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Examining the Impact of Participatory Agroecology on Social Capital, Sustainable Land Management and Nutrition in Smallholder Farming Communities in Malawi

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Abstract

Globally, hunger has been on the rise, with concentration among smallholder farmers who paradoxically constitute the majority of the world's food-producing population. In sub-Saharan Africa (SSA) where smallholder agriculture dominates, the persistent failure of the agricultural system to address the food needs of the population has been linked to the interactive effect of multiple drivers, including climate change, environmental degradation, social inequalities, political instability and the increased alignment of smallholder farming towards an input-intensive model. Over the past few decades, most governments in SSA have resorted to an input-intensive production approach for improving smallholder agriculture, which emphasizes the use of synthetic inputs. In Malawi and other countries where this input-intensive model has been widely promoted, there is evidence of its counterproductive effects including the shrinking of the hitherto diversified food baskets of traditional farming communities, environmental degradation, erosion of traditional knowledge systems and breakdown of the beneficial social relations that characterize traditional smallholder agriculture. Amid these ecological and social contradictions, the Food and Agriculture Organization called for countries to align their agricultural sectors towards approaches that are ecologically sustainable and socially just. Agroecology is an approach to agriculture that focuses on addressing the ecological and social contradictions of the current food system. At the farm-level, agroecology emphasizes improved nutrient flows and energy use efficiency through ecologically friendly practices such as composting, agroforestry and legume intercropping as opposed to the use of synthetic inputs. Agroecology also has a social justice dimension which focuses on improving the social relations of production between farmers at the local level while addressing social inequalities at different scales in the food system. Despite gaining traction in the past few decades, there is little empirical evidence on the impact of agroecology in smallholder farming communities.

Using a two-wave survey data from a five-year agroecology intervention in Malawi (n=914 farming households, comprising 514 treatment households and 400 control households) and the metabolic rift as an overarching theoretical lens, this dissertation examined the impact of agroecology on farmer social capital, sustainable land management and nutrition. Difference-in-Difference (DID), mediation analysis and regression techniques were employed in data analysis.

Overall, findings from the DID analysis demonstrate a positive treatment effect of the agroecological intervention on social capital, production diversity and dietary diversity. Findings from the logistic regression analysis also show that farming households that received the agroecology intervention were significantly more likely to adopt crop residue recycling, composting, legume integration, mulching, agroforestry and integration of vetiver grass compared to households in the control group after controlling for demographic, socioeconomic and plot-level factors.

These findings demonstrate the multifunctional role of agroecology in smallholder farming contexts. Theoretically, the dissertation also illuminates contemporary understanding of the metabolic rift in the current global food system and the potential of agroecology to address key aspects of the social, ecological and individual dimensions of this rift. In the context of the ongoing pursuit of the Sustainable Development Goals, these findings have practical implications for agricultural policy in Malawi and similar contexts in the Global South.

Keywords: Agroecology, smallholder agriculture, social capital, sustainable land management, dietary diversity, production diversity.

Summary for Lay Audience

Although food is a basic human need, globally, about 1 in 9 people do not have access to enough food. The paradox is that smallholder farmers who constitute the majority of the world's food-producing population are the most food insecure, with concentration in sub-Saharan Africa (SSA) and Asia. The increasing failure of smallholder farming systems in SSA to address hunger is linked to the intensifying biophysical and social challenges resulting partly from the increased inclination of smallholder agriculture towards an input-intensive production model. In Malawi, where the government has promoted the use of synthetic inputs as a pathway to addressing food insecurity over the past few decades, there is evidence that the approach does not work with poor smallholder farmers who struggle to meet the financial burden associated with purchasing these inputs. The increased reliance of smallholder farming systems on synthetic inputs also produces ecological and social problems including environmental degradation, erosion of traditional agricultural knowledge systems and crops, the narrowing of local food systems and the social relations on which smallholder agriculture is founded. Agroecology, which emphasizes the use of organic soil management approaches and pays attention to social inequalities in the food system, is a promising approach for addressing these ecological and social rifts. This dissertation examined the impact of a participatory agroecological intervention to improve household nutrition, sustainable land management and social capital in smallholder farming communities in Malawi.

Overall, our findings show that agroecology can improve farmer social capital, sustainable land management, household dietary diversity and production diversity. Compared to control households that did not receive the agroecological intervention, those that received the intervention had higher mean social capital endowments, dietary diversity and production diversity scores, and were more likely to adopt diverse sustainable land management practices at the endline. These findings provide evidence of the multifunctional role of agroecology in smallholder farming contexts, particularly how it can be deployed to improve household nutrition, farmer interconnectnedness and environmental sustainability. In Malawi for instance, where an input-intensive model has been promoted through the Farm Input Subsidy Program (FISP) as a pathway for improving smallholder agriculture, there is evidence that the approach

benefits only a small fraction of smallholder farmers given that the core poor are unable to afford subsidized modern inputs. The government's focus on promoting maize cultivation under the FISP has also contributed to the narrowing of the food basket and household diets. Thus, agroecology, which draws on locally available resources to generate farming practices that poor smallholder farmers can use to improve and diversify production, can be a pro-poor approach for improving nutrition and environmental sustainablity. The findings also suggest that the participatory farmer-to-farmer knowledge sharing approach used in the MAFFA intervention can be leveraged to improve agricultural extension and the uptake of SLM technologies in SSA. Amid the broader pursuit of sustainable development under the Global Sustainability Goals, these findings further provide salient policy pointers for improving smallholder agriculture in similar resource-poor contexts in the Global South.

Co-Authorship Statement

This dissertation contains three manuscripts which are either published or have been submitted for publication and are currently under peer review. While each manuscript has been co-authored with my supervisors, Dr. Isaac Luginaah and Dr. Rachel Bezner Kerr, and other members of the Malawi Farmer-to-Farmer Agroecology Project, as the first author, I conceptualized and developed the manuscripts with guidance from my co-authors. The manuscripts include the following:

Chapter Four: Kansanga, M. M., Luginaah, I., Bezner Kerr, R., Lupafya, E., & Dakishoni, L. (2020). Beyond ecological synergies: examining the impact of participatory agroecology on social capital in smallholder farming communities. *International Journal of Sustainable Development & World Ecology*, 27(1), 1-14.

Chapter Five: Kansanga, M. M., Bezner Kerr, R., Lupafya, E., & Dakishoni, L. Luginaah, I. Participatory agroecology and the uptake of sustainable land management practices: evidence from Malawi. *Land Use Policy* (under review)

Chapter Six: Kansanga, M. M., Kangmennaang, J., Bezner Kerr, R., Lupafya, E., & Dakishoni, L. Luginaah, I. The impact of agroecology on household production diversity and dietary diversity: Evidence from a five-year agroecological intervention in rural Malawi. *Social Science and Medicine.* (under review)

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CHAPTER 1

1. INTRODUCTION

This dissertation examines the potential for participatory agroecology to improve household production and dietary diversity, farmer social capital and sustainable land management in smallholder farming communities in Malawi. This chapter provides context for the main issues addressed in this dissertation. The first section of the chapter highlights the challenges of smallholder agriculture in sub-Saharan Africa (SSA) in the broader context of the growing biophysical and social contradictions of input-intensive agriculture. The second section of the chapter discusses agroecology as an alternative approach to agriculture while the third section introduces the objectives of the study. The fourth sub-section describes the organization of the dissertation.

1.1 Contextualizing the research problem

Hunger continues to be a major global problem. Reflecting the priority it commands globally, Goal 2 of the Sustainable Development Goals (SDGs) is dedicated to eradicating all forms of hunger and malnutrition by 2030. Notwithstanding this enormous global attention, food insecurity has been on the rise in the last three successive years following a decade of modest decline (FAO, 2019). According to the global food security assessment report of the Food and Agriculture Organization (FAO), the number of people suffering from food insecurity rose from 777 million in 2015 to 804 million and 821 million in 2017 and 2018, respectively (FAO, 2019). Interestingly, a significant proportion of the world's hungry population are smallholder farmers in the Global South who constitute about 80% of the global food producing population (FAO, 2019). In SSA in particular, the FAO points to the interactive role of multiple drivers including climate change, environmental degradation, social inequalities and political instability as the main causes of the growing hunger in the sub-region (FAO, 2018b). Amid the complexity of drivers, the global debate about how a 21st century population of about 9.5 billion people can feed itself sustainably has remained crucial (Bernard & Lux, 2017; Dalgaard, Hutchings, & Porter, 2003; Jacobsen, Sørensen, Pedersen, & Weiner, 2013).

Drawing largely from a neo-Malthusian perspective, some scholars and development practitioners have argued that to address hunger, global food production needs to be increased, and this increase can only be attained through high-input agriculture. Across many countries in SSA, these efforts at promoting input-intensive agriculture have been consolidated under a range of farm input subsidy models as part of the ongoing agenda for an African new Green Revolution (Gengenbach, Schurman, Bassett, Munro, & Moseley, 2018; Ignatova, 2017; Kansanga et al., 2018). Meanwhile, as observed by the FAO (2009), aggregate increase in food supply at the global or national levels through large-scale commercial agriculture does not guarantee that all people, especially the poor, will have adequate access to nutritious food. Indeed, there is evidence that the world currently produces enough food to be able to feed every mouth, yet, geographical disparities in the distribution of global aggregate yield explain why there is abundance in some places and scarcity in others (Holt-Giménez, Shattuck, Altieri, Herren, & Gliessman, 2012).

Moreover, modern agricultural inputs and technologies have been argued to largely benefit large-scale commercial agriculture and only marginally improving smallholder agriculture (Stinner, Lorenzoni, & Paoletti, 2012). In smallholder farming communities where modern inputs may be accessible through subsidies under government-led subsidy schemes, research has shown that these inputs are tied to the production of a few energy-dense cereals and livestock fodder crops such as maize, wheat, rice and soybeans that have export value (Garibaldi et al., 2017). As a result, against the generally acknowledged need for agriculture to address the full range of human dietary requirements, household diets eventually become less diversified (Herrero et al., 2017). Moreover, due to the high capital and operational cost associated with using modern inputs, intensive agriculture does not work with poor smallholder farmers who struggle to purchase these inputs (Gliessman, 2014). Ecological and social problems including the erosion of genetic diversity, over-dependence on external inputs and non-renewable resources, increased release of greenhouse gases, and loss of traditional knowledge are some of the major outcomes of input-intensive agriculture (Altieri, 2002; Gliessman, 2014; Gliessman, Engles, & Krieger, 1998; Montenegro, 2015; O'Rourke, DeLonge, & Salvador, 2017). With the rise of input-intensive agriculture, smallholder farming systems are now heavily reliant on agro-input dealers, while rural lands are simultaneously being grabbed by transnational agro-investors. This erodes the beneficial social relations on which traditional smallholder agriculture is grounded, including farmer-to-farmer social networks (Bezner Kerr, Hickey, Lupafya, & Dakishoni, 2019; Chinsinga, Chasukwa, & Zuka, 2013).

Malawi is one of the most food insecure countries in SSA, despite having over 85% of its population engaged in agriculture (Bezner Kerr & Patel, 2014; Diao, Thurlow, Benin, & Fan, 2012). Findings from the 2016 Malawi Micronutrient Survey indicate that 60% of households experienced moderate to severe hunger, with rural areas being more food insecure (about 65%) compared to urban areas (29%) (National Statistical Office, 2017). Comparing the current state of food insecurity in the country to earlier years (see Bezner Kerr & Patel, 2014), it is evident that the hunger situation has not improved in any significant way. Meanwhile, since the last decade, both drought and flooding have increased in intensity and frequency, resulting in repeated annual famines. In 2014 and 2016 for instance, the Malawi government declared a state of emergency due to severe food shortages following episodes of intense floods and droughts (Hamel, 2016; Stevens & Madani, 2016).

Since 2005, the government has responded to the food insecurity situation by promoting input-intensive agriculture particularly the use of synthetic fertilizer and hybrid maize under input-subsidy schemes (Chinsinga, 2012; Nkhoma, Bosman, & Eduful, 2019). Empirical evidence however demonstrate skewed targeting in these input programmes whereby relatively wealthy smallholder farmers tend to benefit from these input schemes while the most vulnerable farmers, particularly women, are sidelined (Chinsinga, 2011; Holden & Lunduka, 2013; Bezner Kerr & Patel, 2014). The persistent promotion of maize by the government has also been linked to the rise of maize monocultures and the eventual 'maizification' of household diets (Chibwana, Fisher, & Shively, 2012). The narrowing of the food basket in smallholder farming communities has has multidimensional impacts on families including household dietary diversity and child malnutrition (Brooks, 2014). Over half of all women and young children in Malawi suffer from vitamin A deficiency which results in significant morbidity and mortality (National Statistical Office, 2017). Despite the argument that the use of modern inputs will promote higher maize yields, evidence shows the government of Malawi continued to import maize since the implementation of the input subsidy program (Lunduka, Ricker-Gilbert, & Fisher, 2013). Amid the rise of input-intensive agriculture and climate change in Malawi, land degradation has also become a major concern. Results from a recent agricultural land suitability analysis by Li *et al.* (2017) show that 8.2%, 24.1%, 28.0%, and 39.7% of agricultural land in Malawi is highly suitable, moderately suitable, marginally suitable, and unsuitable, respectively.

Like other countries in SSA, the food insecurity situation in Malawi is not merely an outcome of biophysical stressors, but also due to structural inequality. Although women contribute significantly to smallholder agriculture at the household level, empirical evidence suggests that their participation in agriculture is limited due to poor access to productive resources (Fisher & Kandiwa, 2014; Me-Nsope & Larkins, 2016; Meijer, Sileshi, Kundhlande, Catacutan, & Nieuwenhuis, 2015; Mutenje, Kankwamba, Mangisonib, & Kassie, 2016). Rural Malawian women have less access to education, lower access to productive resources including land, credit and seeds and other agricultural resources compared to men (Bezner Kerr et al., 2019). In addition, women are constrained by highly unequal workloads, including agricultural labour, household tasks and childcare responsibilities. According to Deininger, Xia, & Holden, tenure insecurity accounts for a 12% decrease in agricultural productivity for Malawian women (Deininger, Xia, & Holden, 2017). The recent rise in plantation agriculture and accociated land grabbing in rural Malawi has further intensified the land challenges experienced by women (Chu, 2011).

Given the increasing biophysical and social contradictions of input-intensive agriculture, the Food and Agriculture Organization of the United Nations has called for the implementation and scaling-up of sustainable agricultural production approaches while paying attention to underlying social inequalities (FAO, 2018a). According to the FAO, if food insecurity is to be addressed sustainably, increases in production must come from the regions with higher concentration of food insecure populations. Agroecology has gained traction in resource-poor agricultural settings as a pathway for improving agricultural productivity and environmental sustainability while addressing social inequalities (Altieri, 2018; Bezner Kerr et al., 2019; Gliessman, 2014; High Level Panel of Experts (HLPE) of the United Nations Committee on

World Food Security, 2020; S. Snapp, 2017). Agroecology is a systematic and participatory approach to agriculture that aims to address the adverse impacts of input-intensive agriculture, with emphasis on two main scales: the farm-level and the broader social system (see Figure 1.1).

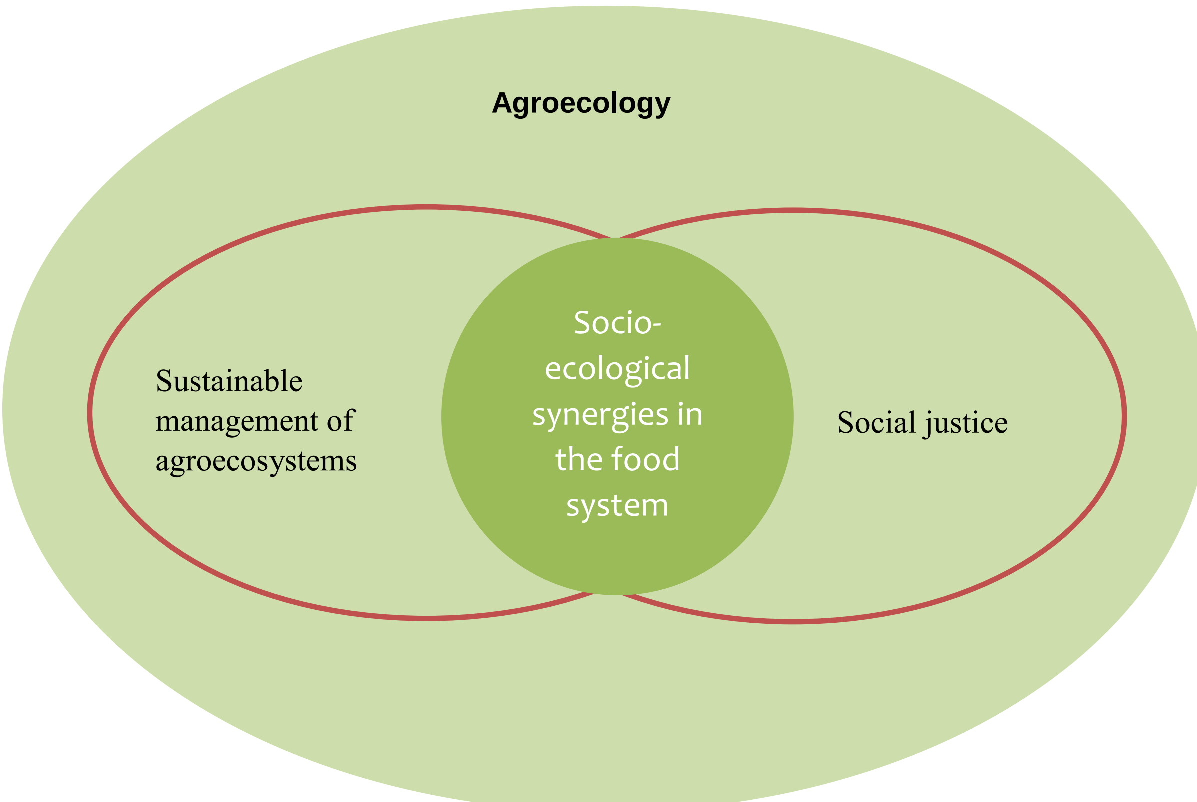

Figure 1.1: Food system transformation through agroecology

At the farm-level, agroecology focuses on managing agroecosystems in ways that mimic the functioning of the natural ecosystem. Emphasis is placed on harnessing locally-available resources (e.g. manure and traditional seeds), and knowledge systems to generate ecologically-friendly and cost-effective farming techniques through key practices such as crop residue integration, manuring, crop diversification, livestock integration, and agroforestry (Altieri, 2002;

Gliessman, 2014). Agroecology is founded on the key organizing principle of ensuring nutrient recycling and energy use efficiency at the farm-level so that agricultural fields can continually replenish their fertility (Altieri, 2002; Gliessman, 2014). As opposed to the use of synthetic inputs, agroecology addresses the problem of soil infertility using organic soil fertilizing practices including manuring/composting, recycling of crop residue, mulching, crop rotation, integrating legumes, and reduced tillage. At the farm-scale, these practices interact to generate beneficial ecological synergies for improving agriculture (Altieri, 2002).

Aside from the focus on sustainable management of agroecosystems, agroecology also has a strong social justice dimension that aims to address social issues inherent in the global capitalist food system including gender inequalities, unequal trade relations and the erosion of farmer social networks (Bezner Kerr, Lupafya, & Dakishoni, 2016; Holt-Giménez & Altieri, 2013). At the macro-scale, this social justice dimension involves re-localizing food systems to ensure food sovereignty[1] through the promotion of local markets, farmer interconnectedness, and delinking of smallholder farmers from modern input-based capitalist markets (Bernard & Lux, 2017; Dumont, Vanloqueren, Stassart, & Baret, 2016). At the local level, agroecology also pays close attention to gender inequalities and emphasizes equity and participation of vulnerable groups such as women in agriculture (Bezner Kerr et al., 2019; Schwendler & Thompson, 2017). As a participatory practice, agroecology builds on traditional knowledge systems and provides opportunities for smallholder farmers to interact and lead the process of knowledge

[1] The term 'food sovereignty' denotes the notion that the producers, consumers and distributors of the world's food should determine and control the policy process that underlie global agriculture rather than food corporations. The concept also encapsulates the right of people to culturally acceptable food (Patel, 2009)

generation and translation (Guzmán, López, Román, & Alonso, 2013; Méndez, Bacon, & Cohen, 2013).

1.2 Current state of the science on the transformative power of agroecology and key gaps

In the context of the increasing socio-ecological impacts of input-intensive agriculture, there has been an increased deployment of agroecology interventions in the Global South aimed at making smallholder farming systems ecologically sustainable and socially just (Adenle, Azadi, & Manning, 2017; Altieri, Nicholls, & Montalba, 2017; De Schutter & Vanloqueren, 2011). Studies emanating from these interventions have shown the potential for agroecology to lead a sustainable food system. For instance, several empirical studies (Bedoussac et al., 2015; Gliessman, 2014; Latati et al., 2016) demonstrate that a combination of agroecology-based farming practices such as crop residue recycling, composting, manuring, crop diversification and legume integration helps balance soil nutrients, and improve weed and pest control (Altieri, 1999; Fernandez & Méndez, 2019; Guzmán, López, Román, & Alonso, 2013; Bezner Kerr et al., 2018). These methods, which eliminate the need for inorganic fertilizers, herbicides and other chemicals, were also found to ultimately reduce the financial burden on poor farmers who struggle to purchase synthetic inputs (Mdee, Wostry, Coulson, & Maro, 2018; Misra, 2017; Mohan, 2002; Nyantakyi-Frimpong et al., 2017; Nyantakyi-Frimpong, Mambulu, Bezner Kerr, Luginaah, & Lupafya, 2016). Not withstanding the positive link between agroecology and the sustainable management of agroecosystems, little is known about the extent to which participatory agroecology training programs and interventions can stimulate the adoption of sustainable farming practices in smallholder farming contexts.

In rain-fed smallholder farming systems, in particular, agroecology has also been reported to improve climate change adaptation and mitigation (Altieri, Nicholls, Henao, & Lana, 2015; Kremen & Miles, 2012; Solorio et al., 2017). The relationship between agroecology, nutrition and human health has also been empirically tested. In their assessment of the relationship between agroecology, food security, and human health, Nyantakyi-Frimpong et al. (2017) found that smallholder farming households that practiced agroecology were 12% more likely to be in optimal (self-reported) health compared to non-agroecology households. This relationship may be linked to the potential for agroecology to improve crop diversity and household dietary diversity (see also Suárez-Torres et al., 2017). Moreover, given the link between human, animal and ecological health, agroecology can provide opportunities for improving ecosystem health and human health through the promotion of environmentally-friendly farming methods and production of healthy food with minimal chemical inputs (Altieri & Nicholls, 2020). As a fundamentally participatory practice, agroecology can stimulate social interaction among farmers, which can also be beneficial for overall human wellbeing.

Although there is growing literature on the positive impacts of agroecology at the farm-level, most of these studies are based on cross sectional data (Bezner Kerr et al., 2019; Fernandez & Méndez, 2019; Nyantakyi-Frimpong et al., 2017). Another key gap in the agroecology literature is the paucity of empirical evidence on the transformative role of agroecology beyond the farm-level, particularly with respect to its ability to address the social contradictions of capitalist agriculture—particularly the rise of monocultures and associated narrowing of the food baskets of smallholder farming communities—and improve the social relations on which smallholder agriculture is grounded. This study, therefore, adds to, and extends the literature on the potential contributions of agroecology at both the farm-level and the broader societal-level using data from a five-year participatory agroecology intervention in Malawi. Thus, the overarching research question in this dissertation focuses on whether agroecology can contribute to addressing some of the social and ecological issues in contemporary smallholder agriculture.

1.3 Study objectives

This dissertation is written as a collection of three manuscripts focusing on understanding the role of agroecology in addressing key ecological and social problems in smallholder agriculture within the broader global capitalist food system. The analysis was guided by the following three research objectives:

i). To examine the impact of participatory agroecology on social capital in smallholder farming communities;

ii). To explore the relationship between participatory agroecology and sustainable land management;

iii). To examine the impact of participatory agroecology on household production diversity and dietary diversity.

1.4 Dissertation outline

This dissertation comprises seven chapters, including this introductory chapter which presents the problem of study and research questions. Chapter 2 summarizes the literature on food system transformation through agroecology and discusses the theoretical underpinnings of agroecology through the lens of the metabolic rift. Chapter 3 discusses the research design and methods of data collection and analysis. Chapters 4 to 6 are three independent manuscripts, of which one is published and two are under review. Guided by theoretical developments on the metabolic rift—discussed in detail in the next section—these three manuscripts examine the potential of agroecology to contribute to addressing some of the ecological and social problems in the contemporary capitalist food system. The order of the manuscripts is informed by the objectives and theoretical underpinnings of the study as opposed to the order of submission or publication.

Chapter 4, which is published in the International Journal of Sustainable Development and World Ecology, addresses objective 1. This manuscript examined the potential of participatory agroecology to improve farmer social capital in smallholder farming communities. It adds to the limited empirical research devoted to understanding how participatory agroecology can help improve farmer-to-farmer networks and provide a basis for sustainable agriculture in contemporary agriculture. Although social capital has been linked to improved management of environmental resources in smallholder communities (Bisung, Elliott, Schuster-Wallace, Karanja, & Bernard, 2014; Bouma, Bulte, & van Soest, 2008; Cramb, 2005; Pretty, 2003; Yoder & Chowdhury, 2018), evidence on strategies to replenish the depleting social capital in smallholder farming communities in the Global South is lacking. The manuscript contributes to the literature by providing evidence on the potential for participatory agroecology to strengthen farmer social capital.

The second manuscript (Chapter 5), relates to objective two and examines the farm-level impact of agroecology. Specifically, the chapter explores the extent to which the agroecology practices can promote sustainable land management in smallholder farming communities. The chapter uses logistic regression techniques to examine the association between participatory agroecology and the adoption of sustainable land management practices. This chapter provides evidence on the potential for participatory agroecology to stimulate the adoption of sustainable farming practices among smallholder farming households.

The third manuscript (Chapter 6) addresses objective three. The manuscript explores the impact of agroecology on household production diversity and dietary diversity. It uses a comparative approach to examine the production diversity and dietary diversity outcomes of households that participated in the Malawi Farmer-to-Farmer Agroecology (MAFFA) intervention and a group of control households that did not participate in the intervention. As mentioned earlier, although some studies have explored the potential for agroecology to improve household food security in resource-poor context (Fernandez & Méndez, 2019; Nyantakyi-Frimpong et al., 2017), these studies are based on data from short-term agroecology trials. Our findings build on these studies using data from the five-year MAFFA intervention.

The final chapter (Chapter 7) summarizes the findings of this dissertation. It also highlights the limitations and implications for future research. The conclusion discusses the contributions of the research. The references, appendices and my curriculum vitae are provided thereafter.

1.5 References

Adenle, A. A., Azadi, H., & Manning, L. (2017). The era of sustainable agricultural development in Africa: Understanding the benefits and constraints. *Food Reviews International*, 1–23.

Altieri, M. A. (1999). Applying agroecology to enhance the productivity of peasant farming systems in Latin America. *Environment, Development and Sustainability*, *1*(3), 197–217.

Altieri, M. A. (2002). Agroecology: the science of natural resource management for poor farmers in marginal environments. *Agriculture, Ecosystems & Environment*, *93*(1), 1–24.

Altieri, M. A. (2018). *Agroecology: the science of sustainable agriculture*. CRC Press.

Altieri, M. A., & Nicholls, C. I. (2020). Agroecology and the emergence of a post COVID-19 agriculture. *Agriculture and Human Values*. https://doi.org/10.1007/s10460-020-10043-7

Altieri, M. A., Nicholls, C. I., Henao, A., & Lana, M. A. (2015). Agroecology and the design of climate change-resilient farming systems. *Agronomy for Sustainable Development*, *35*(3), 869–890.

Altieri, M. A., Nicholls, C. I., & Montalba, R. (2017). Technological Approaches to Sustainable Agriculture at a Crossroads: An Agroecological Perspective. *Sustainability*, *9*(3), 349.

Bedoussac, L., Journet, E.-P., Hauggaard-Nielsen, H., Naudin, C., Corre-Hellou, G., Jensen, E. S., … Justes, E. (2015). Ecological principles underlying the increase of productivity achieved by cereal-grain legume intercrops in organic farming. A review. *Agronomy for Sustainable Development*, *35*(3), 911–935.

Bernard, B., & Lux, A. (2017). How to feed the world sustainably: an overview of the discourse on agroecology and sustainable intensification. *Regional Environmental Change*, *17*(5), 1279–1290.

Bezner-Kerr, R., Lupafya, E., & Dakishoni, L. (2016). Food Sovereignty, Agroecology and Resilience: Competing or Complementary Frames? In *Global governance/politics, climate justice & agrarian/social justice: linkages and challenges* (pp. 1–14). Hague, Netherlands.

Bezner-Kerr, R., & Patel, R. (2014). *Food Security in Malawi*. (U. S. Nagothu, Ed.), *Food Security and Development: Country Case Studies*. London: Routledge.

Bezner Kerr, R., Hickey, C., Lupafya, E., & Dakishoni, L. (2019). Repairing rifts or reproducing inequalities? Agroecology, food sovereignty, and gender justice in Malawi. *The Journal of Peasant Studies*, 1–20.

Bezner Kerr, R. B., Nyantakyi-Frimpong, H., Dakishoni, L., Lupafya, E., Shumba, L., Luginaah, I., & Snapp, S. S. (2018). Knowledge politics in participatory climate change adaptation research on agroecology in Malawi. *Renewable Agriculture and Food Systems*, 1–14.

Bisung, E., Elliott, S. J., Schuster-Wallace, C. J., Karanja, D. M., & Bernard, A. (2014). Social capital, collective action and access to water in rural Kenya. *Social Science & Medicine*, *119*, 147–154.

Bouma, J., Bulte, E., & van Soest, D. (2008). Trust and cooperation: Social capital and community resource management. *Journal of Environmental Economics and Management*, *56*(2), 155–166.

Brooks, S. (2014). Enabling adaptation? Lessons from the new 'Green Revolution'in Malawi and Kenya. *Climatic Change*, *122*(1–2), 15–26.

Chibwana, C., Fisher, M., & Shively, G. (2012). Cropland allocation effects of agricultural input subsidies in Malawi. *World Development*, *40*(1), 124–133.

Chinsinga, B. (2011). Seeds and subsidies: The political economy of input programmes in Malawi. *IDS Bulletin*, *42*(4), 59–68.

Chinsinga, Blessings. (2012). The political economy of agricultural policy processes in Malawi: A case study of the fertilizer subsidy programme.

Chinsinga, Blessings, Chasukwa, M., & Zuka, S. P. (2013). The political economy of land grabs in Malawi: Investigating the contribution of Limphasa Sugar Corporation to rural development. *Journal of Agricultural and Environmental Ethics*, *26*(6), 1065–1084.

Chu, J. (2011). Gender and 'Land Grabbing'in Sub-Saharan Africa: Women's land rights and customary land tenure. *Development*, *54*(1), 35–39.

Cramb, R. A. (2005). Social capital and soil conservation: evidence from the Philippines. *Australian Journal of Agricultural and Resource Economics*, *49*(2), 211–226.

Dalgaard, T., Hutchings, N. J., & Porter, J. R. (2003). Agroecology, scaling and interdisciplinarity. *Agriculture, Ecosystems & Environment*, *100*(1), 39–51.

De Schutter, O., & Vanloqueren, G. (2011). The new green revolution: how twenty-first-century science can feed the world. *Solutions*, *2*(4), 33–44.

Deininger, K., Xia, F., & Holden, S. (2017). Gender-differentiated impacts of tenure insecurity on agricultural performance in Malawi's customary tenure systems.

Diao, X., Thurlow, J., Benin, S., & Fan, S. (2012). *Strategies and priorities for African agriculture: Economywide perspectives from country studies*. Intl Food Policy Res Inst.

Dumont, A. M., Vanloqueren, G., Stassart, P. M., & Baret, P. V. (2016). Clarifying the socioeconomic dimensions of agroecology: Between principles and practices. *Agroecology and Sustainable Food Systems*, *40*(1), 24–47.

FAO. (2009). *How to feed the world in 2050. High Level Expert Forum*. Rome. Retrieved from http://www.fao.org/fileadmin/templates/wsfs/docs/expert_paper/How_to_Feed_the_World_in_2050.pdf

FAO. (2018a). *The 10 Elements of Agroecology: Guiding the transition to sustainable food and agricultural systems*.

FAO. (2018b). *The state of food security and nutrition in the world*. Rome. Retrieved from http://www.fao.org/state-of-food-security-nutrition/en/

Fernandez, M., & Méndez, V. E. (2019). Subsistence under the canopy: Agrobiodiversity's contributions to food and nutrition security amongst coffee communities in Chiapas, Mexico. *Agroecology and Sustainable Food Systems*, *43*(5), 579–601.

Fisher, M., & Kandiwa, V. (2014). Can agricultural input subsidies reduce the gender gap in modern maize adoption? Evidence from Malawi. *Food Policy*, *45*, 101–111.

Food and Agriculture Organization. (2019). *The State of Food Security and Nutrition in the World: Safeguarding against Economic Slowdowns and Downturns*. Rome. Retrieved from https://reliefweb.int/sites/reliefweb.int/files/resources/ca5162en.pdf

Garibaldi, L. A., Gemmill-Herren, B., D'Annolfo, R., Graeub, B. E., Cunningham, S. A., & Breeze,

T. D. (2017). Farming approaches for greater biodiversity, livelihoods, and food security. *Trends in Ecology & Evolution*, *32*(1), 68–80.

Gengenbach, H., Schurman, R. A., Bassett, T. J., Munro, W. A., & Moseley, W. G. (2018). Limits of the New Green Revolution for Africa: Reconceptualising gendered agricultural value chains. *The Geographical Journal*, *184*(2), 208–214.

Gliessman, S. R. (2014). *Agroecology: the ecology of sustainable food systems*. CRC press.

Gliessman, S. R., Engles, E., & Krieger, R. (1998). *Agroecology: ecological processes in sustainable agriculture*. CRC Press.

Guzmán, G. I., López, D., Román, L., & Alonso, A. M. (2013). Participatory action research in agroecology: building local organic food networks in Spain. *Agroecology and Sustainable Food Systems*, *37*(1), 127–146.

Hamel, R. (2016). Drought-Ravaged Malawi Faces Largest Humanitarian Emergency in its History.

Herrero, M., Thornton, P. K., Power, B., Bogard, J. R., Remans, R., Fritz, S., … Waha, K. (2017). Farming and the geography of nutrient production for human use: a transdisciplinary analysis. *The Lancet Planetary Health*, *1*(1), e33–e42.

High Level Panel of Experts (HLPE) of the United Nations Committee on World Food Security. (2020). *Agroecological and other innovative approaches for sustainable agriculture and food systems that enhance food security and nutrition*. Rome. https://doi.org/https://ec.europa.eu/knowledge4policy/publication/agroecological-other-innovative-approaches-sustainable-agriculture-food-systems-enhance_en

Holden, S. T., & Lunduka, R. W. (2013). Who benefit from Malawi's targeted farm input subsidy program? In *Forum for Development Studies* (Vol. 40, pp. 1–25). Taylor & Francis.

Holt-Giménez, E., & Altieri, M. A. (2013). Agroecology, food sovereignty, and the new green revolution. *Agroecology and Sustainable Food Systems*, *37*(1), 90–102.

Holt-Giménez, E., Shattuck, A., Altieri, M., Herren, H., & Gliessman, S. (2012). We already grow enough food for 10 billion people… and still can't end hunger. Taylor & Francis.

Ignatova, J. A. (2017). The 'philanthropic'gene: biocapital and the new green revolution in Africa. *Third World Quarterly*, *38*(10), 2258–2275.

Jacobsen, S.-E., Sørensen, M., Pedersen, S. M., & Weiner, J. (2013). Feeding the world: genetically modified crops versus agricultural biodiversity. *Agronomy for Sustainable Development*, *33*(4), 651–662.

Kansanga, M., Andersen, P., Kpienbaareh, D., Mason-Renton, S., Atuoye, K., Sano, Y., … Luginaah, I. (2018). Traditional agriculture in transition: examining the impacts of agricultural modernization on smallholder farming in Ghana under the new Green Revolution. *International Journal of Sustainable Development & World Ecology*, 1–14.

Kremen, C., & Miles, A. (2012). Ecosystem services in biologically diversified versus conventional farming systems: benefits, externalities, and trade-offs. *Ecology and Society*, *17*(4).

Latati, M., Bargaz, A., Belarbi, B., Lazali, M., Benlahrech, S., Tellah, S., … Ounane, S. M. (2016). The intercropping common bean with maize improves the rhizobial efficiency, resource use and grain yield under low phosphorus availability. *European Journal of Agronomy*, *72*, 80–90.

Li, G., Messina, J. P., Peter, B. G., & Snapp, S. S. (2017). Mapping land suitability for agriculture in Malawi. *Land Degradation & Development*, *28*(7), 2001–2016.

Lunduka, R., Ricker- Gilbert, J., & Fisher, M. (2013). What are the farm- level impacts of Malawi's farm input subsidy program? A critical review. *Agricultural Economics*, *44*(6), 563–579.

Mdee, A., Wostry, A., Coulson, A., & Maro, J. (2018). A pathway to inclusive sustainable intensification in agriculture? Assessing evidence on the application of agroecology in Tanzania. *Agroecology and Sustainable Food Systems*, 1–27.

Me-Nsope, N., & Larkins, M. (2016). Beyond crop production: Gender relations along the pigeon pea value chain and implications for income and food security in Malawi. *Journal of Gender, Agriculture and Food Security (Agri-Gender)*, *1*(302-2016–4760).

Meijer, S. S., Sileshi, G. W., Kundhlande, G., Catacutan, D., & Nieuwenhuis, M. (2015). The role of gender and kinship structure in household decision-making for agriculture and tree planting in Malawi. *Journal of Gender, Agriculture and Food Security*, *1*(1), 54–76.

Méndez, V. E., Bacon, C. M., & Cohen, R. (2013). Agroecology as a transdisciplinary, participatory, and action-oriented approach. *Agroecology and Sustainable Food Systems*, *37*(1), 3–18.

Misra, M. (2017). Moving away from technocratic framing: agroecology and food sovereignty as possible alternatives to alleviate rural malnutrition in Bangladesh. *Agriculture and Human Values*, 1–15.

Mohan, S. (2002). Agroecological Innovations: Increasing Food Production with Participatory Development. N. Uphoff (ed.). Earthscan Publications Ltd., London, UK. *Agroforestry Systems*, *56*(1), 87–88.

Montenegro, M. (2015). Agroecology Can Help Fix Our Broken Food System: Here's How. *Ensia Magazine*.

Mutenje, M., Kankwamba, H., Mangisonib, J., & Kassie, M. (2016). Agricultural innovations and food security in Malawi: Gender dynamics, institutions and market implications. *Technological Forecasting and Social Change*, *103*, 240–248.

National Statistical Office. (2017). *Malawi Micronutrient Survey: Key Indicators Report 2015-16*. Zomba.

Nkhoma, P. R., Bosman, M. M., & Eduful, M. (2019). Constituting Agricultural and Food Security Policy in Malawi: Exploring the Factors that Have Driven Policy Processes in the Farm Inputs Subsidy Programme. *Journal of Asian and African Studies*, *54*(3), 360–375.

Nyantakyi-Frimpong, H., Kangmennaang, J., Kerr, R. B., Luginaah, I., Dakishoni, L., Lupafya, E., … Katundu, M. (2017). Agroecology and healthy food systems in semi-humid tropical Africa: Participatory research with vulnerable farming households in Malawi. *Acta Tropica*, *175*, 42–49.

Nyantakyi-Frimpong, H., Mambulu, F. N., Kerr, R. B., Luginaah, I., & Lupafya, E. (2016).

Agroecology and sustainable food systems: Participatory research to improve food security among HIV-affected households in northern Malawi. *Social Science & Medicine*, *164*, 89–99.

O'Rourke, M. E., DeLonge, M. S., & Salvador, R. (2017). Insights from agroecology and a critical next step: Integrating human health. *Agroecology and Sustainable Food Systems*, *41*(7), 880–884.

Patel, R. (2009). Food sovereignty. *The Journal of Peasant Studies*, *36*(3), 663–706.

Pretty, J. (2003). Social capital and the collective management of resources. *Science*, *302*(5652), 1912–1914.

Schwendler, S. F., & Thompson, L. A. (2017). An education in gender and agroecology in Brazil's Landless Rural Workers' Movement. *Gender and Education*, *29*(1), 100–114.

Snapp, S. (2017). Agroecology: principles and practice. In *Agricultural Systems* (pp. 33–72). Elsevier.

Solorio, S. F. J., Wright, J., Franco, M. J. A., Basu, S. K., Sarabia, S. L., Ramírez, L., … Ku, V. J. C. (2017). Silvopastoral Systems: Best Agroecological Practice for Resilient Production Systems Under Dryland and Drought Conditions. In *Quantification of Climate Variability, Adaptation and Mitigation for Agricultural Sustainability* (pp. 233–250). Springer.

Stevens, T., & Madani, K. (2016). Future climate impacts on maize farming and food security in Malawi. *Scientific Reports*, *6*(36241 |).

Stinner, B. R., Lorenzoni, G. G., & Paoletti, M. G. (2012). *Agricultural ecology and environment*. Elsevier.

Suárez-Torres, J., Suárez-López, J. R., López-Paredes, D., Morocho, H., Cachiguango-Cachiguango, L. E., & Dellai, W. (2017). Agroecology and health: lessons from indigenous populations. *Current Environmental Health Reports*, *4*(2), 244–251.

Yoder, L., & Chowdhury, R. R. (2018). Tracing social capital: How stakeholder group interactions shape agricultural water quality restoration in the Florida Everglades. *Land Use Policy*, *77*, 354–361.

CHAPTER 2

2. THEORETICAL CONTEXT

2.1 Introduction

This chapter provides theoretical context to the key arguments in this dissertation. It opens with a discussion of the theoretical underpinnings of agroecology in relation to the contemporary food system. The chapter then discusses the theory of the metabolic rift as a lens to understanding the ecological, social and individual dimensions of the contradictions of the current global food system and the prospects of agroecology in addressing these contradictions.

2.2 Pathways to food system transformation through agroecology

The 'agroecosystem' provides the conceptual foundation for agroecology at the farm-level. According to Altieri (2002: 8) "agroecosystems are communities of plants and animals interacting with their physical and chemical environments that have been modified by people to produce food". The general structure and functioning of an agroecosystem is based on an input-output approach in which socioeconomic and biophysical elements interact in the process of agriculture (Caporali, 2015). Agroecology, therefore, strives to ensure a balance in energy and nutrient flows in the system by minimizing losses, promoting nutrient recycling and other internal processes that reinforce synergistic outcomes for improved soil fertility and food production (Altieri, 2002; O'Rourke et al., 2017). Agroecology is founded on the principle that an agroecosystem should mimic the functioning of the natural ecosystem with less dependence on external inputs in order to create a natural balance through uninterrupted nutrient and energy recycling (Gliessman, 2014). By relying on natural interactions in the agroecosystem, agroecology generates sustainable ecological synergies, so that agricultural fields are able to replenish the fertility of their soils, regulate pest and increase productivity (Altieri, 2018; Gliessman, 2014). Beyond the agroecosystem, agroecology also has a social justice dimension that targets transforming the entire food system by addressing the social contradictions of the contemporary capitalist food system towards achieving food sovereignty for smallholder farmers (Dumont et al., 2016; Figueroa-Helland, Thomas, & Aguilera, 2018; Holt-Giménez & Altieri, 2013; Misra, 2017).

Gliessman (2016) provides a five-step integrated roadmap for transforming the global food system including 1) increasing the efficiency of industrial and conventional inputs and practices; 2) substituting alternative practices for industrial/conventional inputs and practices; 3) redesigning agroecosystems to function according to ecological processes; 4) re-establishing a direct link between those who grow the world's food and those who consume it; and 5) building a new global food system based on the successes achieved in levels 3 and 4. Level 1 of the agroecology transition roadmap entails ensuring the efficient use of industrial inputs such as fertilizers and improved seeds in order to minimize the impacts of unsustainable input use on the environment while preparing the grounds for their gradual elimination. This is crucial in countries like Malawi where the government is preoccupied with promoting the use of synthetic inputs and hybrid seeds (Nkhoma et al., 2019). While ensuring input use efficiency can help address some of the adverse ecological contradictions of the current food system, these efforts are not enough to break the heavy dependence of smallholder farming systems on synthetic inputs. Level 2 in the agroecology transition, therefore, builds on level 1 and focuses on achieving the complete substitution of external inputs and environmentally unsustainable agricultural practices with organic inputs and practices. This entails the introduction of alternative farming practices such as composting, manuring and integration of nitrogen-fixing crops as opposed to the use of chemical fertilizers and other modern inputs such as weedicides and pesticides (Altieri, 2018). Gliessman (2016) argues that input substitution, although important, is not adequate to create the holistic ecological synergies necessary for ensuring sustainable management of agroecosystems. Consequently, level 3 involves redesigning the entire agroecosystem through proactive as opposed to reactive approaches that eliminate the root causes of the underlying problems that continue to persist in levels 1 and 2. This entails organizing agricultural landscapes to mimic the functioning of the natural ecosystem by creating and sustaining ecological synergies through broader scale practices such as agroforestry. The aim at this level is to move beyond achieving improved yields to lay a foundation for addressing broader biophysical problems such as climate change.

While levels 1, 2 and 3 are transitions concentrated at the farm-level, level 4 goes beyond the farm-scale to include the fostering of direct relationships between local farmers who are struggling to achieve the first three levels and between farmers and food consumers. Achieving this implies re-localizing the food system to strengthen ties between smallholder farmers at the local level, shortening the agricultural production chain and promoting direct marketing arrangements through community agricultural marketing initiatives, consumer cooperatives, and other direct arrangements (Altieri, 2009; Figueroa-Helland et al., 2018). Level 5 goes beyond food production by focusing on extending the sustainable synergies achieved at the farm-scale through farmer-driven changes in agroecology application to other frontiers of environmental and social relations so that a paradigm shift that makes current agricultural systems sensitive to future needs is achieved. From Gliessman's exposition, it is evident that research on the various levels of the food system transformation road map is crucial. This dissertation examines the farm-level of agroecology, with emphasis on farmer sustainable land management, production diversity, and dietary diversity. The study also explores the broader social impact of agroecology with emphasis on its potential to improve farmer social capital and restore the beneficial social relations on which smallholder agriculture is founded.

It is worth noting that agroecology is not the only approach to agriculture that strives to improve smallholder farming. Other sustainable intensification approaches such as conservation agriculture and climate smart agriculture have gained traction in SSA (Baudron, Corbeels, Monicat, & Giller, 2009; McCarthy, Lipper, & Branca, 2011; Ndoli et al., 2018; Vanlauwe et al., 2014). In a recent analysis, Wezel, Soboksa, McClelland, Delespesse, & Boissau (2015) draw attention to the blurred epistemic boundaries of sustainable intensification and agroecology which makes it difficult to distinguish between the two. That nothwithstanding, there are marked differences between agroecological intensificatoion and sustainable intensification in practice. Although both agroecology and sustainable intensification share the tenet of improving food production, the pathways to realizing this vary between the two approaches. While sustainable intensification subscribes to the use of external inputs, agroecology focuses on reducing dependency on external fossil-fuel based inputs (Altieri, 1999). Thus, at the farm-level, agroecology is grounded on a non-tolerance/minimal use of fossil-fuiel based inputs, which may be allowed under sustainable intensification. Agroecology also takes a systems approach towards addressing the challenges in the food system which goes beyond the farm level to include addressing socio-political inequalities in the broader food system (Gliessman & Engles, 2014) Moreover, while agroecology builds on local knowledge systems and resources, contextual socio-cultural practices are not central to sustainable intensification (Wezel et al., 2015).

2.3 Agroecology and the metabolic rift

In the context of the increasing social and biophysical contradictions of the global capitalist food system (Weis, 2010), an increasing body of research points to the potential for participatory agroecology to repair the ecological rifts of capitalist agriculture while generating beneficial social synergies that address underlying structural inequalities and reconnect food producers at the local level (Altieri, Nicholls, & Montalba, 2017; Bezner Kerr et al., 2019; Gliessman, 2016; Méndez, Bacon, & Cohen, 2013). To understand agroecology as a multifunctional approach capable of addressing these problems requires a broader theoretical perspective that links political ecology and social learning and transformation. The theory of metabolic rift presents such an integrated lens (Foster, 1999). Drawing largely from Marxist thinking, critical geographers and environmentalist have sought to explain the socioecological impacts of the capitalist food system by building on Marx's initial observation that capitalism is increasingly disconnecting humans from the natural environment and disrupting the traditional forms of social metabolism that characterized traditional/subsistence agriculture (McClintock, 2010; Moore, 2000; Schneider & McMichael, 2010; Wittman, 2009). In his seminal work *A Contribution to the Critique of Political Economy,* Marx viewed social reproduction as the constantly evolving process that connects society to nature through labour (Marx, 1970 [1859). According to Marx, labour is central to social metabolism in that, apart from being a constantly evolving process between humans and nature, labour is also the means through which humans regulate and control metabolism with nature (Marx, 1970 [1859). Marx ascribes the basis of the socioecological rift in social metabolism to the rise of a capitalist mode of production and the eventual commodification of nature in the context of increasing urbanization and industrialization (Marx, 1970 [1859). The concept of the metabolic rift was first propounded by Foster (1999) as an extension of Marx's idea of socioecological metabolism. Consistent with Marx, Foster (1999) argues that the rise of capitalism and the associated commodification of labour created a rift in the traditional metabolism that existed between humans and nature. This rift, Foster argues, is intensified by industrial agriculture and the constant movement of produce from the periphery to the urban core over long distances (Foster, 1999). Although other scholars like Moore (2000) disagree with Foster's argument that the metabolic rift has its origin in nineteenth-century industrialization, there is consensus on the theoretical foundations of the concept as both a rupture in the traditional forms of reproduction (including the recycling of nutrients in traditional agricultural systems) between humans and nature and the disruption of the social relations of production that characterised pre-capitalist social reproduction (Schneider & McMichael, 2010).

Based on these developments, three different but interdependent dimensions of the metabolic rift stand out: the ecological, social and individual (McClintock, 2010). The ecological dimension, which by far is the popularly deployed facet in critical environmental scholarship, highlights capitalism's role in severing the sustainable biophysical ties between humans and nature in the drive for accumulation. According to Marx, the metabolism between nature and society was formerly maintained through a unique nutrient recycling approach in traditional agriculture whereby farmers turned soil nutrients into food and replenished soil fertility with organic waste from the processes of production and consumption (Clark & Foster, 2013; Wittman, 2009). This ensured the continued reproduction of social life in traditional agrarian societies until the advent of capitalism and the associated commercialization of nature and labour. The commodification of nature and the capitalist drive for accumulation disrupted this nutrient recycling regime that characterized traditional agriculture, resulting in an increased reliance on synthetic fertilizer (Moore, 2000; Schneider & McMichael, 2010). As capitalism extends its frontiers to new agrarian spaces in search of opportunities for accumulation, it produces "a cycle of 'rifts and shifts' whereby attempts to address a metabolic rift in one place simply lead to 'geographic displacement' of ecological crisis" (McClintock, 2010:194). A common case used to exemplify the devastating effects of capitalist expansion over space is the soil infertility crisis which resulted from industrial agricultural expansion in North America and the consequent scramble for guano in South America as an alternative for replenishing soil fertility (Clark & Foster, 2009, 2013). The extraction of guano resulted in widespread environmental degradation in Southern America. At a much localized form of abstraction, the shipping of food from rural to urban areas further deepens the ecological crisis as soil nutrients, which under traditional forms of agriculture are recycled into the soil, end up being moved from rural areas to cities where they build up as urban waste and pollute the environment (Schneider & McMichael, 2010). Thus, the biophysical problems created by capitalism end up being merely shifted to distant lands rather than being addressed. As such, rescaling these biophysical contradictions and limiting smallholder farmers' dependence on fossil fuel-based synthetic inputs is central to agroecology's drive to mitigate the ecological dimension of the metabolic rift.

