food security, explain the choice to pursue adoption of certain practices over others. However, despite promotion and some implementation of CSA, on-the-ground adoption levels do remain low. This is to be expected for smallholder farmers, who may face significant adoption barriers. These can include lack of knowledge, little access to appropriate financial resources, and lack of land tenure security (CIAT & World Bank, 2018).

Most practices popularly adopted in Malawi fall into the general categories of soil management, crop management, livestock, water management, energy management, forestry, and fisheries and aquaculture. Within these categories, CSA practices commonly used in Malawi include agroforestry, conservation agriculture, using improved seeds and varieties, using fertilizers, and intercropping. Although more practices are certainly adopted, these in particular were frequently cited in the literature, and were therefore chosen as the focus of the analysis.

4 Analysis

The following analysis seeks to answer the research question of which agricultural practices women and men choose, and why, in the context of climate change and food security in Malawi. The analysis of the above-mentioned literature revealed not necessarily the specific practices and what made them attractive as adaptation options, but that there are many dimensions of decision-making that influence whether a farmer may choose to adopt a specific practice over another. Adoption decisions were not uniform across the literature on Malawi or the literature on female farmers, but demonstrated the importance of considering individual farmer circumstances and contexts to determine which agricultural practices they find most practical or beneficial to adopt in the context of climate change.

4.1 Dimensions of decision-making

In the literature analyzed, the following categories of dimensions that feed into decision-making about agricultural innovation were identified: characteristics of the farmers and farms themselves (i.e. age, education, plot size, land tenure), circumstances external to the farmer (i.e. access to information, services, and resources), and personal preferences and motivations.

4.1.1 Farmer characteristics

The individual circumstances of each farmer are central to providing context for how they might make decisions. These dimensions were prevalent in the literature about why a farmer may or may not adopt a particular agricultural practice. These items were coded 116 times under the "dimensions of decision-making" code. The high number of codes in this category sheds light into how decisions were made and demonstrates how these issues were framed in the literature. However, the simple quantitative measure may not be an accurate representation of the entire decision-making process, as both these dimensions and personal motivations were described as important.

The "dimensions of decision-making" category encompassed information about farmer's personal characteristics, access to information or services, debates on land tenure, and other factors. Through analysis of this code and a key-word search of the coded literature, the following characteristics were determined to play a role in the decision-making process for all farmers, regardless of gender: age, education level, economic status, household size, marital status, and employment status. Factors like household size, marital status, and employment status (i.e. off-farm employment) were apparent, but not as frequently mentioned as other characteristics, and are therefore not covered in the scope of this analysis. Age, education level, and economic status were noted as key decision-making factors, whether because they become inherent characteristics of the farmer themselves, or because they provide the farmer with tools or skills to adopt practices they may otherwise not choose.

Age. Age of the farmer is one characteristic that shapes a farmer's decision to adopt certain CSA practices, and can play both a positive and negative role in decision-making. Older farmers can be associated with experience and knowledge, greater wealth, as well as greater aversion to risk or innovation (Asfaw, McCarty, Lipper, Arslan, & Cattaneo, 2013; Kassie et al., 2015;

Makate, Makate, Mango, & Siziba, 2019). Smallholders who are older may prefer to stick with traditional practices and technologies and avoid the risk of adopting new practices with potentially unknown or unforeseeable results. Meanwhile, others are more willing to adopt new practices, perhaps because they also have more wealth or education. Younger farmers were more prominently associated with adopting riskier new practices (Asfaw et al., 2013). Thus, while age is an important factor, its intersectionality with other factors is equally as important, and is not considered an ultimate determining factor on its own.

Education. The education level of the farmer or household head also contributes to decision-making. While the average level of education in smallholder farming families is five years (FAO, 2018b), some members of the household may have higher education levels, which were shown to be positively correlated with higher adoption of CSA practices. In almost all of the literature about education levels, higher levels of education, and therefore literacy, knowledge, and skills, were connected with greater adoption (Asfaw et al., 2013; Fapojuwo et al., 2018; Murray et al., 2016). Education increases one's ability to acquire and retain new information and skills, and therefore understand and implement new technologies. It also allows the individual to increase their returns from the adoption of new technologies compared to older ones (Kassie et al., 2015).

Economic status. Level of income or wealth of a farmer was perhaps one of the most strongly correlated factors with increased adoption. Wealth corresponds with an elevated ability to adopt: increased and surplus income creates more financial stability and allows the farmer to spend and invest more in new technologies and resources than a poorer farmer may be able to (Bernier et al., 2013; Kassie et al., 2015). Thus, families with greater wealth have the ability to adopt CSA practices which are considered more investment-intensive, and wealth may boost the confidence of the farmer in their ability to adopt riskier options (Shikuku et al., 2017). Lower income farmers are not entirely prevented from adopting new practices, but may be more constrained to adopting lower- or no-cost practices, or those that involve less risk with regard to expected returns (Khatri-Chhetri et al., 2017).

4.1.2 Farm characteristics

In addition to these key farmer characteristics, the circumstances of their farmland can also impact decision-making. In particular, the plot size, soil quality, and security of land tenure are key considerations for adoption of new practices.