According to Marx, the capitalist drive for accumulation also fuelled the commodification of nature and increased separation of rural farmers who produce food, and the rise of antagonistic relations between the core and periphery (Marx, 1970 [1859). The commodification of nature, in explicit terms land and labour, forms the social dimension of the metabolic rift (McClintock, 2010). In what he theorized as 'primitive accumulation', Marx argues that the commodification of land and labour served the basis for the strategic 'grabbing' of communal land and the eventual rendering of subsistence farmers as a proletariat for the labour needs of the capitalist food system and the urban industry (Marx, 1970 [1859). At the local level, the creation of labour markets further produces a new and more localized form of social rift expressed in the alteration of the social relations of production in agrarian communities and the consequent production of social stratification and gender inequalities (Bezner Kerr et al., 2019). As argued by Boserup, Tan, & Toulmin (2013), capitalism contributed to altering the social relations of production in traditional farming communities while constantly feeding on the resultant systems of inequality and degeneration of the ties between farmers to accumulate capital.

According to McClintock (2010:201), "as a broader social rift is cleaved by the commodification of land and labour, people experience an internalized dimension of metabolic rift". This rift is an outcome of what Marx described as alienation from nature (Marx, 1970 [1859) which manifests among dispossessed or marginalized subsistence farmers "as the perception of self as external to the environment" (McClintock, 2010:201). Again, a salient aspect of the individual rift stands out when considering the fact that the world of smallholder farmers transcends just the ties with nature, but also ties with other farmers and households which are an integral part of the agrarian environment (Ramisch, 2016). The notion of 'place' has grown in importance in critical environmental and health geography research (Kearns & Moon, 2002; Page & Hall, 2014; Seamon, 2018; Tobias & Richmond, 2014; Townsend, Henderson-Wilson, Ramkissoon, & Werasuriya, 2018). Beyond the traditional recognition of ‘place’ as a spatial locale/container where interaction between humans and their environment occur, place is recognized as a relational construct that embodies a sense of attachment to space (Conradson, 2005; Cummins, Curtis, Diez-Roux, & Macintyre, 2007; Graham & Healey, 1999; Tobias & Richmond, 2014). As a result, the intimate emotional, cultural and political sense of belonging that social actors nurture in their environment over time, are central to contemporary reflections on the geographies of environmental dispossession and social exclusion highlighted by Marx. This broader appreciation of place provides a more nuanced approach to understanding smallholder farmers’ lived experiences with the degradation of the beneficial social relations that characterized smallholder agriculture. Aside from the separation from land, the individual rift also implies the rupturing of the longstanding traditional knowledge-base that farming households have used in agriculture over time. This has roots in the rationalization of labour, technological advancement and the increased movement of sophisticated agricultural machinery and synthetic inputs into hitherto traditionally managed agrarian spaces (Braverman, 1998). Consequently, a system of labour differentiation (manual and intellectual labour) is produced, which further alienates the worker from what is produced and how it is produced (McClintock, 2010). Inherent in the social justice dimension of agroecology is the commitment to re-localize the food system, by working simultaneously to improve farmer-to-farmer connectedness and knowledge exchange at the local level on one hand and reconnecting the growers of food and consumers on the other hand (Bisht et al., 2018; Gliessman, 2016). As a locally driven and participatory process, agroecology holds great potential in addressing the social and individual dimensions of the metabolic rift engendered by capitalist agriculture.

Marx does not deny the inevitability of progress in society. Instead, he designates economic development and to a large extent, capitalist production as 'progress here, deterioration there', suggesting that humanity's interactions with nature is but a necessary evil (Marx, 1970; Napoletano et al., 2019). Harvey clarifies this position by arguing that the metabolic relations of humans with nature is an endless necessity of capitalism, and the drive towards reorganizing these relations under the current capitalist food system should focus on rendering this presently harmful relationship less contradictory through conscious control over the social metabolism process (Harvey, 2006). This clarification connects directly to the key organizing principles of agroecology as advanced by Gliessman (2016). Increasingly, environmental geographers and sociologists have deployed the theory of metabolic rift in understanding the biophysical contradictions of capitalist agriculture and proposing sustainable approaches to mending this rift (Bahers & Giacchè, 2019; Bezner Kerr et al., 2019; Clark & Foster, 2009; Clausen & Clark, 2005; Clausen, Clark, & Longo, 2015; Magdoff, Foster, & Buttel, 2000; McClintock, 2010; Pungas, 2019; Wittman, 2009). Despite the increased application of the concept in contemporary critical environmental scholarship, emphasis is skewed towards the ecological dimension as opposed to the social and individual dimensions of the rift. Meanwhile, as observed by McClintock (2010) although the three dimensions of the metabolic rift appear to be independent outcomes, they are co-produced through capitalist agriculture and must be engaged concurrently in order to holistically understand and address the contradictions of capitalist agriculture.

Napoletano et al. (2019) have made a clarion call for scholars to make space for the metabolic rift in contemporary critical geography. In this dissertation, I leverage these three distinct dimensions of the metabolic rift to illuminate the contributions of participatory agroecology towards addressing some of the key social and ecological issues in a smallholder farming context that has in the past three decades been purposefully aligned to an input-intensive production approach. Specifically, I engaged with the three distinct but mutually reinforcing dimensions of the metabolic rift. I connect with the *ecological dimension* to highlight the potential of agroecology to improve sustainable land management and encourage smallholder farming households to return to traditional ways of addressing soil infertility. I leverage the *social and individual dimensions of the metabolic rift* to demonstrate the role of agroecology in addressing underlying issues of hunger and promoting farmer-to-farmer interconnectedness. This broader framing enables the individual papers in this dissertation to amplify the social and ecological dimensions of agroecology's multifunctional prowess in the context of the longstanding agrarian crisis in Malawi.

2.4 References

Altieri, M. A. (1999). Applying agroecology to enhance the productivity of peasant farming systems in Latin America. *Environment, Development and Sustainability*, *1*(3), 197–217.

Altieri, M. A. (2002). Agroecology: the science of natural resource management for poor farmers in marginal environments. *Agriculture, Ecosystems & Environment*, *93*(1), 1–24.

Altieri, M. A. (2009). Agroecology, small farms, and food sovereignty. *Monthly Review*, *61*(3), 102.

Altieri, M. A. (2018). *Agroecology: the science of sustainable agriculture*. CRC Press.

Altieri, M. A., Nicholls, C. I., & Montalba, R. (2017). Technological Approaches to Sustainable Agriculture at a Crossroads: An Agroecological Perspective. *Sustainability*, *9*(3), 349.

Bahers, J.-B., & Giacchè, G. (2019). Towards a metabolic rift analysis: The case of urban agriculture and organic waste management in Rennes (France). *Geoforum*, *98*, 97–107.

Baudron, F., Corbeels, M., Monicat, F., & Giller, K. E. (2009). Cotton expansion and biodiversity loss in African savannahs, opportunities and challenges for conservation agriculture: a review paper based on two case studies. *Biodiversity and Conservation*, *18*(10), 2625–2644.

Bezner Kerr, R., Hickey, C., Lupafya, E., & Dakishoni, L. (2019). Repairing rifts or reproducing inequalities? Agroecology, food sovereignty, and gender justice in Malawi. *The Journal of Peasant Studies*, 1–20.

Bisht, I. S., Mehta, P. S., Negi, K. S., Verma, S. K., Tyagi, R. K., & Garkoti, S. C. (2018). Farmers' rights, local food systems, and sustainable household dietary diversification: A case of Uttarakhand Himalaya in north-western India. *Agroecology and Sustainable Food Systems*, *42*(1), 77–113.

Boserup, E., Tan, S. F., & Toulmin, C. (2013). *Woman's role in economic development*. Routledge.

Braverman, H. (1998). *Labor and monopoly capital: The degradation of work in the twentieth century*. NYU Press.

Caporali, F. (2015). History and Development of Agroecology and Theory of Agroecosystems.

In *Law and Agroecology* (pp. 3–29). Springer.

Clark, B., & Foster, J. B. (2009). Ecological imperialism and the global metabolic rift: Unequal exchange and the guano/nitrates trade. *International Journal of Comparative Sociology*, *50*(3–4), 311–334.

Clark, B., & Foster, J. B. (2013). Guano: The global metabolic rift and the fertilizer trade. In *Ecology and Power* (pp. 84–98). Routledge.

Clausen, R., & Clark, B. (2005). The metabolic rift and marine ecology: An analysis of the ocean crisis within capitalist production. *Organization & Environment*, *18*(4), 422–444.

Clausen, R., Clark, B., & Longo, S. B. (2015). Metabolic rifts and restoration: Agricultural crises and the potential of Cuba's organic, socialist approach to food production. *World Review of Political Economy*, *6*(1), 4–32.

Conradson, D. (2005). Landscape, care and the relational self: therapeutic encounters in rural England. *Health & Place*, *11*(4), 337–348.

Cummins, S., Curtis, S., Diez-Roux, A. V, & Macintyre, S. (2007). Understanding and representing 'place'in health research: a relational approach. *Social Science & Medicine*, *65*(9), 1825–1838.

Dumont, A. M., Vanloqueren, G., Stassart, P. M., & Baret, P. V. (2016). Clarifying the socioeconomic dimensions of agroecology: Between principles and practices. *Agroecology and Sustainable Food Systems*, *40*(1), 24–47.

Figueroa-Helland, L., Thomas, C., & Aguilera, A. P. (2018). Decolonizing Food Systems: Food Sovereignty, Indigenous Revitalization, and Agroecology as Counter-Hegemonic Movements. *Perspectives on Global Development and Technology*, *17*(1–2), 173–201.

Foster, J. B. (1999). Marx's theory of metabolic rift: Classical foundations for environmental sociology. *American Journal of Sociology*, *105*(2), 366–405.

Gliessman, S. (2016). Transforming food systems with agroecology. Taylor & Francis.

Gliessman, S. R. (2014). *Agroecology: the ecology of sustainable food systems*. CRC press.

Gliessman, S. R., & Engles, E. W. (2014). *Agroecology: the ecology of sustainable food systems*. (E. W. Engles, Ed.) (3rd ed.). New York: CRC press.

Graham, S., & Healey, P. (1999). Relational concepts of space and place: Issues for planning theory and practice. *European Planning Studies*, 7(5), 623–646.

Harvey, D. (2006). *Spaces of global capitalism*. Verso.

Holt-Giménez, E., & Altieri, M. A. (2013). Agroecology, food sovereignty, and the new green revolution. *Agroecology and Sustainable Food Systems*, *37*(1), 90–102.

Kearns, R., & Moon, G. (2002). From medical to health geography: novelty, place and theory after a decade of change. *Progress in Human Geography*, *26*(5), 605–625.

Magdoff, F., Foster, J. B., & Buttel, F. H. (2000). *Hungry for profit: The agribusiness threat to farmers, food, and the environment*. NYU Press.

Marx, K. (1970). A Contribution to the Critique of Political Economy. *Trans. SW Ryazanskaya. Ed. Maurice Dobbs. Moscow: Progress*.

McCarthy, N., Lipper, L., & Branca, G. (2011). Climate-smart agriculture: smallholder adoption and implications for climate change adaptation and mitigation. *Mitigation of Climate Change in Agriculture Working Paper*, *3*(1), 1–37.

McClintock, N. (2010). Why farm the city? Theorizing urban agriculture through a lens of metabolic rift. *Cambridge Journal of Regions, Economy and Society*, *3*(2), 191–207.

Méndez, V. E., Bacon, C. M., & Cohen, R. (2013). Agroecology as a transdisciplinary, participatory, and action-oriented approach. *Agroecology and Sustainable Food Systems*, *37*(1), 3–18.

Misra, M. (2017). Moving away from technocratic framing: agroecology and food sovereignty as possible alternatives to alleviate rural malnutrition in Bangladesh. *Agriculture and Human Values*, 1–15.

Moore, J. W. (2000). Environmental crises and the metabolic rift in world-historical perspective. *Organization & Environment*, *13*(2), 123–157.

Napoletano, B. M., Foster, J. B., Clark, B., Urquijo, P. S., McCall, M. K., & Paneque-Gálvez, J. (2019). Making Space in Critical Environmental Geography for the Metabolic Rift. *Annals of the American Association of Geographers*, 1–18.

Ndoli, A., Baudron, F., Sida, T. S., Schut, A. G. T., van Heerwaarden, J., & Giller, K. E. (2018). Conservation agriculture with trees amplifies negative effects of reduced tillage on maize performance in East Africa. *Field Crops Research*, *221*, 238–244.

Nkhoma, P. R., Bosman, M. M., & Eduful, M. (2019). Constituting Agricultural and Food Security Policy in Malawi: Exploring the Factors that Have Driven Policy Processes in the Farm Inputs Subsidy Programme. *Journal of Asian and African Studies*, *54*(3), 360–375.

O'Rourke, M. E., DeLonge, M. S., & Salvador, R. (2017). Insights from agroecology and a critical next step: Integrating human health. *Agroecology and Sustainable Food Systems*, *41*(7), 880–884.

Page, S. J., & Hall, C. M. (2014). *The geography of tourism and recreation: Environment, place and space*. Routledge.

Pungas, L. (2019). Food self-provisioning as an answer to the metabolic rift: The case of 'Dacha Resilience'in Estonia. *Journal of Rural Studies*, *68*, 75–86.

Ramisch, J. J. (2016). "Never at ease": cellphones, multilocational households, and the metabolic rift in western Kenya. *Agriculture and Human Values*, *33*(4), 979–995.

Schneider, M., & McMichael, P. (2010). Deepening, and repairing, the metabolic rift. *The Journal of Peasant Studies*, *37*(3), 461–484.

Seamon, D. (2018). *Life takes place: Phenomenology, lifeworlds, and place making*. Routledge.

Tobias, J. K., & Richmond, C. A. M. (2014). "That land means everything to us as Anishinaabe….": Environmental dispossession and resilience on the North Shore of Lake Superior. *Health & Place*, *29*, 26–33. https://doi.org/10.1016/j.healthplace.2014.05.008

Townsend, M., Henderson-Wilson, C., Ramkissoon, H., & Werasuriya, R. (2018). Therapeutic landscapes, restorative environments, place attachment, and well-being. *Oxford Textbook of Nature and Public Health: The Role of Nature in Improving the Health of a Population*, 57.

Vanlauwe, B., Wendt, J., Giller, K. E., Corbeels, M., Gerard, B., & Nolte, C. (2014). A fourth principle is required to define conservation agriculture in sub-Saharan Africa: the appropriate use of fertilizer to enhance crop productivity. *Field Crops Research*, *155*, 10–13.

Weis, T. (2010). The accelerating biophysical contradictions of industrial capitalist agriculture. *Journal of Agrarian Change*, *10*(3), 315–341.

Wezel, A., Soboksa, G., McClelland, S., Delespesse, F., & Boissau, A. (2015). The blurred boundaries of ecological, sustainable, and agroecological intensification: a review. *Agronomy for Sustainable Development*, *35*(4), 1283–1295.

Wittman, H. (2009). Reworking the metabolic rift: La Vía Campesina, agrarian citizenship, and food sovereignty. *The Journal of Peasant Studies*, *36*(4), 805–826.

CHAPTER 3

3. METHODS

This chapter provides background on the study context and describes the study design and methods. Although the individual articles contain brief discussions of the study design and methodology, this chapter discusses the Malawi Farmer-to-Farmer Agroecology (MAFFA) intervention in detail, highlighting the key programmes that were implemented. The chapter also discusses the methods underpinning the research, with emphasis on the sampling strategies, data collection and data analysis.

3.1 Study context

The geographical context of this study is the Mzimba and Dedza districts in Malawi. According to the 2008 population census, Mzimba district has a population of about 610,944 while Dedza district has 623,789 people. Malawi is a landlocked country in southern Africa (see Figure 1.2) with over 80% of its estimated 16 million population living in rural areas (Kassie, Stage, Teklewold, & Erenstein, 2015). The agricultural sector is dominated by smallholder farmers with average land holdings between 0.2–3 hectares (Ellis, Kutengule, & Nyasulu, 2003; Stevens & Madani, 2016). Farming activities are heavily reliant on the annual unimodal rainfall regime that occurs from December to March with an average rainfall amount ranging between 760 – 1,150 mm (Kassie et al., 2015). A long dry season of about 8 months follows the single cropping season during which some farmers use residual moisture in valley floors (known locally as dambos) to cultivate crops with low water requirements and vegetables such as tomatoes and pepper (Ellis et al., 2003). The short annual rainfall pattern has serious implications for the predominantly rain-fed agriculture of smallholder farmers. As evidenced by the repeated famines recorded in the area in the past few years (see Bezner Kerr, 2014; Hamel, 2016), slight variations in the already limited rainfall amounts tend to have serious implications for smallholder agriculture. Although local farmers grow other crops such as sorghum, millet, rice, groundnuts and beans, maize is the dominant food crop in Malawi, covering over 90% of the production area for cereals (Bezner Kerr, 2013; Kassie et al., 2015).

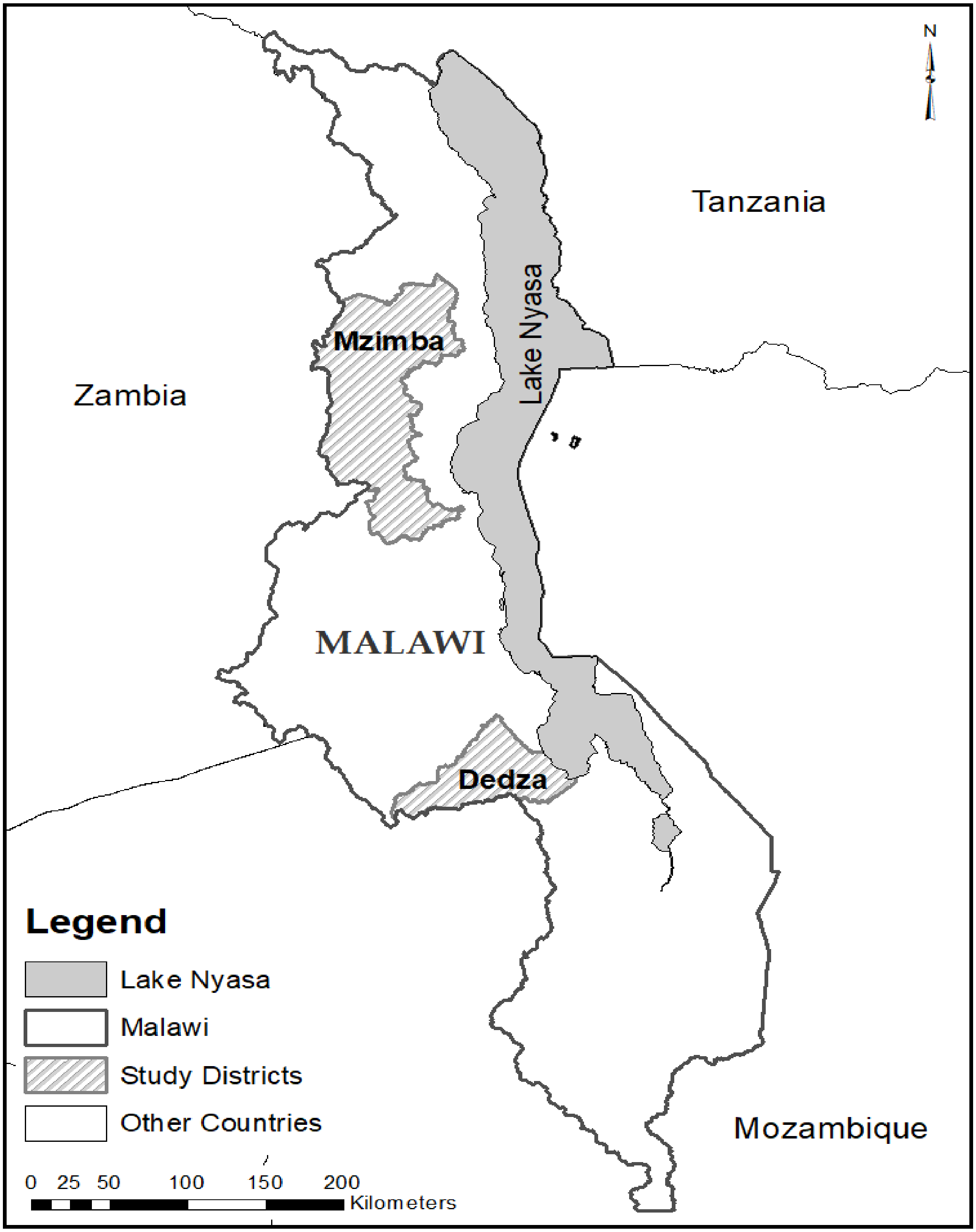

Figure 3.1: Map of Malawi showing the study districts (Dedza and Mzimba)

Smallholder farming in Malawi is done primarily on customary land (M. Fisher & Kandiwa, 2014). Customary land is vested in the state but administered by chiefs with individual households having user rights (Fisher & Kandiwa, 2014). Local chiefs have the responsibility of allocating land to families and adjudicating disputes that may arise from local land use activities (Peters, 2010). Access to land is mainly through inheritance, which varies in form across tribes. Two main forms of customary land inheritance are practiced in Malawi namely matrilineal and patrilineal (Kishindo, 2004). According to Fisher & Kandiwa (2014), these two customary land transfer methods are based on residence status whereby in matrilocal settings married men reside in their wife's village and in patrilocal contexts married women reside in their husband's village. In northern Malawi where the patrilineal inheritance system is practiced, inheritance to land is the reserve of men (Kishindo, 2004). Women in this system may, however, obtain temporary user rights to family land through their husbands (Peters & Kambewa, 2007). In matrilineal inheritance systems of central and southern Malawi however, women inherit their mother's land. With intensifying pressure on customary land due mainly to an increasing number of large-scale land grabs, changing social norms and widespread statutory acquisition by the government, the land tenure system is evolving (Kishindo & Mvula, 2017). According to Kishindo (2004), the matrilineal system in particular has changed greatly in recent times as it has become increasingly common for wives to reside in their husband's house, and for parents to allocate land to their sons.

Like most countries in SSA, economic growth in Malawi has been stagnant (Mussa, 2017). Data from the forth Malawi Integrated Household Survey indicate that the proportion of poor Malawians increased from 50.7 in 2010 to 51.5 in 2017, with a concentration in rural areas (World Bank, 2019). The poverty headcount in rural areas increased from 56.6% in 2010 to

59.5% in 2017 while urban poverty increased marginally from 17.3% to 17.7% for the period 2004-2011 (World Bank, 2019). There are also spatial disparities in rural poverty at the regional level with northern Malawi having the highest proportion of vulnerable households (58.5%), followed by southern at 45.6% and central at 21.6% (McCarthy, Brubaker, & De La Fuente, 2016). In terms of health, Malawi is currently experiencing a double burden of disease: with rising rates of non-communicable diseases including obesity and hypertension, along with a high burden of infectious diseases particularly Human Immunodeficiency Virus (HIV) (Allain et al., 2017). This health burden continues to negatively impact household agricultural production. The country is still struggling with the effects of the HIV pandemic in particular as HIV-related deaths have produced many orphans and single-parent households (Cuadros, Branscum, & Mukandavire, 2018; Mkandawire, Luginaah, & Baxter, 2014).

A nuanced understanding of the agricultural sector in contemporary Malawi cannot be reached without reference to the historical background of the sector during colonial and early post-colonial times. British colonial rule in Malawi until independence in 1964 adversely influenced the domestic economy mainly through the reorienting of agriculture to an export-based production concentrated on a few cash crops (mainly tobacco and cotton) and the reconfiguration of relations of control over the factors of production – especially land and labour (Bezner Kerr & Patel, 2014; Vail, 1983). Local community lands primarily in central and southern Malawi were appropriated and diverted from food crop production to tobacco estates thereby pushing local farmers to marginal lands (Good, 1990; Matchaya, 2009; Mkandawire, 1992; Vail, 1983). Agricultural research and transportation facilities were, as a result, developed to support export production at the expense of smallholder farming (Bezner Kerr & Patel, 2014).

The 30-year post-independence autocratic rule of Kamuzu Banda built on the skewed colonial agrarian policy to further favour estate production at the expense of smallholder farming (Lele, 1990). Banda`s dictatorship government took more customary land through statutory acquisition under the 1965 Land Act, and channelled it to estate agriculture (Bezner Kerr & Patel, 2014; Kydd & Christiansen, 1982). According to Ellis, Kutengule, & Nyasulu (2003), this redistribution of customary land favoured a minority of political elites and middle class farmers who specialized in tobacco production for export.

The deplorable socioeconomic situation in the 1980s precipitated a debt crisis which compelled the government to adopt the World Bank and International Monetary Fund-led structural adjustment programs (SAPs) as a prerequisite to continued access to foreign loans (Orr, 2000; Winter, 1984). Under structural adjustment, the government was compelled to fulfil a number of conditions including market liberalization, currency devaluation and reduction of funding for public services such as health, education and agricultural extension (Bezner Kerr & Patel, 2014). This impacted negatively on smallholder agriculture as emphasis was placed on export crop production, price decontrol and removal of subsidies for agricultural inputs (Ellis et al., 2003; Harrigan, 2003). Following the SAPs, the ratification of neoliberal trade agreements particularly the Agreement on Agriculture and the Trade-Related Aspects of Intellectual Property Rights (TRIPS) further constrained smallholder farming in Malawi. These neoliberal agreements have been reported to have resulted in intensified land grabs in rural areas by agro-based transnational corporations (Chinsinga & Chasukwa, 2012). The enactment of intellectual property rights on seeds through the TRIPS coupled with the rise of transnational seed corporations also stifled the informal seed sector – the main source of seeds for rural farmers (Bezner Kerr, 2013).

A notable feature of contemporary agricultural policy in Malawi is the focus on promoting the use of modern agricultural inputs as a pathway to ensuring food security. As outlined earlier, this agenda for transforming Malawian smallholder agriculture to input-intensive production has mainly been consolidated under the agenda for a new green revolution in Africa. With support from international development partners, the government of Malawi, has over the years, implemented modern input-based agricultural policies including the Farm Input Subsidy Program (FISP) to supply subsidized synthetic fertilizer and modern seeds (mainly maize) to local farmers. The expectation has been that, the use of these modern farm inputs will address soil infertility and help augment the production of maize, a crop that has been described as 'life' in Malawi (Chinsinga, 2012).

As hinted earlier, the outcomes of these policies have proved less sustainable than professed. An empirical assessment of the FISP reveals that the programme has encouraged the rise of maize monocultures at the expense of other traditional food crops such as millet and sorghum (Chibwana et al., 2012). Amid the increasing effects of climate change, the neglect of traditional crops, which are proven to be relatively resilient to climate change, has implications for food security (Bezner Kerr, 2014). At the same time, such narrowing of the range of crops grown by local farmers does not promote dietary diversity and overall nutrition security. Research has also revealed that the most vulnerable smallholder farmers particularly women were often left out in the implementation of such modern input-based agricultural initiatives (Chibwana et al., 2012; Holden & Lunduka, 2013). Other scholars have analysed such government-led input subsidy schemes as politically driven programmes used to serve the interests of the ruling elite who distribute fertilizer and seeds to farmers for political favour

(Chirwa et al., 2012). This has led some scholars to even describe the electoral politics in Malawi as 'a politics of maize' (Harrigan, 2001; Sahley, Groelsema, Marchione, & Nelson, 2005).

3.2 The Malawi Farmer-to-Farmer Agroecological intervention

Amid the underlying adverse impacts of input-intensive agriculture in Malawi, the need for an alternative farming system that builds on locally available resources and traditional knowledge systems while ensuring ecological sustainability is obvious. In October 2012, Ekwendeni Hospital in collaboration with University of Western Ontario, University of Manitoba, Chancellor College, and the Soils, Food and Healthy Communities (SFHC), implemented the Global Affairs Canada-funded Malawi Farmer-to-Farmer Agroecology (MAFFA) project in Mzimba and Dedza districts. The project built upon earlier work of SFHC in northern Malawi, which involved farmers in direct experimentation with agroecological methods, with evidence of significant improvements in child growth and household food security (see Bezner Kerr, Berti, & Shumba, 2011; Kerr, Snapp, Chirwa, Shumba, & Msachi, 2007). The initial project by SFHC was participatory and included farmers as leaders of community work and research, through the Farmer Research Team (FRT). The FRT suggested that the agroecological methods be extended to farmers in neighbouring regions, using farmer-to-farmer methods. Visiting farmers from some of these areas also expressed interest in learning from their fellow farmers. While there is an increasing body of work on farmer participatory research, there are few examples of small-scale projects scaling up. Based on the potential to scale up the agroecological activities into other food insecure areas in Malawi and the requests from farmers and community leaders from outside the initial SFHC impact area in northern Malawi who saw the positive results of agroecological innovations by SFHC, the

MAFFA project therefore aimed to use the same participatory approach in Mzimba and Dedza Districts by forming FRTs, which in turn will act as teachers within their communities. The key objectives of the project were to: 1) Improve the food security, nutritional status and sustainable agricultural practices of farming households in central and northern Malawi; 2) Test the potential for a farmer-to-farmer model of education for scaling up use of agroecological methods in Malawi; 3) Determine the potential for local yellow maize as an acceptable socio-economic, cultural and biological option to improve the vitamin A content of diets in Malawi; and 4) Extend the agroecological, participatory approach to youth livelihoods, by using participatory training methods in food processing and local food market development to improve food security, dietary diversity and income for the youth. The project harnessed locally available resources to generate alternative farming techniques that poor smallholder farmers can use to improve production in an environmentally sustainable manner. A participatory farmer-to-farmer knowledge sharing approach was used to train farmers on compost making and application, recycling of crop residue, legume intercropping, agroforestry, manure application. This approach provided farmers the opportunity to experiment with these diverse agroecological practices while receiving support from their peers.

The project also had a social justice dimension. A gender-transformative approach was used to create spaces of dialogue for men and women from participating households to discuss pressing and difficult gender topics such as men's participation in household chores and women's ownership of land. Routine gender-transformative programmes such as dramas on gender equality and 'recipe days' in which men took part in household chores like cooking and bathing of children which are traditionally recognized as women's roles, were organized. The project also targeted improving farmer-to-farmer networks by facilitating routine inter-community farmer exchanges and local enterprise development. The MAFFA intervention presents a unique opportunity to examine the extent to which participatory agroecology can improve farmer-to-farmer networks, nutrition and sustainable land management in smallholder farming contexts.

Various studies have explored the impact of this intervention including its impacts on food security and household income (Kangmennaang et al., 2017), household health and wellbeing (Nyantakyi-Frimpong et al., 2017, 2016), gender relations (Bezner Kerr et al., 2019). While most of these studies were preliminary, this dissertation seeks to answer key questions surrounding the impact of the intervention on farmer interconnectedness, sustainable land management, production diversity and dietary diversity following the end of the project.

3.3 Study design

The MAFFA intervention used a quasi-experimental study design. In typical experimental designs, populations are randomly assigned to control and intervention groups that are then exposed to different levels of the independent variable (Bärnighausen et al., 2017; Christensen, Johnson, Turner, & Christensen, 2011; Sills et al., 2017). The popular approach in experimental design in the social sciences is having two groups of participants, thus, the experimental group, and the control group, and then introducing a treatment to only the experimental group. The researcher then studies the effect of the treatment on the dependent variables of interest. Given the challenges with randomization (Desai, Pieper, & Mahaffey, 2014; Heard, O'Toole, Naimpally, & Bressler, 2017; Murnane & Willett, 2010), quasi-experimental approaches to human geographical research have increased in popularity in recent times, with human geographers increasingly applying the experimental approach in relatively flexible ways to confront complex socioeconomic and political problems (Besbris, Faber, Rich, & Sharkey, 2018; Cummins, 2003; Druckman, Green, Kuklinski, & Lupia, 2006; Sherman & Strang, 2004; Thompson, 2015). Unlike experimental studies where the participants are randomly assigned, in quasi-experimental design, the researcher controls the assignment of participants to the treatment and control condition using a clear criterion (Adelman, 1991; Cook & Campbell, 1979; Shadish, Cook, & Campbell, 2002). In the MAFFA intervention, the same criterion was used to recruit participants into both control and treatment groups in order to improve comparability. The criterion included being food insecure; being able to farm, expressed in the household's access to productive resources such as land and actively cultivating crops; and interest in being part of the project.

The MAFFA intervention aimed to use participatory agroecology to improve smallholder agriculture in a context where conventional approaches to agriculture have failed to achieve food security and rather intensified gender inequalities. A total of 13 village areas were identified to participate in the project following village consultations with stakeholders. Village areas were included based on the conditions that no similar interventions were ongoing in the community and interest in taking part in the study. A total of 6772 farming households from 10 village areas were assigned to the treatment group and given the agroecology intervention. A stepped wedge design was used to include households in the intervention group. In the context of resource constraints, the stepped-wedge approach has proven useful in intervention research (Hemming, Haines, Chilton, Girling, & Lilford, 2015; Hughes, Heagerty, Xia, & Ren, 2018). At the baseline (the year 2012), 2089 farming households participated in the intervention while 2121 and 2562 households joined the intervention in 2013 and 2014, respectively. A total of 1500 households from 3 village areas served as controls and never participated in the intervention (see Table 3.1). These control households are currently benefitting from a similar intervention by the MAFFA project team.

Table 3.1: Showing project and survey samples

Sample type	**Treatment group**			**Control group**
	Joined 2012	Joined in 2013	Joined in 2014	2012-2017
Project sample	2089	2121	2562	1500
Survey sample	514	154	150	400

The main distinguishing feature between the treatment and control groups was participation/membership in the agroecology programme described above. Thus, the treatment sample included households that used agroecology practices in farming. These households received training on the application of agroecology practices and local seeds in the first year of joining. Agroecology training was based on a horizontal farmer-to-farmer approach. After an initial training, selected farmers from intervention communities called Farmer Research Team assisted the project team in organizing routine community level trainings and meetings. They also assisted farmers to solve problems they encountered while applying agroecology methods. Intervention households were also supported in local enterprise development to identify local markets and use locally available agricultural products to meet those markets. Gender concerns were central to the MAFFA intervention. The project engaged men and women from intervention households in gender-transformative activities including participatory drama and recipe days during which men performed culturally ascribed female roles such as cooking and caring for children. These gender-transformative programmes aimed to create spaces for dialogue where men and women can discuss pressing gender concerns. Control households, on the other hand, continued to use input-intensive approaches in production and never participated in the agroecological program. This was to facilitate comparison to ascertain the effect of the participatory agroecology intervention.

3.4 Data collection

A pre-test-post-test approach was adopted in data collection. Data were collected at two time points. In 2012 (Time 1) a baseline survey was conducted with 818 and 404 treatment and control groups, respectively. An endline survey was conducted with the same households in 2017. The survey sample for the treatment group included 154 and 150 households that received the intervention in 2013 and 2014 (see Table 3.1). The surveys collected information on the background characteristics of respondents, household characteristics, nutrition, land management practices, gender relations, and social networks. Given that the project was community-driven and based at the household level, attrition was minimal. The primary male or female farmer in the household could respond to the survey for the household, which made follow-up easier. It is, however, worth noting that four households from the control group were lost to follow up (some declined to participate, and others migrated). This brought the analytical sample to 818 agroecology households and 400 treatment households. Data was collected by trained enumerators who were also fluent in the local languages. The research team trained enumerators on the survey instrument and supervised data collection activities in the local communities. Both baseline and endline surveys lasted about an hour on average. The Non-Medical Research Ethics Board of the University of Western Ontario granted ethical clearance for the study.

3.5 Data analysis

Data were entered in Excel by trained enumerators. These enumerators were the same individuals who did the data collection. This helped to ensure familiarity with the administered questionnaire and to minimize potential biases in the interpretation of hand-written entries on questionnaires. At the baseline, participating households were given unique identity numbers to aid follow up and matching of responses.

Data was cleaned in Excel and converted into Stata files for analysis. The baseline and endline datasets were merged using the unique identity numbers that were assigned to households. As explained earlier, four households were lost to follow-up at the endline. These cases were therefore dropped from the baseline. All analyses for the three manuscripts were conducted in Stata. Depending on the research question, the sample was limited in several noteworthy areas as explained in the individual manuscripts. Different statistical models are estimated to answer the research questions.

3.6 Researcher positionality

Human Geographers have engaged with debates on the implications of the insider-outsider binary in geographic inquiry (Fisher, 2015; Mullings, 1999). The complexities of negotiating researcher identity in cross-cultural contexts—as exemplified by my situation as a research who is a Ghanaian researching agriculture and food security issues in Malawi—has been highlighted in the literature (Fisher, 2015). While being an insider as expressed in having strong ties with a given place by birth or through deep lived experience of contextual dynamics—including the subject of study—may enhance community access, promote understanding of the issue of study and ensure cultural sensitivity, being an outsider who is unfamiliar with the study context can also enhance scrutiny of issues insiders may ignore in the interpretation of research findings.

My positionality in this research straddles these two statuses. As a Ghanaian by birth, I am an outsider, given that several underlying socio-cultural issues including language vary between Ghana and Malawi. However, haven grown up in a rural farming household in the northern savannah zone of Ghana, which is the most food insecure ecological zone in the country and previously researched smallholder agricultural issues in this context, the experiences of Malawian smallholder farmers with food insecurity resonated with me. This familiarity with the subject of study accorded me an insider status at some points. Thus, I was concurrently an outsider and an insider – positions I had to constantly navigate during my visit to Malawi and in the interpretation of the findings in this dissertation. To ensure transparent reflexivity, I provide a brief reflection on how my positionality shaped this dissertation.

As indicated earlier, the MAFFA intervention was implemented in 2012. Prior to joining the project, both baseline and endline surveys had been conducted by the MAFFA team. After joining the project as a PhD student, I undertook a project immersion visit to Malawi in the summer of 2019. This visit was to provide context to the data and the opportunity to visit all project communities (intervention and control village areas) to interact with the project team and participating househoklds. Before the project immersion visit, I had already started cleaning the the baseline and endline datasets. This gave me an idea of some of the major issues to clarify during the visit. In my first week of arrival, I had the opportunity to meet the FRT members who led the MAFFA intervention in their project communities. The FRT members then led me to their respect communities to interact with some of the MAFFA households and visit their fields to gain firsthand experience of some of the agroecological practices they implemented. Despite the attempt to identify with the farmers as someone with a rural farming background during visits to MAFFA project villages, I was mostly viewed as an outsider given my ethnicity and inability to coomunicate in the local languiages. The FRT members from respective communities facilitated my interaction with the farmers, although, occasionally I met some farmers who could speak English. These FRT members were farmers themselves for which reason their explanation of some issues could be skewed towards their world view. I was therefore keen during these interactions in order to grasp the underlying meanings from the tone, facial expression and overall body language of farmers.

My field familiarization visit coincided with some important political developments in Malawi. While the country was dealing with a post election case in court between the two major political parties, there were protests across major cities in the country challenging the validity of the Presidential election. This coincided with the annual lean season. Due to food shortages, there were long queues in communities to purchase imported corn supplied by the government. Despite having some lived experience with food insecurity growing up in northern Ghana, the severity of food insecurity in this context was something I have never seen nor experienced. Indeed, this field visit was timely given the socieoconomic and political climate in Malawi at the time. This visit provided me the opportunity to witness some crucial aspects of the political economy of socioeconomic vulnerability in Malawi. I returned to Canada to continue analyzing the data for this dissertation haven stayed in Malawi and seen the everyday struggles of some smallholder farmers as they queue to purchase corn (a maximum of 5 kilograms of per head) to sustain their households while some simply could not afford rationed corn. This food crisis reminded me of how this dissertation was an important opportunity to better understand the challenges of smallholder farmers and how agroecology was being positioned in this context to better address those challenges. As a Geographer who joined the MAFFA project with a deep appreciation of diversity of experiences and contextual socieoeconomic dynamics, I must say this sense of appreciation deepened as I interacted with Malawian smallholder farmers in putting together this dissertation.

The field familiarzation visit provided context and understanding for statistical analysis and interpretation of findings. For instance, although I am familiar with most of the SLM practices deployed under the MAFFA intervention from my experience growing up in a rural farming community in Ghana, there were unique differences in how Malawian farmers applied some of these practices. Knowledge from my interaction with farming households also informed the selection and coding of variables. My outsider-insider status also shaped the interpretation of findings from statistical analysis in diverse ways. For instance, my familiarity with smallholder farming in Ghana enhanced interpretation of some of the findings that emerged. My understanding of the land tenure dynamics in Ghana, which are largely consistent with Malawi, was instrumental in contextualizing the potential impact of land tenure issues on the uptake of agroecological practices. While drawing upon this broader contextual knowledge, I maintained a reflexive approach to ensure my previous research experiences with smallholder farmers did not overshadow relevant contextual issues.

That notwithstanding, analysing and interpreting data that was already collected came with some noteworthy limitations. For instance, I had no control over the study design and data collection, given that the intervention commenced several years before I began my PhD. Despite the community immersion visit, some components of the surveys required explanations from the research team. While my experiences did not shape the design and data collection processes, they informed the contextualization of findings in this dissertation. As I examined the impact of this participatory agroecology intervention in this dissertation, I am constantly reminded by the fact that there is uncertainty in scientific enquiry. Therefore, opportunities for other sustainable farming approaches to improve smallholder agriculture are by no means foreclosed by my findings and the interpretations presented in this dissertation. Indeed, my findings provide an opportunity for continuous learning and understanding of the complex challenges confronting smallholder agriculture in Malawi and the Global South in general.

3.7 References

Adelman, L. (1991). Experiments, quasi-experiments, and case studies: a review of empirical methods for evaluating decision support systems. *IEEE Transactions on Systems, Man, and Cybernetics*, *21*(2), 293–301.

Allain, T. J., Aston, S., Mapurisa, G., Ganiza, T. N., Banda, N. P., Sakala, S., … Peterson, I. (2017). Age Related Patterns of Disease and Mortality in Hospitalised Adults in Malawi. *PloS One*, *12*(1), e0168368.

Bärnighausen, T., Tugwell, P., Røttingen, J.-A., Shemilt, I., Rockers, P., Geldsetzer, P., … Brown, A. (2017). Quasi-experimental study designs series–Paper 4: uses and value. *Journal of Clinical Epidemiology*.

Besbris, M., Faber, J. W., Rich, P., & Sharkey, P. (2018). The geography of stigma: Experimental methods to identify the penalty of place. In *Audit Studies: Behind the Scenes with Theory, Method, and Nuance* (pp. 159–177). Springer.

Bezner-Kerr, R., & Patel, R. (2014). *Food Security in Malawi*. (U. S. Nagothu, Ed.), *Food Security and Development: Country Case Studies*. London: Routledge.

Bezner Kerr, R. (2013). Seed struggles and food sovereignty in northern Malawi. *Journal of Peasant Studies*, *40*(5), 867–897.

Bezner Kerr, R. (2014). Lost and found crops: agrobiodiversity, indigenous knowledge, and a feminist political ecology of sorghum and finger millet in northern Malawi. *Annals of the Association of American Geographers*, *104*(3), 577–593.

Bezner Kerr, R., Berti, P. R., & Shumba, L. (2011). Effects of a participatory agriculture and nutrition education project on child growth in northern Malawi. *Public Health Nutrition*, *14*(8), 1466–1472.

Bezner Kerr, R., Hickey, C., Lupafya, E., & Dakishoni, L. (2019). Repairing rifts or reproducing inequalities? Agroecology, food sovereignty, and gender justice in Malawi. *The Journal of Peasant Studies*, 1–20.

Bezner Kerr, R. B., Snapp, S., Chirwa, M., Shumba, L., & Msachi, R. (2007). Participatory research on legume diversification with Malawian smallholder farmers for improved human nutrition and soil fertility. *Experimental Agriculture*, *43*(4), 437–453.

Chibwana, C., Fisher, M., & Shively, G. (2012). Cropland allocation effects of agricultural input subsidies in Malawi. *World Development*, *40*(1), 124–133.

Chinsinga, B. (2012). The political economy of agricultural policy processes in Malawi: A case study of the fertilizer subsidy programme.

Chinsinga, B., & Chasukwa, M. (2012). Youth, agriculture and land grabs in Malawi. *IDS Bulletin*, *43*(6), 67–77.

Chirwa, E., Dorward, A., & Matita, M. (2012). Thinking about 'graduation'from the Farm Input Subsidy Programme in Malawi. *Policy Brief*, (3).

Christensen, L. B., Johnson, B., Turner, L. A., & Christensen, L. B. (2011). Research methods, design, and analysis.

Cook, T. D., & Campbell, D. T. (1979). The design and conduct of true experiments and quasi-experiments in field settings. In *Reproduced in part in Research in Organizations: Issues and Controversies*. Goodyear Publishing Company.

Cuadros, D. F., Branscum, A. J., & Mukandavire, Z. (2018). Temporal stability of HIV prevalence in high-burden areas regardless of declines in national HIV prevalence in Malawi and Zimbabwe. *Aids*, *32*(10), 1381–1383.

Cummins, S. C. J. (2003). From observation to experimentation: one prescription for a geography of public policy. *Area*, *35*(2), 220–222.

Desai, M., Pieper, K. S., & Mahaffey, K. (2014). Challenges and solutions to pre-and post-randomization subgroup analyses. *Current Cardiology Reports*, *16*(10), 531.

Druckman, J. N., Green, D. P., Kuklinski, J. H., & Lupia, A. (2006). The growth and development of experimental research in political science. *American Political Science Review*, *100*(4), 627–635.

Ellis, F., Kutengule, M., & Nyasulu, A. (2003). Livelihoods and rural poverty reduction in Malawi. *World Development*, *31*(9), 1495–1510.

Fisher, K. T. (2015). Positionality, subjectivity, and race in transnational and transcultural geographical research. *Gender, Place & Culture*, *22*(4), 456–473.

Fisher, M., & Kandiwa, V. (2014). Can agricultural input subsidies reduce the gender gap in modern maize adoption? Evidence from Malawi. *Food Policy*, *45*, 101–111.

Good, K. (1990). The direction of agricultural development in Zambia, Zimbabwe and Malawi. *Studies in the Economic History of Southern Africa. Vol. 1: The Frontline States*, 127–158.

Hamel, R. (2016). Drought-Ravaged Malawi Faces Largest Humanitarian Emergency in its History.

Harrigan, J. (2001). *From Dictatorship to Democracy. Economic Policy in Malawi 1964-2000*. Ashgate.

Harrigan, J. (2003). U-turns and full circles: two decades of agricultural reform in Malawi 1981–2000. *World Development*, *31*(5), 847–863.

Heard, K., O'Toole, E., Naimpally, R., & Bressler, L. (2017). Real world challenges to randomization and their solutions. *J-PAL North America, Cambridge. Https://Www. Povertyactionlab. Org/Sites/Default/Files/Resources/2017.04*.

Hemming, K., Haines, T. P., Chilton, P. J., Girling, A. J., & Lilford, R. J. (2015). The stepped wedge cluster randomised trial: rationale, design, analysis, and reporting. *Bmj*, *350*, h391.

Holden, S. T., & Lunduka, R. W. (2013). Who benefit from Malawi's targeted farm input subsidy program? In *Forum for Development Studies* (Vol. 40, pp. 1–25). Taylor & Francis.

Hughes, J. P., Heagerty, P. J., Xia, F., & Ren, Y. (2018). Robust Inference for the Stepped Wedge Design. *Biometrics*.

Kangmennaang, J., Kerr, R. B., Lupafya, E., Dakishoni, L., Katundu, M., & Luginaah, I. (2017). Impact of a participatory agroecological development project on household wealth and food security in Malawi. *Food Security*, 1–16.

Kassie, M., Stage, J., Teklewold, H., & Erenstein, O. (2015). Gendered food security in rural Malawi: why is women's food security status lower? *Food Security*, *7*(6), 1299–1320.

Kishindo, P. (2004). Customary land tenure and the new land policy in Malawi. *Journal of Contemporary African Studies*, *22*(2), 213–225.

Kishindo, P., & Mvula, P. (2017). Malawi's land problem and potential for rural conflict. *Journal of Contemporary African Studies*, *35*(3), 370–382.

Kydd, J., & Christiansen, R. (1982). Structural change in Malawi since independence: Consequences of a development strategy based on large-scale agriculture. *World Development*, *10*(5), 355–375.

Lele, U. (1990). Structural adjustment, agricultural development and the poor: Some lessons from the Malawian experience. *World Development*, *18*(9), 1207–1219.

Matchaya, G. (2009). Land ownership security in Malawi. *African Journal of Agricultural Research*, *4*(1), 1–13.

McCarthy, N., Brubaker, J., & De La Fuente, A. (2016). *Vulnerability to Poverty in rural Malawi*. World Bank.

Mkandawire, P., Luginaah, I., & Baxter, J. (2014). Growing up an orphan: vulnerability of adolescent girls to HIV in Malawi. *Transactions of the Institute of British Geographers*, *39*(1), 128–139.

Mkandawire, R. M. (1992). The Land Question and Agrarian Change in Malawi', in. GCZ Mhone (Ed.), Malawi at the Crossroads: The Post-colonial Political Economy. Harare. Sapes Books.

Mullings, B. (1999). Insider or outsider, both or neither: some dilemmas of interviewing in a cross-cultural setting. *Geoforum*, *30*(4), 337–350.

Murnane, R. J., & Willett, J. B. (2010). *Methods matter: Improving causal inference in educational and social science research*. Oxford University Press.

Mussa, R. (2017). Poverty in Malawi: Policy Analysis with Distributional Changes.

Nyantakyi-Frimpong, H., Kangmennaang, J., Kerr, R. B., Luginaah, I., Dakishoni, L., Lupafya, E., … Katundu, M. (2017). Agroecology and healthy food systems in semi-humid tropical Africa: Participatory research with vulnerable farming households in Malawi. *Acta Tropica*, *175*, 42–49.

Nyantakyi-Frimpong, H., Mambulu, F. N., Kerr, R. B., Luginaah, I., & Lupafya, E. (2016). Agroecology and sustainable food systems: Participatory research to improve food security among HIV-affected households in northern Malawi. *Social Science & Medicine*, *164*, 89–99.

Orr, A. (2000). 'Green Gold'?: Burley Tobacco, smallholder agriculture, and poverty alleviation in Malawi. *World Development*, *28*(2), 347–363.

Peters, P. E. (2010). "Our daughters inherit our land, but our sons use their wives" fields": matrilineal-matrilocal land tenure and the New Land Policy in Malawi." *Journal of Eastern African Studies*, *4*(1), 179–199.

Peters, P. E., & Kambewa, D. (2007). Whose security? Deepening social conflict over 'customary'land in the shadow of land tenure reform in Malawi. *The Journal of Modern African Studies*, *45*(3), 447–472.

Sahley, C., Groelsema, B., Marchione, T., & Nelson, D. (2005). *The governance dimensions of food security in Malawi. USAID Bureau of Democracy, Conflict, and Humanitarian Assistance, Washington, DC*. Washington, DC.

Shadish, W. R., Cook, T. D., & Campbell, D. T. (2002). *Experimental and quasi-experimental designs for generalized causal inference*. Wadsworth Cengage learning.

Sherman, L. W., & Strang, H. (2004). Experimental ethnography: The marriage of qualitative and quantitative research. *The Annals of the American Academy of Political and Social Science*, *595*(1), 204–222.

Sills, E. O., de Sassi, C., Jagger, P., Lawlor, K., Miteva, D. A., Pattanayak, S. K., & Sunderlin, W. D. (2017). Building the evidence base for REDD+: Study design and methods for evaluating the impacts of conservation interventions on local well-being. *Global Environmental Change*, *43*, 148–160. https://doi.org/10.1016/j.gloenvcha.2017.02.002

Stevens, T., & Madani, K. (2016). Future climate impacts on maize farming and food security in Malawi. *Scientific Reports*, *6*(36241 |).

Thompson, N. (2015). *Experimental geography: radical approaches to landscape, cartography, and urbanism*. Melville House.

Vail, L. (1983). The state and the creation of colonial Malawi's agricultural economy. *Imperialism, Colonialism and Hunger: East and Central Africa. Lexington, MA: Lexington Books*, 39–88.

Winter, C. (1984). Structural adjustment lending: Boon or blow for Malawi? *Journal of Contemporary African Studies*, *4*(1–2), 103–118.

World Bank. (2019). *Malawi Poverty Measurement using the Fourth Integrated Household Survey 2016-17 (IHS4)*. Washington, D.C. https://doi.org/http://documents.worldbank.org/curated/en/352171563253680156/Malawi-Poverty-Measurement-using-the-Fourth-Integrated-Household-Survey-2016-17-IHS4

CHAPTER 4

Beyond ecological synergies: examining the impact of participatory agroecology on social capital in smallholder farming communities

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4. BEYOND ECOLOGICAL SYNERGIES: EXAMINING THE IMPACT OF PARTICIPATORY AGROECOLOGY ON SOCIAL CAPITAL IN SMALLHOLDER FARMING COMMUNITIES

The pivotal role of social capital in smallholder agriculture is widely acknowledged. The growth effect of social capital manifests in how networks and trust facilitate access to productive resources and knowledge sharing among farmers. While sub-Saharan Africa is considered a storehouse of rich social capital, recent literature indicates its rapid depletion due mainly to the rise of capitalist agriculture and concomitant reorganization of the relations of production that characterize smallholder agriculture. Agroecology is an alternative approach to agriculture aimed at addressing the adverse impacts of capitalist agriculture, including improving farmer-to-farmer networks and trust. In this paper, we draw on longitudinal data from a five-year participatory agroecology intervention in Malawi using Difference-in-Difference (DID) to compare the social capital endowment of agroecology-practicing households ($n=514$) and a control group of non-agroecology households ($n=400$). We further employed linear regression to examine the relationship between social capital and adoption of agroecology practices. Results from the DID analysis show a positive and statistically significant treatment effect of the agroecology intervention on social capital ($\beta=0.217$, $p<0.01$) after controlling for theoretically relevant variables. Results from the regression analysis also show a significant relationship between social capital and adoption of agroecology practices ($\beta=0.12$, $p<0.001$). These findings reveal the positive inroads of agroecology beyond the farm-level and demonstrate the potential for policymakers to leverage the reinforcing relationship between social capital and agroecology to promote sustainable agriculture.

4.1 Introduction

For the past few decades, the concept of social capital—defined broadly as the resources inherent in networks and shared norms, which individuals and groups can draw upon to facilitate diverse social transactions and accomplish common goals—has gained popularity in development literature (Chriest & Niles, 2018; Coleman, 1988; Granovetter, 1973; Pretty & Ward, 2001; Schafft & Brown, 2003). An increasing body of literature demonstrates the pivotal role of social capital in smallholder farming contexts (Hunecke, Engler, Jara-Rojas, & Poortvliet, 2017; Liverpool-Tasie, Kuku, & Ajibola, 2011; Rivera, Knickel, María Díaz-Puente, & Afonso, 2019; Saint Ville, Hickey, Locher, & Phillip, 2016; Sseguya, Mazur, & Flora, 2018). The growth effect of social capital on smallholder agriculture manifests in the role social networks and trust play in: facilitating improved access to productive resources and reducing production/transaction costs (Taylor & Featherstone, 2018; Yoder & Chowdhury, 2018); enhancing knowledge flows and adoption of new farming technologies (Conley & Udry, 2001; Kansanga, 2017; Mekonnen, Gerber, & Matz, 2018; Saint Ville et al., 2016; Van Rijn, Bulte, & Adekunle, 2012); promoting sustainable management of natural resources and agroecosystems through collective action (Pretty & Ward, 2001; Shiferaw, Okello, & Reddy, 2009; Wossen, Berger, & Di Falco, 2015; Yoder & Chowdhury, 2018); and improving access to markets (Lyon, 2000; Overå, 2006).

Although sub-Saharan Africa (SSA) is widely regarded as a storehouse of social capital expressed in closely knit social ties, particularly at the micro-level (Van Rijn et al., 2012), recent literature shows the increased erosion of community-level social capital and the many benefits smallholder farmers derive from such networks to surmount production challenges (Claasen & Lemke, 2019; Ntale, 2013). The waning social capital in smallholder farming contexts, in particular, has been reported to contribute to poor climate change adaptation (Sadiq, Al-Hassan, & Kuwornu, 2019; Williams, Crespo, & Abu, 2018); the depletion of local resource exchange networks, particularly seed exchange networks (Coomes et al., 2015; van Niekerk & Wynberg, 2017) and environmental degradation resulting from the breakdown of longstanding traditional conservation practices that forged collective action in environmental conservation (Bisung et al., 2014; Farnworth et al., 2016; Hyakumura & Inoue, 2006; Thuy, Dwivedi, Rossi, Alavalapati, & Thapa, 2011). Many scholars have attributed the declining social capital in smallholder farming contexts partly to the rise of capitalist agriculture (Chloupkova, Svendsen, & Svendsen, 2003; Hendrickson & James, 2005). The adverse impact of colonial and post-colonial land and labour regimes and associated forced displacements on farmer mobility and interconnectedness has also been recognized (Chinsinga et al., 2013). In the context of the search for sustainable pathways for improving farmer-to-farmer networks in local communities, research has emphasized the need to move from the prevailing 'technical top down' approach that characterizes state-led agricultural production initiatives to a 'systemic' and 'endogenous' approach that includes local farmers and their knowledge in agricultural development (Klerkx, Van Mierlo, & Leeuwis, 2012; Knickel, Brunori, Rand, & Proost, 2009; Moschitz, Roep, Brunori, & Tisenkopfs, 2015).

Agroecology emerged as an alternative approach to smallholder agriculture aimed at promoting ecological sustainability and improving the relations of production on which smallholder agriculture is grounded (Gliessman, 2016; Holt-Giménez & Altieri, 2013). Thus agroecology should consequently improve social networks and trust in traditional agricultural settings, including addressing knowledge gaps and power inequalities for marginalized groups (Dumont et al., 2016; Méndez et al., 2013). Gliessman (2016) identified five interrelated pathways through which agroecology can transform the global food system, namely: 1). increasing the efficiency of industrial and conventional inputs and practices, 2). substituting alternative practices for industrial/conventional inputs and practices, 3). redesigning agroecosystems to function according to ecological processes, 4). re-establishing a direct link between those who grow the world's food and those who consume it, and 5). building a new global system that is not only sustainable but also helps restore Earth's life-support systems based on the successes achieved in levels 2 and 3. This food system is based on participation, localness, fairness and justice. Levels 4 and 5 of this classification directly relate to improving the social relations of production including farmer social networks and addressing social inequalities.

Agroecology adopts a holistic approach towards reorienting smallholder agricultural systems in ways that will restore beneficial elements such as informal seed and information exchange networks while creating new synergies that address social inequalities and ecological degradation (Altieri, 2018; Bezner Kerr et al., 2019). As opposed to the vertical knowledge transfer approach that characterizes industrial agriculture, agroecology uses horizontal learning and social transformation approaches through farmer-to-farmer knowledge sharing to foster sustainable farming relations and a fair food system (Bacon, Mendez, & Brown, 2005; Bezner Kerr et al., 2019; Dumont et al., 2016). By building on and strengthening existing networks and interaction among farmers, agroecology can foster social cohesion and socioeconomic synergies in the exchange of agricultural information and inputs among other benefits (Méndez et al., 2013; Winters, Cavatassi, & Lipper, 2006). Thus, apart from promoting ecologically sustainable farming practices, agroecology also focuses on building more just social systems in which small-scale food producers and communities can thrive.

The potential for agroecology to improve social capital in smallholder farming systems has been acknowledged (Misra, 2017; van Niekerk & Wynberg, 2017). That notwithstanding, research as to the extent and pathways through which agroecology can improve social capital remains unexplored. Drawing on a two-wave panel data from a five-year participatory farmer-to-farmer agroecology project implemented in Malawi, this paper explores the effect of participatory agroecology on social capital. We compare the social capital endowment of smallholder farming households that engaged in participatory farmer-to-farmer agroecology activities from 2012 to 2017 to a control group of non-agroecology practicing households. With empirical evidence that social capital has a stronger potential to shape the level of adoption of agricultural innovations and collective action, we further explored the existence of a bidirectional relationship between social capital and agroecology. This study is the first to empirically examine the linkages between agroecology and social capital in a smallholder farming context. Given the crucial role social capital plays in supporting smallholder agriculture, our findings will have relevant implications for local level agroecology programming and agricultural policy.

4.2 Background of Malawian agriculture

A nuanced understanding of agricultural development in Malawi cannot be reached without linking contemporary dynamics to historical processes in the agricultural sector dating back to the colonial and early post-colonial times. Before independence in 1994, British colonial rule significantly shaped Malawi's domestic economy mainly through the reorienting of agriculture to an export-based production system focused around a few cash crops, mainly, tobacco and cotton (Bezner-Kerr & Patel, 2014; Vail, 1983). The shift to cash crop production also led to the reconfiguration of relations of production in smallholder agriculture, particularly, control over the factors of production such as land and labour. Customary lands were appropriated and diverted to tobacco estates at the expense of smallholder agriculture (Good, 1990; Matchaya, 2009; Mkandawire, 1992; Vail, 1983). Through the 'hut tax', the colonial government also controlled the labour of indigenes: males were compelled to work on plantations to meet tax obligations (Bryceson, 2006; Chirwa, 1994; Vail, 1983). Similarly, agricultural research and extension services were developed to support cash crop production at the expense of smallholder agriculture although smallholder farmer's participation in the cultivation and trading of cash crops was restricted by the colonial administration (Bezner Kerr & Patel, 2014; Ng'ong'ola, 1986; Vail, 1983). These processes negatively influenced the traditional organization of smallholder agriculture and the social relations of production in farming households given that agriculture was left to females while most men worked in tobacco estates to meet tax obligations.

The 30-year post-independence government of Kamuzu Banda built on this skewed colonial agrarian policy and favoured estate agriculture at the expense of smallholder farming (Lele, 1990). More customary lands were taken through statutory acquisition under the 1965 Land Act and channeled into cash crop production (Bezner Kerr & Patel, 2014; Kydd & Christiansen, 1982). Subsequent land reforms by the post-independence government favoured a minority of political elites and middle class farmers (Ellis, Kutengule, & Nyasulu, 2003). The poor socioeconomic conditions in the early 1980s triggered a debt crisis, compelling the government to subscribe to the structural adjustment programs (SAPs) as a requirement to continue to access foreign loans (Orr, 2000; Winter, 1984). The SAPs came with several conditions including market liberalization, currency devaluation, withdrawal of subsidies on public goods and services (Bezner Kerr & Patel, 2014). The removal of subsidies on public goods and services including agricultural inputs, negatively affected smallholder farmers (Ellis et al., 2003; Harrigan, 2003; Lele, 1990). Other neoliberal policies including the Agreement on Agriculture (AoA) and the Trade-Related Aspects of Intellectual Property Rights further stifled smallholder agriculture. For instance, the AoA required member countries to further liberalize trade, a move which resulted in the increased presence of agro-based transnational corporations in Malawi and resource grabbing in rural areas (Chinsinga & Chasukwa, 2012).

In contemporary times, agricultural development in Malawi has centered on the promotion of modern agricultural inputs particularly improved seeds and inorganic fertilizer. For the past two decades, the agenda to transform smallholder agriculture into an input-intensive production system has been pursued under the Farm Input Subsidy Program (FISP) through which the government, in partnership with a range of multilateral donors, supply farmers with modern inputs at subsidized rates (Chinsinga, 2014). In the context of persistent food insecurity, empirical evidence suggests that the FISP is a politically driven program used to serve the interests of the ruling class who distribute fertilizer and seeds to farmers for political favour (Chirwa et al., 2012). Some authors have even christened the electoral politics in Malawi as a 'politics of maize' (Harrigan, 2001; Sahley et al., 2005). Other scholars have also reported that the most vulnerable smallholder farmers, especially women, do not have access to input coupons (Chinsinga, 2011; Kilic, Whitney, & Winters, 2014). Evidence also suggests that smallholder agriculture in Malawi has lost its traditional production diversity due to the persistent promotion of maize under the FISP (Bezner Kerr, 2014). In this context, the need for an alternative approach to smallholder agriculture that can improve the social relations of production is crucial for achieving food security.

4.3 Social capital: a theoretical and conceptual overview

Social capital has become an increasingly important analytical tool in understanding development in the past few decades. Although its definition is a subject of debate, it is generally described as the resources and opportunities inherent in networks and shared norms which individuals and groups can draw upon in daily endeavors including agricultural production (Coleman, 1988; Fukuyama, 1995; Granovetter, 1973; Putnam, 2000; Woolcock, 2001). These resources are deemed social given that they are made available only through social relations, norms of reciprocity and trust, unlike other tangible assets. Theoretically, social capital is discussed in two distinct but interrelated forms: cognitive and structural. Cognitive social capital denotes the resources that individuals are able to leverage by virtue of their relationship with other people and the shared understandings and trust that derive from such networks (Grootaert, Narayan, Jones, & Woolcock, 2004).

Moving away from trust and norms, structural social capital, which is largely associated with the work of Putnam (1995), emphasizes the role of formal and informal networks. Structural social capital manifests in two forms: bonding and bridging social capital (Putnam, 2000). Bonding social capital refers to the resources inherent in horizontal ties between individuals with the same characteristics (Narayan-Parker, 1999). This can be expressed in relationships with other individuals within families, close friendships, community-based farmer associations, ethnic fraternal organizations and church-based women groups. In an agricultural context, bonding social capital can be crucial in facilitating access to productive resources such as agricultural land and seeds (Coomes et al., 2015). In contrast, bridging social capital refers to the resources individuals derive from vertical ties that extend beyond immediate social connections as exemplified by the relationship between extension officers and local farmers

(Grootaert et al., 2004). Some scholars have argued for a third form of structural social capital—linking social capital—to denote an individual's ties with persons in positions of authority, such as workers in public institutions (Pretty & Ward, 2001; Woolcock, 2001). Generally, it is important to note that although social capital is not tangible, it has the potential of transferability into other forms of capital where for instance a farmer by virtue of his/her membership to a local farming association, is able to obtain land (a tangible resource) from another member of the association for cultivation (Bourdieu, 1986).

At the conceptual level, there is a general recognition to approach social capital from a multi-dimensional analytical perspective. The call for a multidimensional perspective draws from several critiques including the political economy perspective that the majority of empirical analysis of social capital fail to take into account structural factors that have the potential to influence people's social capital (Bezner Kerr, 2005; Schafft & Brown, 2003). Indeed, this call has seen the increased unbundling of social capital, especially into key analytical/measurable categories including bonding and bridging to enable more disaggregated analysis (Grootaert et al., 2004; Narayan & Cassidy, 2001; Van Rijn et al., 2012). Some scholars have also argued for the recognition of the interdependencies between these different sub-categories of social capital. For instance, the need to consider both bridging and bonding social capital at the conceptual level relates to the interdependencies between the two forms. As argued by Harpham, Grant & Thomas (2002), without vertical networks connecting local farming communities to external groups or institutions with financial resources and technologies, only the resources inherent in shared norms and trust (cognitive social capital) may not be able to adequately deliver the desired positive impacts in agrarian communities. Likewise, without horizontal links (structural social capital) to other farmers or farming households locally, information flows, support networks and other benefits from social cohesion will be lost. Given the complex and multidimensional nature of social capital, its measurement has been problematic. Diverse techniques have been used in the literature. An increasing number of studies have explored social capital based on survey data (Dakhli & De Clercq, 2004; Narayan & Pritchett, 1999; Ross, Kwon, Kulinna, & Searle, 2019; Vikram, 2018; Vincens, Emmelin, & Stafström, 2018). Other scholars have used artefactual field experiments to measure social capital (see Bouma, Bulte, & van Soest, 2008; Carter & Castillo, 2011; Karlan, 2005).

In quantitative measurements of social capital, a key area of conflict has been the determination of proxies for capturing its diverse dimensions adequately. For instance, Bullen & Onyx (1998) used factor analysis to identify eight proxies of social capital namely: participation in the local community, neighborhood connections, family and friends connection, work connection, proactivity in social context, feelings of trust and safety, tolerance of diversity and value of life. Similarly, the Social Capital Community Benchmark Survey[2] administered in the United States of America and directed by Putnam, used 11 proxies including social trust, inter-racial trust, diversity of friendships, political participation, civic leadership and associational involvement, informal socializing, volunteering, faith-based engagement, equality of civic engagement across community, and variation between communities (Saguaro, 2001). Krishna & Shrader (2000) also developed the Social Capital Assessment Tool specific for developing countries using 11 indicators. Although these measures have been applauded for their extensiveness in capturing the different aspects of social capital, a common limitation has been the overlapping nature of some of the proxies. The overlap has given rise to concerns related to attempts to separate social capital into cognitive and structural dimensions. This concern is

[2] Detailed discussion of this instrument is provided by Subramanian, Kim, & Kawachi (2002)

based on the theoretical argument that in most contexts, norms and relationships may not necessarily be independent dimensions, but may reinforce each other (Snijders, Steglich, & Schweinberger, 2007; Van Rijn et al., 2012). Amid these concerns, the Integrated Questionnaire for the Measurement of Social Capital (SC-IQ) was developed by the World Bank for use in developing country contexts (Grootaert et al., 2004). In this paper, we draw on the SC-IQ tool to construct our social capital variable. The SC-IQ measures social capital based on 6 key indicators namely: group belongingness and networks; trust and solidarity; information flow and communication; social cohesion and inclusion; collective action and cooperation; and empowerment and political action (Grootaert et al., 2004). As outlined by Grootaert et al. (2004), the SC-IQ tool is particularly useful for assessing the impact of community-level interventions on social capital such as the MAFFA project. Detailed explanations of the 6 indicators of the SC-IQ and how they were measured in the MAFFA survey are discussed in detail in the methodology section.

4.4 The Malawi Farmer-to-Farmer Agroecology intervention

The MAFFA project is a participatory farmer-to-farmer agroecology intervention implemented in Malawi from 2012 to 2017. The project aimed to draw on local resources and use horizontal knowledge sharing among smallholder farmers to improve land management, food security, nutrition and social equity. Apart from teaching farmers environmentally sustainable farming practices including composting, manure application, crop residue integration, agroforestry, legume interaction, and crop rotation, the project also targeted improving the social relations and networks of production on which smallholder agriculture is grounded. The rationale is that improving the social context, especially addressing gender and other social inequalities and fostering networks among local farmers will in conjunction with the application of farm-level agroecological practices, help improve sustainable land management, food security, nutrition and social relations.

As outlined earlier, in smallholder farming communities, well-functioning networks and trust among farmers can help facilitate resource sharing particularly agricultural knowledge and inputs such as seeds (Lyon, 2000; Taylor & Featherstone, 2018; Van Rijn et al., 2012). By using participatory farmer-to-farmer knowledge sharing, the project aimed to build social cohesion among smallholder farmers, foster knowledge exchange and improve existing networks among farming households. For the five years of implementation, the project created a platform for regular interaction among farmers at the community level through periodic dramas, farmer training workshops, local farmer cooperatives and occasional farmer exchanges with other regions. Aside from promoting knowledge sharing, these activities also created a sense of group belongingness for participating farmers and provided opportunities for them to build useful relationships with farmers from other communities. These networks and the trust they engendered also created avenues for participating farmers to share pressing concerns about agriculture and other life challenges.

The intervention also promoted local enterprise development. Participating households were supported to establish diverse local enterprises and village savings and loan groups to generate alternative income and promote social cohesion. Through these enterprises, households developed networks and marketing relations within and outside their communities. Research has shown the enduring role of these local marketing networks and how farmers leverage the trust that ensues from them to solve pressing problems, including acquiring loans for funding farming activities (see Lyon, 2000). Cognizant of the prevailing gender inequality in smallholder agriculture in Malawi, women from participating households were prioritized in the formation of local enterprise development groups. Given the focus on improving social networks, trust and cohesion at the local level, the MAFFA intervention provides a unique opportunity to examine the effect of participatory agroecology activities on social capital in smallholder farming contexts.

4.5 Methods

4.5.1 Data and sample

This analysis is based on a two-wave survey data from the five-year Malawi Farmer-to-Farmer Agroecology project. The project employed a stepped wedge longitudinal design whereby households from control villages were sequentially added into the intervention over the period of the project. Participating village areas were purposively selected in consultation with village leaders and residents following community awareness meetings to introduce the project. Selection of village areas was guided by two main benchmarks: majority of population of the village being smallholder farmers; and, no similar agricultural projects or programs being implemented in the area. A total of 13 participating village areas were selected: 10 village areas received the intervention—5 village areas at the baseline (2012), while 3 and 2 village areas were added sequentially in 2013 and 2014, respectively—and 3 village areas served as controls and were never exposed to the intervention (see details of sampling on Table 4.1). In terms of distribution by District, village areas in the intervention group in the Mzimba district were Chimbongondo, Emtiyani, Kafulufulu, Mlimo, Kabanda and Edundu while Chumachitsala, Mphathi, Chimoto North and Makowe were from the Dedza District. Village areas in the control group comprised Mtwalo and Dunduzu in Mzimba and Mtendere in Dedza. While the distribution of village areas varies across Districts, the two sample groups are comparable given that the same criteria was used to select farming househulds into both control and intervention groups across the two districts.

Table 4.1: Showing sampling design and study sample

Category	**District**	**Village Area**	**Joined 2012**	**Joined 2013**	**Joined 2014**	**Total sample**
Intervention	Mzimba	Chimbongondo	122			**818**
		Emtiyani	63			
		Kafulufulu	117			
		Mlimo	98			
		Kabanda		58		
		Edundu		48		
	Dedza	Mphathi	114			
		Chumachitsala		48		
		Chimoto North			105	
		Makowe			45	
Sub-total			514	154	150	
Control	Mzimba	Mtwalo	200			**400**
		Dunduzu	55			
	Dedza	Mtendere	145			
Total						**1218**

Sampling into the control and intervention groups was done across separate village areas to avoid the problem of 'contamination' of intervention knowledge and materials. At the baseline (2012), 2089 farming households received the intervention. Using a stepped wedge approach, 2121 and 2562 households were sequentially sampled into the intervention group in 2013 and 2014, respectively. In a typical stepped wedge design, more participants are exposed to the intervention at the endline than the baseline. This implies that the effect of the intervention can be confounded with an underlying temporal trend (Hemming et al., 2015). Cognizant of this potential for confounding of the treatment effect, the MAFFA project employed a modified stepped wedge design by ensuring that at the endline, there were control households from the baseline (n=1500) who were not exposed to the intervention. This design can facilitate an unbiased estimation of the treatment effect of the intervention independent of any trend effects by comparing intervention households to those that were never exposed to the intervention. Sampling of households into both intervention and control groups was based on the following criteria: being food insecure (assessed qualitatively by asking preliminary questions on food availability and access); ability to farm (self-reported based on whether the household had access to productive resources such as land and labor and was already cultivating crops), and interest in participating in the project. Gender equity was also considered in the sampling process.

Data collection followed a longitudinal approach. Prior to the intervention, a baseline survey was conducted in 2012 with households from all participating villages (n=1218) who agreed to be contacted for an endline survey. The baseline survey sample was a randomly selected sub-sample from those households that were scheduled to receive the intervention (n=818: 514 households received the intervention in 2012 and, 154 and 150 joined in 2013 and 2014 respectively), and those households who never received the intervention (n=404). In November 2017, an endline survey was conducted with the same control and intervention households that were interviewed at the baseline. In both baseline and endline surveys, the control households were farming households from 3 village areas that never received the MAFFA intervention. Four of the control households were lost to follow-up, bringing the endline survey sample to 400 households.

With the objective of estimating the treatment effects of the MAFFA intervention on social capital, we restricted our analytical sample to the 514 households that received the intervention in 2012 (the baseline year) and the control group (n=400 households) who were not exposed to the intervention. As mentioned earlier, comparing households that received the intervention at the baseline with those who never received the intervention will facilitate an unbiased estimation of the treatment effects of the agroecology intervention on social capital independent of any general temporal trends in the project environment.

In each household, the survey was administered to the husband or wife. In polygamous households, where more than one wife was present at the time of the survey, a dice was cast to select one of the wives. Both baseline and endline surveys contained the same set of questions across a wide range of issues including household gender relations, social networks, health and food security. Survey instruments were pre-tested to ensure content validity and clarity. The data was collected by trained enumerators in the local languages (Tumbuka and Chichewa).

4.5.2 Measures

Conceptually, our computation of social capital was guided by the SC-IQ developed by the World Bank for measuring social capital in developing countries (Grootaert et al., 2004). As explained earlier, a key concern with categorizing social capital into dimensions is that cognitive and structural forms of social capital are not necessarily discrete dimensions (Van Rijn et al., 2012). Rather, as demonstrated by Snijders et al. (2007) norms and social relationships reinforce each other significantly. Therefore, as a multidimensional concept with interrelated components, social capital may be better measured as a composite outcome. To reflect this conceptual standpoint, we employed principal component analysis to create a 'social capital index' based on the indicators of social capital outlined by the World Bank in the SC-IQ. In the next paragraph, we identify the respective social capital questions in the MAFFA survey and how they are matched to the SC-IQ indicators.

The first indicator on the SC-IQ is *'groups and networks'*. At the household level, this indicator centres on household members' participation in various types of social organizations and the possession of informal networks. In the baseline and endline surveys, both agroecology and non-agroecology households were asked about membership to organizations at the local level. With respect to networks, the SC-IQ outlined three alternative ways of capturing it: the size of the network, its internal diversity or the extent to which it would provide assistance in times of need. Given the complexity and difficulty with measuring the extent of social networks, Grootaert et al. (2004:11) suggest that any approach taken should consider a network as "a circle of close friends"—that is, people one feels at ease with, can talk to about private matters, or call upon for help". Based on this conceptual premise, we focused on the possession of such close relationships. Given that the context of the MAFFA intervention is agrarian, households were asked whether they had a source (other farming households) in the community to turn to for assistance such as seeds or soft loans in times of difficulty. The second proxy of social capital outlined in the SC-IQ is *'trust and solidarity'*, which focuses on the cognitive aspect of social capital. Akin to networks, trust is complex. Following Narayan & Cassidy (2001), we measured trust based on a households' confidence in members of their immediate local community. This was captured using a question that asked whether participants had someone to confide in about pressing household problems. The third indicator of social capital is *'collective action and cooperation'*. We captured this proxy based on responses to a question which asked whether the household participated in or contributed towards activities of collective interest to the community. The fourth indicator outlined in the SC-IQ measures a household's source of information for agricultural decisions. This was measured using a question that asked whether households were had any sources of information (e.g. relatives, friends and agricultural extension agents) they relied on in solving pressing agricultural challenges aside from self-experience. '*Social cohesion'*, which is the fifth indicator in the SC-IQ, is expressed in the occurrence of every-day social interaction among households. This can assume the form of community-level meetings, visits to other people's homes or visits from others. Because measures on engagement in community-level events or meetings can be strongly correlated with the questions on community participation (Grootaert et al., 2004), we captured this indicator based on interaction between households. The first question used asked whether members of the household frequently visited their friends and relatives in other households in the community. The second question asked whether the household members frequently visited friends and relatives outside the community. The final indicator in the SC-IQ tool is *'empowerment and political action'*. Given that empowerment is a broad concept, in the context of the SC-IQ, it is defined narrowly to denote the ability to make decisions that affect everyday life (Grootaert et al., 2004). We included two questions from our data to reflect this indicator: first, whether a household participated in community-level activities, and second, whether households practiced joint decision making about production and major household expenditures. We included the latter on the premise that the household is a very important unit in everyday life where participation is crucial (Aberman, Behrman, & Birner, 2018).

Consistent with previous quantitative studies that measured social capital (Njuki, Mapila, Zingore, & Delve, 2008; Sseguya et al., 2018; Van Rijn et al., 2012), we used principal factor analysis with varimax rotation to construct a social capital index based on the eight social capital questions/indicators used to capture social capital in the MAFFA survey. The Kaiser criteria recommended the retention of six factors, with a Cronbach's alpha of 0.82. These proxies had factor loadings ranging between 0.78 and 0.84. These independent factor loadings suggest that although each indicator contributes significantly to the social capital index, none is exhaustive. Hence the need for a composite measure. Thus, we loaded the six factors into a single latent construct. The resultant scale was further normalized to have a range of 0 to 1. Given that all social capital proxies in our survey were binary (0= 'no', if a household has no endowment in a given proxy; 1= 'yes', if the household had endowment), higher scores on the social capital index implies higher endowment in social capital, while lower scores indicate lower social capital endowment. Other authors have used principal factor analysis to organize social capital proxies (Njuki et al., 2008; Onyx & Bullen, 2000; Van Rijn et al., 2012).

It is important to mention that the SC-IQ is not without limitations. A significant body of literature from the early 2000s have contested the manner in which the World Bank operationalized social capital (Bebbington, 2004; Fine, 2002; Harriss, 2002). One of the major arguments is that social capital is broad and difficult to measure with quantitative indicators as operationalized by the World Bank through the SC-IQ. According to Fine (2002), while more and more variables tend to be included to measure social capital across its different forms (e.g. from bonding to briding and vertical to horizontal) quantitatively, a widely ignored weakness is that these proxies or categories are typically mediated by underlying social issues such as class, ethnicicty, gender, marital status, age etc. Thus, quantitative measures of social capital may fail to adequately capture the mutidimentional nature of social stratification.

The focal independent variables in this analysis were membership in the participatory agroecology project (0=no; 1=yes) and wave of survey (0=wave 1; 1=wave 2). Regarding membership, those in the 'yes' category are the households that practiced agroecology, while the ‘no’ category denotes the counterfactual group of control households that did not practice agroecology. Although our measure of household social capital endowment included a wide variety of indicators, the index does not include other relevant factors that may influence social capital. Informed by the literature on social capital (Bullen & Onyx, 1998; Grootaert et al., 2004; Narayan & Cassidy, 2001; Sseguya et al., 2018; Van Rijn et al., 2012), we controlled for theoretically relevant variables including household structure (0=monogamous; 1=polygamous; 2=separated/divorced), husband/primary male’s age (0=<30; 1=30-45; 2=46-60; 3=>60), wife/primary female’s age (0=<30; 1=30-45; 2=46-60; 3=>60), level of education of husband/primary male (0=no education; 1=primary; 2=secondary education or higher), level of education of wife/primary female (0=no education; 1=primary; 2=secondary or higher), household food security (0=food secure; 1=insecure) measured using the Household Food insecurity Access Scale which comprises a set of 9 questions (Coates, Swindale, & Bilinsky, 2007). The HFIAS measures the prevalence of food insecurity through feelings of uncertainty or anxiety over food availability in the household; perceptions of food insufficiency in terms of quantity and quality, reported reductions of food intake in the household; and feelings of indignity from resorting to culturally/socially unacceptable ways of obtaining food. An overall food insecurity score (ranging from 0-27) is then generated such that a household is scored ‘0’ if it answered ‘no’ (indicating non-occurrence) to all the nine questions and a maximum of 27 if all responses to the nine questions were ‘yes’. A high score on the HFIAS implies higher household food insecurity. Based on this benchmark, households can be classified into food secure (HFIAS = 0–1), mildly food insecure (HFIAS = 2–7), moderately food insecure (HFIAS = 8–11), and severely food insecure (HFIAS > 11). Due to the distribution, we generated two categories (0=food secure; 1=insecure). We also controlled for household land ownership status (0=yes; 1=no), household wealth (0=poor; 1=middle income; 2=rich), number of crops grown (0=only one; 1=two; 2=three or more), household alcohol consumption (0=no; 1=yes) and land ownership (0=no; 1=yes). It is important to mention that these variables are not exhaustive of all potential theoretically relevant factors that may shape social capital. For instance, due to data limitations, we could not account for factors such as labour migration and remittance flow which are equally important in the Malawian context.

4.5.3 Analysis

To estimate the treatment effect of the agroecology intervention on social capital, we used the Difference-in-Difference (DID) technique with propensity score matching. The DID approach is a widely used method in impact analysis (see Grillos, 2018; Kabunga, Dubois, & Qaim, 2012). The DID estimator compares the change in the outcome variable (social capital) between the treatment group and control group before and after the intervention and estimates the average treatment effect as either a linear regression or a probit model. Our statistical approach is expressed as follows:

$$SC_{ijt} = \alpha_0 + X_{ijt}\beta_1 + X_{ijt}\beta_2 + \tau^{2012}\beta_3 + \tau^{2017}\beta_4 + \mathrm{P}_{jt}\tau^{2012}\beta_5 + \mathrm{P}_{jt}\tau^{2017} + \varepsilon_{ijt}$$

where i is an index for a household, participating in the survey j in year t. The dependent variable $SC_{ijt,}$ reflects the social capital endowment of the household and X_{ijt} is a vector of control variables. P_j is a dummy variable, which takes the value of 1 if the household j received the intervention and 0 if in the control group. T^{2012} and T^{2017} are dummies for years of survey.

Following the DID analysis, we tested for the existence of a bidirectional relationship between social capital and agroecology at the endline using linear regression. Given the evidence on the crucial role of social capital in shaping the adoption of agricultural innovations in smallholder farming contexts (Hunecke et al., 2017; Mekonnen et al., 2018; Van Rijn et al., 2012; Yoder & Chowdhury, 2018), we hypothesized that social capital may, in turn, reinforce agroecology practice. For this analysis, we restricted the sample to only households that received the agroecology intervention at the baseline (n=514). To understand the relationship between social capital and agroecology practice, we constructed an additive scale on agroecology using the different agroecological farming practices MAFFA households received training on as proxies of agroecology. These practices include crop residue incorporation, legume intercropping, mulching, manure application, agroforestry, intercropping, crop rotation, planting of vetiver grass for erosion control, and livestock integration. This scale was normalized to have a range of 0 to 1. There was a strong internal consistency among these variables with a Cronbach's alpha of 0.78. The equation for examining the relationship between social capital and agroecological application is specified as follows:

$$\mathrm{Y} = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3 + \ldots + \beta_k x_k$$

where Y is the predicted value of agroecology application, x_1 through x_k are independent or variables, β_0 is the value of Y when all of the independent variables are equal to zero, and β_1 through β_k are the estimated regression coefficients.

4.6 Results

Table 4.2 presents the sample characteristics at baseline. More than half of the sample were monogamous married households in both treatment (66%) and control (62%) groups. Also, the distribution of age and education of husband/primary male and wife/primary female was similar across the two sample groups. However, household size, farm size, dry season community gardening (*dimba*), land ownership, and household wealth varied between the two sample groups. For example, 48% of agroecology households were in the 'richer' wealth category compared to non-agroecology households (40%). Also, while 23% of control households had more than 6 members, 18% of agroecology practicing households had above 6 members. Also, 11% and 7% of treatment and control households cultivated more than 5 acres of farmland, respectively. A higher proportion of agroecology practicing households (49%) engaged in dry season gardening compared to non-agroecology households (43%).

Table 4.2: Baseline sample characteristics

Variable	Treatment (%)	Control (%)	Pooled (%)
Household structure			
Monogamous	339 (66)	248 (62)	587 (64)
Polygamous	41 (8)	36 (9)	77 (9)
Separated/Divorced	134 (26)	116 (29)	250 (27)
Age of primary male			
Less than 30	170 (33)	124 (31)	294 (32)
30-44	164 (32)	124 (31)	288 (31)
46-60	98 (19)	84 (21)	182 (20)
Greater than 60	82 (16)	68 (17)	150 (17)
Age of primary female			
Less than 30	190 (37)	136 (34)	326 (36)
30-44	159 (31)	132 (33)	291 (32)
46-60	93 (18)	80 (20)	173 (19)
Greater than 60	72 (14)	52 (13)	124 (14)
Education of primary male			
None	144 (28)	108 (27)	252 (28)
Primary	267 (52)	216 (54)	483 (52)
Secondary or higher	103 (20)	76 (19)	179 (20)
Education of primary female			
None	170 (33)	136 (34)	306 (33)
Primary	288 (56)	220 (55)	508 (56)
Secondary or higher	56 (11)	44 (11)	100 (11)
Household size			
Less than 4	247 (48)	172 (43)	419 (46)
4 to 6	175 (34)	136 (34)	311 (34)
More than 6	92 (18)	92 (23)	184 (20)
Farm size			
Less than 2.5 acres	344 (67)	280 (70)	624 (68)
2.5 to 5 acres	113 (22)	92 (23)	201 (22)
More than 5 acres	57 (11)	28 (7)	85 (10)
Dimba/dry season gardening			
No	262 (51)	228 (57)	490 (54)
Yes	252 (49)	172 (43)	424 (46)
Household wealth			
Poor	149 (29)	140 (35)	289 (31)
Middle	118 (23)	100 (25)	218 (24)
Rich	247 (48)	160 (40)	407 (45)
Food security			
Food secure	93 (18)	84 (21)	177 (19)
Food insecure	421 (82)	316 (79)	737 (81)
Household alcohol consumption			
No	344 (67)	232 (58)	576 (63)
Yes	170 (33)	168 (42)	338 (37)
Land ownership			
Yes	329 (64)	288 (72)	617 (68)
No	185 (36)	112 (28)	297 (32)
Total	514	400	914

Although any intervention with true randomization enables researchers to directly compare outcomes between treatment and control groups, the MAFFA intervention was based on a quasi-experimental design. Typically, intervention outcomes become comparable only if sample characteristics are similar across treatment and control groups. In the context of this study, comparison is ideal where the only difference between the treatment and control group is that one group practices agroecology or not. In social settings where differences are expected, we used kernel-based propensity score matching to address potential differences between the two sample groups (Lee, 2013; Leuven & Sianesi, 2018). Kernel-based propensity score matching is a statistical procedure for resembling a random experiment by balancing individuals in treatment and control groups according to observed characteristics. Based on a predicted probability of being selected into the treatment group, this technique produces an inverse probability of treatment weighting by matching all treated subjects with a weighted average of all controls. A balancing test is required after matching to see whether the differences in covariates between the two sample groups have been addressed, and also to ensure that the matched comparison group is a seemingly reasonable comparison group (Lee, 2013). Table 4.3 provides information on the means of selected covariates before and after weighting

Table 4.3: Differences in means by participation before and after weighting

	Before weighting			After weighting		
Variable	Control	Intervention	t-value	Control	Intervention	t-value
Household size	1.164	1.038	0.19*	1.062	1.038	0.16
Age of primary male	1.369	1.409	0.24	1.398	1.409	0.12
Age of primary female	1.283	1.262	0.68	1.269	1.262	0.44
Education of primary male	1.287	1.189	0.99	1.230	1.189	0.04
Education of primary female	1.226	1.184	0.76	1.191	1.184	0.53
Household structure	1.737	1.703	0.58	1.710	1.703	0.39
Household wealth	1.970	1.926	1.41	1.926	1.926	0.17
Land ownership	0.926	0.862	1.19	0.903	0.862	0.06
Farm size	0.428	0.354	0.65	0.374	0.354	0.43
Dimba/community gardening	0.530	0.412	1.63***	0.429	0.412	0.09
Alcohol consumption	1.396	1.624	1.82**	1.571	1.624	0.27

*p<0.05, **p<0.01, ***p<0.001

As shown in Table 4.3, there were significant differences in mean of some variables including household size, household alcohol consumption, and dry season gardening. However, after weighting, the differences linked to these variables were no longer significantly meaningful.

Results of the unadjusted DID estimates of mean social capital scores for agroecology and non-agroecology households are shown in Table 4.4. At baseline, the difference in mean social capital (β=0.047) between treatment and control households was not statistically significant. However, following the agroecology intervention, there was a significant difference in mean social capital between the control group and the treatment group (β=0.293, p<0.01). In terms of within-group changes in social capital, the difference in mean social capital endowment for households in the participatory agroecology intervention (β=0.277) over the five years was larger compared to non-agroecology households (β=0.031). The overall treatment effect of the agroecological intervention on mean social capital was positive and statistically significant (β=0.246, p<0.01), implying a greater improvement in social capital endowment for households in the treatment group.

Table 4.4: Unadjusted average treatment effects of agroecology on social capital

Outcome	**Baseline**			**Endline**			**Difference-in-Difference**
	Control (2012)	Treatment (2012)	Diff (BL)	Control (2017)	Treatment (2017)	Diff (EL)	
Social capital	0.355	0.402	0.047	0.386	0.679	0.293***	0.246***
Robust std. errors	0.032	0.021	0.013	0.041	0.054	0.012	0.018
t-statistic	13.46	14.31	3.62	14.16	18.24	24.31	13.57
***p<0.01, **p<0.05, ***p<0.01. Means and Standard Errors are estimated by linear regression. Table shown in standard DID format. R^2: 0.126.							

We controlled for the effect of theoretically relevant variables including those which showed significant differences at baseline between the two sample groups (see Table 4.5). These variables include household structure, household size, age and education of husband and wife, farm size, dimba/community gardening, household food security and household wealth. Although we conducted a balancing test to account for potential differences between the two sample groups before estimating the treatment effects of the intervention on social capital, further controlling for relevant variables in an adjusted DID model served as a robustness check. Results from the adjusted DID model were largely consistent with the unadjusted DID model without controls.

Table 4.5: Adjusted average treatment effects of agroecology on social capital

Outcome	Baseline			Endline			Difference-in-Difference
	Control (2012)	Treatment (2012)	Diff (BL)	Control (2017)	Treatment (2017)	Diff (EL)	
Social capital	0.322	0.381	0.059	0.430	0.706	0.276***	0.217***
Robust std. errors	0.029	0.021	0.013	0.053	0.051	0.012	0.018
t-statistic	11.96	13.68	4.51	15.03	16.51	22.40	11.99***

***p<0.01, **p<0.05, ***p<0.01. Means and Standard Errors are estimated by linear regression. Table shown in standard DID format. R^2: 0.131.

The overall difference in the change in mean social capital endowment (β=0.217, $p<0.01$) between agroecology practicing households and non-agroecology households following the intervention remained statistically significant after accounting for theoretically relevant factors. This positive treatment effect implies that the participatory agroecology activities deployed in the MAFFA intervention significantly improved the social capital endowment of agroecology practicing households.

Table 4.6: Linear regression predicting the association between social capital and agroecology practice

Variable	Model 1 β	Model 2 β	Model 3 β
Social capital	0.18***	0.15***	0.12***
Household structure (ref: Monogamous)			
Polygamous		0.08	0.10
Separated/Divorced		0.12	0.11
Age of primary male (ref: Less than 30)			
30-44		-0.04	-0.06
46-60		-0.06	-0.12
Greater than 60		-0.15	-0.14
Age of primary female (ref: Less than 30)			
30-44		-0.06	-0.03
46-60		-0.14	-0.10
Greater than 60		-0.07	-0.18
Household size (ref: Less than 4)			
4 to 6		0.02	0.00
More than 6		0.28	0.18*
Education of primary male (ref: None)			
Primary		-0.05	-0.07
Secondary or higher		0.21	0.24
Education of primary female (ref: None)			
Primary		-0.09	-0.21
Secondary or higher		0.11	0.04
Household wealth (ref: Poor)			
Middle			0.13
Rich			0.42***
Household food security (ref: food secure)			
Food insecure			0.14
Land ownership (Ref: No)			
Yes			0.32***
Farm size (ref: Less than 2.5 acres)			
2.5 to 5 acres			0.02
More than 5 acres			0.12
Household alcohol consumption (ref: Yes)			
No			0.19***
Dimba/dry season gardening (ref: No)			
Yes			0.14***
N	514	514	514
R2	0.02	0.16	0.24

***p<0.001, **p<0.01, *p<0.05.

In the regression analyses examining the existence of a bidirectional association between social capital and agroecology practice among farmers that benefitted from the MAFFA intervention (see Table 4.6), we found that social capital was positively associated with agroecology practice ($\beta=0.12$, $p<0.001$) even after controlling for relevant covariates. In the adjusted model, being rich ($\beta=0.42$, $p<0.01$), owning land ($\beta=0.32$, $p<0.001$), having more than 6 household members ($\beta=0.18$, $p<0.05$), consuming no alcohol ($\beta=0.19$, $p<0.001$), and engaging in dry season community gardening ($\beta=0.14$, $p<0.01$) were also associated with increased application of agroecology practices.

4.7 Discussion and conclusions

The crucial role of social capital in agricultural development is widely acknowledged in contemporary times (Hunecke et al., 2017; Sseguya et al., 2018; Taylor & Featherstone, 2018; Yoder & Chowdhury, 2018). In the context of the increasing adverse social impacts of global industrial agriculture including its role in the reorganization of the beneficial relations of production on which traditional smallholder agriculture is grounded, the search for sustainable pathways for improving farmer social networks and social relations in smallholder farming communities has remained an important aspect of the struggle to transform the current global capitalist food system to a socially just one (Bezner Kerr et al., 2019; Dumont et al., 2016; Gliessman, 2016; Holt-Giménez & Altieri, 2013; Misra, 2017). In this paper, we draw on a novel two-wave longitudinal dataset to investigate the effect of participatory agroecology on social capital using DID techniques. We also tested the hypothesis of the existence of a bidirectional relationship between social capital and agroecology. Results from the DID analysis show significant improvements in social capital endowment for agroecology households compared to non-agroecology households. We also found a positive association between social capital and agroecological practice. Overall, these findings suggest the existence of a bidirectional and reinforcing relationship between agroecology and social capital.

These findings indicate that the participatory agroecology approach deployed in the MAFFA intervention, which prioritized farmer-to-farmer knowledge sharing and interaction, formation of local farmer associations, gender-transformative learning through theatre performances on gender equality, and the establishment of local agricultural produce marketing enterprises, is useful in improving social capital in smallholder farming contexts. Our findings are consistent with empirical findings from several other counterfactual social experiments which established that social capital levels in local communities respond to external interventions (Classen et al., 2008; Fearon, Humphreys, & Weinstein, 2009; Humphries et al., 2012). These findings demonstrate the positive inroads of agroecology beyond the farm-level in the context of the broader agenda of transforming the global food system to an environmentally sustainable and socially just one. Indeed, Gliessman (2016) called specifically on agroecologists to investigate the impacts of agroecology beyond the farm-level to include its contribution and success in improving the social relations of production. Our findings are also consistent with other recent empirical works in the field of agroecology (Bezner Kerr et al., 2019; Mdee et al., 2018; van Niekerk & Wynberg, 2017) which demonstrate the potential for agroecology to repair existing social rifts and inequalities that characterize contemporary agriculture. This progress ties in with level 4 of Gliessman's (2016) 5 levels of food system transformation through agroecology which centers on the re-establishment of direct links between food producers and consumers at the local level.

Results showing a bidirectional relationship between social capital and agroecology practice among smallholder farmers in the MAFFA intervemntion are noteworthy. Figure 4.1 provides a conceptual framework of how agroecology and social capital may reinforce each other in local agrarian communities. As explained earlier, agroecology, through its focus on improving the social relations of production enhances social capital by promoting farmer-to-farmer connectedness, knowledge sharing and collective action in local farming communities (Lyon, 2000; Pretty, 2003; Taylor & Featherstone, 2018; Winters et al., 2006; Yoder & Chowdhury, 2018). Likewise, endowments in social capital as expressed in closely knit relations and trust among farmers has the potential to positively shape agroecology practice. In a recent analysis of the multidimensional processes that enabled the bringing to scale of agroecology in smallholder farming contexts using farmer-to-farmer agroecology movements as case studies, Mier et al. (2018) found that "organization and social fabric are the growth media on which agroecology advances." Generally, the role of social capital in facilitating the adoption of sustainable agricultural innovations is also widely acknowledged (Hunecke et al., 2017; Saint Ville et al., 2016; Van Rijn et al., 2012; Wossen et al., 2015; Yoder & Chowdhury, 2018).

However, as demonstrated in our findings, other contextual factors including land ownership, household labour size and wealth may be important in understanding agroecology practice and the potential reinforcing relationship with social capital among farming households that received the MAFFA intervention. Consistent with the literature (Adimassu, Langan, & Johnston, 2016; Kassie, Jaleta, Shiferaw, Mmbando, & Mekuria, 2013; Teklewold, Kassie, & Shiferaw, 2013), land ownership a key role in promoting the adoption of SLM technologies as smallholder farmers who have secure tenure tend to more invest on their plots (for example integration of trees) compared to those who do not own the plots on which they cultivate.

Similarly, given the labour-intensive nature of agriculture in the Malawian context, most agroecology practices would require considerable labour to implement. Consistentent with the literature (Asrat *et al.*, 2004; Pender and Gebremedhin, 2007; Teshome *et al.*, 2016), farming households with higher labour capacity may therefore be able to adopt labour intensive agroecological practices like crop residue recycling and composting. In terms of wealth, it is important to contextualize the potential diverse relationship with diverse SLM practice according corresponding cost requiremnets. For stanace, while poorer households may often rely on practices like composting and crop residue integration that can improve soil fertility in the short-term, other practices like agroforestry that entail some capital investment (especially with the procurement of seedlings) may be adopted by richer households. This is especially the case in the MAFFA intervention where farmers were not given seedlings.

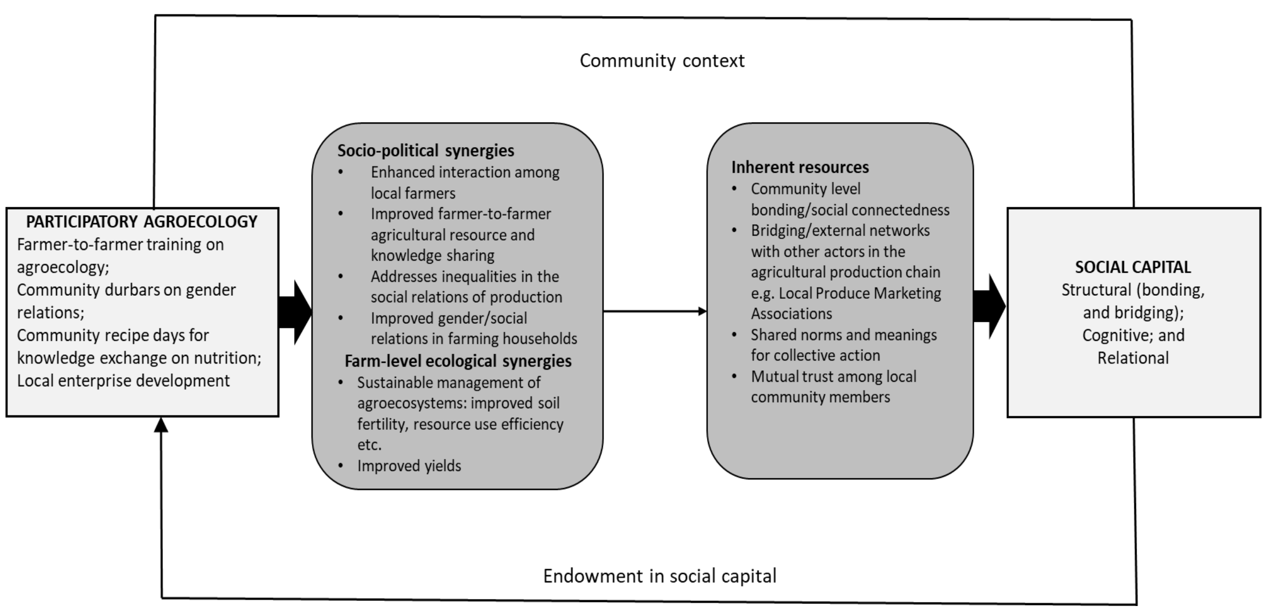

Figure 4.1: Framework on the relationship between participatory agroecology and social capital

In an era where empirical evidence points to the unprecedented deterioration of the foundations of livelihoods, food security, health and quality of life globally, and the need for sustainable agriculture, this reinforcing relationship between social capital and agroecology is promising for environmental sustainability. Thus, stakeholders aiming to promote sustainable agriculture in smallholder farming communities could rely on improving farmer social networks at the local level. The recent landmark Global Assessment Report of the United Nations' Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES), which is currently the most comprehensive assessment of the earth's ecosystem and first-ever UN report to draw on indigenous and local knowledge at a global scale (across 50 countries), has called for 'transformative change'[3] (IPBES, 2019). According to the IPBES this change must start at the local scale if the earth is to be restored, conserved and used sustainably. Our findings suggest that agroecology, through the local-level social synergies it engenders (which have been demonstrated to be instrumental in promoting social cohesion and collective norms on 'acting upon nature'), can be instrumental to the realization of this global agenda for transformative change.

Overall, our findings provide a useful insight for policy makers to draw upon participatory agroecology to improve the beneficial social relations of production on which smallholder agriculture is grounded. That notwithstanding, there are opportunities for improvements in future research. While our analysis went beyond exploring correlations to understanding the treatment effects of participatory agroecology on social using longitudinal data, it will be interesting to include more social capital proxies (especially proxies that capture more information on external networks of households) in future analysis. Moreover, given that both agroecology and social capital are context-specific outcomes, the way the two will interact

[3]According to the IPBES, transformative change denotes a system-wide restructuring across technological, economic and social realms, including paradigms, goals and values (IPBES, 2019).

may vary from place to place. As a result, our findings and interpretations may be limited to the Malawian context. There is, therefore, the need for more research to understand the relationship between agroecology and social capital across different smallholder farming contexts. Future research could also focus on mapping the diversity and extent of farmer social networks.