Plot size. Most farmers in Malawi are smallholders, occupying approximately one hectare of land or less. Average landholding size ranges between 0.2 and 0.6 hectares, and can be much larger, up to 8 hectares, depending on the region and income level of the household (CIAT & World Bank, 2018; Government of Malawi, 2017). Thus, most smallholder farmers in Malawi are working with a limited land area. Regardless, farm size is an important factor when it comes to the adoption of CSA (Kassie et al., 2015; Khatri-Chhetri et al., 2017; Makate et al., 2019; Murray et al., 2016). Having more land at one's disposal offers more opportunity to experiment with new practices, without negatively impacting the ability to maintain yields for subsistence and sale (Makate et al., 2019). For example, farmers with larger plot sizes are able to adopt practices that occupy more space, such as agroforestry, whereas those with smaller plots may choose to adopt practices that aim to maximize the space they have, such as intercropping or fertilizer use. In addition, plot size may indicate farmer or household wealth, and having secure land tenure and ownership can facilitate access to capital. Thus, those with larger plot sizes may be able to invest in more capital intensive practices than those with smaller plots (Asfaw et al., 2013).

Soil conditions. Related to plot size is the quality of the plot and its soil. As several CSA practices involve techniques that aim to improve soil quality and fertility and therefore plot productivity, those with lower quality soil prefer to adopt of these types of practices, such as using fertilizers. It was also found that farmers with already highly fertile plots are less likely to adopt similar practices, as soil quality is not a concern (Asfaw et al., 2013). Combined with considerations of plot size, those with lower quality soil on smaller plots – namely, women – may choose to adopt CSA practices which make the best use of the space they have to improve soil fertility and maximize productivity (Fapojuwo et al., 2018).

Land tenure. Finally, perhaps one of the most critical factors to the adoption of new CSA practices is land tenure security. While land tenure is associated with complicated gender dynamics, it is an important decision-making factor for all farmers regardless of gender. Overall, land tenure security positively impacts the likelihood of adopting CSA. Farmers are more willing to invest in inputs for their plot if they own the land (Asfaw, 2015; CIAT & World Bank, 2018; Glemarec, 2017; Kassie et al., 2015). Lack of secure tenure can hinder CSA adoption, especially of practices with high initial costs or a long-term results trajectory. Without the security of knowing whether one will reap the benefits of CSA, it is understandable that farmers would be cautious to take on new technologies.

Beuchelt and Badstue found that land tenure security matters less when farmers are experimenting with new technologies or practices. In this case, farmers prefer to experiment on rented plots before committing to implementing on owned plots of land (Beuchelt & Badstue, 2013). Additionally, those who rent their plot often prefer to adopt practices that require shorter-term, less labour intensive, and less costly inputs, such as fertilizer, compared to those who own their land and can adopt practices that are costlier or take longer to produce results (Asfaw et al., 2013). Land tenure security increases the likelihood, overall, of farmers adopting strategies that have longer-term benefits and returns from their investments (Asfaw, 2015).

4.1.3 Institutional factors

To a significant extent, farmers' willingness or ability to adopt CSA practices has to do with whether information about adoption of new practices and technology is available to them. Without access to resources, services, or information, adoption of CSA may simply not be an option. Further, the results of coding on this topic showed that access to these services and resources is a particularly gendered issue, even more so than other factors. Almost every passage coded on this subject made reference to gendered differences or was focused specifically on women's lack of access compared to men.

Access to extension services, information, and resources positively influences the decision to adopt new CSA practices (Asfaw, 2015). Access to extension services first depends on whether these are available, either through the local government or other organizations. If available and accessible to those who need it, extension services can be an important source of introduction or information about climate change adaptation and CSA (Asfaw et al., 2013).

However, many farmers, and particularly female farmers, lack access to these essential services and tools. In some cases, women are not targeted as beneficiaries of information the same way men are, and in other cases it may mean that women do not have the right mobility, education, or capacity to benefit from what is offered in their communities. This decreases the likelihood of women adopting CSA practices as they are not privy to the appropriate information needed to do so (Beuchelt & Badstue, 2013; Collins, 2018; Glemarec, 2017; Huyer, 2016; Perez et al., 2015).

Following from extension services is access to information. This includes information and training about CSA and its implementation, as well as information about climate and weather patterns. Greater access to information about climate change, its impacts, and alternative agricultural practices that promote adaptation can lead to higher adoption rates (Huyer, 2016). Some ways in which farmers access this information include technologies such as radio, mobile phones, internet, and television. Indigenous and local knowledge systems and word-of-mouth about observed climatic changes in the community can also be important. NGOs, government officials, and extension officers can also provide this information to smallholder farmers (Challinor et al., 2007; Huyer, 2016; Nyasimi & Huyer, 2017).

While some CSA practices are relatively easy and intuitive to adopt, some are far more complex and require more training and understanding. A poor understanding of the practice and how to implement it acts as a knowledge barrier and often deters or prevents farmers from adopting altogether (Bunderson et al., 2017). Further, farmers who are better informed about climate and weather patterns may be more motivated to seek methods of adapting to climate change (Nyasimi & Huyer, 2017). However, lack of access to this information can be a barrier to CSA adoption. Not all farmers have access to the technologies that disseminate this information, with female farmers having far less access than male farmers (Nelson & Huyer, 2016; Nyasimi & Huyer, 2017). Extension services and NGOs can provide this information instead, however many extension services do not consider women to be farmers, and they can therefore be excluded from training or other channels of communication (Huyer, 2016).

Once informed about CSA, the final access barrier is to the resources and technology needed for implementation. This can include the proper tools and inputs for CSA, including mechanized farming tools (compared to traditional manual tools), and inputs such as seeds and fertilizers. While mechanized tools are not critical for the adoption of CSA, manual tools that are predominately used by (female) smallholders are often overlooked by support services, making some practices very labour intensive (Huyer, 2016; Murray et al., 2016). Inputs like seeds and fertilizers can also still be out of reach for many farmers, with poverty and information acting as barriers to accessing and using these resources (Bernier et al., 2013; Bunderson et al., 2017). Farmers' ability to adopt new practices is influenced by their level of access to services, information, and resources. For those without proper access to the right tools and training, implementing CSA is much more difficult.

4.1.4 Personal motivations

Finally, personal motivations play a central role in decision-making. These motivations, driven by a combination of the other factors already mentioned, largely revolve around beliefs and understandings of CSA benefits and perceived outcomes. These were captured in the coding 55 times under the "general preferences" code, 45 times under "women's preferences", and 21 times under "men's preferences". Motivations were more specifically coded under the "preferences – why" sub-codes for both women and men.

These personal motivations were found to be marked by gendered differences. While both men and women are driven by the potential for increased yields, the intended use of these yields varies based on traditional gender roles. Men typically prefer to maximize yields of cash crops, whereas women prefer crop varieties that are nutritious and easier to cook, as they are responsible for household tasks and food security (Beuchelt & Badstue, 2013; Jost et al., 2016).

In addition, perceived reduction in labour burden or time commitment may be a motivator for some farmers, and perceived increase in labour or time burden may be a demotivator (Beuchelt & Badstue, 2013; Huyer, 2016; Murray et al., 2016). These general motivators are important considerations that play a role in decision making, and will be reviewed more in-depth in the following section.

4.2 Adoption of CSA practices: gendered preferences and motivations

CSA is not comprised of a specific set of practices, but rather a variety of practices can be considered climate-smart if they meet any of CSA's three criteria. However, the literature tends to focus on particular practices that are popularly reported. According to the literature, the following CSA practices are most commonly adopted in Malawi, and in Africa more broadly: conservation agriculture (CA), agroforestry, maize-legume intercropping, use of fertilizers, and use of improved seeds and varieties.

4.2.1 Conservation agriculture

Conservation agriculture (CA) is a well-known set of practices that falls under the CSA umbrella, and is often promoted on its own. Conservation agriculture was mentioned as a preferred practice in 7 articles, and conducting a keyword search of CA and its associated practices on the coded literature revealed its specific use in 17 instances. Much of the literature noted CA's popularity among other CSA practices and mentioned that it is widely promoted by governments and NGOs. Approximately 78% of all CSA projects in Malawi promote conservation agriculture (CIAT & World Bank, 2018). Despite widespread promotion, adoption rates are still very low, with about 1.7% of the arable land in the country operating under CA (CIAT & World Bank, 2018; Schaafsma et al., 2018).

CA has three main principles of minimum soil disturbance, good soil cover with biomass, and diversification of cropping (Andersson & D'Souza, 2014; Bunderson et al., 2017). This includes techniques such as avoiding ploughing, directly planting seeds into small holes made with a dibble stick, and retaining crop residues on the surface of the soil after harvesting. The aim of these practices is to disturb the soil as little as possible, which protects the soil from the elements, improves its quality and structure, maximizes water retention, and reduces erosion (Bunderson et al., 2017). The third principle of CA, crop diversification, involves practices like intercropping or crop rotation, which are also considered CSA practices in their own right and will be discussed in a following section.

Conservation agriculture has many benefits, chief of those being increased productivity and profitability of crops. Several studies have demonstrated these benefits, with one study of CA's use in Malawi over a 10-year period revealing an increase of maize and other staple crop yields by up to 70% within two seasons, even in years of low rainfall (Nyasimi et al., 2014). In addition to increased yields, CA also decreases labour costs. Adopting reduced tillage requires less labour to prepare land for planting and harvesting, and can eliminate the need for labour intensive work like using a traditional hoe to create ridges for planting (Andersson & D'Souza, 2014). CA is also a method for farmers to mitigate the impacts of climate change and adapt to erratic weather conditions, reduce the rainfall lost to runoff, and improve the overall health of their soil (Bunderson et al., 2017).

However, adoption of CA is still quite low among smallholder farmers in Malawi. The literature showed mixed results in terms of preference for adopting CA, with neither men nor women preferring it in comparison to one another. The key reported drivers for CA adoption were increased crop yields, and subsequent increased food security, reduced labour costs, better water retention, soil improvement, and increased incomes from selling surplus crops, which all relate to climate change adaptation (Bunderson et al., 2017). For example, greater water retention and improved soil quality help reduce the impacts of droughts and dry spells by keeping the soil productive during those times. Additionally, greater availability of food through increased crop productivity has two main benefits. First, surplus crops can be sold for additional cash, a preference associated with male farmers. Surplus crops also promote increased household food security, with more food available for consumption, a preference associated with female farmers (Beuchelt & Badstue, 2013).