4.8 References

Aberman, Noora- Lisa, Julia Behrman, and Regina Birner. 2018. "Gendered Perceptions of Power and Decision- making in Rural Kenya." *Development Policy Review* 36 (4). Wiley Online Library: 389–407.

Adimassu, Zenebe, Simon Langan, and Robyn Johnston. 2016. "Understanding Determinants of Farmers' Investments in Sustainable Land Management Practices in Ethiopia: Review and Synthesis." *Environment, Development and Sustainability* 18 (4). Springer: 1005–1023.

Altieri, Miguel A. 2018. *Agroecology: The Science of Sustainable Agriculture*. CRC Press.

Asrat, Paulos, Kassa Belay, and Desta Hamito. 2004. "Determinants of Farmers' Willingness to Pay for Soil Conservation Practices in the Southeastern Highlands of Ethiopia." *Land Degradation & Development* 15 (4). Wiley Online Library: 423–438.

Bacon, Chris, Ernesto Mendez, and Martha Brown. 2005. "Participatory Action Research and Support for Community Development and Conservation: Examples from Shade Coffee Landscapes in Nicaragua and El Salvador." *Center for Agroecology & Sustainable Food Systems*.

Bebbington, Anthony. 2004. "Social Capital and Development Studies 1: Critique, Debate, Progress?" *Progress in Development Studies* 4 (4). Sage Publications Sage CA: Thousand Oaks, CA: 343–349.

Bezner-Kerr, Rachel, and Raj Patel. 2014. *Food Security in Malawi*. Edited by Udaya Sekhar Nagothu. *Food Security and Development: Country Case Studies*. London: Routledge.

Bezner Kerr, Rachel. 2005. "Informal Labor and Social Relations in Northern Malawi: The Theoretical Challenges and Implications of Ganyu Labor for Food Security." *Rural Sociology* 70 (2). Wiley Online Library: 167–187.

Bezner Kerr, Rachel. 2014. "Lost and Found Crops: Agrobiodiversity, Indigenous Knowledge, and a Feminist Political Ecology of Sorghum and Finger Millet in Northern Malawi." *Annals of the Association of American Geographers* 104 (3). Taylor & Francis: 577–593.

Bezner Kerr, Rachel, Catherine Hickey, Esther Lupafya, and Laifolo Dakishoni. 2019. "Repairing Rifts or Reproducing Inequalities? Agroecology, Food Sovereignty, and Gender Justice in Malawi." *The Journal of Peasant Studies*. Taylor & Francis, 1–20.

Bisung, Elijah, Susan J Elliott, Corinne J Schuster-Wallace, Diana M Karanja, and Abudho Bernard. 2014. "Social Capital, Collective Action and Access to Water in Rural Kenya." *Social Science & Medicine* 119. Elsevier: 147–154.

Bouma, Jetske, Erwin Bulte, and Daan van Soest. 2008. "Trust and Cooperation: Social Capital and Community Resource Management." *Journal of Environmental Economics and Management* 56 (2). Elsevier: 155–166.

Bourdieu, Pierre. 1986. "The Forms of Capital. Handbook of Theory and Research for the Sociology of Education. Edited by: Richardson J." New York: Greenwood Press.

Bryceson, Deborah Fahy. 2006. "Ganyu Casual Labour, Famine and HIV/AIDS in Rural Malawi: Causality and Casualty." *Journal of Modern African Studies* 44 (2). Cambridge University Press: 173–202. doi:10.1017/S0022278X06001595.

Bullen, Paul, and Jenny Onyx. 1998. *Measuring Social Capital in Five Communities in NSW: A Practitioner's Guide*. Management Alternatives Pty Limited.

Carter, Michael R, and Marco Castillo. 2011. "Trustworthiness and Social Capital in South Africa: Analysis of Actual Living Standards Data and Artifactual Field Experiments." *Economic Development and Cultural Change* 59 (4). University of Chicago Press Chicago, IL: 695–722.

Chinsinga, B. 2011. "Seeds and Subsidies: The Political Economy of Input Programmes in Malawi." *IDS Bulletin* 42 (4). Wiley Online Library: 59–68.

Chinsinga, B. 2014. *Beyond the Farm Input Subsidy Programme (FISP)? The Political Economy of the Comprehensive Africa Agriculture Development Programme (CAADP) Processes in Malawi. Working Paper-Future Agricultures*. Brighton: Future Agricultures Consortium.

Chinsinga, Blessings. 2012. "The Political Economy of Agricultural Policy Processes in Malawi: A Case Study of the Fertilizer Subsidy Programme." Future Agricultures Consortium.

Chinsinga, Blessings, and Michael Chasukwa. 2012. "Youth, Agriculture and Land Grabs in Malawi." *IDS Bulletin* 43 (6). Wiley Online Library: 67–77.

Chinsinga, Blessings, Michael Chasukwa, and Sane Pashane Zuka. 2013. "The Political Economy of Land Grabs in Malawi: Investigating the Contribution of Limphasa Sugar Corporation to Rural Development." *Journal of Agricultural and Environmental Ethics* 26 (6). Springer: 1065–1084.

Chirwa, Ephraim, Andrew Dorward, and Mirriam Matita. 2012. "Thinking about 'Graduation'from the Farm Input Subsidy Programme in Malawi." *Policy Brief*, no. 3.

Chirwa, Wiseman Chijere. 1994. "Alomwe and Mozambican Immigrant Labor in Colonial Malawi, 1890s-1945." *The International Journal of African Historical Studies* 27 (3). JSTOR:

525–550.

Chloupkova, Jarka, Gunnar Lind Haase Svendsen, and Gert Tinggaard Svendsen. 2003. "Building and Destroying Social Capital: The Case of Cooperative Movements in Denmark and Poland." *Agriculture and Human Values* 20 (3). Springer: 241–252.

Chriest, Alana, and Meredith Niles. 2018. "The Role of Community Social Capital for Food Security Following an Extreme Weather Event." *Journal of Rural Studies* 64. Elsevier: 80–90.

Claasen, Nicole, and Stefanie Lemke. 2019. "Strong Ties, Weak Actors? Social Networks and Food Security among Farm Workers in South Africa." *Food Security*. Springer, 1–14.

Classen, Lauren, Sally Humphries, John FitzSimons, Susan Kaaria, José Jiménez, Fredy Sierra, and Omar Gallardo. 2008. "Opening Participatory Spaces for the Most Marginal: Learning from Collective Action in the Honduran Hillsides." *World Development* 36 (11). Elsevier: 2402–2420.

Coates, Jennifer, Anne Swindale, and Paula Bilinsky. 2007. "Household Food Insecurity Access Scale (HFIAS) for Measurement of Food Access: Indicator Guide." *Washington, DC: Food and Nutrition Technical Assistance Project, Academy for Educational Development* 34.

Coleman, James S. 1988. "Social Capital in the Creation of Human Capital." *American Journal of Sociology* 94. University of Chicago Press: S95–S120.

Conley, Timothy, and Christopher Udry. 2001. "Social Learning through Networks: The Adoption of New Agricultural Technologies in Ghana." *American Journal of Agricultural Economics* 83 (3). JSTOR: 668–673.

Coomes, Oliver T, Shawn J McGuire, Eric Garine, Sophie Caillon, Doyle McKey, Elise Demeulenaere, Devra Jarvis, Guntra Aistara, Adeline Barnaud, and Pascal Clouvel. 2015. "Farmer Seed Networks Make a Limited Contribution to Agriculture? Four Common Misconceptions." *Food Policy* 56. Elsevier: 41–50.

Dakhli, Mourad, and Dirk De Clercq. 2004. "Human Capital, Social Capital, and Innovation: A Multi-Country Study." *Entrepreneurship & Regional Development* 16 (2). Taylor & Francis: 107–128.

Dumont, Antoinette M, Gaëtan Vanloqueren, Pierre M Stassart, and Philippe V Baret. 2016. "Clarifying the Socioeconomic Dimensions of Agroecology: Between Principles and Practices." *Agroecology and Sustainable Food Systems* 40 (1). Taylor & Francis: 24–47.

Ellis, Frank, Milton Kutengule, and Alfred Nyasulu. 2003. "Livelihoods and Rural Poverty

Reduction in Malawi." *World Development* 31 (9). Elsevier: 1495–1510.

Farnworth, Cathy Rozel, Frédéric Baudron, Jens A Andersson, Michael Misiko, Lone Badstue, and Clare M Stirling. 2016. "Gender and Conservation Agriculture in East and Southern Africa: Towards a Research Agenda." *International Journal of Agricultural Sustainability* 14 (2). Taylor & Francis: 142–165.

Fearon, James D, Macartan Humphreys, and Jeremy M Weinstein. 2009. "Can Development Aid Contribute to Social Cohesion after Civil War? Evidence from a Field Experiment in Post-Conflict Liberia." *American Economic Review* 99 (2): 287–291.

Fine, Ben. 2002. "It Ain't Social, It Ain't Capital and It Ain't Africa." *Studia Africana*, no. 13: 18–33.

Fukuyama, Francis. 1995. "Social Capital and the Global Economy." *Foreign Affairs*. JSTOR, 89–103.

Gliessman, Steve. 2016. "Transforming Food Systems with Agroecology." Taylor & Francis.

Good, Kenneth. 1990. "The Direction of Agricultural Development in Zambia, Zimbabwe and Malawi." *Studies in the Economic History of Southern Africa. Vol. 1: The Frontline States*, 127–158.

Granovetter, Mark S. 1973. "The Strength of Weak Ties." *American Journal of Sociology* 78 (6). University of Chicago Press: 1360–1380.

Grillos, Tara. 2018. "Women's Participation in Environmental Decision-Making: Quasi-Experimental Evidence from Northern Kenya." *World Development* 108. Elsevier: 115–130.

Grootaert, Christiaan, Deepa Narayan, Veronica Nyhan Jones, and Michael Woolcock. 2004. *Measuring Social Capital: An Integrated Questionnaire*. The World Bank.

Harpham, Trudy, Emma Grant, and Elizabeth Thomas. 2002. "Measuring Social Capital within Health Surveys: Key Issues." *Health Policy and Planning* 17 (1). Oxford University Press: 106–111.

Harrigan, Jane. 2001. *From Dictatorship to Democracy. Economic Policy in Malawi 1964-2000*. Ashgate.

Harrigan, Jane. 2003. "U-Turns and Full Circles: Two Decades of Agricultural Reform in Malawi 1981–2000." *World Development* 31 (5). Elsevier: 847–863.

Harriss, John. 2002. *Depoliticizing Development: The World Bank and Social Capital*. Anthem Press.

Hemming, Karla, Terry P Haines, Peter J Chilton, Alan J Girling, and Richard J Lilford. 2015.

"The Stepped Wedge Cluster Randomised Trial: Rationale, Design, Analysis, and Reporting." *Bmj* 350. British Medical Journal Publishing Group: h391.

Hendrickson, Mary K, and Harvey S James. 2005. "The Ethics of Constrained Choice: How the Industrialization of Agriculture Impacts Farming and Farmer Behavior." *Journal of Agricultural and Environmental Ethics* 18 (3). Springer: 269–291.

Holt-Giménez, Eric, and Miguel A Altieri. 2013. "Agroecology, Food Sovereignty, and the New Green Revolution." *Agroecology and Sustainable Food Systems* 37 (1). Taylor & Francis: 90–102.

Humphries, Sally, Lauren Classen, José Jiménez, Fredy Sierra, Omar Gallardo, and Marvin Gómez. 2012. "Opening Cracks for the Transgression of Social Boundaries: An Evaluation of the Gender Impacts of Farmer Research Teams in Honduras." *World Development* 40 (10). Elsevier: 2078–2095.

Hunecke, Claudia, Alejandra Engler, Roberto Jara-Rojas, and P Marijn Poortvliet. 2017. "Understanding the Role of Social Capital in Adoption Decisions: An Application to Irrigation Technology." *Agricultural Systems* 153. Elsevier: 221–231.

Hyakumura, Kimihiko, and Makoto Inoue. 2006. "The Significance of Social Capital in Local Forest Management in Laos: Overcoming Latent Conflict between Local People and Local Forestry Officials." *The International Journal of Sustainable Development and World Ecology* 13 (1). Taylor & Francis: 16–24.

IPBES. 2019. "2019 Global Assessment Report on Biodiversity and Ecosystem Services." http://sdg.iisd.org/news/ipbes-previews-2019-global-assessment-report-on-biodiversity/.

Kabunga, Nassul Ssentamu, Thomas Dubois, and Matin Qaim. 2012. "Heterogeneous Information Exposure and Technology Adoption: The Case of Tissue Culture Bananas in Kenya." *Agricultural Economics* 43 (5). Wiley Online Library: 473–486.

Kansanga, Moses Mosonsieyiri. 2017. "Who You Know and When You Plough? Social Capital and Agricultural Mechanization under the New Green Revolution in Ghana." *International Journal of Agricultural Sustainability* 15 (6). Taylor & Francis: 708–723.

Karlan, Dean S. 2005. "Using Experimental Economics to Measure Social Capital and Predict Financial Decisions." *American Economic Review* 95 (5): 1688–1699.

Kassie, Menale, Moti Jaleta, Bekele Shiferaw, Frank Mmbando, and Mulugetta Mekuria. 2013. "Adoption of Interrelated Sustainable Agricultural Practices in Smallholder Systems:

Evidence from Rural Tanzania." *Technological Forecasting and Social Change* 80 (3). Elsevier: 525–540.

Kilic, Talip, Edward Whitney, and Paul Winters. 2014. "Decentralised Beneficiary Targeting in Large-Scale Development Programmes: Insights from the Malawi Farm Input Subsidy Programme." *Journal of African Economies* 24 (1). Oxford University Press: 26–56.

Klerkx, Laurens, Barbara Van Mierlo, and Cees Leeuwis. 2012. "Evolution of Systems Approaches to Agricultural Innovation: Concepts, Analysis and Interventions." In *Farming Systems Research into the 21st Century: The New Dynamic*, 457–483. Springer.

Knickel, Karlheinz, Gianluca Brunori, Sigrid Rand, and Jet Proost. 2009. "Towards a Better Conceptual Framework for Innovation Processes in Agriculture and Rural Development: From Linear Models to Systemic Approaches." *Journal of Agricultural Education and Extension* 15 (2). Taylor & Francis: 131–146.

Krishna, Anirudh, and Elizabeth Shrader. 2000. "Measuring Social Capital." *World Bank Social Capital Initiative Working Paper Series*.

Kydd, Jonathan, and Robert Christiansen. 1982. "Structural Change in Malawi since Independence: Consequences of a Development Strategy Based on Large-Scale Agriculture." *World Development* 10 (5). Elsevier: 355–375.

Lee, Wang-Sheng. 2013. "Propensity Score Matching and Variations on the Balancing Test." *Empirical Economics* 44 (1). Springer: 47–80.

Lele, Uma. 1990. "Structural Adjustment, Agricultural Development and the Poor: Some Lessons from the Malawian Experience." *World Development* 18 (9). Elsevier: 1207–1219.

Leuven, Edwin, and Barbara Sianesi. 2018. "PSMATCH2: Stata Module to Perform Full Mahalanobis and Propensity Score Matching, Common Support Graphing, and Covariate Imbalance Testing." Boston College Department of Economics.

Liverpool-Tasie, Lenis Saweda, Oluyemisi Kuku, and Akeem Ajibola. 2011. *Review of Literature on Agricultural Productivity, Social Capital and Food Security in Nigeria*. International Food Policy Research Institute (IFPRI).

Lyon, Fergus. 2000. "Trust, Networks and Norms: The Creation of Social Capital in Agricultural Economies in Ghana." *World Development* 28 (4). Elsevier: 663–681.

Matchaya, Greenwell. 2009. "Land Ownership Security in Malawi." *African Journal of Agricultural Research* 4 (1). Academic Journals: 1–13.

Mdee, Anna, Alex Wostry, Andrew Coulson, and Janet Maro. 2018. “A Pathway to Inclusive Sustainable Intensification in Agriculture? Assessing Evidence on the Application of Agroecology in Tanzania.” *Agroecology and Sustainable Food Systems*. Taylor & Francis, 1–27.

Mekonnen, Daniel Ayalew, Nicolas Gerber, and Julia Anna Matz. 2018. “Gendered Social Networks, Agricultural Innovations, and Farm Productivity in Ethiopia.” *World Development* 105. Elsevier: 321–335.

Méndez, V Ernesto, Christopher M Bacon, and Roseann Cohen. 2013. “Agroecology as a Transdisciplinary, Participatory, and Action-Oriented Approach.” *Agroecology and Sustainable Food Systems* 37 (1). Taylor & Francis: 3–18.

Mier y Terán Giménez Cacho, Mateo, Omar Felipe Giraldo, Miriam Aldasoro, Helda Morales, Bruce G Ferguson, Peter Rosset, Ashlesha Khadse, and Carmen Campos. 2018. “Bringing Agroecology to Scale: Key Drivers and Emblematic Cases.” *Agroecology and Sustainable Food Systems* 42 (6). Taylor & Francis: 637–665.

Misra, Manoj. 2017. “Moving Away from Technocratic Framing: Agroecology and Food Sovereignty as Possible Alternatives to Alleviate Rural Malnutrition in Bangladesh.” *Agriculture and Human Values*. Springer, 1–15.

Mkandawire, R M. 1992. “The Land Question and Agrarian Change in Malawi’, in. GCZ Mhone (Ed.), Malawi at the Crossroads: The Post-Colonial Political Economy. Harare.” Sapes Books.

Moschitz, Heidrun, Dirk Roep, Gianluca Brunori, and Talis Tisenkopfs. 2015. “Learning and Innovation Networks for Sustainable Agriculture: Processes of Co-Evolution, Joint Reflection and Facilitation.” Taylor & Francis.

Narayan-Parker, Deepa. 1999. *Bonds and Bridges: Social Capital and Poverty*. Vol. 2167. World Bank Publications.

Narayan, Deepa, and Michael F Cassidy. 2001. “A Dimensional Approach to Measuring Social Capital: Development and Validation of a Social Capital Inventory.” *Current Sociology* 49 (2). Sage Publications: 59–102.

Narayan, Deepa, and Lant Pritchett. 1999. “Cents and Sociability: Household Income and Social Capital in Rural Tanzania.” *Economic Development and Cultural Change* 47 (4). The University of Chicago Press: 871–897.

Ng’ong’ola, Clement. 1986. “Malawi’s Agricultural Economy and the Evolution of Legislation on the Production and Marketing of Peasant Economic Crops." *Journal of Southern African Studies* 12 (2). Taylor & Francis: 240–262.

Njuki, Jemimah M, Mariam T Mapila, Shamie Zingore, and Robert Delve. 2008. "The Dynamics of Social Capital in Influencing Use of Soil Management Options in the Chinyanja Triangle of Southern Africa." *Ecology and Society* 13 (2). JSTOR.

Ntale, Fredrick Kisekka. 2013. "Forcing the Dumb to Sing? Rejuvenating Farmer Cooperatives in Uganda amidst Waning Social Capital." *Journal of African Studies and Development* 5 (8). Academic Journals: 224–235.

Onyx, Jenny, and Paul Bullen. 2000. "Measuring Social Capital in Five Communities." *The Journal of Applied Behavioral Science* 36 (1). Sage Publications Sage CA: Thousand Oaks, CA: 23–42.

Orr, Alastair. 2000. "'Green Gold'?: Burley Tobacco, Smallholder Agriculture, and Poverty Alleviation in Malawi." *World Development* 28 (2). Elsevier: 347–363.

Overå, Ragnhild. 2006. "Networks, Distance, and Trust: Telecommunications Development and Changing Trading Practices in Ghana." *World Development* 34 (7). Elsevier: 1301–1315.

Pender, John, and Berhanu Gebremedhin. 2007. "Determinants of Agricultural and Land Management Practices and Impacts on Crop Production and Household Income in the Highlands of Tigray, Ethiopia." *Journal of African Economies* 17 (3). Oxford University Press: 395–450.

Pretty, Jules. 2003. "Social Capital and the Collective Management of Resources." *Science* 302 (5652). American Association for the Advancement of Science: 1912–1914.

Pretty, Jules, and Hugh Ward. 2001. "Social Capital and the Environment." *World Development* 29 (2). Elsevier: 209–227.

Putnam, Robert D. 1995. "Bowling Alone: America's Declining Social Capital." *Journal of Democracy* 6 (1). The Johns Hopkins University Press: 65–78.

Putnam, Robert D. 2000. "Bowling Alone: America's Declining Social Capital." In *Culture and Politics*, 223–234. Springer.

Rivera, Maria, Karlheinz Knickel, José María Díaz-Puente, and Ana Afonso. 2019. "The Role of Social Capital in Agricultural and Rural Development: Lessons Learnt from Case Studies in Seven Countries." *Sociologia Ruralis* 59 (1). Wiley Online Library: 66–91.

Ross, Allison, Ja Youn Kwon, Pamela Hodges Kulinna, and Mark Searle. 2019. "Active Transportation: The Role of Parent Attitude, The Physical Environment, and Social

Capital." *Journal of Physical Activity and Health* 16 (1). Human Kinetics Champaign, Illinois, USA: 60–67.

Sadiq, Mustapha Abubakar, Ramatu M Al-Hassan, and John K M Kuwornu. 2019. "Vulnerability of Smallholder Maize Farming Households to Climate Variability in the Eastern Region of Ghana." *Climate Change and Sub-Saharan Africa: The Vulnerability and Adaptation of Food Supply Chain Actors*. Vernon Press, 173.

Saguaro, Seminar. 2001. "Social Capital Benchmark Survey, 2000." John F. Kennedy School of Government Cambridge, MA.

Sahley, Caroline, Bob Groelsema, Tom Marchione, and David Nelson. 2005. *The Governance Dimensions of Food Security in Malawi*. *USAID Bureau of Democracy, Conflict, and Humanitarian Assistance, Washington, DC*. Washington, DC.

Saint Ville, Arlette S, Gordon M Hickey, Uli Locher, and Leroy E Phillip. 2016. "Exploring the Role of Social Capital in Influencing Knowledge Flows and Innovation in Smallholder Farming Communities in the Caribbean." *Food Security* 8 (3). Springer: 535–549.

Schafft, Kai, and David Brown. 2003. "Social Capital, Social Networks, and Social Power." *Social Epistemology* 17 (4). Taylor & Francis: 329–342.

Shiferaw, Bekele A, Julius Okello, and Ratna V Reddy. 2009. "Adoption and Adaptation of Natural Resource Management Innovations in Smallholder Agriculture: Reflections on Key Lessons and Best Practices." *Environment, Development and Sustainability* 11 (3). Springer: 601–619.

Snijders, Tom A B, Christian Steglich, and Michael Schweinberger. 2007. "Modeling the Co-Evolution of Networks and Behavior. Chapter 3 in K. van Montfort, H. Oud and A. Satorra (Eds.): Longitudinal Models in the Behavioral and Related Sciences." Mahwah NJ, Lawrence Erlbaum.

Sseguya, Haroon, Robert E Mazur, and Cornelia B Flora. 2018. "Social Capital Dimensions in Household Food Security Interventions: Implications for Rural Uganda." *Agriculture and Human Values* 35 (1). Springer: 117–129.

Subramanian, Subu V, Daniel J Kim, and Ichiro Kawachi. 2002. "Social Trust and Self-Rated Health in US Communities: A Multilevel Analysis." *Journal of Urban Health* 79 (1). Springer: S21–S34.

Taylor, Mykel R, and Allen M Featherstone. 2018. "The Value of Social Capital in Farmland

Leasing Relationships." *Agricultural Finance Review*. Emerald Publishing Limited.

Teklewold, Hailemariam, Menale Kassie, and Bekele Shiferaw. 2013. "Adoption of Multiple Sustainable Agricultural Practices in Rural Ethiopia." *Journal of Agricultural Economics* 64 (3). Wiley Online Library: 597–623.

Teshome, Akalu, Jan de Graaff, Coen Ritsema, and Menale Kassie. 2016. "Farmers' Perceptions about the Influence of Land Quality, Land Fragmentation and Tenure Systems on Sustainable Land Management in the North Western Ethiopian Highlands." *Land Degradation & Development* 27 (4). Wiley Online Library: 884–898.

Thuy, Nguyen Ngoc, Puneet Dwivedi, Frederick Rossi, Janaki R R Alavalapati, and Brijesh Thapa. 2011. "Role of Social Capital in Determining Conservation Attitude: A Case Study from Cat Tien National Park, Vietnam." *International Journal of Sustainable Development & World Ecology* 18 (2). Taylor & Francis: 143–153.

Vail, Leroy. 1983. "The State and the Creation of Colonial Malawi's Agricultural Economy." *Imperialism, Colonialism and Hunger: East and Central Africa. Lexington, MA: Lexington Books*, 39–88.

van Niekerk, Jaci, and Rachel Wynberg. 2017. "Traditional Seed and Exchange Systems Cement Social Relations and Provide a Safety Net: A Case Study from KwaZulu-Natal, South Africa." *Agroecology and Sustainable Food Systems* 41 (9–10). Taylor & Francis: 1099–1123.

Van Rijn, Fédes, Erwin Bulte, and Adewale Adekunle. 2012. "Social Capital and Agricultural Innovation in Sub-Saharan Africa." *Agricultural Systems* 108. Elsevier: 112–122.

Vikram, Kriti. 2018. "Social Capital and Child Nutrition in India: The Moderating Role of Development." *Health & Place* 50. Elsevier: 42–51.

Vincens, Natalia, Maria Emmelin, and Martin Stafström. 2018. "Social Capital, Income Inequality and the Social Gradient in Self-Rated Health in Latin America: A Fixed Effects Analysis." *Social Science & Medicine* 196. Elsevier: 115–122.

Williams, Portia Adade, Olivier Crespo, and Mumuni Abu. 2018. "Assessing Vulnerability of Horticultural Smallholders' to Climate Variability in Ghana: Applying the Livelihood Vulnerability Approach." *Environment, Development and Sustainability*. Springer, 1–22.

Winter, Carolyn. 1984. "Structural Adjustment Lending: Boon or Blow for Malawi?" *Journal of Contemporary African Studies* 4 (1–2). Taylor & Francis: 103–118.

Winters, Paul, Romina Cavatassi, and Leslie Lipper. 2006. "Sowing the Seeds of Social Relations:

The Role of Social Capital in Crop Diversity." *Book Sowing the Seeds of Social Relations: The Role of Social Capital in Crop Diversity*. The Food and Agriculture Organization, 6–16.

Woolcock, Michael. 2001. "The Place of Social Capital in Understanding Social and Economic Outcomes." *Canadian Journal of Policy Research* 2 (1): 11–17.

Wossen, Tesfamicheal, Thomas Berger, and Salvatore Di Falco. 2015. "Social Capital, Risk Preference and Adoption of Improved Farm Land Management Practices in Ethiopia." *Agricultural Economics* 46 (1). Wiley Online Library: 81–97.

Yoder, Landon, and Rinku Roy Chowdhury. 2018. "Tracing Social Capital: How Stakeholder Group Interactions Shape Agricultural Water Quality Restoration in the Florida Everglades." *Land Use Policy* 77. Elsevier: 354–361.

CHAPTER 5

Participatory agroecology and the uptake of sustainable land management practices: evidence from Malawi

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Land Use Policy (Under Review)

5. PARTICIPATORY AGROECOLOGY AND THE UPTAKE OF SUSTAINABLE LAND MANAGEMENT PRACTICES: EVIDENCE FROM MALAWI

According to the Land Degradation and Restoration Assessment report of the United Nations Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services, human-induced land degradation is driving environmental change at an unprecedented rate that currently threatens the livelihoods of over 3 billion people globally. While Sustainable Land Management (SLM) has emerged as a widely accepted approach for addressing land degradation in agroecosystems, the uptake of SLM remains low among smallholder farmers due to underlying barriers, including limited agricultural extension. Empirical research points to the potentially beneficial role of participatory farmer-to-farmer (F2F) training and knowledge sharing in fostering sustainable land management in resource-poor contexts. Drawing theoretical insights from social learning and using data from a participatory agroecological intervention in Malawi, this paper examines the association between agroecology and the uptake of diverse SLM practices. Findings from logistic regression analysis show that farming households that received the participatory F2F agroecology training were significantly more likely to practise crop residue recycling ($OR=2.88$, $p<0.001$), composting ($OR=1.90$, $p<0.001$), mulching ($OR=1.24$, $p<0.001$), legume intercropping ($OR=1.22$, $p<0.01$) and agroforestry ($OR=1.15$, $p<0.05$) after controlling for demographic, socioeconomic and plot-level factors. These findings contribute to a growing body of literature that demonstrates the potential for participatory F2F training to improve sustainable land management. In the context of resource constraints and the associated low agricultural extension in sub-Saharan Africa, participatory F2F learning may be an effective approach to reach a wide range of smallholder farmers and promote SLM.

5.1 Introduction

According to the landmark report of the Land Degradation and Restoration Assessment report of the United Nations Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES), human-induced land degradation is driving environmental change at an unprecedented rate that undermines the livelihoods of more than 3 billion people worldwide (IPBES, 2018). In Malawi, land degradation is a major challenge. In a recent agricultural land suitability analysis, Li *et al.* (2017) found that 39.7% of agricultural land in Malawi is degraded and highly unsuitable for cultivation. That notwithstanding, empirical research shows that sustainable land management practices continue to be underutilized among smallholder farmers (Cai *et al.*, 2019; Chinseu *et al.,* 2019).

SLM involves the use of land and land-based resources in meeting human needs in a manner that ensures the long-term integrity and productive potential of these resources (Dallimer et al., 2018). Specific to agriculture, SLM involves the farm-level application of key practices including crop residue integration, terracing, mulching, manuring, composting, legume intercropping, planting of cover crops and agroforestry. Apart from the environmental benefits, SLM has been found to improve agricultural productivity, particularly in resource-poor contexts where farmers struggle to purchase synthetic inputs (Branca, Lipper, McCarthy, & Jolejole, 2013; Issahaku & Abdulai, 2020). Despite these benefits, in most low-income countries, the training of smallholder farmers on SLM practices is limited due to insufficient agricultural extension staff (Cordingley, Snyder, Rosendahl, Kizito, & Bossio, 2015). In Malawi for instance, limited agricultural extension is linked to neoliberal policies such as structural adjustment – whose implementation led to significant cuts in the budgets for these services. These impacts were further exacerbated by the fertilizer subsidy programs (Chowa, Garforth, & Cardey, 2013;

Ragasa, Mazunda, & Kadzamira, 2015). Empirical research points to the potentially beneficial role of participatory farmer-to-farmer (F2F) training approaches which value farmer knowledge, experience and observations in fostering sustainable land management (SLM) in resource-poor contexts (Bezner Kerr et al., 2019; Nakano, Tsusaka, Aida, & Pede, 2018; Rose et al., 2019; Takahashi, Mano, & Otsuka, 2019).

Participatory agroecology is a contrasting approach to the expert-driven technology diffusion approach for enhancing agricultural knowledge flows in smallholder farming contexts (Bacon, Mendez, & Brown, 2005; Bezner Kerr, Lupafya, & Dakishoni, 2016; Guzmán, López, Román, & Alonso, 2013; Méndez, Bacon, & Cohen, 2013). Participatory agroecology emphasizes horizontal learning which typically involves using farmers to reach other farmers in local communities. This horizontal knowledge sharing approach has the advantage of providing a platform for improved knowledge flows and real-time field-level demonstration of novel farming practices to other farmers in the community (Franzel, Kiptot, & Degrande, 2019; Ramisch, Misiko, Ekise, & Mukalama, 2006). The practical example-oriented and real-time demonstration of farming approaches in participatory agroecology could, therefore, stimulate the application sustainable farming practices and timely resolution of the challenges associated with their application better than the common expert-driven top-down approach which often appears abstract since training is mostly removed from the farm-scape (Nakano et al., 2018).

Despite gaining traction in the Global South in the past few decades, little is known about the extent to which participatory agroecology can improve the sustainable management of agroecosystems. This paper investigates the impact of a participatory F2F agroecology project on the adoption of SLM practices in rural Malawi. The project aimed to improve soil fertility and yields by using a F2F approach to train smallholder farmers on how to apply diverse

SLM practices. A team of farmers from project communities called the Farmer Research Team was initially trained on key SLM practices. These farmers then assisted the project team by visiting participating farmers to train them and problem-solve any issues that arose. Monthly community level meetings were also organized in participating villages to enhance interaction and knowledge sharing. This intervention provides a unique opportunity to examine whether participatory agroecology can promote the adoption of SLM practices.

5.2 Theoretical approach: social learning in the context of participatory agroecology

Increasingly, social learning has become a pivotal tool for promoting behavioural change towards sustainable natural resource management (Pahl-Wostl & Hare, 2004; Rodela, 2011; Schusler, Decker, & Pfeffer, 2003; Stone, 2016). The concept has gained traction in the past few decades given the multi-faceted nature of socioecological systems and the need to understand social actors and the motivations for the choices they make in relation to nature. The first attempt to define and theorize social learning can be traced to the work of Miller and Dollard (1941) who opined that social actors observe the behaviour of other actors, transform what they observe into cognitive illustrations and replicate the behaviour based on the associated benefits while taking into consideration the potential constraints (Conley & Udry, 2001; Muro & Jeffrey, 2008).

Social learning theory is grounded on the foundational principle that different knowledge sets and 'ways of doing' are embodied in social actors, and interaction between actors facilitates knowledge sharing and stimulates behavioural change (Bandura & Walters, 1977; Miller &

Dollard, 1941). Thus, at the community level, social networks serve as the pathways for interactions between actors and ultimately for social learning to occur (Mekonnen et al., 2018). Enhancing interaction among local actors through participatory knowledge exchange activities is therefore observed to have potential benefits for people to display pro-environmental behaviour (Kollmuss & Agyeman, 2002). Jacobson (1996) justifies the centrality of interaction in social learning by observing that cognition is not an internalized rational process but is essentially shaped by the socio-cultural context and the constant interaction among actors.

Amid the varied theoretical lines of social learning advanced in the literature on natural resource management, the concept of transformative learning is central to this analysis. Transformative social learning denotes the process of gradual change in views and ways of acting when social actors are confronted with challenges in their environment (Dougill et al., 2006; Pahl-Wostl, 2002). Rodela (2011) refers to this form of social learning as the network-centric perspective, which typically involves actors with a common interest or identity, such as smallholder farmers striving to address soil infertility and adapt to a changing climate. This network-centric approach makes transformative social learning inherently linked to participatory approaches that work towards promoting farmer knowledge exchange (Bezner Kerr et al., 2019). The changes in the way(s) of doing in transformative social learning are therefore typically in response to an external trigger such as land degradation that is not amenable to previous ways of doing things (Muro & Jeffrey, 2008). In such situations, social actors share knowledge on new ideas and test those ideas. Testing of ideas leads to reflection, the building of new experiences and ultimately, a gravitation towards new ways of understanding the environment and relating to it (Pahl-Wostl & Hare, 2004; Stone, 2016). As an iterative process, the outcomes of transformation feedback into future ideas (Muro & Jeffrey, 2008). In participatory social learning settings, a group of local farmers may evolve into a community with a common purpose of working together to share knowledge and overcome land degradation, while implementing SLM ideas individually at the farm-level according to their respective capacities and preferences (Muro & Jeffrey, 2008; Webler, Kastenholz, & Renn, 1995). Thus as succinctly argued by Muro & Jeffrey (2008), social learning is not just a precondition for behavioural change among the individual network members, but also collective action. Muro & Jeffrey (2008) emphasize that learning is enhanced when a social actor is situated in a cultural context where both learning and knowing have meaning. This highlights the need for learning to be anchored in locally driven participatory approaches.

Participatory agroecology is grounded on a pedagogical and knowledge production approach that builds on traditional knowledge systems and horizontal farmer-led knowledge sharing (Guzmán, López, Román, & Alonso, 2013; Bezner Kerr et al., 2019; Méndez, Bacon, & Cohen, 2013). As opposed to the widely used top-down teacher-student agricultural extension approach in the Global South, in participatory agroecology, learning is conceptualized as a mutual process. This connects directly to Freire's (1996) 'pedagogy of the oppressed' thesis and the need for learning to be based on 'dialogics' characterized by cooperation, unity and cultural synthesis. As opposed to the prevailing top-down agricultural knowledge translation approach under the current capitalist food system, agroecology respects local people's knowledge and holds them as an integral part of knowledge generation and translation (Dumont, Vanloqueren, Stassart, & Baret, 2016; Bezner Kerr et al., 2019). This decolonial approach to learning also pays close attention to structural barriers to farmer-led knowledge mobilization and translation produced by external agents. Stone (2016) draws attention to the politics of social learning and the role of some 'agricultural didacts', actors external to farming communities including, agricultural input dealers, government departments and Non-Governmental Organisations who introduce off-farm interests in the learning process which may not be fully aligned with the interests of smallholder farmers. That notwithstanding, it is important to mention the crucial role of some external agents in catalyzing and sustaining horizontal learning, especially through the provision of resources.

Although several studies on social learning in natural resource management provide positive accounts of its impacts, Schusler et al. (2003) caution that there is the potential for mistaken learning, conflict and unhealthy competition. Thus, social learning may not always lead to behavioural change. This observation is very important for the conceptualization of measures of behavioural change in social settings. For instance, in this analysis, we predict the effect of participatory F2F agroecology on SLM adoption while recognizing that some farming households may receive training and peer support on SLM and yet not adopt any of the methods in farming. This limitation also highlights the complexity of behavioural change and the need for careful study design, particularly, the need for quantitative estimations of behavioural change processes in social learning to account for potential confounding structural factors.

5.3. Materials and methods

5.3.1 Study context

As outlined earlier, land degradation is a major environmental problem confronting smallholder farmers in Malawi. Over the past two decades, the Malawian government has tackled the problem of soil infertility by subsidizing and encouraging farmers to use synthetic fertilizers under the flagship Farm Input Subsidy Program (FISP) (Lunduka et al., 2013). Although the FISP makes up a significant proportion of the budget of the Ministry of Agriculture, the subsidy is not evenly distributed among farmers (Chinsinga, 2011; Chinsinga, 2014; Holden & Lunduka, 2013). The application of synthetic fertilizer does not, in and of itself, address land degradation holistically, since it does nothing to address issues of soil erosion, declining organic matter, or declining soil microorganisms, which all influence soil health and land quality (Bi, Yao, & Zhang, 2015; Hall-Spencer, 2017; Reganold, Elliott, & Unger, 1987). Synthetic fertilizer use also does not address issues of declining biodiversity including pollinators.

This study is based on a five-year agroecological intervention implemented in the Dedza and Mzimba districts of Malawi from 2012 to 2017. Figure 1 provides information on the study sites. The project used farmer-to-farmer learning and locally available resources to generate a farming approach that poor and food insecure smallholder farming households can use to improve food security. The project harnessed local resources such as manure and crop residue to generate organic soil amendment techniques to improve soil fertility for participating households. Farmers were trained on SLM practices such as crop residue incorporation, intercropping, mulching, agroforestry and integration of vetiver grass[4] using a F2F learning approach at the community level. In the first year of the intervention, farmers in the treatment group also received diverse local seed varieties. There was a control group made up of farming households that never received the agroecological training. The key distinguishing feature between the control and intervention households was that treatment households received F2F

[4]Vetiver is a tropical perennial grass that forms a thick hedge with a dense and deep rooting system. It is used as a vegetative barrier for checking soil erosion (Amiri & Emami, 2019; D'Souza, Choudhary, Basak, & Shukla, 2019; Dalton, Smith, & Truong, 1996). The phyto-remediation potential of vetiver in contaminated soils is also widely known (Banerjee, Goswami, Pathak, & Mukherjee, 2016; Vargas, Pérez-Esteban, Escolástico, Masaguer, & Moliner, 2016).

training and routine peer support on the application of diverse SLM practices while control households did not.

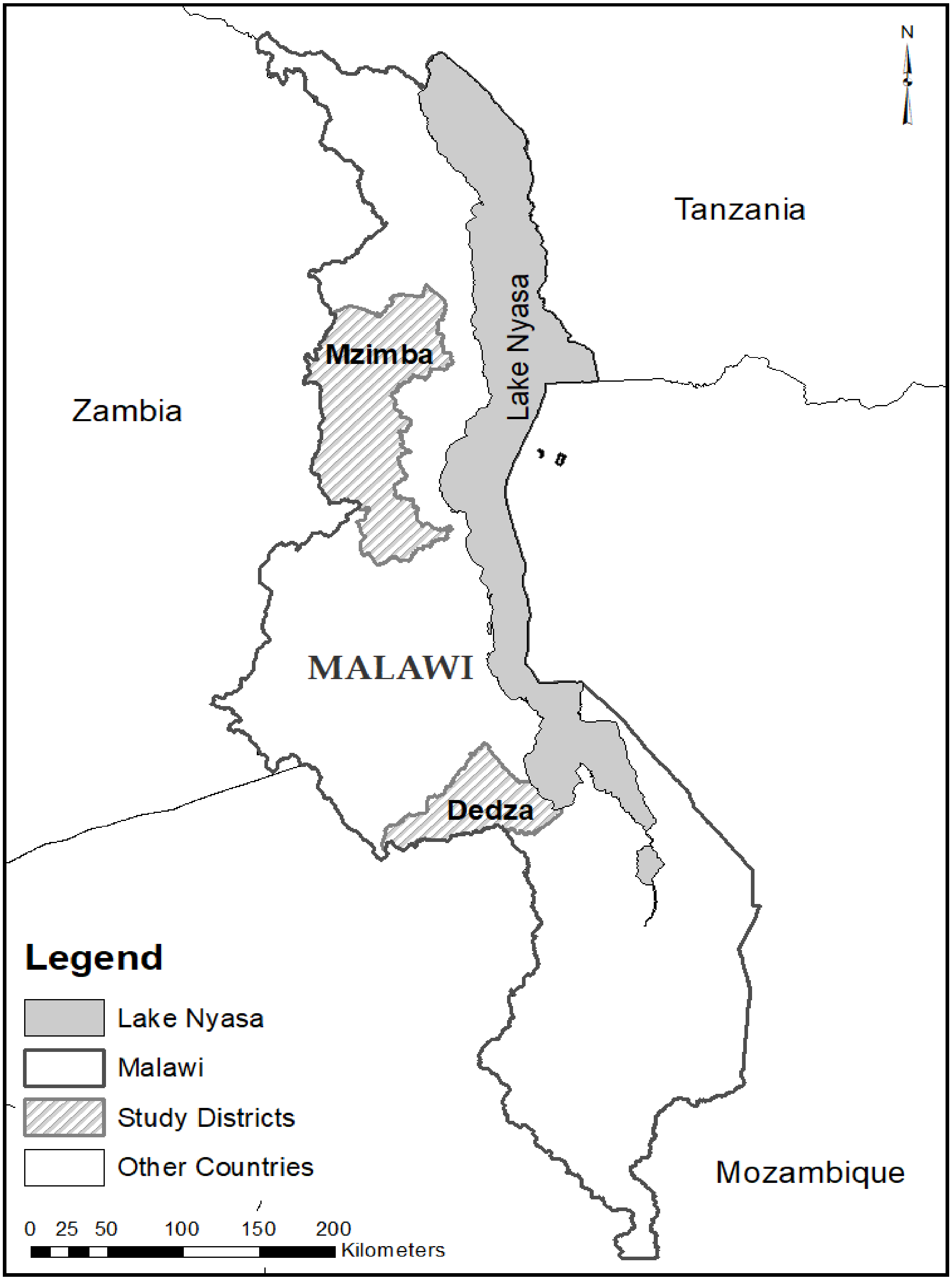
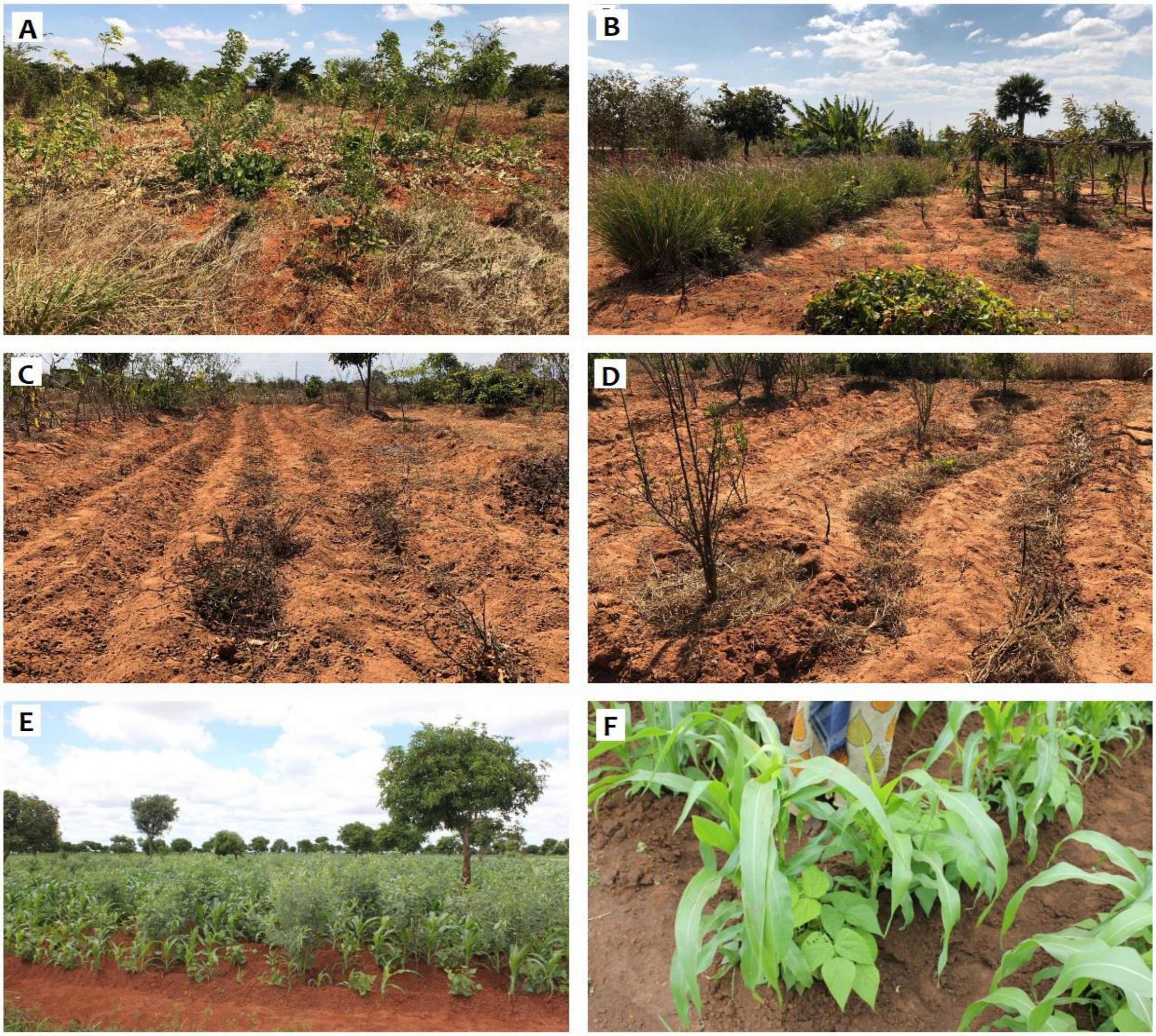


Figure 5.1: showing study sites

The participatory F2F knowledge sharing approach used in the intervention involved the initial identification and training of 2 farmer research team (FRT) members, a man and a woman, from each intervention community. These FRT members were selected by the village members taking into consideration the capacity to farm, interest and dedication towards community initiatives. These farmers received intensive participatory training on agroecology, nutrition and social equity. The training involved field demonstration of the different SLM practices including how to integrate crop residue into the soil as opposed to burning, legume intercropping, and compost making. In collaboration with the project team, the FRT members subsequently held routine community–level training on the application of agroecology-based SLM practices for households in the treatment group at two stages of the farming year—before land preparation and after harvesting. Farmers were encouraged to apply these methods to improve soil fertility. Figure 5.2 provides information on some of the SLM practices farmers exchanged knowledge on and implemented.



KEY
A: Agroforestry on a recently harvested maize field.
B: Vetiver grass planted across the slope on the farm to control erosion.
C: A farmer burying crop residue after harvest.
D: Mulching of field prior to planting.
E: Legume (pigeon pea) intercrop in a maize field.
F: A maize field intercropped with soybean.

Figure 5.2: Some of the SLM practices applied by farmers during the intervention.

The project also involved routine community level meetings among farmers from participating households to deliberate on practical challenges from the everyday application of SLM practices on their farms and to share knowledge on ways of addressing these challenges.

These monthly meetings, which continued until the end of the intervention provided an avenue for farmers to share knowledge, provide and receive peer support, and give feedback on their experiences. The meetings also served as deliberative spaces for discussing household nutrition and gender issues.

5.3.2 Data

To facilitate an unbiased assessment of the impacts of the intervention, the project used an experimental design involving intervention and control households. A total of 6772 households were recruited into the intervention group. Using a stepped wedge design, 2089 farming households received the intervention at the baseline (2012), while 2121 and 2562 households were sequentially sampled into the intervention group in 2013 and 2014, respectively using the following criteria: interest to participate in the agroecology training and experiments having the capacity to farm; not currently participating in a similar agricultural intervention, and being food insecure (assessed through a qualitative baseline assessment). The same criteria was used to select control households (n=1500).

The data for this analysis is drawn from an endline survey that was conducted in 2017 at end of the intervention. The sample comprises 514 randomly sampled households that received the intervention at the baseline and 400 randomly sampled households from the control group. The same set of questions were asked to farming households in both the intervention and control groups. Both control and intervention households were asked about the SLM practices they applied in the 2016/17 planting season. The survey also sourced information on household food security and household socioeconomic and demographic characteristics. This data enables us to estimate the application of SLM practices for farming households that received the participatory F2F agroecology training on SLM and those that did not.

5.3.3 Analysis

Given our interest in understanding the use of different SLM practices between farming households that received the participatory agroecology training and the control households that did not, we estimate separate logistic regression models across the individual SLM practices. As a result, we have six dependent variables representing six different SLM practices: crop residue integration, mulching, manuring, composting, legume intercropping, planting of vetiver grass and agroforestry. As mentioned earlier, farming households in both treatment and control households were asked whether they applied the above SLM practices in the 2016/2017 cropping season. Response to each SLM practice was binary (coded as Yes=1 and No=0).

The key independent variable in this analysis is participation in the agroecological intervention (1=Yes, 0=No), which is a direct proxy of whether a household was in the intervention or control group. Following the SLM literature on SLM adoption (Adimassu, Kessler, & Hengsdijk, 2012; Adimassu et al., 2016; Gebremedhin & Swinton, 2003), we included several relevant demographics, socioeconomic and farm-level variables. These control variables include: household structure (0=monogamous; 1=polygamous; 2=single-parent household), age of primary male farmer (0=<30; 1=30-45; 2=46-60; 3=>60), level of education of primary male (0=no education; 1=primary education; 2=secondary education or higher), size of active household labour (0=1-2, 1=3-4, 2=5 or more), household wealth (0=poor; 1=middle income;

2=rich), farm size in acres (0=more than 5; 1=2.5 to 5; 2=less than 2.5), and household land ownership status (0=yes; 1=no).

Our analysis is organized in three main parts. First, we employed univariate analysis to explore the distribution of the sample across our dependent and independent variables. We also used binary logistic regression to understand the relationship between the dependent variables (each of the 6 SLM categories) and the main independent variable. Finally, we conducted multivariate logistic regression analysis to examine the association between participatory agroecology and SLM adoption while adjusting for theoretically relevant control variables. The equation for our regression model can be specified as follows:

$$\ln\left(\frac{\mathrm{P}}{1-\mathrm{P}}\right) = \alpha + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3 + \dots + \beta_k x_k$$

where p is the probability that households that benefited from the participatory agroecology training applied a given form of SLM practice, α is the constant, $\beta 1$, $\beta 2$, …, β k are regression coefficients, and x_1, x_2, …, x_k are independent and control variables (Hosmer, Lemeshow, & Sturdivant, 2013). Findings are reported with odds ratios (ORs). ORs larger than 1 imply higher likelihood of adopting a given SLM practice, while those smaller than 1 indicate lower odds of adoption.