Minimum or reduced tillage is the most common CA practice adopted in Southern Africa, and is prominently associated with a reduced labour burden (Andersson & D'Souza, 2014). Contrarily, two studies noted that female farmers were less likely to adopt minimum tillage and manure for soil fertility (Murray et al., 2016; Ndiritu et al., 2014). Ndiritu et al. explain this difference as not only a demand for more labour on the part of women rather than men (i.e. unequal distribution of labour within the household), but also women's lower access to knowledge and resources about the practice, and these being barriers to their adoption (Ndiritu et al., 2014). Murray et al. provide an alternative, but complementary explanation, noting that tillage responsibilities may fall to men, therefore causing the adoption of CA to reduce their labour burden. However, women are responsible for weeding, which increases under CA, therefore explaining their potential lower preference for these types of practices if they increase women's labour burden at a later point in the farming cycle (Murray et al., 2016).

Other barriers to the adoption of CA include lack of information or a poor understanding of what CA entails, as well as conflicting messages about the approaches that can be taken, limited access to inputs, and credit constraints (Bunderson et al., 2017; Kassie et al., 2015). As mentioned, women have less access to these resources and information, which supports the assumption that CA adoption would be lower among female smallholder farmers. Further, understanding who benefits from CA and how gender relations play a role in its adoption and decision-making are important considerations for its productive and beneficial adoption. Failure to consider these circumstances has been noted as a key cause of low adoption rates (CIAT & World Bank, 2018).

4.2.2 Agroforestry

Agroforestry promotes improved soil quality and fertility, and is sometimes considered under the umbrella of conservation agriculture, or adopted alongside it. Agroforestry was discussed in 4 articles, and through a keyword search of the coded articles, was mentioned in 12 instances. The premise behind agroforestry is to intercrop trees and smaller food crops (for example, a shrubby legume plant) to prevent soil erosion and improve the health of the surrounding ecosystem. Agroforestry also promotes water infiltration and retention and helps improve soil cover and organic matter, with the added advantage of providing shade, which is beneficial for some crops, such as tobacco (CIAT & World Bank, 2018; Collins, 2018). Agroforestry also helps mitigate climate change impacts in two ways. First, it provides a buffer for farmers against climate variability through the provided shade and additional soil cover, and second, helps to reduce greenhouse gases through carbon sequestration (Altieri & Koohafkan, 2008). Agroforestry can also generate additional income depending on the species of tree planted, for example fruit-bearing trees (CIAT & World Bank, 2018).

Agroforestry appeared to be relatively popular among both female and male smallholder farmers. Asfaw et al. found that 39% of maize plots in their Malawi-based study used agroforestry. The adoption of agroforestry contributed to increased maize yields compared to those who did not adopt, although the yield increases were lower than those associated with adoption of other CSA practices (Asfaw et al., 2013). Factors that increase the likelihood of adoption include the farmer's age, access to information, and farm size. Those with more experience and information are more likely to adopt agroforestry, as were those with larger farms, as they have more space to sufficiently plant the trees (Asfaw et al., 2013). For those with smaller farms, adoption of agroforestry is less attractive. Without the space to plant, competition between planting trees or additional staple food crops may pose a constraint to adoption (Andersson & D'Souza, 2014). Additionally, and importantly, land tenure was found to positively and strongly influence agroforestry adoption, as it has a longer-term trajectory in terms of results and return on investment. Owning the land provides more security that the farmer would reap those benefits in the long run (Asfaw et al., 2013).

While the literature suggests agroforestry is a preferred CSA practice overall, evidence on the gendered preferences for adoption was contradictory. Fapojuwo et al. found that female plot managers were more likely than male plot managers to adopt agroforestry, and were more likely to adopt agroforestry than other CSA practices such as crop rotation, potentially due to labour and time burdens or upfront costs (Fapojuwo et al., 2018). However, this study was conducted in West Africa, where the circumstances may differ from those in Malawi. Alternatively, Shikuku et al., in their Malawi-based study, found that male-headed households were more likely to adopt agroforestry than female-headed households. The gender inequity in resource and land access was the major driver for this difference, where men had more access to the capital and resources needed to adopt agroforestry, and lack of access was a constraint for women (Shikuku et al., 2017). Overall, although agroforestry is well-promoted in Malawi, it has failed to achieve wide-spread adoption at this point (Schaafsma et al., 2018).

4.2.3 Maize-legume intercropping

Intercropping, a CSA practice that can fall under the umbrella of conservation agriculture, was another popular practice for adoption. It appeared in 9 articles, and a keyword search of the coded literature had it appear in 24 instances. Intercropping involves growing two or more different crops or plants combined together in a single field. In Malawi, intercropping is relatively common, used in 53% of plots across the country (Government of Malawi, 2017). Maize-legume intercropping is the most common combination, intercropping maize with legume varieties such as pigeon peas (Andersson & D'Souza, 2014).

Intercropping allows farmers to benefit from the interactions among individual crops. These interactions can result in improved soil quality and fertility, reduced incidence of weeds and pests, improved soil water retention, and increased yields, particularly for maize in maize-legume intercropping scenarios (Kassie et al., 2015; Ndiritu et al., 2014). Farmers who adopted maize-legume intercropping experienced significant maize yield increases, harvesting up to 80% more maize per acre than non-adopters (Asfaw, 2015). Intercropping also allows farmers to diversify their crops and plant crops that have different needs and responses to various environmental stresses. This can contribute to the stabilization and security of farm income over time, by evening out the impacts of price fluctuations (Ndiritu et al., 2014). Diversification also helps mitigate the negative impacts of climate change by reducing reliance on one main crop, and allows farmers to reduce labour burdens by planting crops that have different harvesting cycles (Kassie et al., 2015; Ndiritu et al., 2014).

Based on these characteristics, it is perhaps unsurprising that intercropping is preferred more among female smallholder farmers compared to male smallholders. First, intercropping provides the ability to plant crops that have different harvesting cycles, and can therefore be harvested at different times and in different places. This spreads the labour burden of harvesting across space and time, and buffers against market and environmental risks (Bunderson et al., 2017; Ndiritu et al., 2014). Additionally, intercropping diversifies the crops harvested, resulting in greater nutritional diversity for the household. This could be an attractive outcome for female farmers, as intercropping allows them to maximize the use of their space by planting multiple diverse crops, for the purpose of improving the food and nutrition security of their household (Beuchelt & Badstue, 2013; Ndiritu et al., 2014). It was also found that male-female jointly-managed plots are still more likely to adopt intercropping than male-managed plots, demonstrating the real preference for this practice among women compared to men, and the prioritization of improved crop productivity for food security purposes (Bunderson et al., 2017; Ndiritu et al., 2014).

Other factors that increase the likelihood of adopting intercropping include ownership of land, education level, and access to information. Those that own their land may be more likely to adopt intercropping, as many of its benefits are felt more strongly over time (Asfaw et al., 2013). Adopting intercropping is also negatively associated with higher education levels, suggesting that only a basic level of knowledge is needed to adopt intercropping. This aligns with the finding that female farmers are more likely to adopt intercropping than male, as women often have lower levels of education and access to information about CSA practices. Intercropping can therefore be seen as a more universally accessible practice to adopt (Asfaw et al., 2013). As with most CSA practices, access to information and extension services increases the likelihood and ability to adopt intercropping, as more information and training builds the capacity of farmers to adopt new practices (Asfaw et al., 2013). In the case of intercropping, perceptions and experiences of climate also play a role, as the likelihood of adopting intercropping increases with the experience of decreased rainfall. As intercropping promotes soil health and water retention, it improves resilience to the impacts of erratic rainfall or droughts, making it a preferable option for adoption in areas where climate variability is experienced regularly (Asfaw, 2015).

4.2.4 Fertilizers

The use of both organic and inorganic fertilizers are considered climate-smart agricultural practices[4]. Fertilizers were very common in the literature, mentioned in 13 articles and several times in a keyword search of the coded literature: 36 instances of “fertilizer”, 20 instances of “inorganic fertilizer”, 12 instances of “organic fertilizer”, and 19 instances of “manure”. The use of both is relatively widespread, although inorganic fertilizer use is higher than organic in Malawi, at 55% and 19% respectively (Government of Malawi, 2017). Additionally, fertilizer use is relatively higher in Malawi compared to other Sub-Saharan African countries due to the

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[4] Although inorganic fertilizers are referred to throughout the literature in the context of climate change adaptation, it must also be noted that their use is a contributor to climate change, through the release of GHG emissions (Wassie & Pauline, 2018). Thus, while not a perfectly climate-smart practice, inorganic fertilizers will be discussed in this paper because of their prevalence in the literature as a method for improving farm productivity in the context of climate change, as well as their common use in Malawi.

FISP, which has subsidized fertilizers for smallholder farmers for many years and has made their use widespread (Andersson & D'Souza, 2014; Asfaw et al., 2013; FAO, 2018b).

Male smallholder farmers and male-headed households are more likely to use fertilizers than their female counterparts, however this difference is slight, at 57% and 55% respectively (CIAT & World Bank, 2018; Government of Malawi, 2017). In general, female farmers are more likely to use organic fertilizers, and male farmers are more likely to use inorganic fertilizers. This can be attributed to the capital input needed for inorganic fertilizers versus organic fertilizers which can be made from manure and compost. Where women have less access to capital, organic fertilizers are far easier to adopt (Asfaw et al., 2013; Fapojuwo et al., 2018; Jost et al., 2016; Murray et al., 2016). Others have noted that the use of fertilizers could also potentially increase the labour burden for women. For example, organic fertilizers like compost or manure can involve additional labour for their preparation or transportation, and using fertilizers could require more weeding or more output to process, which tend to be roles that fall to women (Beuchelt & Badstue, 2013; Collins, 2018; Ndiritu et al., 2014).

Apart from these slight gendered differences, fertilizer use also rests on many other decision-making factors. As a short-term, easy to implement input, fertilizer use is associated with implementation by younger farmers, on larger plots of land, on rented versus owned land, and in circumstances where rainfall is good (Asfaw, 2015; Asfaw et al., 2013). Somewhat surprisingly, adoption of inorganic fertilizer increases with education level. While this is a relatively simple practice to implement, adoption was highest among household heads that had tertiary education (70%) compared to those with lower levels of education (54%) (Government of Malawi, 2017). This likely demonstrates the information and knowledge required to properly implement the use of fertilizers, perhaps showing that it can be relatively inaccessible for those with lower levels of education (Asfaw et al., 2013; Fapojuwo et al., 2018). The primary result of fertilizer use, both organic and inorganic, is increased yields, making it attractive for both men and women, who may choose to use the surplus yields in different ways.