5.4. Results

5.4.1 Univariate analysis

Table 5.1 shows the characteristics of the sample at endline. In terms of the uptake of the different SLM practices, more than two-thirds of the treatment households that received the participatory agroecology training practiced crop residue recycling, composting, mulching, legume intercropping, and planting of vetiver grass to control soil erosion. More than half of control households practiced crop residue recycling, composting, legume integration and planting of vetiver grass. Less than half of the control households practiced mulching and agroforestry. More than half of both farming households in both sample groups cultivated plots less than 2.5 acres and reported experiencing soil erosion on their farms. Also, the majority of farming households in both sample groups had between four and six working members. More than half of households in both sample groups also owned the land on which they cultivated and had the principal male having primary school education. In terms of wealth, 29% and 35% of households from the treatment and intervention groups were in the poor wealth category, respectively.

Table 5.1: showing sample characteristics at endline

Variable	Treatment (%)	Control (%)	Pooled (%)
Crop residue recycling			
No	41 (8)	98 (25)	139 (15)
Yes	473 (92)	302 (75)	775 (85)
Composting			
No	32 (6)	90 (23)	122 (13)
Yes	482 (94)	310 (77)	792 (87)
Mulching			
No	185 (36)	228 (57)	413 (45)
Yes	329 (64)	172 (43)	501 (55)
Legume integration			
No	62 (12)	97 (24)	159 (17)
Yes	452 (88)	303 (76)	755 (83)
Agroforestry			
No	236 (46)	224 (56)	460 (50)
Yes	278 (54)	176 (44)	454 (50)
Vetiver grass			
No	134 (26)	128 (32)	262 (29)
Yes	380 (74)	272 (68)	652 (71)
Plot size (acres)			
Less than 2.5	344 (67)	280 (70)	624 (68)
2.5 to 5	113 (22)	92 (23)	205 (22)
More than 5	57 (11)	28 (7)	85 (10)
Soil erosion			
Yes	370 (72)	304 (76)	674 (74)
No	144 (28)	96 (24)	240 (26)
Active household labour			
1-2	93 (18)	56 (14)	149 (16)
2-4	154 (30)	116 (29)	271 (30)
4-6	175 (34)	136 (34)	311 (34)
>6	92 (18)	92 (23)	183 (20)
Household wealth			
Poor	149 (29)	140 (35)	289 (31)
Middle	118 (23)	100 (25)	218 (24)
Rich	247 (48)	160 (40)	407 (45)
Land ownership			
Yes	329 (64)	288 (72)	617 (68)
No	185 (36)	112 (28)	297 (32)
Age of primary male farmer			
<30	170 (33)	124 (31)	294 (32)
30-45	164 (32)	124 (31)	288 (31)
46-60	98 (19)	84 (21)	182 (20)
>60	82 (16)	68 (17)	150 (17)
Education of primary male farmer			
None	144 (28)	108 (27)	252 (28)
Primary	267 (52)	216 (54)	483 (52)
Secondary or higher	103 (20)	76 (19)	179 (20)
Total	514	400	914

5.4.2 Bivariate and multivariate analysis of the association between participatory agroecology and SLM

Table 5.2 presents findings on bivariate and multivariate logistic regression analysis of the relationship between participatory agroecology and the adoption of the six different SLM practices. At the bivariate level, our findings show that farming households that benefited from the participatory agroecology intervention were significantly more likely to practise crop residue recycling (OR=3.74, $p<0.01$), composting (OR=4.37, $p<0.01$), mulching (OR=2.36, $p<0.01$), agroforestry (OR=1.50, $p<0.01$), legume intercropping (OR=2.33, $p<0.01$), and vetiver grass integration (OR=1.33, $p<0.1$).

Table 5.2: Bivariate and multivariate logistic regression analysis of the association between participatory agroecology and adoption of SLM practices

Variable	Crop residue recycling		Composting		Mulching		Agroforestry		Legume integration		Vetiver grass	
	Bivariate	Multivariate	Bivariate	Multivariate	Bivariate	Multivariate	Bivariate	Multivariate	Bivariate	Multivariate	Bivariate	Multivariate
	OR (SE)	OR (SE)	OR (SE)	OR (SE)	OR (SE)	OR (SE)	OR (SE)	OR (SE)	OR (SE)	OR (SE)	OR (SE)	OR (SE)
Agroecology												
No	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Yes	3.74 (0.75)***	4.85 (0.88)***	4.37 (0.75)***	4.75 (0.82)***	2.36 (0.32)***	2.71 (0.40)***	1.50 (0.20)***	1.61 (0.23)***	2.33 (0.42)***	2.35 (0.44)***	1.33 (0.20)*	1.36 (0.21)*
Plot size (acres)												
>5		1.00		1.00		1.00		1.00		1.00		1.00
2.5 to 5		1.35 (0.55)		0.92 (0.82)		1.61 (0.60)		1.30 (0.37)		2.48 (1.36)*		0.83 (0.34)
Less than 2.5		1.47 (0.22)*		4.11 (1.55)*		1.38 (0.45)		0.65 (0.20)**		1.80 (0.88)		1.26 (0.46)
Soil erosion												
No		1.00		1.00		1.00		1.00		1.00		1.00
Yes		0.67 (0.15)*		2.13 (0.55)***		1.03 (0.16)		0.92 (0.14)		0.87 (0.17)		1.32 (0.22)
Active labour												
1-2		1.00		1.00		1.00		1.00		1.00		1.00
3-4		1.64 (0.04)***		1.35 (1.22)*		0.49 (0.25)		0.51 (0.26)		2.72 (0.94)		0.82 (0.45)
5-6		1.21 (0.17)*		1.46 (0.98)*		1.34 (0.72)		1.17 (0.61)		2.95 (1.30)		1.35 (0.79)
>6		1.13 (0.09)***		1.61 (0.78)**		0.86 (0.34)		0.75 (0.29)		1.04 (0.60)		1.29 (0.56)
Wealth												
Rich		1.00		1.00		1.00		1.00		1.00		1.00
Middle		0.66 (0.25)		0.64 (0.15)		0.85 (0.24)		0.90 (0.25)		0.88 (0.19)		0.33 (0.11)***
Poor		2.57 (0.89)***		2.28 (1.31)**		1.15 (0.22)		1.36 (0.25)*		2.12 (0.84)**		0.64 (0.12)**
Land ownership												
Yes		1.00		1.00		1.00		1.00		1.00		1.00
No		0.52 (0.12)***		2.03 (0.45)***		0.71 (0.11)**		0.63 (0.10)***		0.82 (0.16)		1.40 (0.22)**
Age of male												
<30		1.00		1.00		1.00		1.00		1.00		1.00
30-45		1.08 (0.37)		0.70 (0.23)		0.73 (0.16)		0.94 (0.20)		1.10 (0.30)		0.68 (0.16)
46-60		1.05 (0.42)		1.13 (0.51)		1.19 (0.34)		1.18 (0.33)		1.36 (0.46)		1.46 (0.47)
>60		0.78 (0.35)		1.09 (0.65)		1.28 (0.44)		1.37 (0.46)		1.08 (0.45)		1.07 (0.40)
Educ of male												
None		1.00		1.00		1.00		1.00		1.00		1.00
Primary		1.31 (0.62)		1.10 (0.38)		0.49 (0.12)***		1.40 (0.10)***		0.79 (0.22)		1.55 (0.42)
Secondary or higher		1.21 (0.05)***		2.24 (0.70)***		0.35 (0.16)***		1.52 (0.09)***		1.71 (0.41)**		2.07 (0.43)***
LR X^2	47.86***	158.71***	52.12***	147.92***	40.27***	101.29***	9.17**	59.35***	23.11***	52.85***	3.85**	54.50***
Pseudo R^2	0.0614	0.2037	0.0726	0.2059	0.0320	0.0805	0.0072	0.0468	0.0274	0.0626	0.0035	0.0497
Log likelihood	-365.70	-310.28	-333.10	-285.19	-609.16	-578.65	-628.93	-603.84	-410.81	-395.94	-545.67	-520.40

***p<0.01; **p<0.05; *p<0.1. Results are shown with odd ratios

For each model on the individual SLM practices, we adjusted for several control variables at the multivariate level. Findings were consistent with the bivariate level. Farming households that received the participatory F2F agroecology intervention were still significantly more likely to practise crop residue recycling (OR=4.85, $p<0.01$), composting (OR=4.75, $p<0.01$), mulching (OR=2.71, $p<0.01$), agroforestry (OR=1.61, $p<0.01$), legume intercropping (OR=2.35, $p<0.01$), and vetiver grass integration (OR=1.36, $p<0.1$). The odds of adopting all SLM categories increased for households that received the participatory agroecology training after adjusting for control variables.

At the multivariate level, there were some noteworthy significant associations between several covariates and the uptake of the diverse SLM practices. For crop residue recycling, the number of active household members, plot size, soil erosion, wealth, land ownership and education of the primary male were significant predictors. Compared to households with one to two active household members, those with three to four (OR=1.64, $p<0.01$), five to six (OR=1.21, $p<0.05$) and more than six (OR=1.13, $p<0.01$) members were significantly more likely to bury crop residue after harvest. In terms of land size, households cultivating less than 2.5 acres (OR=1.47, $p<0.1$) were significantly more likely to bury crop residue compared to those cultivating more than five acres. Farming households that reported experiencing soil erosion at the plot level (OR=0.67, $p<0.1$) were significantly less likely to recycle crop residue compared to households that did not experience erosion. Compared to households in the rich wealth category, poor households (OR=2.57, $p<0.01$) were significantly more likely to integrate crop residue into the soil after harvest. Compared to households that owned the land on which they cultivated, those that did not own the land (OR=0.52, $p<0.01$) were significantly less likely to recycle crop residue after harvest. Households with the primary male having secondary or higher education (OR=1.21, $p<0.01$) were significantly more likely to recycle crop residue compared to households with the primary male having no formal education.

Multivariate results for composting also show some significant associations across several covariates. For instance, farming households cultivating on plots less than 2.5 acres (OR=4.11, $p<0.01$) were significantly more likely to practice composting compared to those cultivating more than five acres. Households that experienced erosion were twice more likely to add compost to their fields. Consistent with crop residue recycling, having more active working members in the household predicted increased chances of practising composting. Poor households (OR=2.28, $p<0.01$) were also about twice more likely to practise composting compared to households in the rich wealth category. Land ownership significantly predicted the chances of composting, with households that owned the land they cultivated (OR=2.03, $p<0.01$) being significantly more likely to apply compost compared to those that did not own the land. Farming households in which the primary male had secondary or higher education (OR=1.24, $p<0.01$) were significantly more likely to practise composting compared to those with the primary male having no education.

At the multivariate level, land ownership and level of education of the primary male in the household were significantly associated with mulching. Households that did not own the land on which they cultivated (OR=0.71, $p<0.05$) were significantly less likely to mulch their fields compared to those that owned the land. Our findings also show a significant inverse relationship between level of education of the primary male and mulching. Households with the primary male having primary school education (OR=0.49, $p<0.01$) and secondary or higher (OR=0.35, $p<0.01$) were both significantly less likely to practise mulching. Although households cultivating smaller plots were more likely to mulch their fields, the relationship was not statistically significant.

Plot size, household wealth, land ownership and level of education of the primary male in the households were significantly associated with agroforestry. Households cultivating less than 2.5 acres ($OR=0.65$, $p<0.05$) were 45% less likely to practice agroforestry compared to those cultivating more than five acres. Similarly, households that did not own the plots on which they cultivated ($OR=0.63$, $p<0.01$) were significantly less likely to practise agroforestry. Compared to households in the rich wealth category, those in the poor wealth category were significantly more likely to practise agroforestry. Households with the primary male farmer having primary education ($OR=1.40$, $p<0.01$) and secondary or higher education ($OR=1.52$, $p<0.01$) were both significantly more likely to practise agroforestry compared to households with the primary male having no education. Thus, as level of education increased, the odds of integrating trees on the farm also increased.

At the multivariate level, plot size, household wealth, and education of the primary male farmer in the household were significant predictors of legume integration. Households in the poor wealth category were 2.2 times more likely to intercrop with legumes compared to households in the rich category. Although generally, households cultivating on relatively smallholder plots were more likely to do intercropping compared to those cultivating above 5 acres, the relationship was statistically significant for households cultivating between 2.5 and 5 acres. Also, households with the primary male farmer having either secondary school education or higher were about twice more likely to practise legume intercropping.

Findings from the multivariate model on vetiver grass integration show that the experience of soil erosion at the farm-level was a significant predictor of the odds of planting vetiver grass, with households that reported experiencing soil erosion on their plots being 1.32 times more likely to plant vetiver grass than those that did not experience erosion. Being in the poor and middle wealth categories were both significantly associated with lower odds of integrating vetiver grass. Household land ownership (OR=0.40, $p<0.05$) also significantly predicted lower odds of integrating vetiver grass. While increasing levels of education of the primary male farmer in the household predicted higher odds of integrating vetiver grass, the relationship was only statistically significant for households with the primary male having secondary of higher education (OR=2.07, $p<0.01$).

5.5 Discussion and conclusions

This study examined the association between participatory F2F agroecology training and the uptake of different SLM practices in Malawi. We hypothesized that participatory F2F agroecology training can have a positive impact on the likelihood of farmers applying diverse SLM practices. Findings from the logistic regression models demonstrate that households that participated in the F2F agroecology training were more likely to be practicing the SLM technologies they were exposed to, compared to their counterparts that did not, after controlling for demographic, socioeconomic and plot-level factors. These findings contribute to a growing body of literature that demonstrates the potential for participatory agroecological programs to promote sustainable land use and environmental conservation. Our findings are consistent with Wellard et al. (2013) who observed that community-level F2F approaches can facilitate innovation in sustainable agriculture among resource-poor smallholder farmers. Other scholars have demonstrated the positive role of participatory F2F knowledge sharing on the adoption of sustainable agricultural technologies (Franzel et al., 2019; Lukuyu, Place, Franzel, & Kiptot, 2012; Misiko, Tittonell, Ramisch, Richards, & Giller, 2008). The role of F2F knowledge sharing in addressing gender inequalities in access to agricultural information in smallholder farming context has also been acknowledged (Franzel et al., 2019). In the context of limited agricultural extension, participatory F2F knowledge sharing can be a useful approach to reach a wide range of farmers. Connecting to social learning theory, enhancing interaction among local farmers through participatory knowledge sharing activities creates avenues for acquisition of new knowledge, farmer experimentation and new ways of acting upon nature, with the potential of enhancing sustainable farming systems (Kollmuss & Agyeman, 2002).

The positive association between participatory F2F agroecology training and the application of diverse agroecological practices is not surprising given that SLM is central to agroecology as a farming approach. Although most of these SLM practices are used in traditional smallholder agriculture, agroecology, which builds on traditional knowledge systems, provides an opportunity for farmers to enhance the use of these practices in ways that are adapted to the local agroecosystem and address challenges associated with their application. For composting, for example, farmers require knowledge on how to prepare the compost: type of materials to use, how to combine these materials and the time composted material takes to be ready for application (Cai et al., 2019). Similarly, for practices like agroforestry, farmers must know the right spacing of plants and pruning requirements to minimize shade and control competition of trees for space for a given agroecosystem. Indeed there is evidence that misconceptions about the impact of trees on crop health and development tend to deter Malawian smallholder farmers from practising agroforestry (Blatner, Bonongwe, & Carroll, 2000). Legume intercropping requires knowledge on the appropriate crop combination for a given farming system and the right spacing between crops to prevent overcrowding and associated crop failure. Indeed, in a study in northern Malawi, Snapp et al. (2010) identified the lack of technical knowledge as a key barrier to the use and scaling of legume diversification and recommended educational support for smallholder farmers. Unlike the top-down state-led extension approach common in most countries in SSA, which is mostly removed from the immediate farm-scape, participatory agroecology provides real-time field-level demonstrations and experimentation with SLM technologies (Guzmán et al., 2013; Méndez et al., 2013; Warner, 2008). Apart from recognizing local farmers' ability to contribute to finding solutions to problems in their environment and fostering a sense of local involvement and ownership, the practical and real-time demonstration of SLM technologies in participatory agroecology provides a learning-by-doing platform for farmers to explore context-driven solutions for addressing the everyday challenges associated with implementing SLM technologies (Berthet, Barnaud, Girard, Labatut, & Martin, 2016).

Other socioeconomic factors significantly predicted the chances of farmers using some SLM practices. The size of the active household labour, land ownership, wealth and education of the primary male farmer were noteworthy. Having a larger active labour size significantly predicted the uptake of SLM practices such as composting, crop residue recycling and legume integration. The role of labour in SLM adoption is widely acknowledged in the literature (Asrat *et al.*, 2004; Pender and Gebremedhin, 2007; Teshome *et al.*, 2016). In smallholder farming communities across SSA, agriculture relies mainly on household labour supply. Therefore, farming households with more active persons may be able to adopt labour-intensive SLM practices like crop residue recycling and composting (Marenya & Barrett, 2007). Similarly, land size and ownership both had a significant impact on the odds of adopting most of the SLM practices explored in this study. Consistent with Kassie, Jaleta, Shiferaw, Mmbando, & Mekuria (2013), our findings show that the ownership status of land significantly shaped the adoption of most SLM practices. Farming households that did not own the land on which they cultivated were less likely to invest in agroforestry, vetiver grass integration, crop residue recycling, mulching and legume intercropping. Security of tenure is an important determinant of investment in land management (Adimassu et al., 2016; Kassie et al., 2013; Teklewold et al., 2013). Farmers cultivating on borrowed plots may not commit their resources to applying SLM practices (Gebremedhin & Swinton, 2003; Wannasai & Shrestha, 2008; Fenske, 2011; Robinson *et al.*, 2014; Teshome *et al.*, 2016). Particularly, for SLM practices such as agroforestry with a long-term turnover, smallholder farmers cultivating on rented plots may be discouraged from investing in such practices given the potential to lose such long-term investments when their tenure expires. The land size can also shape the likelihood of applying SLM practices both positively and negatively. For instance, given the potential for SLM practices like agroforestry and vetiver grass to compete for space with plants, which provide food and important livelihood services (Sirrine, Shennan, & Sirrine, 2010), households cultivating relatively smaller plots may not be willing to spare reasonable space for these technologies (De Graaff *et al.*, 2008; Adimassu *et al.*, 2012; Teshome *et al.*, 2016; Ndagijimana *et al.*, 2019). Labour-intensive SLM practices like crop residue integration and composting may also be easily implemented on smaller plots.

The finding that households in the poorer wealth category were more likely to practice composting, legume intercropping, crop residue recycling, and mulching is also consistent with the literature. Compared to synthetic fertilizer, alternative low-cost organic soil fertilizing practices like compost manure amendment, crop residue recycling and legume integration may be easily used by poor farmers to improve soil fertility (Waithaka, Thornton, Shepherd, & Ndiwa, 2007). Given the potential for these practices to improve soil fertility and yields in the short run and at a low cost, empirical evidence shows that relatively poorer smallholder farming households who cannot purchase synthetic fertilizer tend to rely on these methods to improve yields (Waithaka et al., 2007). A recent study in northern Malawi found that low-income farmers using agroecological practices considered these practices worthwhile because they led to more reliable food security and income (Bezner Kerr et al., 2019). Consistent with the literature (Adimassu et al., 2016; Hălbac-Cotoară-Zamfir, Keesstra, & Kalantari, 2019; Ndagijimana et al., 2019), education of the primary male farmer in the household also emerged a significant predictor of the use of several SLM practices. The centrality of education to SLM may be explained by the role it plays in ensuring a better understanding of the processes of implementing diverse SLM technologies and the benefits of SLM (Teklewold et al., 2013; Waithaka et al., 2007).

Although this study provides important insights for sustainable land management, it also provides pointers for future research. SLM is a complex process that is shaped by diverse underlying factors. Hence, a broader understanding of the use of SLM practices may also require qualitative research approaches that allow for the uncovering of the lived experiences of smallholder farmers. Moreover, the range of SLM practices included in this analysis is not exhaustive. Future research may also investigate the impact of F2F knowledge sharing on the uptake of other SLM practices. Due to data limitations, this analysis does not include the cost and benefit of implementatipon of the different SLM practices.

In the context of increasing climate change and environmental degradation in Malawi and other countries in SSA, these findings suggest that participatory F2F agroecology may be a viable approach for promoting the uptake of SLM practices. The findings also highlight the important role underlying factors such as labour, plot size, and land ownership may exert on the adoption of SLM technologies in smallholder farming communities.

5.6 References

Adimassu, Zenebe, Aad Kessler, and Huib Hengsdijk. 2012. "Exploring Determinants of Farmers' Investments in Land Management in the Central Rift Valley of Ethiopia." *Applied Geography* 35 (1–2). Elsevier: 191–198.

Adimassu, Zenebe, Simon Langan, and Robyn Johnston. 2016. "Understanding Determinants of Farmers' Investments in Sustainable Land Management Practices in Ethiopia: Review and Synthesis." *Environment, Development and Sustainability* 18 (4). Springer: 1005–1023.

Amiri, Elham, and Hojat Emami. 2019. "Shear Strength of an Unsaturated Loam Soil as Affected by Vetiver and Polyacrylamide." *Soil and Tillage Research* 194. Elsevier: 104331.

Asrat, Paulos, Kassa Belay, and Desta Hamito. 2004. "Determinants of Farmers' Willingness to Pay for Soil Conservation Practices in the Southeastern Highlands of Ethiopia." *Land Degradation & Development* 15 (4). Wiley Online Library: 423–438.

Bacon, Chris, Ernesto Mendez, and Martha Brown. 2005. "Participatory Action Research and Support for Community Development and Conservation: Examples from Shade Coffee Landscapes in Nicaragua and El Salvador." *Center for Agroecology & Sustainable Food Systems*.

Bandura, Albert, and Richard H Walters. 1977. *Social Learning Theory*. Vol. 1. Prentice-hall Englewood Cliffs, NJ.

Banerjee, Ritesh, Priya Goswami, Khanindra Pathak, and Anita Mukherjee. 2016. "Vetiver Grass: An Environment Clean-up Tool for Heavy Metal Contaminated Iron Ore Mine-Soil." *Ecological Engineering* 90. Elsevier: 25–34.

Berthet, Elsa T A, Cécile Barnaud, Nathalie Girard, Julie Labatut, and Guillaume Martin. 2016. "How to Foster Agroecological Innovations? A Comparison of Participatory Design Methods." *Journal of Environmental Planning and Management* 59 (2). Taylor & Francis: 280–301.

Bezner-Kerr, Rachel, Esther Lupafya, and Laifolo Dakishoni. 2016. "Food Sovereignty, Agroecology and Resilience: Competing or Complementary Frames?" In *Global Governance/Politics, Climate Justice & Agrarian/Social Justice: Linkages and Challenges*, 1–14.

Hague, Netherlands.

Bezner Kerr, Rachel, Catherine Hickey, Esther Lupafya, and Laifolo Dakishoni. 2019. "Repairing Rifts or Reproducing Inequalities? Agroecology, Food Sovereignty, and Gender Justice in Malawi." *The Journal of Peasant Studies*. Taylor & Francis, 1–20.

Bezner Kerr, Rachel, Sera L Young, Carrie Young, Marianne V Santoso, Mufunanji Magalasi, Martin Entz, Esther Lupafya, Laifolo Dakishoni, Vicki Morrone, and David Wolfe. 2019. "Farming for Change: Developing a Participatory Curriculum on Agroecology, Nutrition, Climate Change and Social Equity in Malawi and Tanzania." *Agriculture and Human Values* 36 (3). Springer: 549–566.

Bi, Lidong, Shuihong Yao, and Bin Zhang. 2015. "Impacts of Long-Term Chemical and Organic Fertilization on Soil Puddlability in Subtropical China." *Soil and Tillage Research* 152. Elsevier: 94–103.

Blatner, Keith A, Charlie S L Bonongwe, and Matthew S Carroll. 2000. "Adopting Agroforestry: Evidence from Central and Northern Malawi." *Journal of Sustainable Forestry* 11 (3). Taylor & Francis: 41–69.

Branca, Giacomo, Leslie Lipper, Nancy McCarthy, and Maria Christina Jolejole. 2013. "Food Security, Climate Change, and Sustainable Land Management. A Review." *Agronomy for Sustainable Development* 33 (4). Springer: 635–650.

Cai, Tian, Charles Steinfield, Hastings Chiwasa, and Tadala Ganunga. 2019. "Understanding Malawian Farmers' Slow Adoption of Composting: Stories about Composting Using a Participatory Video Approach." *Land Degradation & Development*. Wiley Online Library.

Chinseu, Edna, Andrew Dougill, and Lindsay Stringer. 2019. "Why Do Smallholder Farmers Dis- adopt Conservation Agriculture? Insights from Malawi." *Land Degradation & Development*. Wiley Online Library.

Chinsinga, B. 2011. "Seeds and Subsidies: The Political Economy of Input Programmes in Malawi." *IDS Bulletin* 42 (4). Wiley Online Library: 59–68.

Chinsinga, B. 2014. *Beyond the Farm Input Subsidy Programme (FISP)? The Political Economy of the*

Comprehensive Africa Agriculture Development Programme (CAADP) Processes in Malawi. Working Paper-Future Agricultures. Brighton: Future Agricultures Consortium.

Chowa, Clodina, Chris Garforth, and Sarah Cardey. 2013. "Farmer Experience of Pluralistic Agricultural Extension, Malawi." *The Journal of Agricultural Education and Extension* 19 (2). Taylor & Francis: 147–166.

Conley, Timothy, and Christopher Udry. 2001. "Social Learning through Networks: The Adoption of New Agricultural Technologies in Ghana." *American Journal of Agricultural Economics* 83 (3). JSTOR: 668–673.

Cordingley, Justine E, Katherine A Snyder, Judith Rosendahl, Fred Kizito, and Deborah Bossio. 2015. "Thinking Outside the Plot: Addressing Low Adoption of Sustainable Land Management in Sub-Saharan Africa." *Current Opinion in Environmental Sustainability* 15. Elsevier: 35–40.

D'Souza, Donal Nixon, A K Choudhary, P Basak, and S K Shukla. 2019. "Assessment of Vetiver Grass Root Reinforcement in Strengthening the Soil." In *Ground Improvement Techniques and Geosynthetics*, 135–142. Springer.

Dallimer, Martin, Lindsay C Stringer, Steven E Orchard, Philip Osano, George Njoroge, Cheng Wen, and Patrick Gicheru. 2018. "Who Uses Sustainable Land Management Practices and What Are the Costs and Benefits? Insights from Kenya." *Land Degradation & Development* 29 (9). Wiley Online Library: 2822–2835.

Dalton, P A, R J Smith, and P N V Truong. 1996. "Vetiver Grass Hedges for Erosion Control on a Cropped Flood Plain: Hedge Hydraulics." *Agricultural Water Management* 31 (1–2). Elsevier: 91–104.

De Graaff, J, Aklilu Amsalu, F Bodnar, A Kessler, Helena Posthumus, and A Tenge. 2008. "Factors Influencing Adoption and Continued Use of Long-Term Soil and Water Conservation Measures in Five Developing Countries." *Applied Geography* 28 (4). Elsevier: 271–280.

Dougill, Andy J, E D G Fraser, J Holden, K Hubacek, C Prell, M S Reed, S Stagl, and L C Stringer. 2006. "Learning from Doing Participatory Rural Research: Lessons from the Peak

District National Park." *Journal of Agricultural Economics* 57 (2). Wiley Online Library: 259–275.

Dumont, Antoinette M, Gaëtan Vanloqueren, Pierre M Stassart, and Philippe V Baret. 2016. "Clarifying the Socioeconomic Dimensions of Agroecology: Between Principles and Practices." *Agroecology and Sustainable Food Systems* 40 (1). Taylor & Francis: 24–47.

Fenske, James. 2011. "Land Tenure and Investment Incentives: Evidence from West Africa." *Journal of Development Economics* 95 (2). Elsevier: 137–156.

Franzel, Steven, Evelyne Kiptot, and Ann Degrande. 2019. "Farmer-To-Farmer Extension: A Low-Cost Approach for Promoting Climate-Smart Agriculture." In *The Climate-Smart Agriculture Papers*, 277–288. Springer.

Freire, Paolo. 1996. "Pedagogy of the Oppressed (Revised)." *New York: Continuum*.

Gebremedhin, Berhanu, and Scott M Swinton. 2003. "Investment in Soil Conservation in Northern Ethiopia: The Role of Land Tenure Security and Public Programs." *Agricultural Economics* 29 (1). Wiley Online Library: 69–84.

Guzmán, Gloria I, Daniel López, Lara Román, and Antonio M Alonso. 2013. "Participatory Action Research in Agroecology: Building Local Organic Food Networks in Spain." *Agroecology and Sustainable Food Systems* 37 (1). Taylor & Francis: 127–146.

Hălbac-Cotoară-Zamfir, Rareș, Saskia Keesstra, and Zahra Kalantari. 2019. "The Impact of Political, Socio-Economic and Cultural Factors on Implementing Environment Friendly Techniques for Sustainable Land Management and Climate Change Mitigation in Romania." *Science of the Total Environment* 654. Elsevier: 418–429.

Hall-Spencer, Jason M. 2017. "Agriculture Production as a Major Driver of the Earth System Exceeding Planetary Boundaries." *Ecology and Society* 22 (4).

Holden, Stein T, and Rodney W Lunduka. 2013. "Who Benefit from Malawi's Targeted Farm Input Subsidy Program?" In *Forum for Development Studies*, 40:1–25. Taylor & Francis.

Hosmer, David W, Stanley Lemeshow, and Rodney X Sturdivant. 2013. *Applied Logistic Regression*. Vol. 398. John Wiley & Sons.

IPBES. 2018. *Summary for Policymakers of the Assessment Report on Land Degradation and Restoration of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services*. Edited by M. Sankaran and L. Willemen (eds.) R. Scholes, L. Montanarella, A. Brainich, N. Barger, B. ten Brink, M. Cantele, B. Erasmus, J. Fisher, T. Gardner, T. G. Holland, F. Kohler, J. S. Kotiaho, G. Von Maltitz, G. Nangendo, R. Pandit, J. Parrotta, M. D. Potts, S. Prince. Bonn. https://www.ipbes.net/system/tdf/spm_3bi_ldr_digital.pdf?file=1&type=node&id=28335.

Issahaku, Gazali, and Awudu Abdulai. 2020. "Sustainable Land Management Practices and Technical and Environmental Efficiency among Smallholder Farmers in Ghana." *Journal of Agricultural and Applied Economics* 52 (1). Cambridge University Press: 96–116.

Jacobson, Wayne. 1996. "Learning, Culture, and Learning Culture." *Adult Education Quarterly* 47 (1). Sage Publications Sage CA: Thousand Oaks, CA: 15–28.

Kassie, Menale, Moti Jaleta, Bekele Shiferaw, Frank Mmbando, and Mulugetta Mekuria. 2013. "Adoption of Interrelated Sustainable Agricultural Practices in Smallholder Systems: Evidence from Rural Tanzania." *Technological Forecasting and Social Change* 80 (3). Elsevier: 525–540.

Kollmuss, Anja, and Julian Agyeman. 2002. "Mind the Gap: Why Do People Act Environmentally and What Are the Barriers to pro-Environmental Behavior?" *Environmental Education Research* 8 (3). Taylor & Francis: 239–260.

Li, Guiying, Joseph P Messina, Brad G Peter, and Sieglinde S Snapp. 2017. "Mapping Land Suitability for Agriculture in Malawi." *Land Degradation & Development* 28 (7). Wiley Online Library: 2001–2016.

Lukuyu, B, Frank Place, Steven Franzel, and E Kiptot. 2012. "Disseminating Improved Practices: Are Volunteer Farmer Trainers Effective?" *The Journal of Agricultural Education and Extension* 18 (5). Taylor & Francis: 525–540.

Lunduka, Rodney, Jacob Ricker-Gilbert, and Monica Fisher. 2013. "What Are the Farm-level Impacts of Malawi's Farm Input Subsidy Program? A Critical Review." *Agricultural Economics* 44 (6). Wiley Online Library: 563–579.

Marenya, Paswel P, and Christopher B Barrett. 2007. “Household-Level Determinants of Adoption of Improved Natural Resources Management Practices among Smallholder Farmers in Western Kenya.” *Food Policy* 32 (4). Elsevier: 515–536.

Mekonnen, Daniel Ayalew, Nicolas Gerber, and Julia Anna Matz. 2018. “Gendered Social Networks, Agricultural Innovations, and Farm Productivity in Ethiopia.” *World Development* 105. Elsevier: 321–335.

Méndez, V Ernesto, Christopher M Bacon, and Roseann Cohen. 2013. “Agroecology as a Transdisciplinary, Participatory, and Action-Oriented Approach.” *Agroecology and Sustainable Food Systems* 37 (1). Taylor & Francis: 3–18.

Miller, Neal Elgar, and John Dollard. 1941. *Social Learning and Imitation.* New Haven, Connecticut: Yale University Press.

Misiko, Michael, Pablo Tittonell, J J Ramisch, P Richards, and Ken E Giller. 2008. “Integrating New Soybean Varieties for Soil Fertility Management in Smallholder Systems through Participatory Research: Lessons from Western Kenya.” *Agricultural Systems* 97 (1–2). Elsevier: 1–12.

Muro, Melanie, and Paul Jeffrey. 2008. “A Critical Review of the Theory and Application of Social Learning in Participatory Natural Resource Management Processes.” *Journal of Environmental Planning and Management* 51 (3). Taylor & Francis: 325–344.

Nakano, Yuko, Takuji W Tsusaka, Takeshi Aida, and Valerien O Pede. 2018. “Is Farmer-to-Farmer Extension Effective? The Impact of Training on Technology Adoption and Rice Farming Productivity in Tanzania.” *World Development* 105. Elsevier: 336–351.

Ndagijimana, Marcien, Aad Kessler, and Marcel van Asseldonk. 2019. “Understanding Farmers’ Investments in Sustainable Land Management in Burundi: A Case-study in the Provinces of Gitega and Muyinga.” *Land Degradation & Development* 30 (4). Wiley Online Library: 417–425.

Pahl-Wostl, Claudia. 2002. “Towards Sustainability in the Water Sector–The Importance of Human Actors and Processes of Social Learning.” *Aquatic Sciences* 64 (4). Springer: 394–411.

Pahl-Wostl, Claudia, and Matt Hare. 2004. “Processes of Social Learning in Integrated Resources Management.” *Journal of Community & Applied Social Psychology* 14 (3). Wiley Online Library: 193–206.

Pender, John, and Berhanu Gebremedhin. 2007. “Determinants of Agricultural and Land Management Practices and Impacts on Crop Production and Household Income in the Highlands of Tigray, Ethiopia.” *Journal of African Economies* 17 (3). Oxford University Press: 395–450.

Ragasa, C, J Mazunda, and M Kadzamira. 2015. *The Impact of Agricultural Extension Services within the Context of Heavily-Subsidized Input System: The Case in Malawi*. Draft IFPRI Discussion Paper.

Ramisch, Joshua J, Michael T Misiko, Isaac E Ekise, and John B Mukalama. 2006. “Strengthening ‘Folk Ecology’: Community-Based Learning for Integrated Soil Fertility Management, Western Kenya.” *International Journal of Agricultural Sustainability* 4 (2). Taylor & Francis: 154–168.

Reganold, John P, Lloyd F Elliott, and Yvonne L Unger. 1987. “Long-Term Effects of Organic and Conventional Farming on Soil Erosion.” *Nature* 330 (6146). Nature Publishing Group: 370.

Robinson, Brian E, Margaret B Holland, and Lisa Naughton-Treves. 2014. “Does Secure Land Tenure Save Forests? A Meta-Analysis of the Relationship between Land Tenure and Tropical Deforestation.” *Global Environmental Change* 29. Elsevier: 281–293.

Rodela, Romina. 2011. “Social Learning and Natural Resource Management: The Emergence of Three Research Perspectives.” *Ecology and Society* 16 (4). The Resilience Alliance.

Rose, David C, William J Sutherland, Andrew P Barnes, Fiona Borthwick, Charles Ffoulkes, Clare Hall, Jon M Moorby, Phillipa Nicholas-Davies, Susan Twining, and Lynn V Dicks. 2019. “Integrated Farm Management for Sustainable Agriculture: Lessons for Knowledge Exchange and Policy.” *Land Use Policy* 81. Elsevier: 834–842.

Schusler, Tania M, Daniel J Decker, and Max J Pfeffer. 2003. “Social Learning for Collaborative Natural Resource Management.” *Society & Natural Resources* 16 (4). Taylor & Francis: 309–326.

Sirrine, Dorothy, Carol Shennan, and J Robert Sirrine. 2010. "Comparing Agroforestry Systems' Ex Ante Adoption Potential and Ex Post Adoption: On-Farm Participatory Research from Southern Malawi." *Agroforestry Systems* 79 (2). Springer: 253–266.

Snapp, Sieglinde S, Malcolm J Blackie, Robert A Gilbert, Rachel Bezner-Kerr, and George Y Kanyama-Phiri. 2010. "Biodiversity Can Support a Greener Revolution in Africa." *Proceedings of the National Academy of Sciences* 107 (48). National Acad Sciences: 20840–20845.

Stone, Glenn Davis. 2016. "Towards a General Theory of Agricultural Knowledge Production: Environmental, Social, and Didactic Learning." *Culture, Agriculture, Food and Environment* 38 (1). Wiley Online Library: 5–17.

Takahashi, Kazushi, Yukichi Mano, and Keijiro Otsuka. 2019. "Learning from Experts and Peer Farmers about Rice Production: Experimental Evidence from Cote d'Ivoire." *World Development* 122. Elsevier: 157–169.

Teklewold, Hailemariam, Menale Kassie, and Bekele Shiferaw. 2013. "Adoption of Multiple Sustainable Agricultural Practices in Rural Ethiopia." *Journal of Agricultural Economics* 64 (3). Wiley Online Library: 597–623.

Teshome, Akalu, Jan de Graaff, Coen Ritsema, and Menale Kassie. 2016. "Farmers' Perceptions about the Influence of Land Quality, Land Fragmentation and Tenure Systems on Sustainable Land Management in the North Western Ethiopian Highlands." *Land Degradation & Development* 27 (4). Wiley Online Library: 884–898.

Vargas, Carmen, Javier Pérez-Esteban, Consuelo Escolástico, Alberto Masaguer, and Ana Moliner. 2016. "Phytoremediation of Cu and Zn by Vetiver Grass in Mine Soils Amended with Humic Acids." *Environmental Science and Pollution Research* 23 (13). Springer: 13521–13530.

Waithaka, Michael M, Philip K Thornton, Keith D Shepherd, and Nicholas N Ndiwa. 2007. "Factors Affecting the Use of Fertilizers and Manure by Smallholders: The Case of Vihiga, Western Kenya." *Nutrient Cycling in Agroecosystems* 78 (3). Springer: 211–224.

Wannasai, Nareeluck, and Rajendra P Shrestha. 2008. "Role of Land Tenure Security and Farm

Household Characteristics on Land Use Change in the Prasae Watershed, Thailand." *Land Use Policy* 25 (2). Elsevier: 214–224.

Warner, Keith Douglass. 2008. "Agroecology as Participatory Science: Emerging Alternatives to Technology Transfer Extension Practice." *Science, Technology, & Human Values* 33 (6). Sage Publications Sage CA: Los Angeles, CA: 754–777.

Webler, Thomas, Hans Kastenholz, and Ortwin Renn. 1995. "Public Participation in Impact Assessment: A Social Learning Perspective." *Environmental Impact Assessment Review* 15 (5). Elsevier: 443–463.

Wellard, Kate, Jenny Rafanomezana, Mahara Nyirenda, Misaki Okotel, and Vincent Subbey. 2013. "A Review of Community Extension Approaches to Innovation for Improved Livelihoods in Ghana, Uganda and Malawi." *The Journal of Agricultural Education and Extension* 19 (1). Taylor & Francis: 21–35.

CHAPTER 6

The impact of agroecology on household production diversity and dietary diversity: Evidence from a five-year agroecological intervention in rural Malawi

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6. EXAMINING THE IMPACT OF AGROECOLOGY ON HOUSEHOLD PRODUCTION DIVERSITY AND DIETARY DIVERSITY

Following a decade of declining hunger, the global undernourished population has increased successively in the last three years. This increasing trend highlights the challenge of meeting the zero hunger and nutrition targets of Sustainable Development Goal (SDG) 2. Malawi is one of the most food insecure countries in Africa, with a significant proportion of its population being undernourished. Some sustainable intensification advocates argue that increasing yield through input-intensive agriculture is necessary for ameliorating global hunger. However, in countries like Malawi, there is evidence of the counter-productive effects of input-intensive agriculture including the narrowing of the food basket and unequal access to inputs. Consequently, other scholars have argued that alternative diversified agricultural approaches, combined with attention to underlying inequalities, maybe more promising in addressing undernutrition. Agroecology is one such approach that promotes biodiversity and pays attention to socio-political inequalities. That notwithstanding, there is limited research on its impact. Drawing theoretical insights from political ecology and based on a five-year agroecological intervention in Malawi, we examine the impact of agroecology on household production diversity and dietary diversity. We used Difference-in-Difference (DID) techniques to compare the production diversity and dietary diversity outcomes of agroecology-practising households (n=514) to a control group of non-agroecology households (n=400). We further conducted mediation analyses using Structural Equation Modelling to examine the links between household production diversity and dietary diversity. Findings from the DID analysis show a positive treatment effect of agroecology on both production diversity ($\beta=0.289$, $p<0.01$) and dietary diversity ($\beta=0.390$, $p<0.01$). Results from the mediation analysis indicate that generally, production diversity has a direct independent effect on dietary diversity ($\beta=0.18$, $p<0.01$), although the effect is higher for households practicing agroecology ($\beta=0.19$, $p<0.01$) compared to non-agroecology households ($\beta=0.14$, $p<0.01$). These findings provide evidence on how agroecology can contribute to improving nutrition in smallholder farming contexts and the achievement SDGs 2.

6.1 Introduction

This paper examines the impact of agroecology on production diversity and dietary diversity among smallholder farming households in Malawi. Following several years of declining hunger, the number of undernourished people in the world has started to rise in the last four successive years (Food and Agriculture Organization [FAO], 2018). The global burden of food insecurity has increased from 795 million people in 2015 to 821.6 million in 2018, with concentration in sub-Saharan Africa (SSA) (FAO, 2018b). What makes the situation in SSA more compelling is that the sub-region is experiencing a double burden of malnutrition marked by both undernourishment and obesity (FAO, 2018b). Despite having over 80% of its population in agriculture, Malawi is one of the countries in SSA that continues to grapple with achieving food security for its rapidly growing population (Bezner Kerr & Patel, 2014). About 30% of Malawians are chronically food insecure while an estimated 60-66% suffer from micronutrient deficiencies (National Statistical Office, 2017; Von Grebmer et al., 2018). The widespread hidden hunger in Malawi is not just an outcome of the unavailability of food but also a function of poor dietary quality (Bezner Kerr, Berti, & Shumba, 2011).

Advocates of a neo-Malthusian perspective argue that increasing yields through input-intensive agriculture is necessary for addressing global hunger (Tamburino, Bravo, Clough, & Nicholas, 2020). Meanwhile, there is evidence that global agriculture currently produces enough to feed every mouth on our planet (Helander, 2017). At the same time, even in contexts where food is available, obesity levels continue to rise (Jaacks et al., 2019). The global co-occurrence of undernourishment and obesity point to the fact that increasing crop yield through input-intensive monocrop systems does not necessarily improve food security and nutrition, given that a few energy-dense cereals with industrial value such as maize and soybean tend to be prioritized (Frison, Cherfas, & Hodgkin, 2011; Bezner Kerr et al., 2019; Rasmussen et al., 2018).

In resource-poor subsistence contexts in the Global South where households draw their food mainly from family farming, empirical research shows that production diversity contributes significantly to household food security and nutrition (Jones, Shrinivas, & Bezner Kerr, 2014; Sibhatu & Qaim, 2018). Apart from providing a sufficient range of food crops for household consumption, diversifying household production has a risk-spreading advantage, especially in rain-dependent agricultural contexts like Malawi where climate change continues to produce repeated drought and rainfall variability (Hamel, 2016). In such contexts, farmers are advised to grow multiple crops so that some crops can provide fall-back for the household in the event others fail (Meldrum et al., 2018). Moreover, given the seasonality of hunger in SSA, production diversity can help improve household food security if the range of crops cultivated includes crops that mature at different times in the cropping season. Across many parts of SSA where crop cultivation is rain-fed and seasonal, research has shown that food insecurity tends to be severe in the middle of the lean season after farmers have sown their crops (de Perez et al., 2019; Devereux et al., 2019). In this context, smallholder farmers are advised to diversify their production and include early maturing crops such as beans which the household can rely on before the major harvesting season. Furthermore, crop diversification also improves biodiversity and soil conservation (Altieri, 2018; Bezner Kerr et al., 2018; Martin & Isaac, 2018).

Despite growing evidence of the link between production diversity and dietary diversity in smallholder farming contexts (Ickowitz, Powell, Rowland, Jones, & Sunderland, 2019; Jones et al., 2014; Koppmair, Kassie, & Qaim, 2017; Sibhatu, Krishna, & Qaim, 2015), recent efforts at improving food security in most SSA countries are preoccupied with the desire to increase aggregate yield and market access without attention to issues of diversity both at the farm and consumption levels (Ignatova, 2017; Martin-Guay, Paquette, Dupras, & Rivest, 2018). In the past decade, the quest to modernize smallholder agriculture in pursuit of a new Green Revolution for Africa is contributing to the narrowing of local food baskets due to the prioritization of a few crops like maize and soybean, which have export and industrial value (Kansanga et al., 2019). In Malawi for instance, where the government has promoted this input-based agricultural intensification approach, there is evidence of the counter-productive effects on smallholder farming communities. Studies on the Farm Input Subsidy Program (FISP)—a government-led country-wide policy aimed at intensifying synthetic input use in smallholder agriculture—reveal that the program has contributed to the rise of maize monocultures and the narrowing of the food basket in local farming communities (Chibwana et al., 2012; Chirwa et al., 2012). The tying of incentives such as subsidized fertilizer and hybrid seeds to maize cultivation resulted in the increased production of maize at the expense of other food crops (Chibwana et al., 2012; Chinsinga, 2014). The eventual 'maizification' of household diets in rural areas, in particular, could be contributing to the increased incidence of hidden hunger in the country (Bezner Kerr et al., 2016; Malawi National Statistical Office, 2017).

In this context, the need for an alternative agricultural production approach that promotes both production diversity and dietary diversity is apparent. Agroecology, through its focus on biodiversification at the farm-level, has the potential to promote production diversity and dietary diversity in smallholder farming communities (Altieri & Toledo, 2011; Mdee et al., 2018). At the farm-level, agroecology encourages diversification, involving the cultivation of diverse crop varieties and integration of livestock (Altieri, 1999; FAO, 2018a; Fernandez & Méndez, 2019). Apart from enhancing beneficial ecological synergies that improve soil fertility and yield, biodiversity has the potential to promote dietary diversity and ultimately, nutrition (Bezner Kerr, Rahmanian, Owoputi, & Batello, 2018; Bisht et al., 2018). That notwithstanding, there is limited empirical research on the relationship between agroecology and household production diversity and dietary diversity. This paper uses a two-wave data from an agroecological intervention in Malawi to examine the impact of agroecology on household production diversity and dietary diversity. We hypothesize that agroecology can improve both production diversity and dietary diversity in smallholder farming contexts.

6.2 Theoretical approach

We draw upon a political ecology approach within the broader framework of the theory of the metabolic rift to understand the relationship between agroecology and household production diversity and dietary diversity. Political ecology combines ecological concerns with a broader political economy to understand the outcomes of human-environmental interaction including issues of food insecurity (Bryant, 1998; Carr, 2015). Political ecology draws largely from Marx's idea of the metabolic rift which views social reproduction as the main linkage between society and nature. In the *Grundrisse* (first published in 1939), Marx argues that, environment related issues such as food insecurity and malnutrition can be better understood through a careful reflection on how social reproduction is constantly shaped over time and space (Marx, 2005). According to Marx capitalist accumulation severed the sustainable ecological synergies that characterised earlier forms of agriculture (see also McClintock, 2010). Under earlier forms of agriculture, humans maintained a sustainable metabolism with nature through the constant recycling of soil nutrients. Soil nutrients were harnessed and transformed into food through the process of crop cultivation while farmers maintained soil fertility by constantly returning crop residue into the soil, and designing agriculture in ways that promoted agrobiodiversity through practices such as intercropping, crop rotation and livestock integration (Clark & Foster, 2013; Wittman, 2009). This form of social reproduction was disrupted by the capitalist drive for accumulation and the eventual reliance on synthetic inputs to increase yields (Moore, 2000; Schneider & McMichael, 2010). This disruption also has adverse implications on the diversity of what is produced and consumed (Altieri, 2009; Figueroa-Helland et al., 2018; Holt-Giménez & Altieri, 2013; Misra, 2017).

A key question that critical food security scholars are increasingly interested in is how food security and nutrition are shaped by the broader political, biophysical and social environment within which they occur (Kimura, 2013). This focus implies a closer consideration of the roles of both ecological and socio-political factors such as global and national agricultural policies as well as micro-level inequalities in the control of productive resources (Elmhirst, 2015; Nygren & Rikoon, 2008; Zimmerer & Bassett, 2003). In the Malawian context, the political economy of agriculture (both historical and contemporary) has favoured an input-intensive production approach due to the government's longstanding commitment to promoting input-based maize cultivation (Chinsinga, 2011). In the context of this skewed policy gaze, this paper seeks to understand whether agroecology-based farming can improve production diversity, and household dietary diversity for resource-poor smallholder farming households who not only lack access to government-subsidized farm inputs but also have limited financial capacity to purchase modern agricultural inputs on their own. By situating our analysis within the broader political economy of Malawian agriculture and the ecological dynamics that underlie smallholder farming, we aim to provide evidence on how agroecology may be positioned to improve production diversity and dietary diversity.

Amid the call for global agricultural systems to be re-oriented toward sustainable approaches that promote the judicious use of resources while improving food production and nutrition in an environmentally sustainable manner (see FAO, 2018a), agroecology has received widespread traction as an alternative agricultural approach, especially for resource-poor smallholder farmers (HLPE, 2020). At the farm-level, agroecology builds on the principles of the improvement of soil fertility and soil biological activity through recycling of crop residue, legume intercropping, mulching and composting without reliance on external inputs such as fertilizers; the promotion of biodiversity within and between species including the cultivation of diverse crop species and integration of livestock; ensuring a balance and minimizing losses in nutrient and energy flows; and ensuring increased biological interactions for improved pest management (Altieri, 2002; Gliessman & Engles, 2014). Interactively, these practices yield an agroecosystem that does not rely on modern inputs but rather on the promotion of ecological synergies for improved soil management (Altieri, 2018). Farmer-to-farmer horizontal teaching methods and participatory research drawing on the use of indigenous knowledge and attention to social and cultural values of food systems are other principles of agroecology (Méndez et al., 2013). A growing body of literature suggests that these beneficial ecological synergies from agroecology could have positive impacts on smallholder agriculture and ultimately, household nutrition (Altieri & Toledo, 2011; Deaconu, Mercille, & Batal, 2019; Kangmennaang et al., 2017; Kremen & Miles, 2012; Mdee et al., 2018; Nyantakyi-Frimpong, Mambulu, Bezner Kerr, Luginaah, & Lupafya, 2016; Oliver, 2016; Solorio et al., 2017). This paper builds upon and extends existing scholarship on the relationship between agroecology and household production diversity and dietary diversity.

6.3 Study setting

6.3.1 A socio-political and environmental context of Malawi

Malawi is a landlocked country in southern Africa. The population is predominantly rural, with about 80% engaged in smallholder farming. Currently, Malawi is one of the poorest countries in the world with about 70% of the population living on less than a dollar a day (World Bank, 2018). Despite having a significant proportion of its population engaged in agriculture, almost one-third of households experience severe food insecurity and about half of children under age five are stunted (FAO, 2017; National Statistical Office, 2017). In the last two decades, persistent droughts and food shortages have compelled the government to repeatedly declare states of emergency (Hamel, 2016; Stevens & Madani, 2016). Another drought and food shortage is forecast in the 2019/2020 planting season which raises further concerns about the country's ability to feed its increasing population (National Smallholder Farmers' Association of Malawi [NASFAM] (2018). Maize is the dominant crop in smallholder farming in Malawi. About 75% of the total land area cultivated under smallholder farming is planted to maize and most rural farming households usually rely heavily on maize as a source of food and income (Silberg, Richardson, Hockett, & Snapp, 2017).

Despite the lack of consensus on the drivers of food insecurity in the Malawian context, the role of environmental change, colonial and post-colonial policy failures have been widely acknowledged. Historically, colonial policies favoured export agriculture which focused on cash crops such as tobacco, at the expense of food crop production (Vail, 1983). The continued pursuit of export-driven agriculture by post-independence governments further led to the diversion of productive resources including land, extension services and farm inputs to the estate agricultural sector at the expense of smallholder farming (Bezner Kerr & Patel, 2014).

Land access remains a major challenge to smallholder agriculture in recent times, especially for women and poor households, and several land reforms have failed to address inequality in land access (Kishindo & Mvula, 2017; Peters, 2010; Sharp, Le Billon, & Zerriffi, 2018).

Recent agricultural policies by the government such as the Farm Input Subsidy Program (FISP) aimed at improving smallholder agriculture through input-intensive production have had some noteworthy counterproductive results (Kilic et al., 2014). Apart from the fact that poor smallholder farmers are unable to meet the financial demands of acquiring these subsidized farm inputs, research also indicates that input subsidy programmes tend to favour elite farmers and local political party 'faithfuls' to the neglect of the most vulnerable smallholder farmers (Lunduka et al., 2013). Moreover, although the FISP increased aggregate maize yield (Chirwa & Dorward, 2013), there is evidence of decreased crop diversity expressed in reduced production of legumes and traditional cereals such as millet and sorghum (Bezner Kerr, 2014; Chibwana et al., 2012; Chinsinga, 2018; Mhango, Snapp, & Phiri, 2013). As highlighted earlier, the reconfiguration of previously diversified smallholder farming systems to maize monocultures through the FISP has also been reported to have negative implications on production diversity and household nutrition (Bezner Kerr, 2014). The 'maizification' of smallholder agriculture implies that at the farm-level, smallholder farmers have no climate risk-spreading opportunity associated with diversified systems that integrate traditional crops such as millet and sorghum, which are known to have drought-tolerance potential in this context (Bezner Kerr, 2014). Given that most rural households draw their food from what they cultivate, household nutrition will be largely shaped by the range of crops produced. Hence, in Malawi where maize monocropping dominates smallholder agriculture, it is not surprising that micro-nutrient deficiency is widespread (National Statistical Office, 2017).

6.3.2 The agroecology intervention

This participatory agroecological intervention was implemented in the Dedza and Mzimba districts of Malawi from 2012 to 2017. The project harnessed local resources and used a farmer-to-farmer knowledge sharing approach to train smallholder farmers on the application of agroecological practices aimed at improving agricultural productivity and household nutrition.

Figure 6.1: Map showing study districts

In the context of the widespread micronutrient deficiencies and soil infertility, the project encouraged farmers to diversify production through the integration of legumes (including pigeon pea, groundnuts and cowpea) and other tuber crops such as cassava and sweet potato. In the first year of joining the project, farmers in the intervention group were supported with a range of local seeds including pigeon pea, groundnut, open pollinated varieties of yellow maize, sweet potato and cassava stalks/cuttings and were expected to save their seeds for subsequent seasons. These methods were aimed at diversifying household production and diets, improving soil health and ultimately improving household nutrition. Aside from supporting farmers to diversify production, the project also used participatory learning approaches to teach smallholder farmers other agroecological practices including mulching, afforestation, intercropping, crop diversification, composting and livestock integration. Although these agroecological practices may help diversify production and improve household nutrition outcomes, other relevant factors such as nutrition education remain crucial to improving household nutrition. The agroecological intervention prioritized nutrition education through recipe days during which both men and women from agroecology households discussed new recipes and exchanged knowledge on nutrition.

Given that social justice concerns are central to agroecology, the project implemented routine programmes explicitly focused on improving household gender relations, including community gender campaigns where husbands and wives from participating households performed culturally ascribed female domestic roles such as cooking and caring for children together. These programmes aimed to create spaces for dialogue and provide opportunities for men and women from participating households to perform new gender roles, in order to demystify unequal patriarchal belief systems and practices in smallholder farming communities such as land tenure norms and gendered division of labour.

6.4. Data and analysis

6.4.1 Data

This analysis is based on a two-wave survey data from the five-year agroecology intervention implemented in the Mzimba and Dedza districts of Malawi. The project used a stepped wedge longitudinal design in which households from control villages were sequentially selected into the intervention in subsequent years of the project. At the baseline, participating village areas were purposively selected in consultation with village leaders and residents following community awareness meetings about the project. Selection of village areas was guided by two main criteria: the majority of the population of the village were smallholder farmers, and no similar agricultural projects or programs were being implemented in the area. A total of 13 participating village areas were selected: 10 village areas received the intervention—5 village areas at the baseline (2012), while 3 and 2 village areas were added sequentially in 2013 and 2014, respectively. The remaining three village areas that were never exposed to the intervention served as the control group. Sampling of village areas into the control and intervention groups was done across separate village areas to avoid the issue of 'contamination' of intervention knowledge and materials. Details of the sampling are provided below on Table 6.1.

Table 6.1: Showing study sample

Category	**District**	**Village Area**	**Joined 2012**	**Joined 2013**	**Joined 2014**	**Total sample**
Intervention	Mzimba	Chimbongondo	122			**818**
		Emtiyani	63			
		Kafulufulu	117			
		Mlimo	98			
		Kabanda		58		
		Edundu		48		
	Dedza	Mphathi	114			
		Chumachitsala		48		
		Chimoto North			105	
		Makowe			45	
Sub-total			514	154	150	
Control	Mzimba	Mtwalo	200			**400**
		Dunduzu	55			
	Dedza	Mtendere	145			
Total						**1218**

Sampling of households into both intervention and control groups was based on the following criteria: being food insecure (assessed qualitatively by asking preliminary questions on food availability and access); ability to farm (self-reported based on whether the household had access to productive resources such as land and was already cultivating, and interest in participating in the project. As observed earlier, the rationale for using the same criteria was to ensure that the sample is ccomparable across both control and treatment groups. At the baseline (2012), 2089 farming households received the intervention while 2121 and 2562 households were sequentially sampled into the intervention group in 2013 and 2014, respectively. In a typical stepped wedge design where more participants are exposed to the intervention at the endline than the baseline, the treatment effect of the intervention can be confounded with an underlying temporal trend in the project context (Hemming et al., 2015). Cognizant of this potential for confounding of the treatment effect, we modified the stepped wedge design so that at the endline there were control households from the baseline who were not exposed to the intervention. This design can facilitate an unbiased estimation of the treatment effects of the intervention independent of any trend effects by comparing intervention households and those that were never exposed to the intervention.

Data collection followed a longitudinal approach. Prior to the intervention, a baseline survey was conducted in 2012 with households from all participating villages (n=1218) who agreed to be contacted for an endline survey. The baseline sample was a randomly selected sub-sample from those households that were scheduled to receive the intervention (n=818 comprising 514 households that received the intervention in 2012, and 154 and 150 of those households that were sequentially sampled into the intervention in 2013 and 2014), and those households who never received the intervention (n=400). In November 2017, an endline survey was conducted with the same households. In both baseline and endline surveys, the control households were farming households from the 3 village areas that never received the intervention. In each household, the survey was administered to the husband or wife. In polygamous households, where more than one wife was present at the time of the survey, a dice was cast to select one of the wives. Both baseline and endline surveys collected information on demographic characteristics, household food security, nutrition, assets, on-farm and off-farm socioeconomic activities and gender relations. Survey instruments were pretested to ensure content validity and clarity. The data was collected by trained enumerators who were fluent in the local languages (Tumbuka & Chichewa). To further minimize the effect of underlying temporal trends in the project context on our analysis, we restricted our analytical sample to the 514 households that received the intervention at the baseline (2012) and the control group (n=400 households) that were not exposed to the intervention throughout the project's lifespan.

6.4.2 Measures

There are two dependent variables in this analysis, namely, dietary diversity and production diversity. Dietary diversity is usually measured using either the Household Dietary Diversity Score (HDDS) or Food Variety Score (FVS). The latter entails a simple count of the different food items consumed in the household during the recall period, usually in the last 24 hours (Sibhatu et al., 2015). While this measure is useful, it is limited in situations where cultural beliefs or other forms of variations in food preferences and dietary habits may exist among households in a given geographical area. Moreover, the HDDS is considered a better measure, given that it reveals the quality of foods available to households from a nutritional perspective (Chegere & Stage, 2020). As a result, we measured dietary diversity using the HDDS. The HDDS is computed based on the number of food groups consumed by a household during the recall period (Koppmair et al., 2017; Sibhatu et al., 2015). While other studies have argued for a week-long recall to account for possible variations in daily household diets, the approach leaves room for recall bias, for which reason we used a 24-hour dietary recall in our surveys. Although there is no universally agreed set of food groups to include in the computation of the HDDS, previous studies (Koppmair et al., 2017; Swindale & Bilinsky, 2006) have used the 12 food groups recommended by the Food and Agriculture Organization (FAO, 2011). These food groups include: Cereals; White tubers and roots; Legumes, nuts and seeds; Vegetables; Meat; Eggs; Fish and other seafood; Fruits; Milk and milk products; Oils and fats;

Sweets; and Spices, condiments and beverages. The resultant production diversity score was normalized to range between 0 and 1.

We measured production diversity using the Agricultural Diversity Score (ADS). Like the HDDS, the ADS is a measure of the number of different food groups produced by the household, based on the 12 groups recommended by the FAO (see Koppmair et al., 2017; Malapit, Kadiyala, Quisumbing, Cunningham, & Tyagi, 2015). Unlike the simple species count, this measure takes into consideration diversity in production across various food groups such that if a given household produces several species of the same food group, its production diversity score will be lower compared to the simple species count. As argued by Koppmair et al. (2017), a simple species count does not show true diversity from the nutritional perspective since food products belonging to the same food group (for instance, a household may produce maize and rice which are both cereals) largely provide the same type of nutrient. Our resultant score was normalized to range between 0 and 1, where every additional food group produced by the household adds the same score point toward the ADS. Conceptually, constructing the ADS and HDSS using similar proxies provides an opportunity to examine the relationship between the two (Berti, 2015).

We also included some independent variables including membership in the agroecology intervention coded as (0=No/non-agroecology and 1=Yes/agroecology), household structure (0=monogamous; 1=polygamous; 2=separated/divorced), age of primary male in the household (0=<30; 1=30-45; 2=46-60; 3=>60), age of primary female in the household (0=<30; 1=30-45; 2=46-60; 3=>60), level of education of primary male in the household (0=no education; 1=primary education; 2=secondary education or higher), level of education of primary female in the household (0=no education; 1=primary education; 2=secondary education or higher), household size (1=Less than 4; 2=4 to 6; 3=More than 6), household wealth (0=poor; 1=middle income; 2=rich), household food security (0=food secure; 1=food insecure) measured using the Household Food Insecurity Access Scale, farm size (0=more than 5 hectares; 1=2.5 to 5 hectares; 2=less than 2.5 hectares), participation in community gardening (0=yes; 1=no), alcohol consumption (0=yes; 1=no), and household land ownership status (0=yes; 1=no).

6.4.3 DID Estimation

The analysis in this paper is organized in two phases. First, we used DID to estimate the treatment effect of agroecology on production diversity and dietary diversity. The DID approach is a widely used method in impact analysis (see Grillos, 2018; Kabunga, Dubois, & Qaim, 2012). Specifically, the DID technique compares the change in the outcome variable between the treated and control group and estimates the effect of the treatment as a linear or probit model (Lechner, 2011). The DID statistical approach is expressed as follows:

$$Y_{ijt} = \alpha_0 + X_{ijt}\beta_1 + X_{ijt}\beta_2 + \tau^{2012}\beta_3 + \tau^{2017}\beta_4 + \mathrm{P}_{jt}\tau^{2012}\beta_5 + \mathrm{P}_{jt}\tau^{2017} + \varepsilon_{ijt}$$

where i is an index for a household, participating in the survey j in year t. The dependent variable $Y_{ijt,}$ reflects the production diversity or dietary diversity of the household and X_{ijt} is a vector of control variables. P_j is a dummy variable, which takes the value of 1 if the household j received the intervention and 0 if the household is in the control group. T^{2012} and T^{2017} are dummies for the years of survey.

Differences in group composition and time trends are potential sources of bias in the estimation of the treatment effects of interventions using the DID approach (Lechner, 2011). An unbiased estimate of the treatment effect can be achieved only when the treatment group and the control group are comparable or exchangeable (Godard-Sebillotte, Karunananthan, &

Vedel, 2019; Lanza, Moore, & Butera, 2013). Exchangeability, also referred to as 'no unmeasured confounding' is achieved when treatment and control groups are similar for all relevant confounding factors (Godard-Sebillotte et al., 2019). As outlined earlier, the intervention used a quasi-experimental design (Bärnighausen et al., 2017; Campbell & Stanley, 2015). Although a common criterion was used to sample farming households into both treatment and control groups to ensure that participating households had similar socioeconomic characteristics, slight differences in background characteristics between households in the two sample groups could bias our estimates. Thus, to estimate the treatment effect of the intervention on production diversity and dietary diversity, we used kernel-based propensity score matching (PSM) difference-in-difference estimation (Leuven & Sianesi, 2018). This technique matches subjects in the treatment group to a weighted average of all subjects in the control group using inversely proportional weights.

6.4.4 Structural Equation Modelling

To understand the relationship between household production diversity and dietary diversity, we conduct a mediation analysis using data from the endline survey. Mediation analysis yields estimates for the total effect (association of production diversity with dietary diversity), the direct effect (association of production diversity with dietary diversity controlling for the mediators), and indirect effects of production diversity on dietary diversity through each mediator (indirect effects). SEM also allows an examination of the extent to which the mediators independently contribute to an explanation of the association of the focal variable (production diversity) with the outcome variable (dietary diversity), as well as a comparison between mediators.

6.5. Results

6.5.1 Univariate analysis

Table 6.2 shows our sample characteristics at baseline. About two-thirds of households were monogamous married couples among both agroecology adopting households (66%) and non-agroecology (62%). A similar distribution was observed for age and education of the primary male and primary female in both treatment and control households. More than two-thirds of households in both sample groups were food insecure at the baseline. By contrast, household size, farm size, dry season vegetable gardens, or *dimba* cultivation, and household wealth were slightly differently distributed between intervention and control households. For instance, a relatively higher proportion of households in the treatment group (23%) had more than 6 members compared to control households (18%). In terms of wealth, 48% of treatment households were part of the richer category compared to control households with 40%. Also, more treatment households (42%) had a household member regularly consuming alcohol compared to control households (33%). Similarly, more treatment households (72%) owned the land on which they cultivated compared to control households (64%).

Table 6.2: Baseline sample characteristics

Variable	Treatment (%)	Control (%)	Pooled (%)
Household structure			
Monogamous	339 (66)	248 (62)	587 (64)
Polygamous	41 (8)	36 (9)	77 (9)
Separated/Divorced	134 (26)	116 (29)	250 (27)
Age of primary male			
Less than 30	170 (33)	124 (31)	294 (32)
30-44	164 (32)	124 (31)	288 (31)
46-60	98 (19)	84 (21)	182 (20)
Greater than 60	82 (16)	68 (17)	150 (17)
Age of primary female			
Less than 30	190 (37)	136 (34)	326 (36)
30-44	159 (31)	132 (33)	291 (32)
46-60	93 (18)	80 (20)	173 (19)
Greater than 60	72 (14)	52 (13)	124 (14)
Education of primary male			
None	144 (28)	108 (27)	252 (28)
Primary	267 (52)	216 (54)	483 (52)
Secondary or higher	103 (20)	76 (19)	179 (20)
Education of primary female			
None	170 (33)	136 (34)	306 (33)
Primary	288 (56)	220 (55)	508 (56)
Secondary or higher	56 (11)	44 (11)	100 (11)
Household size			
Less than 4	247 (48)	172 (43)	419 (46)
4 to 6	175 (34)	136 (34)	311 (34)
More than 6	92 (18)	92 (23)	184 (20)
Farm size			
Less than 2.5 acres	344 (67)	280 (70)	624 (68)
2.5 to 5 acres	113 (22)	92 (23)	201 (22)
More than 5 acres	57 (11)	28 (7)	85 (10)
Dimba/dry season gardening			
No	262 (51)	228 (57)	490 (54)
Yes	252 (49)	172 (43)	424 (46)
Household wealth			
Poor	149 (29)	140 (35)	289 (31)
Middle	118 (23)	100 (25)	218 (24)
Rich	247 (48)	160 (40)	407 (45)
Food security			
Food secure	93 (18)	84 (21)	177 (19)
Food insecure	421 (82)	316 (79)	737 (81)
Household alcohol consumption			
No	344 (67)	232 (58)	576 (63)
Yes	170 (33)	168 (42)	338 (37)
Land ownership			
Yes	329 (64)	288 (72)	617 (68)
No	185 (36)	112 (28)	297 (32)
Total	**514**	**400**	**914**

6.5.2 DID estimation of the impact of agroecology on household production diversity and dietary diversity

To facilitate an unbiased estimation of the treatment effects using the DID approach, we first explored the likelihood of participating in the agroecology intervention using a probit model to ascertain the factors associated with receiving the agroecology intervention. Table 6.3 shows probit estimates of the probability of participating in the agroecology intervention. The results suggest that household size, age of the primary male, household food security and household wealth were significantly associated with participating in the agroecology intervention. To address differences across baseline characteristics between treatment and control households and associated potential confounding, we applied Kernel based PSM. As explained earlier, the kernel-based method matches all treated subjects to a weighted average of all controls, using inversely proportional weights (Lee, 2013).

Table 6.3: Probit estimates of the chance of receiving the agroecology intervention

Variable	**Probit estimates of receiving the intervention**
Household size	-0.09(0.039)**
Household structure	-0.03(0.048)
Age of primary male	0.11(0.064)*
Age of primary female	0.01(0.055)
Education of primary male	0.06(0.075)
Education of primary female	-0.13(0.082)*
Household food security	0.16(0.057)***
Household wealth	-0.14(0.011)***
Land ownership	0.07(0.020)
Farm size	0.09(0.064)
Dimba/community gardening	0.06(0.086)
Alcohol consumption	-0.03(0.033)

***p<0.01**p<0.5, *p<0.1

Results from the DID model showing the treatment effect of agroecology on production diversity are shown on Table 6.4. Following the MAFFA intervention, the difference in mean production diversity score (β=0.278, $p<0.01$) between treatment and control households was positive and statically significant. The overall treatment effect of the agroecological intervention on household production diversity was positive and statistically significant (β=0.289, $p<0.01$), indicating that the agroecological intervention had a positive impact on household production diversity.

Table 6.4: DID model of the average effect of agroecology adoption on household production diversity

Outcome variable	Baseline			Endline			Difference-in-Difference
	Control (2012)	Treatment (2012)	Diff (BL)	Control (2017)	Treatment (2017)	Diff (EL)	
Production diversity	0.221	0.210	-0.012	0.229	0.507	0.278***	0.289***
Robust std. errors	0.049	0.064	0.012	0.036	0.061	0.013	0.017
t-statistic	4.54	3.30	-1.00	6.39	8.32	22.08	16.88
Means and Standard Errors are estimated by linear regression. ***p<0.01, **p<0.05, *p<0.1. Adjusted R^2: 0.29.							

Table 6.5 shows adjusted results from DID analysis of the impact of agroecology adoption on household dietary diversity. At Wave 1, both agroecology (β=0.180) and non-agroecology (β=0.184) households reported similar levels of dietary diversity. At the endline following the intervention, there was a significant difference in mean dietary diversity (β=0.190, p<0.01) between the treatment and control groups. Overall, the treatment effect of the intervention on dietary diversity was positive and statistically significant (β=0.175, p<0.01).

Table 6.5: Adjusted DID model of the average effect of agroecology on household dietary diversity

Outcome variable	Baseline			Endline			Difference-in-Difference
	Control (2012)	Treatment (2012)	Diff (BL)	Control (2017)	Treatment (2017)	Diff (EL)	
Dietary diversity	0.184	0.200	0.015	0.195	0.385	0.190***	0.175***
Robust std. errors	0.032	0.054	0.011	0.042	0.036	0.012	0.017
t-statistic	5.79	3.71	1.36	4.68	10.71	15.54	10.46
Means and Standard Errors are estimated by linear regression. ***p<0.01, **p<0.05, *p<0.1. Adjusted R^2: 0.17.							

6.5.3 Mediation analysis of the relationship between production diversity and dietary diversity

The first mediation results indicate that production diversity has a direct and independent effect on household dietary diversity ($\beta=0.18$, $p<0.01$), even after accounting for potential confounding factors (see Table 6.6 and Figure 6.2). Thus, agricultural production diversity significantly increased dietary diversity generally although the effect was higher for households practicing agroecology. As shown by the thicker red lines in Figure 6.2, production diversity may shape household dietary diversity indirectly through demographic and socio-economic factors including the level of education of the primary male in the household ($\beta=0.09$, $p<0.01$), educational level of the primary female ($\beta=0.12$, $p<0.01$), year of survey ($\beta=-0.21$, $p<0.01$), family size ($\beta=0.08$, $p<0.01$), household wealth ($\beta=0.22$, $p<0.01$), and household food security ($\beta=-0.08$, $p<0.01$). Production diversity also indirectly shaped dietary diversity through agricultural factors such as farm size ($\beta=0.08$, $p<0.01$).

We further fitted two separate mediation models to examine the differential mediation effects of production diversity on household dietary diversity by project membership (thus between households in the treatment group and control group).

Table 6.6: Links between production diversity and household dietary diversity (coefficients are visualized on Figure. 6.2, Figure 6.3 and Figure 6.4 respectively)

Variable	Pooled	Control	Treatment
	Β(95% CI)	Β(95% CI)	Β(95% CI)
Production diversity	0.18(0.12 - 0.24)***	0.14(0.04 - 0.23)***	0.19(0.11 - 0.27)***
Age of primary male	0.03(-0.01 – 0.07)	0.05(-0.03 – 0.13)	0.02(-0.04 – 0.07)
Age of primary female	-0.03(-0.08 – 0.01)	-0.13(-0.21 – -0.04)*	0.01(-0.05 – 0.07)
Education of primary male	0.09(0.04 – 0.13)***	0.12(0.03 – 0.20)***	0.07(0.02 – 0.13)**
Education of primary female	0.12(0.07 – 0.16)***	0.07(-0.01 – 0.15)*	0.13(0.07 – 0.19)***
Year of Survey	-0.21(-0.28 – -0.14)***	-0.29(-0.41 – -0.18)***	-0.17(-0.26 – -0.08)***
Household wealth	0.22(0.18 – 0.27)***	0.23(0.16 – 0.30)***	0.22(0.17 – 0.28)***
Household food security	-0.08(-0.13 – -0.03)***	-0.04(-0.11 – 0.03)	-0.09(-0.15 – -0.04)***
Farm size	0.08(0.04 – 0.12)***	0.12(0.05 – 0.18)***	0.05(0.001 – 0.10)**
Dimba/community gardening	0.03(-0.01 – 0.07)	0.06(-0.01 – 0.14)*	0.02(-0.03 – 0.07)
Alcohol consumption	-0.01(-0.03 – 0.04)	0.02(-0.04 – -0.09)	-0.01(-0.05 – 0.04)
Household size	-0.04(-0.08 - 0.002)**	-0.09(-0.16 – -0.02)***	-0.03(-0.07 - 0.02)
Household structure	-0.01(-0.06 - 0.05)	0.03(-0.06 – 0.12)	-0.02(-0.09 - 0.04)
CFI	0.446	0.401	0.469
R^2	0.631	0.585	0.658
AIC	90246.404	29392.268	57747.742
BIC	90582.961	29646.591	58038.671
Observations	914	400	514

Notes: β= Beta; Ref = Reference Category; *p≤0.10, **p≤0.05, ***p≤0.01; CI = confidence intervals, CFI=Comparative fit index.

We found that the direct effect of production diversity on household dietary diversity among treatment households (β=0.14, p<0.05) (see Figure 6.3) was relatively smaller compared to the direct effect among treatment households (β=0.19, p<0.01) (see Figure 6.4). Also, the indirect paths linking production diversity and dietary diversity were different for agroecology-practicing households and non-agroecology households. For instance, among non-agroecology households, the significant paths included educational level of the primary male (β=0.12, $p<0.01$), year of survey (β=0.28, p=0.01), household wealth (β=0.22, $p<0.01$), and farm size (β=0.12, $p<0.01$) (see Figure 6.3). However, among agroecology households, the significant pathways included education levels of both primary male and female, year of survey, household wealth, household food security and farm size (see Figure 6.4).

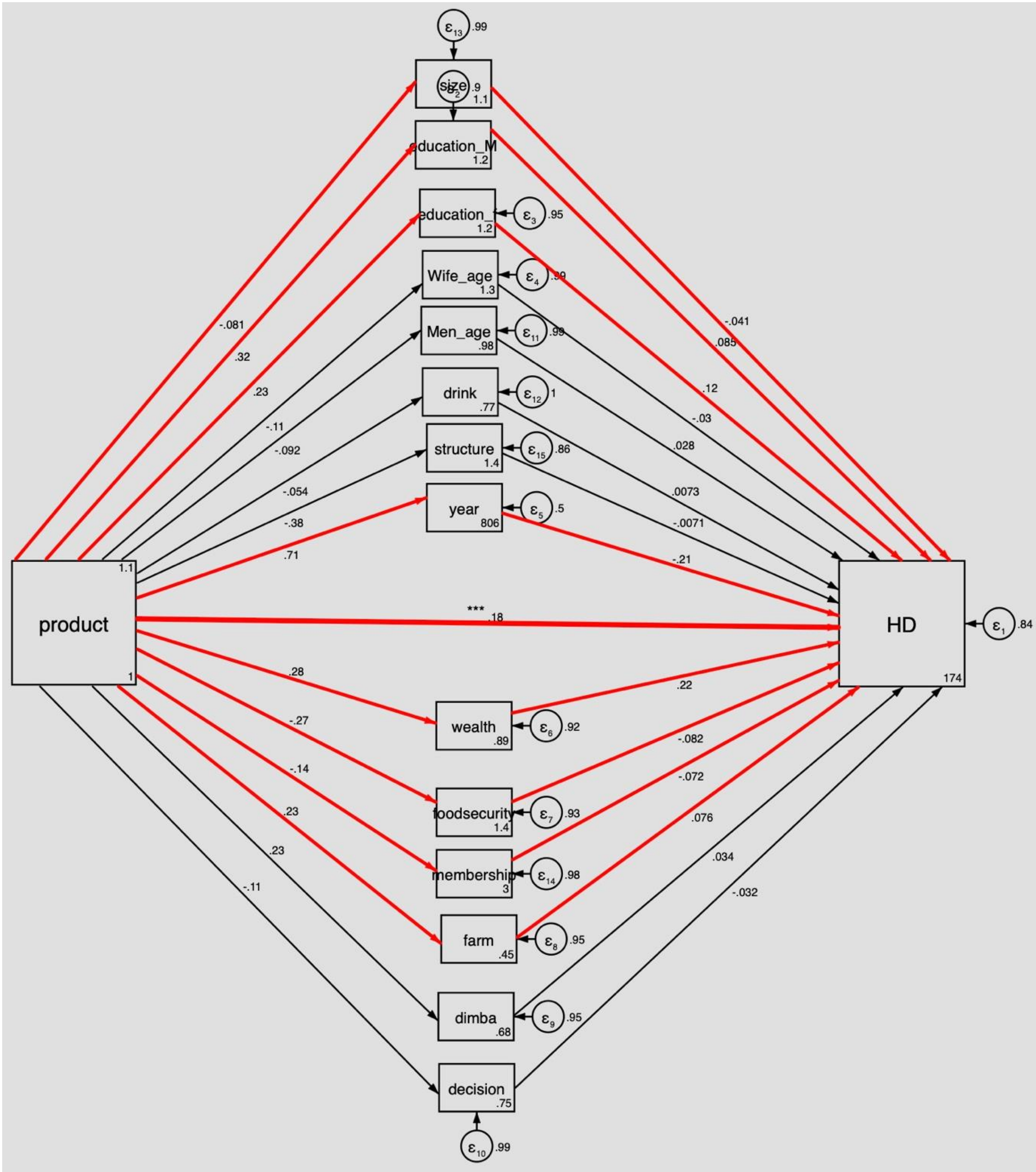

Figure 6.2: Link between production diversity and dietary diversity among smallholder farmers (total sample). Significant pathways are highlighted in red

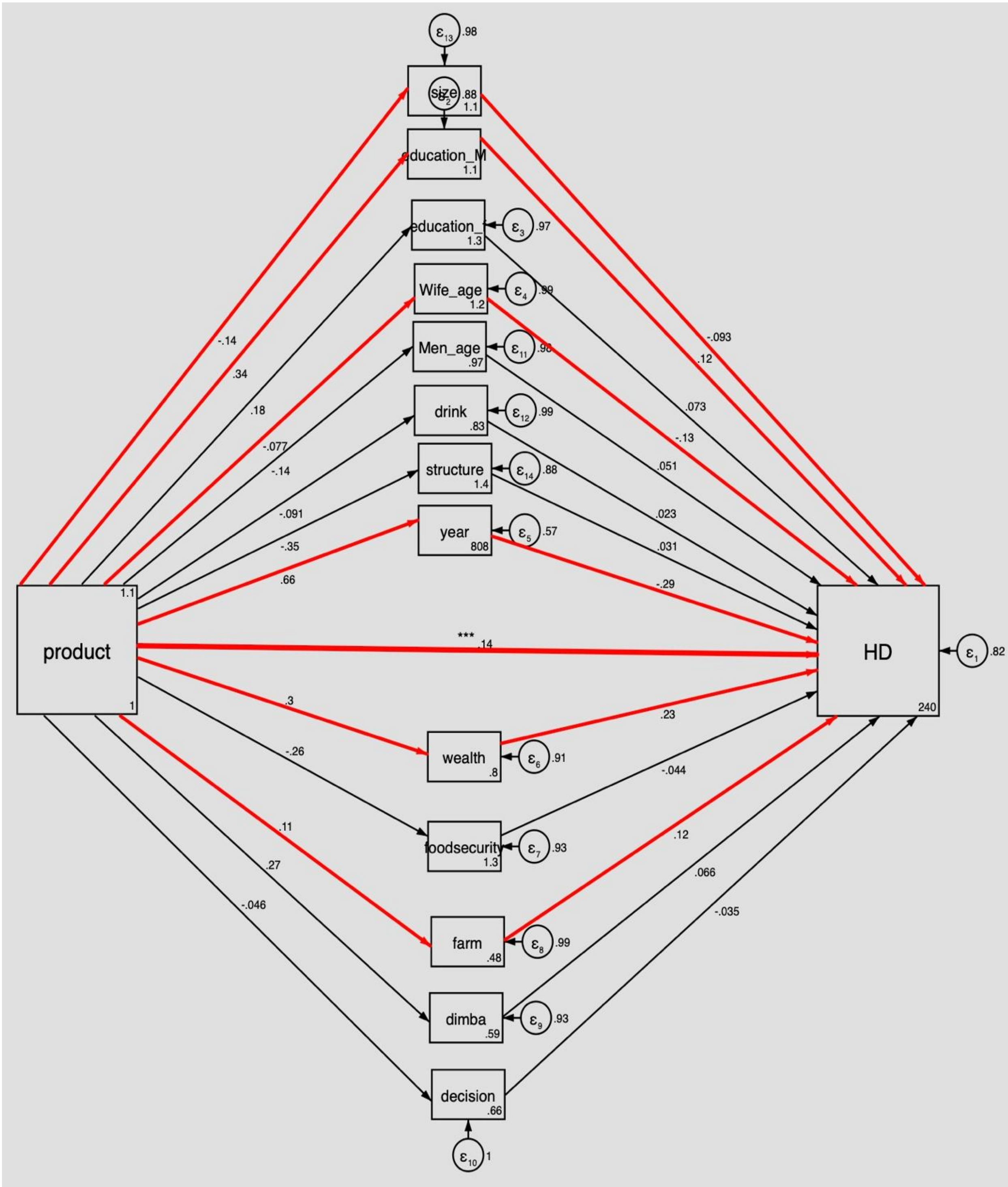

Figure 6.3: Links between production diversity and dietary diversity among non-agroecology households. Significant pathways are highlighted in red

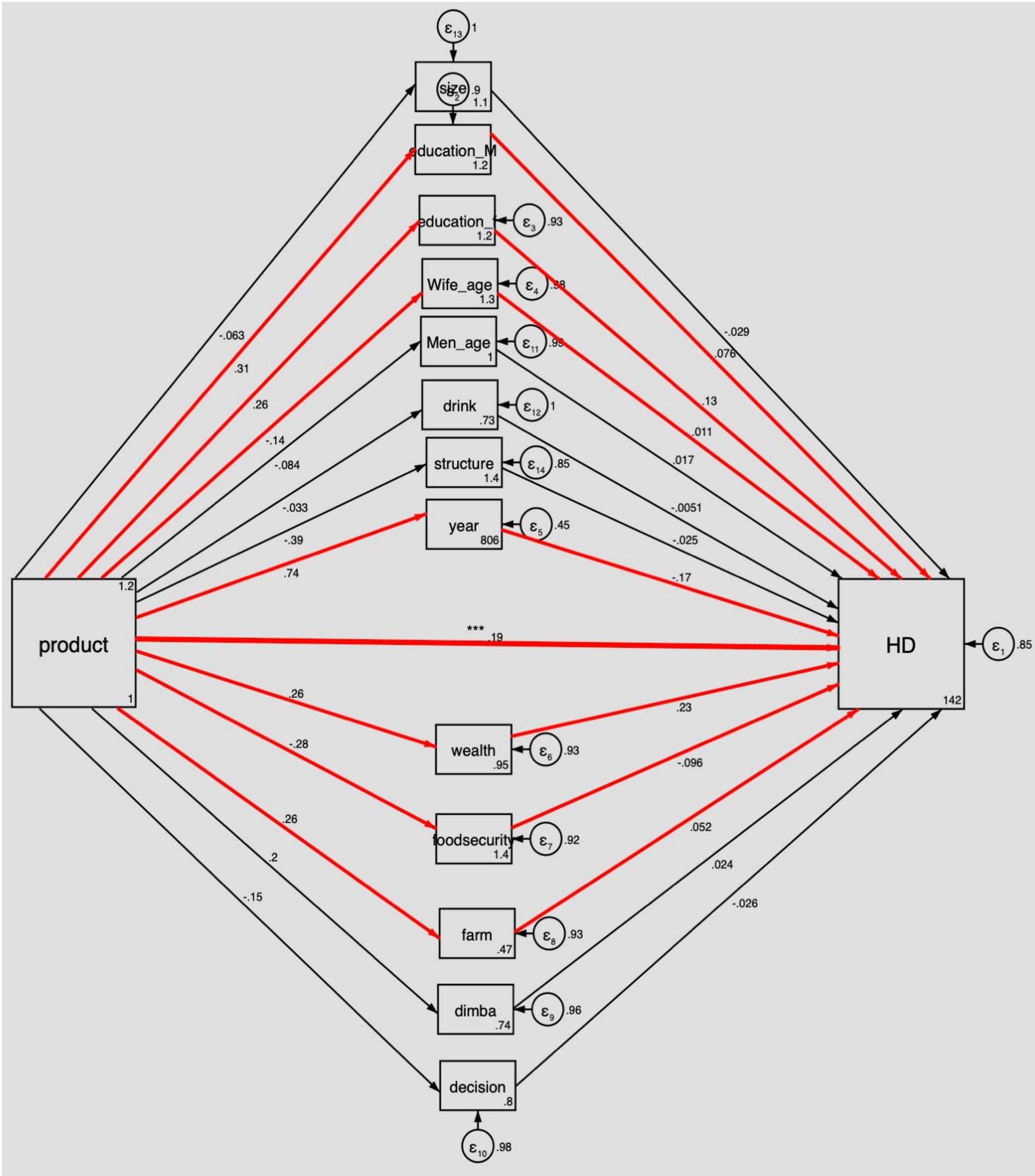

Figure 6.4: Links between production diversity and dietary diversity among agroecology households. Significant pathways are highlighted in red

6.6 Discussion and conclusions

In the context of increasing food insecurity and widespread micronutrient deficiencies in the Global South, improving smallholder farmers' production diversity has been identified as a viable strategy to tackling hunger and malnutrition (Massawe, Mayes, & Cheng, 2016; Waha et al., 2018). Given that most rural smallholder farming households draw a significant proportion of their dietary needs from subsistence production, approaches at improving household dietary diversity typically require diversifying agricultural production (Sibhatu et al., 2015). Notwithstanding increasing empirical evidence of the link between production diversity and improved household dietary diversity (Bezner Kerr et al., 2016; Jones et al., 2014; Nyantakyi-Frimpong, 2017; Onyango, 2003; Sibhatu et al., 2015), practical approaches at achieving the two, especially in countries where a majority of the population are smallholder farmers, has remained a challenge. This paper is one of the few studies to demonstrate that the use of agroecology practices by smallholder farmers can significantly improve both household production diversity and dietary diversity. Compared to farming households in the control group, households that practiced agroecology had significantly higher production diversity and dietary diversity. Our findings further reveal that generally, household agricultural production diversity significantly improved dietary diversity (Ecker, 2018; Jones et al., 2014; Koppmair et al., 2017; Sibhatu et al., 2015; Tesfaye & Tirivayi, 2020; Zanello, Shankar, & Poole, 2019). It is however, important to mention that the relationship between production diversity and dietary diversity was larger for households in the intervention group after accounting for confounding factors. Our findings build on previous research which highlights the positive transformative role of agroecology in smallholder farming contexts (Altieri, 2002; Bezner Kerr et al., 2018; Kangmennaang et al., 2017; O'Rourke, DeLonge, & Salvador, 2017).

These findings suggest that participatory farmer-to-farmer knowledge sharing about agroecology and nutrition are effective in improving household production diversity and dietary diversity. Apart from the potential for agroecology to increase the range of crops and livestock produced by smallholder farming households through its focus on ensuring agrobiodiversity (Bezner Kerr et al., 2016; Mdee et al., 2018; Oliver, 2016), the application of other agroecological practices such as intercropping, mulching and incorporating crop residue into the soil can engender sustainable synergies for improving soil fertility, crop productivity and overall availability of diverse foods to the household (Altieri, 2002; Altieri et al., 2015). Moreover, enhanced agricultural productivity can improve the purchasing power of farming households in the procurement of other relevant foodstuffs that may not be produced on the farm. In rural farming households in Malawi, it is typical for households to purchase ingredients such as oils, salt and fish from local markets. Some scholars have further argued that the mere availability of different foods to a household does not necessarily translate into proper food combinations to achieve dietary diversity in the absence of adequate knowledge on nutrition (Bezner Kerr et al., 2016; Koppmair et al., 2017). The emphasis on nutrition education and knowledge sharing through recipe days under the agroecological intervention could have contributed to the improved diversity in diets for treatment households. It is also plausible that the marginal improvements in production diversity and dietary diversity among control households may be partly explained by the spill-over effect of the agroecological intervention.

In the context of increasing evidence of the positive relationship between household production diversity and dietary diversity in resource-poor contexts (see also Jones et al., 2014; Koppmair et al., 2017; Sibhatu et al., 2015) our findings further buttress the point that agroecology could be drawn upon to simultaneously improve both production diversity and dietary diversity. In many parts of the Global South, however, the dilemma has been how to reorient smallholder farming systems in ways that can generate these benefits in an ecologically sustainable manner. The debate for improving smallholder agriculture has therefore been between moving to an input-based production system or an agroecology-based system that builds on local resources and knowledge systems (Godfray et al., 2010; Lipper & Zilberman, 2018). In the Malawian context where the government has promoted input-intensive agriculture through the Farm Input Subsidy Scheme, there is evidence of the rise of maize monocultures and the eventual 'maizification' of rural diets, with adverse implications on nutrition (Bezner Kerr & Patel, 2014; Chinsinga, 2004). In this context, agroecology presents a unique potential for reorienting smallholder agriculture to co-deliver improved production diversity and household nutrition.

While these findings provide critical policy pointers on the potential for agroecology to improve both household production diversity and dietary diversity in poor smallholder farming contexts, there are some noteworthy limitations. For instance, the data used in this paper are not nationally representative; hence, our results may not be generalizable to other contexts. Moreover, production diversity and dietary diversity can be influenced by several context-specific sociocultural factors. Although we accounted for the effects of several covariates in our analysis, our list of control variables may not be exhaustive of the varied factors that may shape household production diversity and dietary diversity. That notwithstanding, our study presents salient findings for agricultural policy in Malawi and similar context in SSA. A key strength of our analysis is that, unlike most previous studies that relied on cross-sectional agroecology interventions, the evidence from this analysis is based on a five-year agroecology intervention.

Broadly, in the context of the increasing malnutrition in smallholder farming settings across SSA (FAO, 2018b), these findings are promising and provide inroads for achieving the nutrition and zero hunger targets of SDG 2. Targets 2 and 5 of SDG 2, respectively, aim to end all forms of malnutrition and improve the genetic diversity of cultivated plants and livestock globally. Thus, agroecology, which emphasizes the diversification of agricultural systems at the farm-level, presents a unique approach to reorienting agricultural systems to co-deliver agricultural genetic diversity and dietary diversity for improved nutrition.

6.7 References

Altieri, Miguel A. 1999. "Applying Agroecology to Enhance the Productivity of Peasant Farming Systems in Latin America." *Environment, Development and Sustainability* 1 (3). Springer: 197–217.

Altieri, Miguel A. 2002. "Agroecology: The Science of Natural Resource Management for Poor Farmers in Marginal Environments." *Agriculture, Ecosystems & Environment* 93 (1). Elsevier: 1–24.

Altieri, Miguel A. 2009. "Agroecology, Small Farms, and Food Sovereignty." *Monthly Review* 61 (3). Monthly Review Press: 102.

Altieri, Miguel A. 2018. *Agroecology: The Science of Sustainable Agriculture*. CRC Press.

Altieri, Miguel A, Clara I Nicholls, Alejandro Henao, and Marcos A Lana. 2015. "Agroecology and the Design of Climate Change-Resilient Farming Systems." *Agronomy for Sustainable Development* 35 (3). Springer: 869–890.

Altieri, Miguel A, and Victor Manuel Toledo. 2011. "The Agroecological Revolution in Latin America: Rescuing Nature, Ensuring Food Sovereignty and Empowering Peasants." *Journal of Peasant Studies* 38 (3). Taylor & Francis: 587–612.

Bärnighausen, Till, Peter Tugwell, John-Arne Røttingen, Ian Shemilt, Peter Rockers, Pascal Geldsetzer, John Lavis, Jeremy Grimshaw, Karen Daniels, and Annette Brown. 2017. "Quasi-Experimental Study Designs Series–Paper 4: Uses and Value." *Journal of Clinical Epidemiology*. Elsevier.

Berti, Peter R. 2015. "Relationship between Production Diversity and Dietary Diversity Depends on How Number of Foods Is Counted." *Proceedings of the National Academy of Sciences* 112 (42). National Acad Sciences: E5656–E5656.

Bezner-Kerr, Rachel, Hickey, Catherin, Lupafya, Easther, Dakishoni, Laifolo. 2018. "Repairing Rifts or Reproducing Inequalities? Agroecology, Food Sovereignty, and Gender Justice in Malawi." *Journal of Peasant Studies*. doi:10.1080/03066150.2018.1547897.

Bezner-Kerr, Rachel, and Raj Patel. 2014. *Food Security in Malawi*. Edited by Udaya Sekhar

Nagothu. *Food Security and Development: Country Case Studies*. London: Routledge.

Bezner Kerr, Rachel. 2014. “Lost and Found Crops: Agrobiodiversity, Indigenous Knowledge, and a Feminist Political Ecology of Sorghum and Finger Millet in Northern Malawi.” *Annals of the Association of American Geographers* 104 (3). Taylor & Francis: 577–593.

Bezner Kerr, Rachel, Peter R Berti, and Lizzie Shumba. 2011. “Effects of a Participatory Agriculture and Nutrition Education Project on Child Growth in Northern Malawi.” *Public Health Nutrition* 14 (8). Cambridge University Press: 1466–1472.

Bezner Kerr, Rachel, Emmanuel Chilanga, Hanson Nyantakyi-Frimpong, Isaac Luginaah, and Esther Lupafya. 2016. “Integrated Agriculture Programs to Address Malnutrition in Northern Malawi.” *BMC Public Health* 16 (1). BioMed Central: 1197.

Bezner Kerr, Rachel, Maryam Rahmanian, Ibukun Owoputi, and Caterina Batello. 2018. “6 Agroecology and Nutrition: Transformative Possibilities and Challenges.” *Sustainable Diets: Linking Nutrition and Food Systems*. CABI, 53.

Bezner Kerr, Rachel, Sera L Young, Carrie Young, Marianne V Santoso, Mufunanji Magalasi, Martin Entz, Esther Lupafya, Laifolo Dakishoni, Vicki Morrone, and David Wolfe. 2019. “Farming for Change: Developing a Participatory Curriculum on Agroecology, Nutrition, Climate Change and Social Equity in Malawi and Tanzania.” *Agriculture and Human Values* 36 (3). Springer: 549–566.

Bisht, I S, P S Mehta, K S Negi, S K Verma, R K Tyagi, and S C Garkoti. 2018. “Farmers’ Rights, Local Food Systems, and Sustainable Household Dietary Diversification: A Case of Uttarakhand Himalaya in North-Western India.” *Agroecology and Sustainable Food Systems* 42 (1). Taylor & Francis: 77–113.

Bryant, Raymond L. 1998. “Power, Knowledge and Political Ecology in the Third World: A Review.” *Progress in Physical Geography* 22 (1). Sage Publications Sage CA: Thousand Oaks, CA: 79–94. doi:10.1177/030913339802200104.

Campbell, Donald T, and Julian C Stanley. 2015. *Experimental and Quasi-Experimental Designs for Research*. Ravenio Books.

Carr, Edward R. 2015. "Political Ecology and Livelihoods." *Handbook of Political Ecology*. Abingdon: Routledge, 332–342.

Chegere, Martin J, and Jesper Stage. 2020. "Agricultural Production Diversity, Dietary Diversity and Nutritional Status: Panel Data Evidence from Tanzania." *World Development* 129. Elsevier: 104856.

Chibwana, Christopher, Monica Fisher, and Gerald Shively. 2012. "Cropland Allocation Effects of Agricultural Input Subsidies in Malawi." *World Development* 40 (1). Elsevier: 124–133.

Chinsinga, B. 2011. "Seeds and Subsidies: The Political Economy of Input Programmes in Malawi." *IDS Bulletin* 42 (4). Wiley Online Library: 59–68.

Chinsinga, B. 2014. *Beyond the Farm Input Subsidy Programme (FISP)? The Political Economy of the Comprehensive Africa Agriculture Development Programme (CAADP) Processes in Malawi. Working Paper-Future Agricultures*. Brighton: Future Agricultures Consortium.

Chinsinga, Blessings. 2004. "Poverty and Food Security in Malawi: Some Policy Reflections on the Context of Crumbling Traditional Support Systems." *Canadian Journal of Development Studies/Revue Canadienne d'études Du Développement* 25 (2). Taylor & Francis: 321–341.

Chinsinga, Blessings. 2018. "The Political Economy of Agricultural Commercialisation in Malawi." APRA, Future Agricultures Consortium.

Chirwa, Ephraim, and Andrew Dorward. 2013. *Agricultural Input Subsidies: The Recent Malawi Experience*. OUP Oxford.

Chirwa, Ephraim, Andrew Dorward, and Mirriam Matita. 2012. "Thinking about 'Graduation'from the Farm Input Subsidy Programme in Malawi." *Policy Brief*, no. 3.

Clark, Brett, and John Bellamy Foster. 2013. "Guano: The Global Metabolic Rift and the Fertilizer Trade." In *Ecology and Power*, 84–98. Routledge.

de Perez, Erin Coughlan, Maarten van Aalst, Richard Choularton, Bart van den Hurk, Simon Mason, Hannah Nissan, and Saroja Schwager. 2019. "From Rain to Famine: Assessing the Utility of Rainfall Observations and Seasonal Forecasts to Anticipate Food Insecurity in East Africa." *Food Security* 11 (1). Springer: 57–68.

Deaconu, Ana, Geneviève Mercille, and Malek Batal. 2019. "The Agroecological Farmer's Pathways from Agriculture to Nutrition: A Practice-Based Case from Ecuador's Highlands." *Ecology of Food and Nutrition* 58 (2). Taylor & Francis: 142–165.

Devereux, Stephen, Keetie Roelen, Ricardo Sabates, Rachel Sabates-Wheeler, Dimitri Stoelinga, and Arnaud Dyevre. 2019. "Graduating from Food Insecurity: Evidence from Graduation Projects in Burundi and Rwanda." *Food Security*. Springer, 1–14.

Ecker, Olivier. 2018. "Agricultural Transformation and Food and Nutrition Security in Ghana: Does Farm Production Diversity (Still) Matter for Household Dietary Diversity?" *Food Policy* 79. Elsevier: 271–282.

Elmhirst, Rebecca. 2015. "Feminist Political Ecology." In *The Routledge Handbook of Gender and Development*, 82–90. Routledge.

FAO. 2011. "Guidelines for Measuring Household and Individual Dietary Diversity." FAO Rome, Italy.

FAO. 2017. *The State of Food Security and Nutrition in Africa: Building Resilience for Peace and Food Security*. Rome. https://www.unicef.org/publications/files/State_of_Food_Security_and_Nutrition_in_the_World_2017.pdf.

FAO. 2018a. *The State of Food Security and Nutrition in the World*. Rome. http://www.fao.org/state-of-food-security-nutrition/en/.

FAO. 2018b. *The 10 Elements of Agroecology: Guiding the Transition to Sustainable Food and Agricultural Systems*.

Fernandez, Margarita, and V Ernesto Méndez. 2019. "Subsistence under the Canopy: Agrobiodiversity's Contributions to Food and Nutrition Security amongst Coffee Communities in Chiapas, Mexico." *Agroecology and Sustainable Food Systems* 43 (5). Taylor & Francis: 579–601.

Figueroa-Helland, Leonardo, Cassidy Thomas, and Abigail Pérez Aguilera. 2018. "Decolonizing Food Systems: Food Sovereignty, Indigenous Revitalization, and Agroecology as Counter-

Hegemonic Movements." *Perspectives on Global Development and Technology* 17 (1–2). Brill: 173–201.

Frison, Emile A, Jeremy Cherfas, and Toby Hodgkin. 2011. "Agricultural Biodiversity Is Essential for a Sustainable Improvement in Food and Nutrition Security." *Sustainability* 3 (1). Molecular Diversity Preservation International: 238–253.

Gliessman, Stephen R, and Eric W. Engles. 2014. *Agroecology: The Ecology of Sustainable Food Systems*. Edited by Eric W. Engles. 3rd ed. New York: CRC press.

Godard-Sebillotte, Claire, Sathya Karunananthan, and Isabelle Vedel. 2019. "Difference-in-Differences Analysis and the Propensity Score to Estimate the Impact of Non-Randomized Primary Care Interventions." *Family Practice* 36 (2). Oxford University Press UK: 247–251.

Godfray, H Charles J, John R Beddington, Ian R Crute, Lawrence Haddad, David Lawrence, James F Muir, Jules Pretty, Sherman Robinson, Sandy M Thomas, and Camilla Toulmin. 2010. "Food Security: The Challenge of Feeding 9 Billion People." *Science* 327 (5967). American Association for the Advancement of Science: 812–818.

Grillos, Tara. 2018. "Women's Participation in Environmental Decision-Making: Quasi-Experimental Evidence from Northern Kenya." *World Development* 108. Elsevier: 115–130.

Hamel, Reid. 2016. "Drought-Ravaged Malawi Faces Largest Humanitarian Emergency in Its History."

Helander, Hanna. 2017. "Geographic Disparities in Future Global Food Security: Exploring the Impacts of Population Development and Climate Change."