4.2.5 Improved seeds and varieties

Similarly related to fertilizer use is the use of hybrid or "improved" seed varieties[5]. Improved seeds, and specifically improved varieties of maize or legumes, are usually chosen for their higher-yielding or drought-resistant properties. These improved varieties make it easier to adapt to climate change impacts and increase yields of staple crops for consumption or sale. For example, adopters of improved maize seeds saw an increase in quantity produced per acre of up to 98% compared to non-adopters (Asfaw, 2015). Improved seeds were mentioned in 6 articles, and a keyword search of the coded literature noted "improved seed" or "improved variety" in 20 instances. Alternatively, the terms "hybrid seed" or "hybrid variety" were only found in 3 instances, indicating the prevalence in the literature of the terminology "improved". The adoption of improved seeds is very common, popular and well promoted, with 65% of all CSA projects in Malawi promoting their use (CIAT & World Bank, 2018). Makate et al. found that drought-tolerant and high-yielding maize varieties had relatively high adoption rates of 27% of their sample in Malawi (Makate et al., 2019).

[5] Hybrid seed varieties are largely referred to in the literature as "improved" seeds. The use of the terminology "improved" can be seen as problematic, when interpreted as indicating these seeds or varieties are "better" than traditional varieties. However, to remain consistent with the literature, hybrid varieties will be referred to as "improved" throughout this paper.

Male smallholders and male-headed households were reported as more likely to adopt improved seed varieties than female farmers and female-headed households (Asfaw et al., 2013; Perez et al., 2015). One possible explanation for this is the capital input required, which women typically have less access to. Additionally, it is well noted that men prefer to plant crop varieties that are high-yielding and have characteristics that increase market value, such as demand and appearance, to increase the possibility of surplus production for sale. Alternatively, female farmers tend to prefer the varieties that are more nutritious for their family's consumption (Beuchelt & Badstue, 2013; Nyasimi & Huyer, 2017). As men are often responsible for buying seeds, or may have more decision-making power over which varieties are purchased, it is clear why these particular high-yielding varieties are chosen. One study noted that female famers found certain high-yielding maize varieties to be harder to cook and require more firewood and labour as a result. These gendered variances may explain why men are more likely to adopt improved varieties than women (Beuchelt & Badstue, 2013; Jost et al., 2016; Nyasimi & Huyer, 2017; Perez et al., 2015).

Other factors also influence the decision to adopt improved varieties. For example, younger farmers are more likely than older farmers to adopt improved varieties, and those with higher levels of education and larger farms are also more likely to adopt (Asfaw et al., 2013). While land ownership does not deter farmers from adoption, improved seeds are more likely to be used on rented plots than other CSA practices, due to the short-term input and reward characteristics of this practice (Asfaw et al., 2013). Climatic conditions also play a role. In areas that are already dry, improved varieties are preferred. Due to the short-term gain nature of this input, those farms experiencing less climatic variability and relatively favourable rainfalls are also likely to adopt improved seeds (Altieri & Koohafkan, 2008; Asfaw, 2015).

5 Discussion

Based on the above findings, certain generalizations and conclusions can be made about the nature of CSA adoption in Malawi, and why male and female smallholders may choose to adopt certain practices over others.

Farmer characteristics are equally as important as personal motivations. While personal motivations for adopting a particular CSA practice are important, the literature showed that the individual circumstances of each farmer were equally as important in driving a decision. Farmer and farm characteristics, such as education, age, land tenure, plot size, and economic status can determine which practices farmers have the capacity or ability to adopt. These characteristics foster an enabling environment for CSA adoption decisions, without which personal motivations may be completely invalidated.

Assuming there is a present ability to adopt CSA practices, women, in general, prefer to adopt practices that help reduce their time and labour burdens, and that require fewer inputs upfront. This could include intercropping, which can help reduce labour burdens by spreading out the harvesting cycle, and using organic fertilizers, which require little to no upfront cost (Asfaw et al., 2013; Bunderson et al., 2017). In contrast, men have greater capacity to adopt practices that are costlier or require more knowledge, such as improved seed varieties, inorganic fertilizer, agroforestry, and conservation agriculture. Men have greater access to inputs and capital, more secure land tenure, and higher levels of education, which better positions them to adopt a wider variety of CSA practices.

Adopting multiple practices is beneficial. An important consideration for CSA adoption is the interdependency of practices. The literature showed that regardless of gender, farmers were likely to adopt more than one CSA practice simultaneously, as doing so produced better results. If one CSA practice was already in use, the tendency to adopt more practices increased (Asfaw, 2015). As different innovations may target different goals or issues, adoption of multiple practices at once allows for complementarities between them, which can have combined positive effects (Makate et al., 2019). For example, adopting multiple practices could both increase soil quality and water retention, resulting in greater resilience to climate change impacts and increased yields (Makate et al., 2019). In fact, it was found that maize yield increases were larger when more than one CSA practice was used, compared to when only one innovation was used (Kassie et al., 2015; Ndiritu et al., 2014).

Gender norms shape preferences and abilities. Women's and men's expected roles and responsibilities provide them with certain capabilities and also impose barriers. For example, men have greater land tenure security and therefore more power within the household and community, and more control over the family's assets and capital (Huyer, 2016; Perez et al., 2015). Thus, they can invest in costlier CSA practices than women, who may have no or very little access to capital. Men may also be less concerned about the labour impacts of certain CSA practices if they are not responsible for the tasks that increase in intensity as a result of adoption. For example, use of inorganic fertilizers may increase the labour required for weeding, which is a typically female task (Beuchelt & Badstue, 2013).

In addition, gendered roles and responsibilities impact personal motivations. As men are typically responsible for the economic security of the home, and women are responsible for the health and food security of the home, they may prefer different practices that produce different results (Murray et al., 2016). Increased yields are a benefit for both, although men prefer increased yields of crops that are easier to sell while women prefer more nutritious crops that improve the food and nutrition security of their family (Beuchelt & Badstue, 2013). While households may have shared priorities of increasing income, maintaining health, and feeding their family, the roles assigned to men and women generate different priorities in adopting agricultural innovations that contribute to achieving their goals.

Gender norms can also dictate status in the household, and therefore access – to services, resources, and information. Studies have shown that when women have the same level of access to information and services as men do, they are equally or more likely than men to adopt CSA (Nelson & Huyer, 2016). However, men typically have more access to these resources, indicating greater capability to adopt CSA, as they are equipped with the knowledge, tools, and institutional support to do so. Women's lower access to these resources may hinder their ability to adopt CSA practices compared to men (Glemarec, 2017).

Women face more barriers to CSA adoption than men. Based on these findings, it is clear that female farmers face significantly more barriers to the adoption of CSA practices than men do. First, with more time-consuming responsibilities, women have less time to devote to learning about and adopting new practices. Second, women typically have less decision-making power in the household, which limits their ability to choose to adopt CSA practices and then which practices to adopt. Third, women have less access to the important inputs, knowledge, training, resources, and services that facilitate CSA adoption. While women may want to adopt agricultural innovations, the barriers they face may prevent this.

Alternatively, men face far fewer barriers to CSA adoption, with more access to tools, resources, credit, knowledge, and training, more time to devote to learning and adoption, and more power to choose when and what to adopt. Thus, men are able to adopt a wider variety of practices, and more costly or technologically advanced practices with this greater status and power. With competing priorities on the farm, this may mean that men's priorities take precedence, or that women must prioritize more strictly and make more compromises with their adoption. This is demonstrated through the higher adoption rates of CSA among male farmers and their preference for practices like agroforestry and improved seed varieties, which are more costly and input heavy. Women, on the other hand, tend to adopt less costly practices that can improve their yields on smaller plots, like organic fertilizers, conservation agriculture, and intercropping.

We can apply this finding of women's barriers to a larger demographic than Malawi. Most of the literature reviewed that was based in other geographic areas found the same barriers to exist. By the virtue of their gender, female smallholders have less access to innovations and therefore a lower ability to adopt such practices. This can also be extended to training and extension services, which target male farmers more often. Gender roles, responsibilities, and norms should be taken into account when conducting CSA promotion or providing services to locales such as Malawi.

These various considerations show that decisions to adopt agricultural innovations on smallholder farms in Malawi are complex, gendered, and context specific. To determine whether CSA adoption will be successful, the personal context of each farmer must be considered. This is certainly a difficult task, but is critical, as the literature shows how many individual factors may play into a decision, making the adoption of CSA practices varied between farms and farmers.

6 Conclusion

This MRP explored the adoption of climate-smart agricultural practices in Malawi, by smallholder female farmers in the context of climate change and food security. By providing an overview of the intersections between climate change, food security, agriculture, and gender, and situating these concepts in the Malawian context, CSA was reviewed as a response to the challenges faced in these areas. The analysis reviewed the five most prominent CSA practices used in Malawi, and why farmers may choose to adopt them. This was also analyzed in the context of gender, acknowledging the different gendered priorities that may influence a decision.

In general, it can be concluded that a combination of personal motivations and other decision-making dimensions are critical to determining which CSA practices, if any, a farmer chooses to adopt. Dimensions of decision-making such as age, education, access to services and information, and land tenure create the enabling environment for adoption. Without this, personal motivations for adopting certain practices may be obsolete. However, both are important in the actual decision to adopt CSA on one's farm.

Gender plays an important role in these decisions, as female and male smallholder farmers experience agriculture, food security, and climate change differently. Female farmers face more barriers to adoption simply because of their gender – they have fewer educational opportunities, less access to training, tools and resources, and have lower land tenure security (if any at all). They also have more household responsibilities than men, which allows less time to devote to learning and benefitting from new innovations. These considerations all make it more difficult for women to adopt new practices.

Climate change impacts like extreme weather events and more rainfall variability will impact crop yields and the growing season in Malawi. In response, adopting CSA practices that improve crop yields and manage these impacts is a key concern for both male and female farmers. This provides more economic, food and nutrition security of the household members. Particularly for female farmers, adopting CSA practices which improve food and nutrition security through increased yields, more diverse crops, and growing varieties that are nutritious and easy to cook is a principal concern.

Based on the analysis conducted and the literature available, as well as the nature of the study, these findings can be considered tentative. While there was sufficient literature available to conduct this research, there were no existing studies which directly related to answering the specific research question. More research would need to be done in Malawi to be able to more fully address the research question and make more decisive conclusions.

What can be concluded is that food security, economic concerns, and climate change are all important considerations for farmers. While decisions around how to address these concerns may manifest in different ways, it is clear that these considerations are critical and should be better incorporated into policies and programs for smallholders. As producers of most of the food for the developing world, smallholder farmers will be central to addressing food security challenges on local and global scales. If we are unable to incorporate climate considerations into programming and innovations, agricultural productivity will suffer.