Hemming, Karla, Terry P Haines, Peter J Chilton, Alan J Girling, and Richard J Lilford. 2015. "The Stepped Wedge Cluster Randomised Trial: Rationale, Design, Analysis, and Reporting." *Bmj* 350. British Medical Journal Publishing Group: h391.

High Level Panel of Experts (HLPE) of the United Nations Committee on World Food Security. 2020. *Agroecological and Other Innovative Approaches for Sustainable Agriculture and Food Systems That Enhance Food Security and Nutrition*. Rome. doi:https://ec.europa.eu/knowledge4policy/publication/agroecological-other-innovative-approaches-sustainable-agriculture-food-systems-enhance_en.

Holt-Giménez, Eric, and Miguel A Altieri. 2013. "Agroecology, Food Sovereignty, and the New Green Revolution." *Agroecology and Sustainable Food Systems* 37 (1). Taylor & Francis: 90–102.

Ickowitz, A, Bronwen Powell, D Rowland, A Jones, and T Sunderland. 2019. "Agricultural Intensification, Dietary Diversity, and Markets in the Global Food Security Narrative." *Global Food Security* 20. Elsevier: 9–16.

Ignatova, Jacqueline A. 2017. "The 'Philanthropic'Gene: Biocapital and the New Green Revolution in Africa." *Third World Quarterly* 38 (10). Taylor & Francis: 2258–2275.

Jaacks, Lindsay M, Stefanie Vandevijvere, An Pan, Craig J McGowan, Chelsea Wallace, Fumiaki Imamura, Dariush Mozaffarian, Boyd Swinburn, and Majid Ezzati. 2019. "The Obesity Transition: Stages of the Global Epidemic." *The Lancet Diabetes & Endocrinology*. Elsevier.

Jones, Andrew D, Aditya Shrinivas, and Rachel Bezner-Kerr. 2014. "Farm Production Diversity Is Associated with Greater Household Dietary Diversity in Malawi: Findings from Nationally Representative Data." *Food Policy* 46. Elsevier: 1–12.

Kabunga, Nassul Ssentamu, Thomas Dubois, and Matin Qaim. 2012. "Heterogeneous Information Exposure and Technology Adoption: The Case of Tissue Culture Bananas in Kenya." *Agricultural Economics* 43 (5). Wiley Online Library: 473–486.

Kangmennaang, Joseph, Rachel Bezner Kerr, Esther Lupafya, Laifolo Dakishoni, Mangani Katundu, and Isaac Luginaah. 2017. "Impact of a Participatory Agroecological Development Project on Household Wealth and Food Security in Malawi." *Food Security*. Springer, 1–16.

Kansanga, M, P Andersen, D Kpienbaareh, S Mason-Renton, K Atuoye, Y Sano, R Antabe, and I Luginaah. 2019. "Traditional Agriculture in Transition: Examining the Impacts of Agricultural Modernization on Smallholder Farming in Ghana under the New Green Revolution." *International Journal of Sustainable Development & World Ecology* 26 (1). Taylor & Francis: 11–24.

Kilic, Talip, Edward Whitney, and Paul Winters. 2014. "Decentralised Beneficiary Targeting in

Large-Scale Development Programmes: Insights from the Malawi Farm Input Subsidy Programme." *Journal of African Economies* 24 (1). Oxford University Press: 26–56.

Kimura, Aya Hirata. 2013. *Hidden Hunger: Gender and the Politics of Smarter Foods*. Cornell University Press.

Kishindo, Paul, and Peter Mvula. 2017. "Malawi's Land Problem and Potential for Rural Conflict." *Journal of Contemporary African Studies* 35 (3). Taylor & Francis: 370–382.

Koppmair, Stefan, Menale Kassie, and Matin Qaim. 2017. "Farm Production, Market Access and Dietary Diversity in Malawi." *Public Health Nutrition* 20 (2). Cambridge University Press: 325–335.

Kremen, Claire, and Albie Miles. 2012. "Ecosystem Services in Biologically Diversified versus Conventional Farming Systems: Benefits, Externalities, and Trade-Offs." *Ecology and Society* 17 (4). The Resilience Alliance.

Lanza, Stephanie T, Julia E Moore, and Nicole M Butera. 2013. "Drawing Causal Inferences Using Propensity Scores: A Practical Guide for Community Psychologists." *American Journal of Community Psychology* 52 (3–4). Wiley Online Library: 380–392.

Lechner, Michael. 2011. "The Estimation of Causal Effects by Difference-in-Difference Methods." *Foundations and Trends® in Econometrics* 4 (3). Now Publishers, Inc.: 165–224.

Lee, Wang-Sheng. 2013. "Propensity Score Matching and Variations on the Balancing Test." *Empirical Economics* 44 (1). Springer: 47–80.

Leuven, Edwin, and Barbara Sianesi. 2018. "PSMATCH2: Stata Module to Perform Full Mahalanobis and Propensity Score Matching, Common Support Graphing, and Covariate Imbalance Testing." Boston College Department of Economics.

Lipper, Leslie, and David Zilberman. 2018. "A Short History of the Evolution of the Climate Smart Agriculture Approach and Its Links to Climate Change and Sustainable Agriculture Debates." In *Climate Smart Agriculture*, 13–30. Springer.

Lunduka, Rodney, Jacob Ricker-Gilbert, and Monica Fisher. 2013. "What Are the Farm-level Impacts of Malawi's Farm Input Subsidy Program? A Critical Review." *Agricultural Economics*

44 (6). Wiley Online Library: 563–579.

Malapit, Hazel Jean L, Suneetha Kadiyala, Agnes R Quisumbing, Kenda Cunningham, and Parul Tyagi. 2015. "Women's Empowerment Mitigates the Negative Effects of Low Production Diversity on Maternal and Child Nutrition in Nepal." *The Journal of Development Studies* 51 (8). Taylor & Francis: 1097–1123.

Martin-Guay, Marc-Olivier, Alain Paquette, Jérôme Dupras, and David Rivest. 2018. "The New Green Revolution: Sustainable Intensification of Agriculture by Intercropping." *Science of The Total Environment* 615. Elsevier: 767–772.

Martin, Adam R, and Marney E Isaac. 2018. "Functional Traits in Agroecology: Advancing Description and Prediction in Agroecosystems." *Journal of Applied Ecology* 55 (1). Wiley Online Library: 5–11.

Marx, Karl. 2005. *Grundrisse: Foundations of the Critique of Political Economy*. Penguin UK.

Massawe, Festo, Sean Mayes, and Acga Cheng. 2016. "Crop Diversity: An Unexploited Treasure Trove for Food Security." *Trends in Plant Science* 21 (5). Elsevier: 365–368.

McClintock, Nathan. 2010. "Why Farm the City? Theorizing Urban Agriculture through a Lens of Metabolic Rift." *Cambridge Journal of Regions, Economy and Society* 3 (2). Oxford University Press: 191–207.

Mdee, Anna, Alex Wostry, Andrew Coulson, and Janet Maro. 2018. "A Pathway to Inclusive Sustainable Intensification in Agriculture? Assessing Evidence on the Application of Agroecology in Tanzania." *Agroecology and Sustainable Food Systems*. Taylor & Francis, 1–27.

Meldrum, Gennifer, Dunja Mijatović, Wilfredo Rojas, Juana Flores, Milton Pinto, Grover Mamani, Eleuterio Condori, David Hilaquita, Helga Gruberg, and Stefano Padulosi. 2018. "Climate Change and Crop Diversity: Farmers' Perceptions and Adaptation on the Bolivian Altiplano." *Environment, Development and Sustainability* 20 (2). Springer: 703–730.

Méndez, V Ernesto, Christopher M Bacon, and Roseann Cohen. 2013. "Agroecology as a Transdisciplinary, Participatory, and Action-Oriented Approach." *Agroecology and Sustainable Food Systems* 37 (1). Taylor & Francis: 3–18.

Mhango, Wezi G, Sieglinde S Snapp, and George Y K Phiri. 2013. "Opportunities and Constraints to Legume Diversification for Sustainable Maize Production on Smallholder Farms in Malawi." *Renewable Agriculture and Food Systems* 28 (3). Cambridge University Press: 234–244.

Misra, Manoj. 2017. "Moving Away from Technocratic Framing: Agroecology and Food Sovereignty as Possible Alternatives to Alleviate Rural Malnutrition in Bangladesh." *Agriculture and Human Values*. Springer, 1–15.

Moore, Jason W. 2000. "Environmental Crises and the Metabolic Rift in World-Historical Perspective." *Organization & Environment* 13 (2). Sage Publications Sage CA: Thousand Oaks, CA: 123–157.

National Smallholder Farmers' Association of Malawi (NASFAM). 2018. "Conservation Agriculture Rescues Smallholder Farmer Household."

National Statistical Office. 2017. *Malawi Micronutrient Survey: Key Indicators Report 2015-16*. Zomba.

Nyantakyi-Frimpong, Hanson. 2017. "Agricultural Diversification and Dietary Diversity: A Feminist Political Ecology of the Everyday Experiences of Landless and Smallholder Households in Northern Ghana." *Geoforum* 86. Elsevier: 63–75.

Nyantakyi-Frimpong, Hanson, Faith Nankasa Mambulu, Rachel Bezner Kerr, Isaac Luginaah, and Esther Lupafya. 2016. "Agroecology and Sustainable Food Systems: Participatory Research to Improve Food Security among HIV-Affected Households in Northern Malawi." *Social Science & Medicine* 164. Elsevier: 89–99.

Nygren, Anja, and Sandy Rikoon. 2008. "Political Ecology Revisited: Integration of Politics and Ecology Does Matter." *Society and Natural Resources* 21 (9). Taylor & Francis: 767–782.

O'Rourke, Megan E, Marcia S DeLonge, and Ricardo Salvador. 2017. "Insights from Agroecology and a Critical next Step: Integrating Human Health." *Agroecology and Sustainable Food Systems* 41 (7). Taylor & Francis: 880–884.

Oliver, Beatriz. 2016. "'The Earth Gives Us So Much': Agroecology and Rural Women's

Leadership in Uruguay." *Culture, Agriculture, Food and Environment* 38 (1). Wiley Online Library: 38–47.

Onyango, Adelheid W. 2003. "Dietary Diversity, Child Nutrition and Health in Contemporary African Communities." *Comparative Biochemistry and Physiology Part A: Molecular & Integrative Physiology* 136 (1). Elsevier: 61–69.

Peters, Pauline E. 2010. "'Our Daughters Inherit Our Land, but Our Sons Use Their Wives' Fields': Matrilineal-Matrilocal Land Tenure and the New Land Policy in Malawi.'" *Journal of Eastern African Studies* 4 (1). Taylor & Francis: 179–199.

Rasmussen, Laura Vang, Brendan Coolsaet, Adrian Martin, Ole Mertz, Unai Pascual, Esteve Corbera, Neil Dawson, Janet A Fisher, Phil Franks, and Casey M Ryan. 2018. "Social-Ecological Outcomes of Agricultural Intensification." *Nature Sustainability* 1 (6). Nature Publishing Group: 275.

Schneider, Mindi, and Philip McMichael. 2010. "Deepening, and Repairing, the Metabolic Rift." *The Journal of Peasant Studies* 37 (3). Taylor & Francis: 461–484.

Sharp, Kelly, Philippe Le Billon, and Hisham Zerriffi. 2018. "Land Reforms and Voluntary Resettlement: Household Participation and Attrition Rates in Malawi." *The Journal of Peasant Studies*. Taylor & Francis, 1–27.

Sibhatu, Kibrom T, Vijesh V Krishna, and Matin Qaim. 2015. "Production Diversity and Dietary Diversity in Smallholder Farm Households." *Proceedings of the National Academy of Sciences* 112 (34). National Acad Sciences: 10657–10662.

Sibhatu, Kibrom T, and Matin Qaim. 2018. "Meta-Analysis of the Association between Production Diversity, Diets, and Nutrition in Smallholder Farm Households." *Food Policy*. Elsevier.

Silberg, Timothy R, Robert B Richardson, Michele Hockett, and Sieglinde S Snapp. 2017. "Maize-Legume Intercropping in Central Malawi: Determinants of Practice." *International Journal of Agricultural Sustainability* 15 (6). Taylor & Francis: 662–680.

Solorio, S F J, J Wright, M J A Franco, S K Basu, S L Sarabia, L Ramírez, B A Ayala, P C Aguilar, and V J C Ku. 2017. "Silvopastoral Systems: Best Agroecological Practice for Resilient Production Systems Under Dryland and Drought Conditions." In *Quantification of Climate Variability, Adaptation and Mitigation for Agricultural Sustainability*, 233–250. Springer.

Stevens, Tilele, and Kaveh Madani. 2016. "Future Climate Impacts on Maize Farming and Food Security in Malawi." *Scientific Reports* 6 (36241 |). Nature Publishing Group.

Swindale, Anne, and Paula Bilinsky. 2006. "Household Dietary Diversity Score (HDDS) for Measurement of Household Food Access: Indicator Guide." *Washington, DC: Food and Nutrition Technical Assistance Project, Academy for Educational Development*.

Tamburino, Lucia, Giangiacomo Bravo, Yann Clough, and Kimberly A Nicholas. 2020. "From Population to Production: 50 Years of Scientific Literature on How to Feed the World." *Global Food Security* 24. Elsevier: 100346.

Tesfaye, Wondimagegn, and Nyasha Tirivayi. 2020. "Crop Diversity, Household Welfare and Consumption Smoothing under Risk: Evidence from Rural Uganda." *World Development* 125. Elsevier: 104686.

Vail, Leroy. 1983. "The State and the Creation of Colonial Malawi's Agricultural Economy." *Imperialism, Colonialism and Hunger: East and Central Africa. Lexington, MA: Lexington Books*, 39–88.

Von Grebmer, Klaus, Claudia Ringler, Mark W Rosegrant, Ousmane Badiane, Maximo Torero, Yisehac Yohannes, Jennifer Thompson, and Green Scenery. 2018. *Global Hunger Index: Forced Migration and Hunger*. *Deutsche Welthungerhilfe, International Food Policy Research Institute, and Concern Worldwide*. Bonn: Citeseer.

Waha, Katharina, Mark T van Wijk, Steffen Fritz, Linda See, Philip K Thornton, Jannike Wichern, and Mario Herrero. 2018. "Agricultural Diversification as an Important Strategy for Achieving Food Security in Africa." *Global Change Biology*. Wiley Online Library.

Wittman, Hannah. 2009. "Reworking the Metabolic Rift: La Vía Campesina, Agrarian Citizenship, and Food Sovereignty." *The Journal of Peasant Studies* 36 (4). Taylor & Francis: 805–826.

World Bank. 2018. "The World Bank In Malawi."

Zanello, Giacomo, Bhavani Shankar, and Nigel Poole. 2019. "Buy or Make? Agricultural Production Diversity, Markets and Dietary Diversity in Afghanistan." *Food Policy*. Elsevier, 101731.

Zimmerer, Karl S, and Thomas J Bassett. 2003. *Political Ecology: An Integrative Approach to Geography and Environment-Development Studies*. Guilford Press.

CHAPTER 7

7. DISCUSSION AND CONCLUSIONS

7.1 Introduction

This dissertation explored the potential for agroecology to contribute to addressing key dimensions of the social and ecological rifts in a smallholder farming context. Specifically, the study examined the impact of a participatory agroecology intervention on farmer social capital, sustainable land management and nutrition in smallholder farming communities. This chapter summarizes the main findings of this dissertation and links them to the objectives outlined in Chapter One. It also presents the practical and theoretical contributions of the study, the implications of the findings for stakeholders, particularly for policymakers, development practitioners and smallholder farmers. The chapter also outlines the limitations of the study based on which I conclude by providing suggestions for future research.

7.2 Linking the findings back to the research problem

Chapter One of this dissertation contextualized the key issues on which this study is built. The chapter demonstrates how the rise of input-intensive agriculture in the current global food system has produced diverse social and ecological rifts in smallholder farming communities including the disruption of farmer-to-farmer networks and the resources inherent in them, environmental degradation and increased undernutrition among vulnerable smallholder farmers. This situation leads to the question of how these social and ecological issues can be addressed. Agroecology has been recognized as an alternative approach to agriculture that can address the social and ecological contradictions produced by the current capitalist food system, especially in smallholder farming contexts (Altieri, 2002; FAO, 2016). While agroecology continues to gain traction in the Global South, there is a clarion call for empirical studies on its potential to transform the food system (Gliessman, 2016; HLPE, 2020). As observed in the introduction, however, most empirical studies are cross-sectional and limited to the farm-level impacts of agroecology.

The three manuscripts in this dissertation collectively provides empirical evidence on the potential for participatory agroecological interventions like the MAFFA to contribute to addressing key aspects of the metabolic rift in smallholder agriculture. I argue that participatory agroecology intervemntions that pay attention to contextual dynamics may simultaneously improve farmer social capital, sustainable land management and nutrition. Table 7.1 provides a summary of the key findings and main arguments in the three manuscripts.

Table 7.1: Summary of key findings and thematic integration of the three manuscripts

Manuscript 1	Manuscript 2	Manuscript 3
Objective: The impact of participatory agroecology on social capital	**Objective**: The association between agroecology and adoption of diverse sustainable land management practices (including, crop residue recycling, composting, mulching, legume intercropping, agroforestry and integration of vetiver grass)	**Objective**: The impact of agroecology on household production diversity and dietary diversity
Data and methods: Baseline and endline survey data from the five-year MAFFA intervention. Difference-in-Difference estimation and linear regression.	**Data and methods**: Endline survey data from the MAFFA intervention. Logistic regression techniques	**Data and methods**: Baseline and endline survey data from the five-year MAFFA intervention. Difference-in-Difference estimation and linear regression.
Key findings: Drawing upon insights from the World Bank Integrated Questionnaire for the Measurement of Social Capital (SC-IQ) in developing countries to create a social capital index, Manuscript one compared the social capital endowments of MAFFA beneficiary households and a control group of non-agroecology households. The findings show a positive and statistically significant treatment effect of the agroecology intervention on social capital. Regression analysis further indicates a reinforcing relationship between social capital and agroecology practice.	**Key findings:** Results from the logistic regression analysis show a positive association between participatory agroecology and the adoption of all SLM practices. Thus, compared to control households, households that participated in the MAFFA intervention were more likely to adopt crop residue recycling, composting, mulching, legume intercropping, agroforestry and integration of vetiver grass.	**Key findings**: Findings from the DID analysis show a positive and statistically significant impact of the agroecology intervention on both production diversity and dietary diversity. These findings imply that farmers that received the participatory agroecology intervention had higher production diversity and dietary diversity scores at the end of the intervention
Summary of key arguments: Agroecology, through its social justice dimension, has the potential to repair social relations and improve farmer-to-farmer interconnectedness in smallholder farming communities — (**reference Manuscript 1**). At the community level, social capital may further reinforce agroecology practice. The enhancement of social capital demonstrates the impact of agroecology beyond the farm-level and its potential to contribute to addressing the social dimensions of the metabolic rift in smallholder farming communities. These findings provide a basis to further explore the impacts of agroecology at the farm level.		

Findings suggest that participatory agroecology may be able to improve sustainable land management. This assertion is based on the findings that households that received the MAFFA intervention were significantly more likely to adopt all categories of SLM practices compared to households in the control group — (**reference Manuscript 2**). As a participatory approach, agroecology promotes horizontal farmer-to-farmer knowledge sharing which can provide farmers with the opportunity to obtain support on the application of diverse SLM practices. The association between agroecology and sustainable land management may be shaped by contextual socioeconomic factors including wealth, household labour size and land ownership.

DID analyses further demonstrate that agroecology can improve both production diversity and dietary diversity (**reference Manuscript 3**). In conjunction with the findings in Manuscript 1 and 2, this manuscript extends the literature on the positive contributory role of agroecology at, and beyond the farm-level.

Based on these findings, I argue that agroecology through its multifunctional prowess, has the potential to contribute to repairing the social, ecological and individual dimensions of the metabolic rift in contemporary agriculture — (**reference Manuscripts 1, 2 and 3**).

Chapter Four, which examined the impact of the participatory agroecology intervention on farmer social capital, provides a broad foundation to further examine the role of agroecology in contributing to sustainable land management and nutrition. The chapter demonstrates how particpatory agroecology activities can contribute to improving the social relations and trust on which smallholder agriculture is founded. The findings also suggest that social capital may reinforce agroecology practice at the local level. While Chapter Four contributes to the literature on the impact of the agroecological intervention beyond the farm level, Chapter Five and Six demonstrate its farm-level impacts. Chapter Five examines the relationship between participation in the agroecological intervention and the uptake of sustainable land management practices. The findings demonstrate that agroecology practice increases the odds of adoption of diverse SLM practices among households in the MAFFA intervention group compared to non-agroecology households. Building on these findings, Chapter Five examined the impact of the agroecological intervention on production diversity and dietary diversity. The findings show a positive treatment effect of the intervention on both dietary diversity and production diversity. Casting these findings within the lens of the metabolic rift in contemporary agriculture, I argue that agroecology provides a solid foundation for addressing the social, ecological and individual dimensions of the metabolic rift in poor smallholder farming contexts. The rest of this sub-section contextaulizes the findings and links them back to the key issues raised in Chapter One.

7.2.1 Objective 1: To examine the impact of participatory agroecology on social capital

To address this objective, the pre-and post-intervention DID technique was used to estimate the treatment effect of the agroecology intervention on social capital. Based on a social capital index constructed from a set of questions (including participation in community organizations, having trusted people to fall back on in times of crisis, and possession of networks outside the community) that were asked to both agroecology and non-agroecology households (Grootaert et al., 2004) at the baseline and endline, the social capital endowments of agroecology practising households and non-agroecology households were estimated. Findings demonstrate a positive and statistically significant treatment effect of the intervention on social capital. Compared to non-agroecology households, agroecology households had higher mean endowment in social capital following the five-year MAFFA intervention. Results from the regression analysis revealed a statistically significant bidirectional association between social capital and agroecology, suggesting that agroecology and social capital have the potential to reinforce each other at the community level.

Traditional smallholder farming communities are generally closely knit, with beneficial relations among farming households (Van Rijn et al., 2012). This interconnectedness and the social capital it produces has been shown to improve agricultural knowledge flows and exchange of productive resources with potential implications for climate change adaptation and sustainable resource management (Bacon et al., 2005; Dougill et al., 2006). Notwithstanding these beneficial impacts of social capital in smallholder farming communities, the rise of capitalist agriculture has seen a decline in farmer interconnectedness as the global expansion of industrial agriculture and associated processes of land grabbing and commodification of the labour of peasants tend to disrupt the key organizing social relations on which smallholder agriculture is grounded. Food produceers at the local level become increasing separated from one another, and many of the dispossessed are rendered cheap labour for plantation agriculture. In Malawi for instance, most of these dispossessed farmers are forced to migrate to South Africa where they serve as cheap labour in the mines (Chirwa, 1997; Christiansen & Kydd, 1983). As highlighted in Chapter One, the breakdown of smallholder farmer interconnectneddness in Malawi also has roots in colonialism and the reorienting of smallholder agricultural systems towards cash crop production for export (Vail, 1983). Post-colonial governments built on this legacy by committing more land to cash crop agriculture – a situation which further undermined smallholder farming (Mkandawire, 1992). Thus, in conjunction with colonial and post-colonial narratives that continue to undermine local agricultural knowledge systems, the increased retooling of smallholder agriculture to an input-intensive approach contributes to the rupturing of farmer-to-farmer ties and the broader relations of production that connects food producers (McClintock, 2010; Schneider & McMichael, 2010).

To promote cohesion among farmers at the local level, the MAFFA intervention created opportunities for routine farmer interaction among participating households through community-level meetings, inter-community farmer exchanges and rural enterprise development programs. These routine participatory programs provided a platform for the strengthening of relationships and trust among farming households.

Generally, local institutions are vital foundations for the development of social capital as they are the social infrastructure for the forging of networks in smallholder farming communities (Grootaert, 2001; Narayan & Pritchett, 1999). This is particularly evident in Malawi and other parts of SSA where smallholder agriculture is founded on key underlying practices such as labour and seed sharing. Depending on how these instutitional processes are (re)organized, they can either promote or hinder smallhoolder engagement and interconnectedness. Participatory agroecology creates spaces for smallholder farmers to interact and support one another in the farming process for example, through knowledge and labour exchange. Under the MAFFA intervention, participating farming households were encouraged to share productive resources in addressing everyday challenges in farming. Indeed, earlier findings from this intervention also demonstrate that the participatory agroecology activities implemented also improved household gender relations, which is a crucial aspect of the metabolic rift (see Bezner Kerr et al., 2019) In line with the clarion call by Gliessman (2016) for contributions of agroecology beyond the farm level, these findings demonstrate that participatory agroecological activities can provide a foundation for promoting smallholder farmer interconnectedness.

7.2.2 Objective 2: To explore the relationship between participatory farmer-to-farmer agroecological knowledge sharing and sustainable land management

This objective explored the association between participatory agroecology and the uptake of sustainable land management practices. While empirical research on the potential for agroecology to improve smallholder agriculture is fast-growing, there is a paucity of literature on the impact of participatory agroecology on sustainable land management. Using logistic regression techniques, this objective provides an understanding of whether smallholder farmers who received MAFFA intervention are more likely to apply SLM practices. Findings show that farming households that participated in the participatory F2F agroecological training and knowledge sharing intervention were significantly more likely to practise crop residue recycling, composting, mulching, agroforestry, and legume intercropping compared to their counterparts that did not benefit from the intervention. The positive association between participatory agroecology training and the uptake of residue recycling, composting, mulching, agroforestry, and legume intercropping remained statistically significant after accounting for demographic, socioeconomic and plot-level factors. These findings are consistent with existing literature that demonstrate the positive impact of F2F knowledge sharing on sustainable agriculture in resource-poor contexts (Franzel et al., 2019; Kiptot, Franzel, Hebinck, & Richards, 2006; Lukuyu et al., 2012; Wellard et al., 2013).

Agroecology has some unique traits which can reinforce its impacts on sustainable land management in smallholder farming communities. Agroecology emphasizes a knowledge translation approach that builds on traditional knowledge systems and practices using horizontal learning—which is typically reinforced by social networks—as opposed to the widely used top-down agricultural extension approach used in the Global South, in which farmers are typically framed as passive recipients of so-called modern scientific agricultural knowledge (Bezner Kerr et al., 2018; Méndez et al., 2013). In contrast to top-down agricultural extension programs that are usually implemented outside the immediate farm-scape and by external experts, horizontal F2F knowledge sharing in agroecology provides smallholder farmers with real-time field-level experimentation with diverse SLM practices and the opportunity to teach one another (Franzel et al., 2019). Aside from stimulating a sense of local ownership of the agricultural knowledge generation and translation processes, the real-time experience from horizontal learning provides a good opportunity for farmers to assist each other in addressing challenges that may be associated with the application of diverse SLM practices at the farm-level.

Overall, these findings suggest that agroecology has the potential to promote sustainable agroecosystem management and contribute to addressing the prevailing ecological contradictions of the current capitalist food system. Agroecology can achieve this through its core founding principles of promoting local knowledge systems and encouraging smallholder farmers to return to using organic soil fertilizing methods that characterized traditional agriculture. As outlined earlier in Chapter One, the failure of the FISP to achieve food security for all smallholder farmers in Malawi is linked to the fact that the poorest of the poor are still unable to afford the so-called subsidized inputs (Holden & Lunduka, 2013). Thus, while the FISP has been found to improve yields for some farmers who are able to afford these subsidized inputs, many poor farmers are left behind (Lunduka et al., 2013). Agroecology provides the opportunity for poor farmers to learn about SLM practices and how to integrate them to improve yields. It is therefore not suprising that households that participated in the MAFFA intervention–the majority of whom are poor–were more likely to adopt theses practices. Indeed, findings from earlier studies by the MAFFA team demonstrate a positive association between the use of these SLM practices and food security (Kangmennaang et al., 2017). Linking back to the metabolic rift, addressing these ecological issues through SLM provides opportunities for addressing some aspects of the social rift in the current capitalist food system, including the narrowing of local food baskets.

7.2.3 Objective 3: To examine the impact of participatory agroecology on household production diversity and dietary diversity

In this objective, I employ the DID analysis to examine the impact of agroecology on household dietary diversity and production diversity. Mediation analysis in SEM was further used to explore the relationship between production diversity and dietary diversity, as well as the pathways through which agroecology may shape household production diversity and dietary diversity. Separate DID models were fitted to compare the production diversity and dietary diversity outcomes of households that received the agroecology intervention compared to the control group. SEM was used to further understand the pathways through which production diversity and dietary diversity may be related in the context of agroecology.

Results from the DID models demonstrate a positive treatment effect of the agroecological intervention on both household production diversity and dietary diversity, suggesting that households that participated in the MAFFA intervention had relatively higher production diversity and dietary diversity scores. Results from the mediation analysis also show that household production diversity has a direct independent effect on production diversity. Despite this general direct relationship between production diversity and dietary diversity, the effect was larger for agroecology households, a finding which is consistent with the findings from the DID analysis. The indirect pathways linking production diversity and dietary diversity were different for agroecology households and non-agroecology households. Farm size, household wealth, education of primary male, year of survey were unique indirect pathways for both agroecology practicing and non-agroecology households. Household food security and education of the primary female were however unique pathways for agroecology households.

These findings augment literature on the potential for agroecology to improve household nutrition (Bezner Kerr et al., 2016; Jones et al., 2014; Nyantakyi-Frimpong, 2017). Earlier from the MAFFA project team demonstrated a positive impact on nutrition and overall wellbeing (Bezner Kerr et al., 2011; Kerr et al., 2007; Nyantakyi-Frimpong et al., 2016). Following two years of implementation, Kangmennaang et al. (2017) find that the project significantly reduced food insecurity ($\beta=-3.21$, $p=0.01$) and improved household wealth ($\beta=3.54$, $p=0.01$) for farming households that received the intervention. Improvement to income also has the potenatial benefit of improving household purchasing capacity and the ability to secure diverse foods including food groups like oil and spices that are typically not produced by farming households but purchased from the market. As outlined earlier, one of the key founding principles of agroecology at the farm-level is diversification (Altieri, 1999; Gliessman & Engles, 2014). The emphasis on species diversification includes the cultivation of different crop varieties and livestock integration. Diversification has the potential to make a wide range of foods available to agroecology practicing households. It is therefore not surprising that agroecology practicing households had higher production diversity and dietary diversity scores compared to non-agroecology households following the MAFFA intervention. There is evidence of a strong relationship between production diversity and dietary diversity in smallholder farming contexts given that most farming households draw a significant proportion of their diet directly from what they produce, and occasionally selling some farm produce to procure soup ingredients (Bezner Kerr et al., 2016; Jones et al., 2014; Nyantakyi-Frimpong, 2017; Onyango, 2003;

Sibhatu et al., 2015). The MAFFA intervention also emphasized nutrition training for agroecology practicing households. This could potentially improve their knowledge of recipes and food combinations for a balanced diet (Bezner Kerr, Berti, & Shumba 2011).

For several decades now, the government of Malawi has constantly framed food insecurity and malnutrition as outcomes of environmental constraints, particularly soil infertility and climate change. This framing has resulted in policy approaches that emphasize the use of synthetic inputs as a pathway to improving household food security (Chinsinga & Chasukwa, 2018; Nkhoma et al., 2019). Apart from the FISP that aims to improve food security, there have also been targeted micronutrient supplementation targeted at addressing hidden hunger. In July 2011, the Government of Malawi launched a Scaling Up Nutrition campaign, an initiative which emphasized the promotion of diversified diets and nutrition education to mitigate malnutrition. Measures to address vitamin A deficiency including fortification and supplementation have also been promoted. These policies have however failed to address malnutrition and food security as expressed in the widespread micronutrient deficiencies in the population and repeated annual food shortages in the country (Lunduka et al., 2013; National Statistical Office, 2017). For instance, fortified foods are inaccessible to rural households due to associated cost and limited availability. Based on these findings, I argue that participatory agroecology which draws on local resources and knowledge systems to promote agricultural diversification and farmer-to-farmer knowledge sharing on agriculture and nutrition, may be more viable for improving household food security and nutrition. Importantly, these agroecological methods were adapted for HIV/AIDS-affected households, with evidence of improved nutrition and wellbeing for these households (Nyantakyi-Frimpong et al., 2017).

7.3 Theoretical contributions

Agroecology is central to the drive for food system re-localization, especially in the Global South where the rise of capitalist modes of production has produced a metabolic rift that continues to work against smallholder agriculture. The negative impacts on smallholders include the high cost of farming due to the heavy reliance on synthetic inputs as opposed to traditional soil fertilizing methods and increasing land degradation (Bezner Kerr & Patel, 2014; Nyantakyi-Frimpong & Bezner Kerr, 2017). This dissertation extends contemporary thinking around Marx's typology of the metabolic rift in Human Geography, and the broader argument that the rise of capitalism delinked rural populations from their environment and disrupted traditional agriculture and the beneficial socio-ecological synergies associated with rural social metabolism (Bezner Kerr et al., 2019; Clark & Foster, 2009; Clausen et al., 2015; Napoletano et al., 2019). The key theoretical contribution of this thesis is the demonstration that agroecology—through its dual focus at the farm and societal levels—provides a formidable basis for reconstituting smallholder agriculture and repairing the ecological, social and individual dimensions of the metabolic rift. In conjunction with earlier studies from the MAFFA intervention (Bezner Kerr et al., 2019), the three manuscripts in this dissertation, illuminate the multifunctionality of participatory agroecology.

Specifically, this dissertation extends our understanding of the metabolic rift by demonstrating how agroecology can help promote farmer interconnectedness at the local level. By estimating the treatment effects of participatory agroecology on the social capital endowments of farming households that participated in the agroecological intervention, Chapter Four of this dissertation contributes to the debate on how agroecology can contribute to repairing the social relations of production that characterize traditional smallholder agriculture (see also Altieri, 2009; Holt-Giménez & Altieri, 2013; Bezner Kerr, et al., 2019; Pimbert, 2015). This is consistent with qualitative evidence from the MAFFA intervention (Bezner Kerr et al., 2019) that demonstrate the positive role of the agroecological intervention on underlying structural inequalities especially, household gender inequality through the reworking of unequal gendered labour dynamics, women's participation in agriculture and control over farm income. Addressing these structural inequalities and ensuring farmer interconnectedness provides a foundation for repairing other aspects of the metabolic rift in agriculture, especially the ecological dimension.

In the context of growing debate on approaches to address the ecological crisis in contemporary agriculture, Chapter Five of this dissertation also sheds light on the contributory role of agroecology in addressing the ecological rift. In most parts of SSA where smallholder agriculture dominates, the rise of an input-intensive production model under the weight of the current capitalist food system produces relatively more intrusive ways of doing agriculture as expressed in the increased use of synthetic fertilizers and mechanized technologies to improve yields (Clark & Foster, 2009; Moore, 2000). As argued earlier, the capitalist attempts to address this ecological rift, particularly the widespread land degradation associated with input-intensive agriculture have often resulted in the mere geographical shifting of these impacts. For instance, as argued by McClintock (2010) the fossil fuel used to produce synthetic fertilizer for addressing land degradation and to power agricultural machinery in input-intensive agriculture is sourced from different areas across the globe, a process that leaves other lasting adverse ecological impacts. While it has become evident, therefore, that such constant spatio-temporal rescaling of ecological risks is endemic to the contemporary food system, agroecology proceeds on the theoretical principle that addressing these ecological risks requires reconnecting people with nature through initial attention to the local scale where smallholder agriculture is situated, and outwardly towards much broader scales at the national, regional and international levels (Dalgaard et al., 2003). Alongside a growing body of literature on the positive ecological potential of agroecology (Altieri, 2002; Bezner Kerr, Lupafya, & Dakishoni, 2016; Holt-Giménez & Altieri, 2013; Méndez et al., 2013), this work provides human geographers theoretical insights on how participatory agroecology can reconstitute smallholder agriculture and promote sustainable land management by encouraging farmers to return to traditional human-nature metabolic practices such as biological nutrient recycling and compost amendment at the field level. As explained by Bezner Kerr et al. (2019:1514), "rural households are rebuilding metabolic rifts, through a range of agroecological practices, such as the use of compost, intercropping and crop diversification." The participatory farmer-to-farmer knowledge sharing approach used in stimulating the application of SLM practices also offers salient theoretical insights to the field of environmental sustainability. The success of the approach demonstrates how social learning processes can be deployed in a non-invasive manner in smallholder farming communities to improve environmental management (Freire, 1996; Bezner Kerr et al., 2019).

The third manuscript in this dissertation broadens our understanding of the role of agroecology in addressing the social dimension of the metabolic rift in contemporary agriculture. Specifically, it extends theoretical understanding of the social dimension of the metabolic rift beyond the widely projected social problems of dispossession and commodification of the labour of smallholder farmers to include other key social problems such as hunger and malnutrition. As outlined earlier, the literature on the metabolic rift mostly highlights the ecological dimension (McClintock, 2010), and in rare cases where the social dimension is highlighted, issues such as hunger are rarely considered despite their strong link to capitalist accumulation. Indeed, Marx argues that a sustainable solution to the social rift requires adequate attention to other dimensions of the rift, and a continuous identification of new frontiers of risks that may emerge within and between dimensions (Marx, 1978).

Chapters Five and Six of this dissertation also contribute to the field of political ecology, particularly our understanding of the framing of the ecological and social rifts in contemporary policy spaces. In the Malawian context where land degradation, food insecurity and malnutrition have been constantly portrayed by the government as problems requiring technical fixes like the FISP, the underlying political and socioeconomic drivers of these problems are seldom highlighted neither do they inform the solutions that are proffered. This tacit evasion of the 'real drivers' of environmental change and hunger often results in the perpetuation of technical solutions that not only result in a mere geographical displacement of risk (Clark & Foster, 2013) but also work against grassroot-driven alternative approaches such as agroecology. Emerging from this research is the synthesis that problems such as land degradation and malnutrition are intricately linked to broader socioeconomic, political and ecological processes in the food system and must be addressed using holistic approaches like agroecology which pays attention to underlying ecological and socio-political issues in the food system.

7.4 Methodological contributions

This dissertation also makes some methodological contributions. First, it demonstrates the value of longitudinal methods in understanding complex ecological and social problems. Although an increasing body of literature has examined the impacts of agroecology on household nutrition and sustainable land management (Bacon, Mendez, & Brown, 2005; Bezner Kerr, et al., 2019; Nyantakyi-Frimpong et al., 2017, 2016), most of these studies are cross-sectional and do not provide a clear temporal picture of the sustainability of the gains from agroecology. By drawing data from the five-year MAFFA intervention, this dissertation contributes to methodological development in the field of agroecology. The longitudinal design applied in the MAFFA intervention offers methodological insights for future agricultural interventions in rural areas.

Similarly, most studies examining the impacts of agroecology are not comparative. The use of a comparative design in this study, therefore, contributes to methodological developments in the field of agroecology. This design also demonstrates the relevance of comparative methods in examining the impacts of rural interventions in similar resource-poor contexts.

7.5 Practical contributions and policy implications

This study also makes some practical contributions that have implications for agricultural policy. The findings suggest that agroecology can be a viable approach for addressing soil fertility and hunger in resource-poor contexts. For the past three decades, the Malawian government has tackled the persistent food insecurity in the country using input-intensive agriculture through the FISP, which provides subsidized synthetic fertilizers and hybrid seeds to smallholder farmers (Lunduka et al., 2013). Since the past decade, these efforts at improving yields through input-intensive agriculture have been consolidated under the ongoing pursuit of a new Green Revolution for Africa (Brooks, 2014). Although this approach has been observed to have led to increases in maize yields for some farmers, there is evidence that poor farmers in rural areas lack access to input subsidy coupons or simply cannot afford these subsidized inputs (Dorward et al., 2008; Holden & Lunduka, 2013). The emphasis on maize cultivation also contributed to the narrowing of the local food basket, with adverse implications on household nutrition (Bezner Kerr & Patel, 2014). Amid these underlying dynamics, this dissertation provides evidence on the potential of agroecology to improve smallholder agriculture using a participatory agroecology approach that builds upon locally available resources and local knowledge systems while paying attention to underlying inequalities.

These findings are relevant to policymakers in similar resource-poor contexts amid the broader pursuit of sustainable development under the SDGs. Given that environmental sustainability and nutrition are key pillars of the SDGs, these findings have broader policy implications beyond Malawi. Thus, agroecology could be harnessed to co-deliver sustainable environmental management and food security in the Global South where smallholder agriculture is the dominant livelihood activity. Particularly, the multifunctionality of agroecology makes it a beneficial paradigm for rural revitalization and sustainable development (Altieri, 1989; Figueroa-Helland et al., 2018).

This study also demonstrates the use of participatory farmer-to-farmer knowledge sharing can be used in similar agricultural interventions in rural farming communities to promote SLM. In the context of poor public extension service provision in rural communities across SSA, farmer-based knowledge sharing approaches are increasingly gaining popularity (Franzel et al., 2019; Nakano et al., 2018; Simpson, Franzel, Degrande, Kundhlande, & Tsafack, 2015). Aside from the potential to reach many farmers, participatory farmer-to-farmer knowledge sharing places local actors at the forefront of knowledge mobilization, transmission and translation as opposed to the dominant top-down agricultural extension approach used by governments and other stakeholders in SSA. Also unique to agroecology is the attention paid to structural inequalities in the engagement of local actors in knowledge mobilization and exchange (Bezner Kerr et al., 2019). Giving local farmers a lead role while paying attention to social inequalities can stimulate local initiative and acceptance of agricultural interventions (Bacon et al., 2005; Dougill et al., 2006). In the context of the increasing call for governments to scale out agroecology as an environmentally sustainable strategy (De Schutter, 2011; FAO, 2016), the MAFFA intervention provides a clear direction on how agroecology can be deployed to benefit poor smallholder farmers in rural areas of the Global South. The farmer-to-farmer approach we applied allowed us to reach more farmers and draw on farmer knowledge. The focus on farmer knowledge sharing and locally available resources in rural communities further provided a built-in exit strategy for the intervention.

7.6 Research Limitations

There are some limitations to this study worth highlighting. First, agroecology is generally a context-specific approach whose application can vary across space depending on contextual dynamics such as resource control dynamics. This context-dependent nature presents a challenge to the scaling of agroecology and the generalizability of findings from agroecological trials like the MAFFA intervention (Dalgaard et al., 2003). This limitation makes it difficult to generalize the findings from this study to other contexts. However, given that most underlying issues such as land tenure and labour norms are similar across SSA, this study may still provide applicable lessons to policymakers in other smallholder farming contexts.

Second, the analysis in this dissertation was done using a quantitative approach. This approach presented some challenges across the three manuscripts. The use of quantitative measures for outcomes such as social capital, which are influenced by underlying socioeconomic and political dynamics can be challenging. Indeed, quantitative measures of social capital, including the SC-IQ, have been criticized for oversimplifying the concept. The design of the MAFFA intervention also had some challenges. While it is useful to have a treatment group that benefited from the participatory agroecological intervention and a control group that did not, it would have also been interesting to compare agroecology households to households using other farming approaches that are commonly used in this context. The dataset used in this dissertation was also limited in diverse ways. For instance, the MAFFA surveys did not capture important measures such as the cost and benefit of the implementation the different SLM practices promoted. This is despite the fact that measures of cost and benefit are crucial in understanding the uptake of SLM practices in smallholder farming contexts.

Similarly, some of the outcomes explored in this dissertation, for example dietary diversity, are complex and shaped by underlying socioeconomic, political and cultural dynamics at both the household and broader community level (Bezner Kerr & Patel, 2014; Dilley & Boudreau, 2001; Nyantakyi-Frimpong & Bezner Kerr, 2017). The use of a quantitative approach may miss the lived experiences of individual farmers. Related to the general methodology, the MAFFA intervention also used the household as the unit of data collection. Food security and nutrition analysis at the household level are critiqued to conflate individual experiences (Gabbert & Weikard, 2001). It is therefore worth noting that some of these dynamics could be further explored using qualitative approaches.

7.7 Future directions

Although this dissertation has shed light on several important issues, the scope of the analysis does not provide a full understanding of some important issues. In this section, I highlight some key grey areas for future research. First, the quantitative approach employed in data collection coupled with the use of the household as the unit of analysis misses individual voices and the potential differentiated experiences and associated insights they can bring to environmental conservation and household food security research. There is, therefore, the need for qualitative studies to explore the lived experiences of smallholder farmers. Several control variables, including household size, land ownership status, education and age emerged as significant predictors in some of the models. This buttresses the need for qualitative analysis to investigate how these factors may influence the application of agroecology practice and its impacts. In contribution to the field of agrarian change, future qualitative studies within agroecology could focus on questions related to the challenges farmers face with the application of agroecological practices; the power dynamics shaping adoption of agroecology and how the benefits of agroecology are distributed among differently positioned social actors.

Finally, the context-specific nature of agroecology and the associated limits on the generalizability of findings from agroecological interventions like the MAFFA project, necessitates a broader scale comparative analysis of the impacts of agroecology. Cross-country comparative research will be relevant for understanding the points of convergence and divergence in agroecology as an approach to agriculture across scale. Understanding these nuances will provide rich spatial evidence on the broad application of agroecology while also identifying important contextual factors across different geographies. This is crucial for the scalability of agroecology. In the context of the ongoing pursuit of sustainable development under the global sustainability goals, such cross-country analysis can provide the basis for the development of a regional agricultural policy. In the context of widespread food insecurity and environmental degradation, the scaling of agroecology is not just crucial to Malawi, but to Africa and other smallholder farming contexts in the Global South if the current global food system is to be transformed to meet the needs of vulnerable smallholder farmers.

7.8 References

Altieri, M. A. (1989). Agroecology: A new research and development paradigm for world agriculture. *Agriculture, Ecosystems & Environment*, *27*(1–4), 37–46.

Altieri, M. A. (1999). Applying agroecology to enhance the productivity of peasant farming systems in Latin America. *Environment, Development and Sustainability*, *1*(3), 197–217.

Altieri, M. A. (2002). Agroecology: the science of natural resource management for poor farmers in marginal environments. *Agriculture, Ecosystems & Environment*, *93*(1), 1–24.

Altieri, M. A. (2009). Agroecology, small farms, and food sovereignty. *Monthly Review*, *61*(3), 102.

Bacon, C., Mendez, E., & Brown, M. (2005). Participatory action research and support for community development and conservation: examples from shade coffee landscapes in Nicaragua and El Salvador. *Center for Agroecology & Sustainable Food Systems*.

Bezner-Kerr, R., Lupafya, E., & Dakishoni, L. (2016). Food Sovereignty, Agroecology and Resilience: Competing or Complementary Frames? In *Global governance/politics, climate justice & agrarian/social justice: linkages and challenges* (pp. 1–14). Hague, Netherlands.

Bezner-Kerr, R., & Patel, R. (2014). *Food Security in Malawi*. (U. S. Nagothu, Ed.), *Food Security and Development: Country Case Studies*. London: Routledge.

Bezner Kerr, R., Berti, P. R., & Shumba, L. (2011). Effects of a participatory agriculture and nutrition education project on child growth in northern Malawi. *Public Health Nutrition*, *14*(8), 1466–1472.

Bezner Kerr, R., Chilanga, E., Nyantakyi-Frimpong, H., Luginaah, I., & Lupafya, E. (2016). Integrated agriculture programs to address malnutrition in northern Malawi. *BMC Public Health*, *16*(1), 1197.

Bezner Kerr, R., Hickey, C., Lupafya, E., & Dakishoni, L. (2019). Repairing rifts or reproducing inequalities? Agroecology, food sovereignty, and gender justice in Malawi. *The Journal of Peasant Studies*, 1–20.

Bezner Kerr, R., Young, S. L., Young, C., Santoso, M. V, Magalasi, M., Entz, M., … Wolfe, D. (2019). Farming for change: developing a participatory curriculum on agroecology, nutrition, climate change and social equity in Malawi and Tanzania. *Agriculture and Human Values*, *36*(3), 549–566.

Bezner Kerr, R. B., Kangmennaang, J., Dakishoni, L., Nyantakyi-Frimpong, H., Lupafya, E., Shumba, L., … Chitaya, A. (2019). Participatory agroecological research on climate change adaptation improves smallholder farmer household food security and dietary diversity in Malawi. *Agriculture, Ecosystems & Environment*, *279*, 109–121.

Bezner Kerr, R. B., Nyantakyi-Frimpong, H., Dakishoni, L., Lupafya, E., Shumba, L., Luginaah, I., & Snapp, S. S. (2018). Knowledge politics in participatory climate change adaptation research on agroecology in Malawi. *Renewable Agriculture and Food Systems*, 1–14.

Bezner Kerr, R. B., & Patel, R. (2014). Food Security in Malawi.

Bezner Kerr, R. B., Snapp, S., Chirwa, M., Shumba, L., & Msachi, R. (2007). Participatory research on legume diversification with Malawian smallholder farmers for improved human nutrition and soil fertility. *Experimental Agriculture*, *43*(4), 437–453.

Brooks, S. (2014). Enabling adaptation? Lessons from the new 'Green Revolution'in Malawi and Kenya. *Climatic Change*, *122*(1–2), 15–26.

Chinsinga, B., & Chasukwa, M. (2018). Narratives, climate change and agricultural policy processes in Malawi. *Africa Review*, *10*(2), 140–156.

Chirwa, W. C. (1997). "No TEBA… forget TEBA": the plight of Malawian ex-migrant workers to South Africa, 1988–1994. *International Migration Review*, *31*(3), 628–654.

Christiansen, R. E., & Kydd, J. G. (1983). The return of Malawian labour from South Africa and Zimbabwe. *The Journal of Modern African Studies*, *21*(2), 311–326.

Clark, B., & Foster, J. B. (2009). Ecological imperialism and the global metabolic rift: Unequal exchange and the guano/nitrates trade. *International Journal of Comparative Sociology*, *50*(3–4), 311–334.

Clark, B., & Foster, J. B. (2013). Guano: The global metabolic rift and the fertilizer trade. In *Ecology and Power* (pp. 84–98). Routledge.

Clausen, R., Clark, B., & Longo, S. B. (2015). Metabolic rifts and restoration: Agricultural crises and the potential of Cuba's organic, socialist approach to food production. *World Review of Political Economy*, *6*(1), 4–32.

Dalgaard, T., Hutchings, N. J., & Porter, J. R. (2003). Agroecology, scaling and interdisciplinarity. *Agriculture, Ecosystems & Environment*, *100*(1), 39–51.

Dilley, M., & Boudreau, T. E. (2001). Coming to terms with vulnerability: a critique of the food security definition. *Food Policy*, *26*(3), 229–247. https://doi.org/10.1016/S0306-

9192(00)00046-4

Dorward, A., Chirwa, E., Kelly, V. A., Jayne, T. S., Slater, R., & Boughton, D. (2008). *Evaluation of the 2006/7 agricultural input subsidy programme, Malawi. Final Report*.

Dougill, A. J., Fraser, E. D. G., Holden, J., Hubacek, K., Prell, C., Reed, M. S., … Stringer, L. C. (2006). Learning from doing participatory rural research: lessons from the Peak District National Park. *Journal of Agricultural Economics*, *57*(2), 259–275.

FAO. (2016). *Outcomes of the international symposium and regional meetings on agroecology for food security and nutrition*. Rome. Retrieved from http://www.srfood.org/images/stories/pdf/officialreports/20110308_a-hrc-16-49_agroecology_en.pdf.

Figueroa-Helland, L., Thomas, C., & Aguilera, A. P. (2018). Decolonizing Food Systems: Food Sovereignty, Indigenous Revitalization, and Agroecology as Counter-Hegemonic Movements. *Perspectives on Global Development and Technology*, *17*(1–2), 173–201.

Franzel, S., Kiptot, E., & Degrande, A. (2019). Farmer-To-Farmer Extension: A Low-Cost Approach for Promoting Climate-Smart Agriculture. In *The Climate-Smart Agriculture Papers* (pp. 277–288). Springer.

Freire, P. (1996). Pedagogy of the oppressed (revised). *New York: Continuum*.

Gabbert, S., & Weikard, H.-P. (2001). How widespread is undernourishment?: A critique of measurement methods and new empirical results. *Food Policy*, *26*(3), 209–228.

Gliessman, S. (2016). Transforming food systems with agroecology. Taylor & Francis.

Gliessman, S. R., & Engles, E. W. (2014). *Agroecology: the ecology of sustainable food systems*. (E. W. Engles, Ed.) (3rd ed.). New York: CRC press.