By better understanding the constraints female smallholder farmers face, and what opportunities are available to them, we can start to better align policies and programming to address their particular needs and challenges. By also understanding farmers' decisions to adopt certain CSA practices, we can better orient CSA to these factors and make it more flexible for a variety of local contexts. The impacts of climate change are a real concern, and will be deeply felt globally, especially by those who have contributed the least to it. With effective global, regional, and national policies and programming, as well as the necessary tools and resources at the local level, smallholder farmers can be equipped and empowered to effectively combat climate change impacts, increase their food security, and improve their quality of life.

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Appendices

Appendix A: Code Descriptions

Code Name	*# Recorded*	*Description*
General preferences	55	Description of CSA practices or farming methods preferred by farmers, without gendered distinction.
Women's preferences	45	Description of CSA practices or farming methods preferred by female farmers
What	23	• What: describes which practices are preferred
Why	17	• Why: describes reasoning behind preference
Men's preferences	21	Description of CSA practices or farming methods preferred by male farmers
What	13	• What: describes which practices are preferred
Why	10	• Why: describes reasoning behind preference
Climate change	11	Descriptions related to general impacts of climate change.
Food security	9	General descriptions of food security and food security challenges.
Climate change impacts on agriculture	16	Description of direct impacts of climate change on the agriculture sector.
Climate change impacts on women	9	Description of impacts of climate change on women.
Climate change impacts on men	5	Description of impacts of climate change on men.
Climate change impacts on food security	2	Description of impacts of climate change on food security at all levels.
CSA adoption	47	Description of experiences and processes for adopting CSA practices on the ground.
Dimensions of decision-making	119	Description of all factors that influence a decision to adopt CSA or not. Can include individual farmer characteristics and other external or institutional factors.
Farmer characteristics	64	• Farmer characteristics: describes individual characteristics of farmers that influence a decision, including age, education, wealth, and land tenure security.
Other imposed factors	53	• Other imposed factors: catch-all to describe all other external and institutional factors that could influence a decision, including access to services and resources, mobility, and experiences of climate change.
Gender dynamics and roles	91	Description of gender differentiated roles on- and off-farm. Describes gender dynamics such as decision-making power, roles and responsibilities, and differences in experiences.

Notes:

1. The total number of passages coded was 367 across 19 articles.
2. Many coded passages may have been assigned more than one code, if the content of the passage was relevant under multiple codes.
3. Codes with sub-codes have overlap. The passages/codes in these categories were coded under both the "main" code and the sub-code.

Appendix B: Summary of Coding

Article	*General prefer-ences*	*Women's prefer-ences*	*Women's prefer-ences: what*	*Women's prefer-ences: Why*	*Men's prefer-ences*	*Men's prefer-ences: what*	*Men's prefer-ences: why*	*Climate change*	*Food Security*	*Climate change impacts - agriculture*	*Climate change impacts -Women*	*Climate change impacts - Men*	*Climate change impacts - food security*	*CSA adoption*	*Dimensions of decision-making*	*Farmer charact -eristics*	*Other imposed factors*	*Gender dynamics and roles*
Khatri-Chhetri et al., 2017	8	1	1	0	0	0	0	1	0	1	0	0	0	0	1	0	0	0
Perez et al., 2015	1	4	3	1	0	0	0	3	2	2	1	0	0	2	8	0	7	16
Shikuku et al., 2017	11	0	0	0	2	1	1	0	0	1	0	0	0	0	7	4	3	0
Murray et al., 2016	1	6	5	0	1	1	0	0	1	3	1	1	1	2	14	9	4	13
Huyer, 2016	0	3	1	2	1	1	1	0	0	0	2	1	0	0	10	5	4	12
Bunderson et al., 2017	0	0	0	0	0	0	0	0	1	0	0	0	0	10	7	1	4	1
Jost et al., 2016	2	9	3	6	7	3	4	1	1	1	1	0	0	1	5	2	4	8
Asfaw et al., 2013	17	1	1	0	1	1	0	3	0	1	0	0	0	3	22	11	12	0
Fapojuqo et al., 2018	3	6	5	3	3	2	2	0	0	0	0	0	0	1	3	3	0	5
Nyasimi and Huyer, 2017	1	2	0	2	1	0	1	0	0	0	1	0	0	1	4	2	4	3
Kassie et al., 2015	0	0	0	0	0	0	0	0	0	0	0	0	0	7	15	13	3	0
Asfaw, 2015	0	0	0	0	0	0	0	0	1	0	0	0	0	0	5	1	3	0
Bernier, 2013	2	0	0	0	0	0	0	0	0	0	1	1	0	1	0	0	0	7
Ndituru et al., 2014	5	3	1	1	0	0	0	0	0	0	0	0	0	2	5	4	1	9
Njuguna et al., 2016	2	6	2	1	3	2	0	0	2	0	0	0	0	1	4	3	1	8
Beuchelt and Badstue, 2013	2	4	1	1	2	2	1	0	0	0	0	0	0	4	1	1	0	7
Collins, 2018	0	0	0	0	0	0	0	0	0	0	2	2	0	2	2	0	2	2
Altieri and Koohafkan, 2008	0	0	0	0	0	0	0	3	1	7	0	0	1	4	0	0	0	0
Makate et al., 2019	0	0	0	0	0	0	0	0	0	0	0	0	0	6	6	5	1	0