Grootaert, C. (2001). *Does social capital help the poor?-a synthesis of findings from the local level institutions studies in Bolivia, Burkina Faso, and Indonesia*. The World Bank.

Grootaert, C., Narayan, D., Jones, V. N., & Woolcock, M. (2004). *Measuring social capital: An integrated questionnaire*. The World Bank.

High Level Panel of Experts (HLPE) of the United Nations Committee on World Food Security. (2020). *Agroecological and other innovative approaches for sustainable agriculture and food systems that enhance food security and nutrition*. Rome. https://doi.org/https://ec.europa.eu/knowledge4policy/publication/agroecological-other-innovative-approaches-sustainable-agriculture-food-systems-enhance_en

Holden, S. T., & Lunduka, R. W. (2013). Who benefit from Malawi's targeted farm input subsidy program? In *Forum for Development Studies* (Vol. 40, pp. 1–25). Taylor & Francis.

Holt-Giménez, E., & Altieri, M. A. (2013). Agroecology, food sovereignty, and the new green revolution. *Agroecology and Sustainable Food Systems*, *37*(1), 90–102.

Jones, A. D., Shrinivas, A., & Bezner-Kerr, R. (2014). Farm production diversity is associated with greater household dietary diversity in Malawi: findings from nationally representative data. *Food Policy*, *46*, 1–12.

Kangmennaang, J., Kerr, R. B., Lupafya, E., Dakishoni, L., Katundu, M., & Luginaah, I. (2017). Impact of a participatory agroecological development project on household wealth and food security in Malawi. *Food Security*, 1–16.

Kiptot, E., Franzel, S., Hebinck, P., & Richards, P. (2006). Sharing seed and knowledge: farmer to farmer dissemination of agroforestry technologies in western Kenya. *Agroforestry Systems*, *68*(3), 167–179.

Lukuyu, B., Place, F., Franzel, S., & Kiptot, E. (2012). Disseminating improved practices: Are volunteer farmer trainers effective? *The Journal of Agricultural Education and Extension*, *18*(5), 525–540.

Lunduka, R., Ricker-Gilbert, J., & Fisher, M. (2013). What are the farm-level impacts of Malawi's farm input subsidy program? A critical review. *Agricultural Economics*, *44*(6), 563–579.

Marx, K. (1978). The Marx-Engels Reader, 2d ed. Edited by Robert C. Tucker. New York: Norton.

McClintock, N. (2010). Why farm the city? Theorizing urban agriculture through a lens of metabolic rift. *Cambridge Journal of Regions, Economy and Society*, *3*(2), 191–207.

Méndez, V. E., Bacon, C. M., & Cohen, R. (2013). Agroecology as a transdisciplinary, participatory, and action-oriented approach. *Agroecology and Sustainable Food Systems*, *37*(1), 3–18.

Mkandawire, R. M. (1992). The Land Question and Agrarian Change in Malawi', in. GCZ Mhone (Ed.), Malawi at the Crossroads: The Post-colonial Political Economy. Harare. Sapes Books.

Moore, J. W. (2000). Environmental crises and the metabolic rift in world-historical perspective. *Organization & Environment*, *13*(2), 123–157.

Nakano, Y., Tsusaka, T. W., Aida, T., & Pede, V. O. (2018). Is farmer-to-farmer extension effective? The impact of training on technology adoption and rice farming productivity in

Tanzania. *World Development*, *105*, 336–351.

Napoletano, B. M., Foster, J. B., Clark, B., Urquijo, P. S., McCall, M. K., & Paneque-Gálvez, J. (2019). Making Space in Critical Environmental Geography for the Metabolic Rift. *Annals of the American Association of Geographers*, 1–18.

Narayan, D., & Pritchett, L. (1999). Cents and sociability: Household income and social capital in rural Tanzania. *Economic Development and Cultural Change*, *47*(4), 871–897.

National Statistical Office. (2017). *Malawi Micronutrient Survey: Key Indicators Report 2015-16*. Zomba.

Nkhoma, P. R., Bosman, M. M., & Eduful, M. (2019). Constituting Agricultural and Food Security Policy in Malawi: Exploring the Factors that Have Driven Policy Processes in the Farm Inputs Subsidy Programme. *Journal of Asian and African Studies*, *54*(3), 360–375.

Nyantakyi-Frimpong, H. (2017). Agricultural diversification and dietary diversity: a feminist political ecology of the everyday experiences of landless and smallholder households in northern Ghana. *Geoforum*, *86*, 63–75.

Nyantakyi-Frimpong, H., & Bezner Kerr, R. (2017). Land grabbing, social differentiation, intensified migration and food security in northern Ghana. *The Journal of Peasant Studies*, *44*(2), 421–444. https://doi.org/10.1080/03066150.2016.1228629

Nyantakyi-Frimpong, H., Kangmennaang, J., Kerr, R. B., Luginaah, I., Dakishoni, L., Lupafya, E., … Katundu, M. (2017). Agroecology and healthy food systems in semi-humid tropical Africa: Participatory research with vulnerable farming households in Malawi. *Acta Tropica*, *175*, 42–49.

Nyantakyi-Frimpong, H., Mambulu, F. N., Kerr, R. B., Luginaah, I., & Lupafya, E. (2016). Agroecology and sustainable food systems: Participatory research to improve food security among HIV-affected households in northern Malawi. *Social Science & Medicine*, *164*, 89–99.

Onyango, A. W. (2003). Dietary diversity, child nutrition and health in contemporary African communities. *Comparative Biochemistry and Physiology Part A: Molecular & Integrative Physiology*, *136*(1), 61–69.

Pimbert, M. (2015). Agroecology as an alternative vision to conventional development and Climate-Smart Agriculture. *Development*, *58*(2–3), 286–298.

Schneider, M., & McMichael, P. (2010). Deepening, and repairing, the metabolic rift. *The Journal of Peasant Studies*, *37*(3), 461–484.

Schutter, D. (2011). Agroecology and the right to food. Report of the Special Rapporteur on the right to food. United Nations.

Sibhatu, K. T., Krishna, V. V, & Qaim, M. (2015). Production diversity and dietary diversity in smallholder farm households. *Proceedings of the National Academy of Sciences*, *112*(34), 10657–10662.

Simpson, B. M., Franzel, S., Degrande, A., Kundhlande, G., & Tsafack, S. (2015). Farmer-to-farmer extension: Issues in planning and implementation. *MEAS Project*.

Vail, L. (1983). The state and the creation of colonial Malawi's agricultural economy. *Imperialism, Colonialism and Hunger: East and Central Africa. Lexington, MA: Lexington Books*, 39–88.

Van Rijn, F., Bulte, E., & Adekunle, A. (2012). Social capital and agricultural innovation in Sub-Saharan Africa. *Agricultural Systems*, *108*, 112–122.

Wellard, K., Rafanomezana, J., Nyirenda, M., Okotel, M., & Subbey, V. (2013). A review of community extension approaches to innovation for improved livelihoods in Ghana, Uganda and Malawi. *The Journal of Agricultural Education and Extension*, *19*(1), 21–35.

APPENDICES

Appendix A: NMREB Approval: Malawi Farmer-to-Farmer Agroecological Project

Western | Research Ethics

Use of Human Participants - Ethics Approval Notice

Principal Investigator: Dr. Rachel Bezner Kerr
File Number: 102941
Review Level: Full Board
Approved Local Adult Participants: 200
Approved Local Minor Participants: 200
Protocol Title: Malawi Farmer-to-Farmer Agroecology
Department & Institution: Social Science\Geography, Western University
Sponsor:
Ethics Approval Date: October 25, 2012 **Expiry Date:** September 30, 2017

Documents Reviewed & Approved & Documents Received for Information:

Document Name	Comments	Version Date
Letter of Information & Consent	Informed consent forms, draft survey and research assistant consent form.	2012/08/09
Western University Protocol		
Other	In-depth interview draft guide	2012/09/26

This is to notify you that The University of Western Ontario Research Ethics Board for Non-Medical Research Involving Human Subjects (NMREB) which is organized and operates according to the Tri-Council Policy Statement: Ethical Conduct of Research Involving Humans and the applicable laws and regulations of Ontario has granted approval to the above named research study on the approval date noted above.

This approval shall remain valid until the expiry date noted above assuming timely and acceptable responses to the NMREB's periodic requests for surveillance and monitoring information.

Members of the NMREB who are named as investigators in research studies, or declare a conflict of interest, do not participate in discussions related to, nor vote on, such studies when they are presented to the NMREB.

The Chair of the NMREB is Dr. Riley Hinson. The NMREB is registered with the U.S. Department of Health & Human Services under the IRB registration number IRB 00000941.

Ethics Officer to Contact for Further Information

✓ Grace Kelly	___ Janice Sutherland

This is an official document. Please retain the original in your files.

Western University, Support Services Bldg Rm. 5150 London, ON, Canada N6A 3K7
t. 519.661.3036 f. 519.850.2466 www.uwo.ca/research/ethics

Appendix B: Malawi Farmer-to-Farmer Agroecology Baseline Survey

Informed Consent. ENUMERATOR, PLEASE READ THE FOLLOWING TO THE RESPONDENT

Zina lane ndine_________. nkupanga kafukufuku wakukhwaskana na mbewu zakupambanapambana na dongo. Nkhugwira ntchito pamoza na Chipatala cha Ekwendeni, Kalongonda, Chancellor College na Department ya Geography ku Western University na University ya Manitoba ku Canada. Nkukhumba kumanya umo kupandandilo ka mbewu zakupambana pambana zikovwilira kusintha dongo na mabanja yinu. Sono nkhukhumba nimulongosolerani umo vikhalirenge pa kuchezga kwithu. Muwe wakumasuka kufumba mafumbo nyengo yiliyose. Vidumbirano vithu vizamuvwira kusanga nthowa zakuti tisangilenge chakurya chinandi. Ivo tisangenge pa vidumbirano ivi vilembekenge ndipo vamusangika ku office ya Kalongonda ku chipatala cha Ekwendeni. Sono nati nimufumbani pala mwanozgeka kuti ningamufumbani.

Na umo mwazomelezgera kuti nimufumbani mafumbo, nkukhumba timanyepo na umo mukulimira. Nitolenge pafupifupi 1 hour kumufumbani za kalimiro kinu na kasangiro ka chakurya pa banja pinu. Mazgoro ghose agho mungatipa ngakukhumbikwa. Nyengo yiliyose muwe wakumasuka pala mundakhumbe kulutilizga vidumbirano vithu.

Palije wovwiri wuliwose wakuti timpasaninge pakutolapo lwande pa kafukufuku uyu, kweni vidumbirano vithu vizamovwira imwe, muzi winu, charu chithu na vyaro vyakuwalo kusanga nthowa ziwemi zakusangira chakurya chinandi na kusazgiramo vundira mudongo.

Paŵenge chisisi chikulu pa nkhani yose iyi tidumbiraninge pano, ine, imwe na wa ku office ndise timanyenge, sono muleke kopa kuti ivi tidumbiranenge pano vamufumiraso panyake.

Sono mukuzomerezga kutolapo lwande pa kafukufuku uyu? ENYA YAYI

Muwe wakumasuka kufumba mafumbo mukati mwa vidumbirano panji pa umaliro. Pala mukukhumba kumanya vinandi va kafukufuku uyu mungakafumba ku Kalongonda ku chipatala cha Ekwendeni panyake mungayowoyeskana na Lizzie Shumba. Pala mungakhumba ningamulekerani pepala ili. Tawonga chifukwa chakuzomera kuti nichezge namwe.

(English translation of informed consent: My name is ______. I am working in collaboration with Ekwendeni Hospital, the Soils, Food and Healthy Communities project, Chancellor College, the Department of Geography at the Western University and University of Manitoba in Canada. We would like to understand more about your family and farming practices. I would like to ask you if I might interview you, and I'd like to explain more about what will be involved. Please feel free to ask any questions at any time. The results from this study will be used to inform future initiatives aimed at improving farmers' food security. We will write up the results of the study and will make the results available at the Soils Food and Healthy Communities Project at the Ekwendeni Hospital.

If you agree to participate in this part of this study, we want to learn from your knowledge and how you are farming. We will be spending about an hour asking you questions about your cropping practices, your diet and other information that affects your family's food security. There is no right or wrong answer to our questions. If you feel uncomfortable at any moment, or would prefer that I not participate/observe certain activities, you can refuse my presence at any time.

There is no direct benefit to you for participating in this part of research; however, it will help you to get to know us and become familiar with our study and provide an opportunity for you to express any concerns that you have regarding your life as a farmer. Additionally, the information gained in this study will benefit your community indirectly. We will share what we learn from your farming practices with local, national and international institutions such that it can be used to inform initiatives for improving food security and soils for smallholder farmers. You will not incur any costs by participating in part of the study other than about an hour spent discussing things with us. You will not receive any payment for this time.

Your participation in this study is completely voluntary and you may refuse to participate or leave the study at any time. If you decide to not participate in the study it will not result in any penalty or loss of benefits to which you are otherwise entitled. Your name will only be recorded to document that you have agreed to participate in this research. It will not be put in any of the project documents to be prepared from this research. Only the research team will have access to the data provided and records will be kept safely in a locked cabinet to which only the research team will have a key, to ensure no one apart from the study investigators can have access to them.

Do you agree to continue with the survey? ☐ YES
☐ NO

You are encouraged to ask me questions at any time during or after this study. To get in touch with us you can contact the Soils Food and Healthy Communities Project located in the Ekwendeni Hospital in Ekwendeni, Malawi. They will be able to put you in contact directly with me. Thank you for all your help and cooperation with this study.

NOTE TO ENUMERATORS: DO NOT CONTINUE IF THE RESPONDENT HAS NOT SAID 'YES' TO ABOVE.

Informed consent obtained (Please circle) YES NO

	DATE ACCOMPLISHED	BY WHOM?	
	Day/Month/Year	Name	Signature
Interview			
Data Check			
Data Entry			

PART A: HOUSEHOLD INFORMATION

Instructions: For the questions in Part A, if it is a monogamous household, interview the husband and wife together, if it is a polygamous household, flip a coin to decide which wife should be interviewed. Make it a priority to involve the wife in the discussion. You should conduct the interview at or near the household's main dwelling unit.

TA/Village Area:____________________ Village: _______________ HHOLD #___

QUESTION	NAME	GENDER and WIFE # (if polygamous)
A1 What is your name? ***Zina linu?*** (if the wife/husband together, ask both of their names and indicate gender).	1. 2.	1. 2. Wife # ___

No.	Question (*Instructions*)	Possible Responses	Code	
			Husban d	Wife
A2.	What year were you born? ***(If don't know, probe using main events e.g. Banda came 1959) Kasi muna vyaka vilinga?***			
A3.	What is your marital status? ***Kasi muli pa nthengwa?***	Monogamous married and living with spouse	1	1
		Polygamous married and living with spouse	2	2
		Married and wife heading household; spouse works or lives elsewhere	3	3
	(*Circle the code that corresponds to the response given*)	Separated/divorced/widowed and living without spouse	4	4
		Never married	5	5
		Other (specify)	97	97

A4.	What is your level of education?	No schooling	1	1
		Some primary school	2	2

	Sukulu muli kulekezgera mphani?	Completed primary school	3	3
		Some secondary school	4	4
		Completed secondary school	5	5
		Post-secondary	6	6
		Other (specify)	97 ______ ______	97 ______ ______ __
		Don't know	98	98
		Refused	99	99
A5.	Were you born in this village? ***Kasi mukababikira mumuzi mwenemuno?***	Yes **(*Skip to A7*)**	1	1
		No **(*Go to A6*)**	2	2
A6.	If you were not born in this village, for how many years have you lived here? ***Para mukababikira mumuzi muno chara mwakhalamo vyaka viringa?***	Less than 5 years	1	1
		Between 5 and 10 years	2	2
		More than 10 years	3	3
		Don't know	98	98
		Refused	99	99
A7.	How many years have you been farming independently (separate from your parents)? ***Ni vyaka viringa ivo mwakhala mukulima pamwekha?***			

A8 Transition (Please read): Sono nifumbenge mafumbo yakukhwaskana na nyumba yinu. Apa nkhung'anamula wanthu wose awo mukukhala nawo pamoza; mukuchitira vyose pamoza kweniso mukuryera pamoza. (We now will ask a number of questions about your household as a whole. When we say household we mean "one or more people related or unrelated, who live together and make common provision for food. They regularly take all their food from the same pot, and/or share the same grain store or incomes for the purposes of purchasing food" (NSO 1998:120).") [For Enumerator:] *Include everyone who eats and sleeps here; also include 'part time' residents ie family members who work away for part of the year but contribute to household income. Record each person's relationship to household head. Ask current school grade (children); grade on leaving school or never attended school. Ask if any of the adults in the household are not able to work. Ask why? (eg too old, blind, chronically sick etc)* ***Kasi pa nyumba pano mukukhalapo walinga?________***

Name	Sex	Age	Relationship to household head	Full time or p/time resident	If part time, how many weeks/ yr?	Children: Current grade	Adults/youth: If unable to work, why? (e.g. often sick,etc)

No.	Question (*Instructions*)	Possible Responses	Code / response
A9	Last year, in 2011, how many <u>fertilizer</u> vouchers did your household receive? ***Kasi chaka chamara, mukapoka makoponi yalinga ya ferteleza?***		

Name	Sex	Age	Relationship to household head	Full time or p/time resident	If part time, how many weeks/ yr?	Children : Current grade	Adults/youth: If unable to work, why? (e.g. often sick,etc)

A10	Did you receive any fertilizer from other sources? A10b If yes, specify source & amount (kg): ________________________	Yes	1
		No	2

A11	**ASSETS Does anyone in your household have the following? K*asi munyumba mwinu walipo uyo wali na…***	Yes	#	No	Don't Know	refused
	Hoe	1		2	98	99
	Radio	1		2	98	99
	Iron sheets for the roof	1		2	98	99
	Cellular phone	1		2	98	99
	Sofa set	1		2	98	99
	Refrigerator	1		2	98	99
	Plough	1		2	98	99
	Bicycle	1		2	98	99
	Tobacco press / jeke	1		2	98	99
	Ox-cart	1		2	98	99
	Motorcycle or car	1		2	98	99
	Wheel barrow	1		2	98	99
	Solar electricity	1		2	98	99
	ESCOM electricity	1		2	98	99
	Sewing machine	1		2	98	99
	Other asset (ask and observe) specify: __________________	1		2	98	99
	Cattle [**enter #**]	1		2	98	99
	Pigs [**enter #**]	1		2	98	99

	Poultry (chicken, doves and/or guinea hen) **[enter #]**	1		2	98	99
	Sheep **[enter #]**	1		2	98	99
	Rabbits [**enter #**]	1		2	98	99
	Goats [**enter#**]	1		2	98	99
	Other livestock (ask, observe): ___________________	1		2	98	99

A12	How much land does your household own? (acres) ***Kasi banja linu liri namunda ukulu uli? [probe for all land, not just cultivated land]***		
A13	How much upland land did your household farm this past year, last rainy season 2011-2012? (acres) ***Kasi banja linu likalima munda ukulu uli chaka chamara 2011-2012?***		
A14a	Did you rent any land *from* anybody last year? ***Kasi mukabwelekapo munda kwa waliyose chaka chamara?***	Yes	1
		No	2
A14b	If yes, how many acres? ***Para enya, ma acres ghalinga?***	# acres: ________________	
A15a	Did you rent any land *to* others last year? ***Kasi mukabwelekeskapo munda kwa waliyose chaka chamara?***	Yes	1
		No	2
A15b	If yes, how many acres? ***Para enya, ma acres ghalinga?***	# acres: ______________________	
A16a	Did you grow crops in a dimba this past dry season? M***ukapanda mbuto mu dimba chihanya chamala? [If no, skip to A18]***	Yes	1
		No	2
A16b	[If yes], A16b. ***Usani dimba?*** What was the size of the dimba?	A16b.Area cultivated:	
A16c.	A16c. What crops did you grow? ***Mukapanda mbuto uli?*** *Enumerator: Probe for all possible crops…*) ***Mphangwe, mapuno, hanyezi, carotes, katofeni, nyungu, nchunga, ngoma, ndozi, mbwete, masimbi, zinde, vikhawu…*** Green leafy vegs, tomatoes, onions, potatoes, carrots, pumpkins, beans, maize, sweet peas, sweet potatoes, yams, sugar cane, cassava…	A16c. Crops:	

A17	What methods do you use to water the dimba crops? ***Pala mukapanda mbuto zinu mu dimba, mukathiliranga uli?***	Diesel pump	1
		Treadle pump	2
		Hand watering	3
		Gravity canals	4
		Deep planting/ residual moisture	5
		Other _____________	97
A18	Have you ever heard of local yellow maize? [if no, skip to A32] ***Kasi muli kupulikapo za ngoma zalokolo za yelo?***	Yes	No
A19	Have you ever seen local yellow maize? ***Kasi muli kuwonapo ngoma za yelo za lokolo?***	Yes	No
A20	Have you ever eaten foods made with local yellow maize? If so, what were they? [list in local language] ***Kasi muli kuryapo vyakurya vyakuphikika kufumila ku ngoma za lokolo za yelo? Pala nadi, vyakarya uli? Lembani vyose***	Yes [if no, skip to A22]	No
A20b	How would you describe these local yellow maize foods? (e.g.taste, smell, write exact words in local language) ***Mukuviwona uli vyakurya vyakupangika kufumila ku ngoma za yelo za lokolo (mwachiyezgelelo kanowelo, kanunkhilo)***		
A21	How long ago was the last time you ate local yellow maize? ***Mukaryapo pauli chakurya chakufumila ku ngoma za lokolo za yelo?***	[name year]	
A22	What is the local name for local yellow maize? ***Zikuchemeka na zina uli ngoma za lokolo izi?***		
A23	Have you or anyone in your household ever grown yellow maize? ***Kasi walipo uyo walikulimapo ngoma za lokolo za yellow mu banja linu?***	Yes No ***[if no, skip to A31]***	
A23a	[If yes] ***Nipauli mukapanda ngoma za lokolo za yelo?*** When was the last time you planted local yellow maize?	[name year] [if was last year, skip A24]	
A24	[If not last year] ***Chifukwa uli mukaleka kupanda ngoma za lokolo za yelo?*** Why did you stop growing local yellow maize?		
A25	How many acres did you plant? ***ma acres ghalinga***	# acres	

A26	Why do you grow yellow maize? (write answers below, find out if they like to eat it) ***Chifukwa uli mukulima ngoma za lokolo za yellow?***		
A27	Have you experienced any problems growing local yellow maize? ***Kasi mwasanganapo na masuzgho ghaliyose pa kulima ngoma zayellow? Skip to A29 if no***	Yes	No
A28	[If yes] what kinds of problems have you experienced? (describe below) ***Masuzgo uli?***		
A29	Did you share ideas about growing local yellow maize with anyone? ***Mulikuphalilanapo na waliyose pa zakalimiro kangoma za yellow?*** ***If no, skip to A31]***	Yes	No
A30	[If yes] who did you share with? ***Nanjani?[category of person]***		
A31	If you have never planted local yellow maize, why not? ***Usange mundapadepo ngoma za lokolo za yelo, chifukwa uli?***		
A32	In the last year, were you or someone in your household sick for 1 week or more such that it affected your farming activities? ***Kasi chaka chamara, walipo uyo wakalwarapo kwa sabata yose panji ku jumpha mpaka ulimi winu ukatimbanizgika? [Skip to A34]***	Yes	No
A33	***[If yes] a*** How long was the sick household member not farming? ***Ulwali ukamutolera nyengo yitali uli?*** b.Were any other household members taken away from farming because of the illness (e.g. to care for the person)? If yes, for how long? ***Vikatola nyengo yitaliuli mu kupwelelera mulwali***?______________________ c. Can you tell me about the illness***? Niphalilani zawulwali uwu?***		
	Sick Person 2 [if more than one person was sick] ***a*** How long was the sick household member not farming? ***Ulwali ukamutolera nyengo yitali uli?*** b.Were any other household members taken away from farming because of the illness (e.g. to care for the person)? If yes, for how long? ***Vikatola nyengo yitaliuli mu kupwelelera mulwali***?______________________ c. Can you tell me about the illness***? Niphalilani zawulwali uwu?***		

	Sick Person 3 ***a*** How long was the sick household member not farming? ***Ulwali ukamutolera nyengo yitali uli?*** b.Were any other household members taken away from farming because of the illness (e.g. to care for the person)? If yes, for how long? ***Vikatola nyengo yitaliuli mu kupwelelera mulwali***?_______________________ c. Can you tell me about the illness***? Niphalilani zawulwali uwu?***

A34: Improved Sustainable Production/Resilience[5] A34 Tell me what you planted last rainy season (2011-2012)?

[5] Adapted from two surveys previously done by SFHC: Participatory Experimental Baseline Survey (2011) and the Crop Diversity and Soil Health survey (2010).

#	***A34aNi mbewu uli izo mukalima mu munda uwu chaka chamala?*** What crops did you plant in each field last year? Possible crops: Maize/Ngoma Tobacco/Hona Cotton/Thonje Pigeonpea/Nyamodolo Groundnut/skaba Soya Bean/Nchunga Velvet bean/Karongonda Cassava/Vikhawu Bambaranut/Zgama Sorghum/Vidomba Sweetpotato/Mbwete/Mboholi Irish potato/Katufeni Cowpea/Nkhunde Pearl Millet/Nyauti Finger Millet/Ripoko Tomato/Mapuno pumpkin/Majungo Paprika Rice/Mpunga Mphangwe/Green leafy vegs Other (specify)	*A34b* ***Kamunda uwo ngukulu uli?*** What was the area planted for each field? (acres or specify unit)	A34c ***Mukakolola vinandi uli?*** What is the estimated yield of each crop from that field? (specify units)	A34d ***Mukaryapo mbeu izi?*** Did you eat any of the crop (s)?	A34e ***Vya kalapo viringa?*** ***[if none] Vikamara pa uli?*** How much do you have left of the crop? **If none, what month did you use up the crop(s)?**	***A34f Kasi pa mbewu izo mwazunulani mbewu uli izo mwaguliska panji mugulisken ge?*** Did you or anyone in your household sell any of the crops? If yes, how much did you sell? (kg or specify amount) (list all crops that they sold).	*A34g* ***Kasi mungani phalirapo fetereza uyo mukagwiriska ntchito na unandi wake?*** (if applied fertilizer) what type did you apply and how much?	*A34h* ***Kasi zikawapo nthowa zinyake izo mukagwiriska ntchito zakuchepeskera matenda panji vibungu mu mbewu zinu?*** How did you deal with pests and plant diseases? Had no problems = 0 Did nothing with problem=1 If did something, methods used: Pesticide = 2 Hand picking=3 Ash=4 Tephrosia or other plant leaves crushed and liquid applied = 5 **Other (specify)=6**	*A34i* ***Kasi viswaswa mukachita navo uli mukati mwakolora****?* What did you do with the crop residues? Nothing = 0 Remove to thresh=1 Remove for livestock=2 Leave & incorporate early =3 Leave & incorporate late =4 Burn for cooking=5 Burn for land clearing or mice hunting=6 Burn for nutrients=7 Herbicide=8(type) Other (describe)=77	*A34j* ***Ni nthowa uli izo mukuchita kuti vyakurya vinu vileke kulyeka na vibungu/ fufuzi/magenge***What did you do to prevent the harvest from insects e.g. weevils or termites? Nothing = 1 Pesticide = 2 Hand sorting=3 Ash=4 Other (specify)=5
1										

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2										

<table>
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Possible crops: Maize/Ngoma Tobacco/Hona Cotton/Thonje Pigeonpea/Nyamodolo Groundnut/skaba Soya Bean/Nchunga Velvet bean/Karongonda Cassava/Vikhawu Bambaranut/Zgama Sorghum/Vidomba Sweetpotato/Mbwete/Mboholi Irish potato/Katufeni Cowpea/Nkhunde Pearl Millet/Nyauti Finger Millet/Ripoko Tomato/Mapuno pumpkin/Majungo Paprika Rice/Mpunga Mphangwe/Green leafy vegs Other (specify)</td><td>A34b Kamunda uwo ngukulu uli?

What was the area planted for each field?

(acres or specify unit)</td><td>A34c Mukakolola vinandi uli?

What is the estimated yield of each crop from that field? (specify units)</td><td>A34d Mukaryapo mbeu izi?

Did you eat any of the crop (s)?</td><td>A34e Vya kalapo viringa?

[if none] Vikamara pa uli?

How much do you have left of the crop? If none, what month did you use up the crop(s)?</td><td>A34f Kasi pa mbewu izo mwazunulani mbewu uli izo mwaguliska panji mugulisken ge?

Did you or anyone in your household sell any of the crops? If yes, how much did you sell? (kg or specify amount)

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Had no problems = 0

Did nothing with problem=1

If did something, methods used:

Pesticide = 2

Hand picking=3

Ash=4

Tephrosia or other plant leaves crushed and liquid applied = 5

Other (specify)=6</td><td>A34i Kasi viswaswa mukachita navo uli mukati mwakolora?
What did you do with the crop residues?
Nothing = 0

Remove to thresh=1

Remove for livestock=2

Leave & incorporate early =3

Leave & incorporate late =4

Burn for cooking=5

Burn for land clearing or mice hunting=6

Burn for nutrients=7

Herbicide=8(type)

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7										
8										

Mbeu/ Crop Type	**A35 *Kasi chaka chino mwangulkima mtundu uli wa [crop type]?*** In 2011/12 growing season, what type of [add crop type] did your household grow? ***(Fill in all variety names using exact words in local language)***	**A36 *Mungatipako pachokowa waka kuti tiyeye kuti tikapime Mungandigayileko pang'ono mbewu zomwe munalimazo kuti akaziwunike kuti muli ma vitamin bwanji?*** Can we have a small sample of your crop? We want to learn about the nutrient value of the food eaten in this area. ***[Check ☐ if they give a sample. Make sure sample is labeled with crop type, Variety # and Hhold #. Put in separate bag & seal, make sure it doesn't get wet]***
Ngoma/ Maize	Variety 1:______________ ☐ Variety 3: ______________ ☐ Variety 2: ______________ ☐ Variety 4: ______________ ☐	
Vidomba/ Sorghum	Variety 1:______________ ☐ Variety 3: ______________ ☐ Variety 2: ______________ ☐ Variety 4: ______________ ☐	
Ripoko/ Finger Millet	Variety 1:______________ ☐ Variety 3: ______________ ☐ Variety 2: ______________ ☐ Variety 4: ______________ ☐	
Skaba/ Groundnut GM	Variety 1:______________ ☐ Variety 3: ______________ ☐ Variety 2: ______________ ☐ Variety 4: ______________ ☐	
Soya	Variety 1:______________ ☐ Variety 3: ______________ ☐ Variety 2: ______________ ☐ Variety 4: ______________ ☐	

Nyamundolo/ Pigeonpea	Variety 1:______________ ☐ Variety 3: ______________ ☐ Variety 2: ______________ ☐ Variety 4: ______________ ☐
Nkhunde/ Cowpea	Variety 1:______________ ☐ Variety 3: ______________ ☐ Variety 2: ______________ ☐ Variety 4: ______________ ☐
Ntchunga/ Beans	Variety 1:______________ ☐ Variety 3: ______________ ☐ Variety 2: ______________ ☐ Variety 4: ______________ ☐
Zgama/ Bambara Groundnut	Variety 1:______________ ☐ Variety 3: ______________ ☐ Variety 2: ______________ ☐ Variety 4: ______________ ☐

A37	Can you tell me what trees you have on your homestead and their use? (*List all named and uses*) ***Munga tiphalirapo makuni ayo muli nawo pa nyumba pinu nantchito zake?*** [probe for trees used for firewood, to improve soils etc]	Trees:	Uses:

A38 Do you know of any ways (including traditional) to improve the quality/health of the soil and water, without applying fertilizer? ***Kasi mukumanya nthowa zilizose zakale zakuwezgera vundira na kusunga mtika mu dongo kwambula kuthila fertileza?***	Yes	1
	No	2
A38a. Methods ***Nthowa***	A39b Where did you learn about these methods? ***Mukusambira nkhu?***	A38c Do you currently use any of these methods? If not, why? ***Muchali kugwiliska nthowa izi? Para yayi, chifukwa uli?***

1	1	1	
2	2	2	
3	3	3	
4	4	4	
A39 Do you know of any ways to improve household food security? ***Kasi mukumanya nthowa zilizose zakusangila chakurya chkukwana þanyumba þinu?***		Yes	1
		No	2
A39a. Methods ***Nthowa***	A39b Where did you learn about these methods? ***Mukusambira kochi?***	A39c Do you currently use any of these methods? If not, why? ***Muchali kugwiliska nthowa izi? Para yayi, chifukwa uli?***	
1	1	1	
2	2	2	
3	3	3	
4	4	4	
A40. Do you know of any ways that you and your family can improve young children's nutrition? ***Kasi mukamanya nthowa zilizose izo mungaþwelelera ŵana ŵinu kuti ŵaleke kunyenthela?***		Yes	1
		No	2
A40a. Methods ***Nthowa***	A40b Where did you learn about these methods? ***Mukusambira kochi?***	A40c Do you currently use any of these methods? If not, why? ***Muchali kugwiliska nthowa izi? Para yayi, chifukwa uli?***	
1	1	1	
2	2	2	
3	3	3	
4	4	4	
A41. Have you heard of Vitamin A? ***Mulikuþulikaþo za Vitamin A?***		Yes	No
A42. [if yes] Do you know of any ways that you and your family can increase Vitamin A in your food? ***Kasi mukamanya nthowa izo zingasazgiramo Vitamin A muchakurya chinu ? [If no, skip to A43]***		Yes	1
		No	2
A42a. Methods ***Nthowa***	A42b Where did you learn about these methods? ***Mukusambira***	A42c Do you currently use any of these methods? If not, why?	

	kochi?	***Muchali kugwiliska nthowa izi? Para yayi, chifukwa uli?***
1	1	1
2	2	2
3	3	3

<u>HOUSEHOLD FOOD SECURITY</u> [6] For each of the following questions, make sure that you refer to the past four weeks. If the answer is 'yes', explain whether: sometimes (once or twice), often (3-10), frequently (more than 10 times).

#	**Question (Check only one response).** **Each of the following questions applies to past 4 weeks.**	**Never**	**Rarely** **(1-2 times)**	**Sometimes** **(3-10 Times)**	**Often** **(More than 10 times)**
A43	In the past 4 weeks, were you ever worried that you may not have enough food in your household? ***Kasi masabata yanayi ghajumpha muli kwenjerwapo kuti chakurya chimumalilaninge***	☐	☐	☐	☐
A44	[in the past 4 weeks] was there anyone in this household unable to eat the kinds of foods you preferred because of a lack of resources***? Kasi walipo munthu munyake munyumba mwinu panji imwe wakaleka kuryanga chakurya icho wakuchitemwa chifukwa chakusoŵerwa?***	☐	☐	☐	☐
A45	In the past four weeks did you or any household member have to eat a limited variety of foods due to a lack of resources? ***Kasi pa masabata yanayi ghajumpha walipo munthu munyake munyumba mwinu panji imwe wakalekanga kurya chakurya chakupambanapambana chifukwa chakusoŵerwa?***	☐	☐	☐	☐
A46	In the past four weeks was there any household member who had to eat some foods that you really did not want to eat because of a lack of resources to obtain other types of food? ***Kasi pa masabata yanayi yajumpha mu nyumba yinu walipo munyake uyowakarya chakurya icho wakuleka kuchitemwa yayi chifukwa***	☐	☐	☐	☐

[6] The English and Chichewa versions of the Household Food Insecurity Access Scale come from a published, pre-tested and back-translated version done in Malawi (Mtimumi and Geresomo 2006, see http://www.foodsec.org/web/publications/pubshome/fsi4dm-pubsarchive/en/). The Tumbuka version comes from previous HFIAS surveys conducted by the SFHC team.

#	Question (Check only one response). Each of the following questions applies to past 4 weeks.	Never	Rarely (1-2 times)	Sometimes (3-10 Times)	Often (More than 10 times)
	chakusoŵerwa?				
A47	In the past four weeks was there anyone in this house hold who ate less amount of food [or a smaller meal than you felt you needed] because there wasn't enough food? ***Kasi walipo munthu munyake munyumba mwinu panji imwe wakaryanga pachoko kwambula kukhuta chifukwa chakuti chakurya chikawa chichoko masabata yanayi ya jumpha?***	☐	☐	☐	☐
A48	In the past four weeks was there any household member who ate fewer times per day because there wasn't enough food? ***Kasi pa masabata yanayi yajumpha walipo munthu munyake panji imwe uyo wakalyanga mwakuperewera pazuwa chifukwa chakuti chakurya chasowa?*** [***Kalinga?***]______	☐	☐	☐	☐
A49	In the past four weeks was there ever no food to eat of any kind in your household because of lack of resources? [make sure all types of food] ***Kasi pa masabata yanayi yajumpha walipo munthu munyake munyumba mwinu panji imwe wakatandarapo na njala chifukwa chakusoŵerwa?***	☐	☐	☐	☐
A50	***Kasi walipo munthu munyake munyumba mwinu panji imwe pamoza nabanja linu wakagonela na njala chifukwa chakuti mulijiretu kalikose? (Masabata yanayi ya jumpha?)*** **<u>Probe more to make sure they are not including any food such as cassava, blackjack.</u>** In the past four weeks, did you or any household member go to sleep at night hungry because there wasn't enough food?	☐	☐	☐	☐
A51	***Kasi walipo munthu munyake munyumba mwinu panji imwe pamoza nabanja linu wakakhalilathu zuwa lose na kugonera nanjala chifukwa chakuti mulijiretu kalikose? (Masabata yanayi aya ya jumpha?)*** **<u>Probe more to make sure they are not including any food such as cassava, green maize.</u>** In the past four weeks was there any household member who had spent a whole day and night without eating because there wasn't enough food?	☐	☐	☐	☐

#	Question (Check only one response). **Each of the following questions applies to past 4 weeks.**	Never	Rarely (1-2 times)	Sometimes (3-10 Times)	Often (More than 10 times)
A52 Have you or any household member had to do ganyu for food in the past 4 weeks because you have run out of your own food sources? ***Kasi walipo munyake munyumba mwinu panji imwe uyo wakagwirapo ganyu masabata yanayi ghajumpha chifukwa chakuti mukaŵevwe chakurya? [Kalinga?]***		**Never** ☐	**Rarely (1-2 times)** ☐	**Sometimes (3-10 times)** ☐	**Often (more than 10 times)** ☐

A53 ***Kasi ngoma izo mukakorora chaka chamala mukuyanayana kuti zimale pauli***/? How long do you expect last year's maize harvest to last? (month) **Month ended or expected to finish:**

HOUSEHOLD DIETARY DIVERSITY: Vyakurya vya Kasinthasintha Pa Nyumba

Read to participant: ***Sono nimufumbaninge za vyakurya na vyakumwa ivyo waliyose wakarya kwambila mayiro mulenji mpaka namise panyumba pinu (kupatula ivyo mukarya panji kumwa kunyakhe)*** Now I will ask you questions about food stuffs and drinks that any household member ate or drank yesterday from the time he/she woke up until he/she went to bed *(Do not include food or drink taken elsewhere*

A54 ***Kasi pali waliyose panyumba pinu uyo wakarya panji kumwa ivi mayiro?*** (Did any household member eat or drink any of the following yesterday?)

#	*Gulu la chakurya*	*Viyezgelero* **Examples**	**Yes**	**No**
1	***Chakurya cha mugulu la ngoma*** **(Cereals)**	***Chakurya chili chose ngati: sima, bala, buledi, supageti, nkhoŵe, mabisiketi, chindongwa, mpunga, chikondamoyo, mandazi, vitumbuwa, paji vyakuya vilivose vyakufumila ku vidomba, ngoma, mupunga, na tiligu?*** Any food such as Nsima, porridge, bread, spaghetti, scones, biscuits, rice, boiled whole maize grain, sweetbeer, boiled samp, milk scone, doughnuts, maize- banana pan cake, or any food made from finger millet, sorghum, bullrush millet, maize and wheat?	**Yes**	**No**
2	***Chakurya cha kufumila ku mphangwe na Vitamin A*** (Vitamin A rich tubers & vegetables)	***Chakurya chilichose mwa ivi: majungu, karoti, panji mbwete za mtundu uswesi na yelo.*** Any food such as: pumpkins, carrots or sweet potatoes having yellow pigment, including local yellow maize? ***[please check here if they indicate that they ate local yellow maize]*** ☐	**Yes**	**No**
3	***Mbwete na vyakurya msisi ya tuwa*** **(**White tubers	***Chakurya chilichose mwa ivi i mbwete zituŵa, vikhawu, katofeni, panji chakurya chilichose chakfumila ku misisi.*** Any food in the group of: white sweet potatoes, coco yams, cassava, irish	**Yes**	**No**

	and roots)	potatoes, yams or any white roots and tubers?		
4	***Mphangwe ya kubiliŵira*** (Dark greenleafy vegetables)	***Dende la mphangwe yakubiliŵira kusazgilapo za kuthondo ngati izi: chigwada, luni, mpiru, kanganje, lepu, khwanya.*** Relish of dark green leafy vegetables as well as the indgenous vegetables including, Cat's whiskers leaves, Amaranthus, cassava leaves, sweet potato leaves, mastard, rape, local rape, pumpkin leaves, cow peas leaves, bean leaves, denje, black jack leaves	**Yes**	**No**
5	***Dende lililose la mphangwe*** (any other vegetables)	***Panyakhe dende lililose la mphangwe ngati: Chinese, delele la kubaba, kabichi, mabilinganya, mapuno, nanyezi, sabola wakubiliŵila na ntchunga za vitheba***. Any kind of relish from leafy vegetables e.g Chinese cabbage, okra, cabbage, egg plants ,tomatoes, onions, green pepper and green beans?	Yes	No
6	***Vipaso vyakuŵa na Vitamini A*** (Vitamin A rich fruits)	***Vipaso vilivyose ngati ni: papaya, mango.*** Any fruits like papaya (pawpaw)?	**Yes**	**No**
7	***Vipaso vilivyose*** **(**Other fruits)	***Vipaso vilivyose kusazgilapo vyamuthondo gati ni ivi: ma olenji, mazobala, matanjalini, mapeyala, matochi, masuku, maviru, matowo, makanamajaha na vinyakhe?*** Any other fruits including the indigenous wild fruits e.g oranges, tangerines, lemons, tamarind, elephant fruits, *masawo*, avocado pears, bananas and baobab fruits?	**Yes**	**No**
8	***Nyama*** (Meats)	***Nyama yiliyose ngati iyi: nyama ya ngombe, ya mbelele ya nkhumba, ya mbuzi, ya kalulu, mbeŵa, nkhuku, baka, nkhanga panji tuyuni, chiwindi, mtima, panji nyama yiliyose ya mkkati olo chakurya chilichose cha nyama***. Any meat e.g beef, lanb, pork, goat meat, rabbit meat, mice, wild game, poultry duck, flying insects e.g nkhunguni, guinea fowl or any other bird, liver, kidney, heart, offals or any other meat.	**Yes**	**No**
9	***Masumbi*** (Eggs)	***Masumbi gha mutundu uliwose***? Eggs of any kind?	**Yes**	**No**
10	**Somba** (Fish)	***Somba ziŵisi panji zakomira***? Fresh or dried fish**?**	**Yes**	**No**
11	***Chakurya cha mugulu la ntchunga*** (Legumes, nuts & seeds)	***Mutundu uliwose wa mugulu la ntchunga ngati: ntchunga, zgama, nyamundolo, ndozi, nkhunde, skaba, soya?*** Any type of beans and peas e.g beans, cow peas, pigeon peas, nkhungudzu, peas, ground beans, soya beans, ground nuts, green gram, custard apple, Nseula, chick peas?	**Yes**	**No**
12	***Mukaka/ Lukama*** (Milk and milk	***Vyakurya vyakufumila ku lukama ngati: lukama, yogati, chambiko?*** Milk and Food made from milk e.g yoghurt, sour milk?	**Yes**	**No**

	products)			
13	***Mafuta ghakuphikila na gha nyama*** (Oils and Fats)	***Mafuta ghalighose ngati: mafuta, ghakuphikira, mafuta ghakufumila ku nyama, majalini***? Any type of fats or oils e.g. cooking oil, animal fats and margarine used for cooking or added to food?	**Yes**	**No**
14	***Vyakurya vyakunowa*** (Sweets)	***Chakuyra chilichose chakunowa ngati: shuga, wuchi, vyakumwa vyambula kulowêleska ngati: Fanta, fizesi, kokakola, sprite, kokopina, vyakurya vyakuthilako shuga ngati chokoleti, masweti?*** Any sweet, sugar, honey, soft drinks such as fanta, fizzes, cocacola, sprite cocopina, drinks to which sugar was added or sugary foods e.g chocolate, sweets?	**Yes**	**No**
15	***Khofi/tiyi*** (coffee/tea)	***Tiyi waliyose, panji khofi?*** Any tea or coffee?	**Yes**	**No**

A55. Can you tell me about any recipes that you use at home for the following crops?

Mungani phalirako za kaphikiro ako mukumanya kufumira ku mbeu izi?

Legume	Recipes Used ***za kaphikiro***	How often in last month? ***Kalinga mwezi wamala?***
Soybeans ***Soya***	1. 3. 2. 4.	1. 3. 2. 4.
Pigeonpea ***Nyamodolo***	1. 3. 2. 4.	1. 3. 2. 4.
Cowpea ***Nkhunde***	1. 3. 2. 4.	1. 3. 2. 4.
Beans ***Nchunga***	1. 3.	1. 3.

Legume	Recipes Used ***za kaphikiro***	How often in last month? ***Kalinga mwezi wamala?***
	2. 4.	2. 4.
Local yellow maize ***Ngoma za lokolo za yellow***	1. 3. 2. 4.	1. 3. 2. 4.
Sweet potatoes ***Mbwete***	1. 3. 2. 4.	1. 3. 2. 4.
Cassava ***Vikhawu***	1. 3. 2. 4.	1. 3. 2. 4.

PART B: FARMING INFORMATION

Instructions for Enumerator: For the questions in Part B, please interview either the husband or the wife <u>separately</u>, in the case of spousal-couple households. Please flip a coin to decide which adult to interview. (If there is more than one wife, you will have to do multiple flips, once for husband vs wife, and then for each wife e.g. Wife 1 vs Wife 2…) <u>You should conduct these interviews alone with the respondent, with enough distance to ensure they do not hear each other.</u>

(Please read*): *Nimufumbaningiko pachoko waka za umo mukupokelera uthenga wa za ulimi, magulu ayo mulimo na umo mukugwiriskira ntchito nkholongo yinu. Niyambenge na mafumbo yakukhwaskana na umo mukupokelera uthenga wa vya ulimi. I would like to ask you a few questions that concern where you get your farming information, what kind of social groups you are in, and other topics. I will start with some questions about farming knowledge and where you get your farming information.

<table>
<tr><td>B1</td><td>Nivinthu uli ivo mukwenjerwa navyo chomene mumoyo winu? (What are your most important concerns when it comes to your life?)</td><td colspan="3"></td></tr>
<tr><td>B2</td><td>What are your most pressing agricultural concerns?

Kasi pavyaulimi nivichi ivo mukwenjerwa navyo chomene?</td><td colspan="3"></td></tr>
<tr><td rowspan="13">B3.</td><td rowspan="13">What are the main ways that you learn new information or solve a problem in your farming? [7]

B1a.Nthowa za kalimiro mukuzimanya uli panji mukufumba kwanjani?

(Circle all that apply)

Rank the top <u>two</u> sources in order of importance for information that you have used in your own farm.

B1b. Pa nthowa izo mwazunura muniphalirepo nthowa ziwiri izo mukugwiriska ntchito pa munda winu izo muzigomezga?

(Put rank to the right of the two top-ranked sources)</td><td></td><td>Code</td><td>Rank</td></tr>
<tr><td>Self- experience / observation</td><td>1</td><td></td></tr>
<tr><td>Ask relatives/friends</td><td>2</td><td></td></tr>
<tr><td>Ask other farmers (not relatives or friends)</td><td>3</td><td></td></tr>
<tr><td>Ask a farmers group – list
________________</td><td>4</td><td></td></tr>
<tr><td>Radio</td><td>5</td><td></td></tr>
<tr><td>Television</td><td>6</td><td></td></tr>
<tr><td>Extension agents (agricultural field assistants)</td><td>7</td><td></td></tr>
<tr><td>Special activities – list
(e.g. field day)
________________</td><td>8</td><td></td></tr>
<tr><td>Demonstration trials</td><td>9</td><td></td></tr>
<tr><td>Newspaper</td><td>10</td><td></td></tr>
<tr><td>Shopkeeper</td><td>11</td><td></td></tr>
<tr><td>Other (specify)</td><td>12</td><td></td></tr>
<tr><td>B4.</td><td>Can you describe 2 types of useful information that you learned from these sources, which you are still using? Kasi ni nthowa uli ziwiri izo mukasambilapo ndipo muchali kugwiliska ntchito pa sono?</td><td colspan="3">(Describe the type of information named)

1.</td></tr>
</table>

[7] Question adapted from Humphries et al 2012 and SFHC Crop Diversity survey 2010.

		2.

B5	In general, compared to other people your age, would you say your health is: Excellent, Very Good, Good, Fair or Poor? ***Kulingana na banthu banyakhe ŵa nthanga zinu ṗachikaya mukughanaghana kuti moyo winu ni uweme uli?***	Excellent ***Nguweme chomene nkhanira***	
		Very Good ***Nguwemi chomene***	
		Good ***Nguwemi***	
		Fair ***Pachoko waka***	
		Poor ***Makora yayi***	
		Not Sure ***Khumanya yayi***	
		Refused ***Wakana***	
B6	How satisfied are you with your health? Would you say you are Very Satisfied, Somewhat Satisfied, Not Too Satisfied, or Not At All Satisfied? ***Kasi umoyo winu, mukuwuwona wuli?***	Very Satisfied ***kukhorwa***	
		Somewhat Satisfied ***kukhutira chomene***	
		Not Too Satisfied ***kukhutira***	
		Not At All Satisfied ***kuleka kukhutira***	
		Not Sure ***nkhumanya cha, kwali***	
		Refused ***wakana***	
B7	How would you rate your ability to handle the day-to-day demands in your life, for example, work, family and farming responsibilities? ***Mukujiṗima/kujiyezga uli nkhongono zinu zakungwilila ntchito zuwa na zuwa (ntchito, zaulimi ṗanyakhe zaṗabanja linu)?***	Excellent ***Nguweme chomene nkhanira***	
		Very Good ***Nguwemi chomene***	
		Good ***Nguwemi***	
		Fair ***Pachoko waka***	
		Poor ***Makora yayi***	
		Not Sure ***Nkhumanya yayi***	
		Refused ***Wakana***	
B8	When you have a family or personal crisis, how would you rate your ability to	Excellent ***Nguweme chomene nkhanira***	

	handle the crisis: excellent, very good, good, fair, poor or not sure?***Para masuzgho ya mabuchibuchi ghachitika, mukughapokerera wuli?***	Very Good ***Nguwemi chomene***	
		Good ***Nguwemi***	
		Fair ***Pachoko waka***	
		Poor ***Makora yayi***	
		Not Sure ***Nkhumanya yayi***	
		Refused ***Wakana***	

INVOLVEMENT IN LOCAL ORGANIZATIONS

B9.	***Walipo munyake mu banja linu uyo wali mugulu la ulimi lakovwira kuti muwe na chakurya chinandi, umoyo uwemi, kalyero kawemi, gulu la muzi banki, panyake bungwe lililose?*** Do you or any members of your household participate in any community group that helps with agriculture, food security, health/nutrition or income or other group?	Yes	1
		No ***(Skip to C1)***	2
		Don't Know ***(Skip to C1)***	98
		Refused ***(Skip to C1)***	99
B10.	IF YES, what group, and please indicate year joined, position and why they participate. ***Ni gulu uli kweniso mukukumana kalinga?***		

Organization Name	**Year joined**	**Position with organization**	**Why do you participate?**

SECTION C: SOCIAL SUPPORT and GENDER RELATIONS

Note to enumerator: the following questions are quite sensitive. Please assure the respondent that all identities are kept confidential and will not be shared with anyone. Please say to respondent: Sono nimufumbaninge vya banja linu na umo mukugwilila ntchito kweneso kukhwaskana na ulamulilo pa banja linu. Manyani kuti vyose ivyo tidumbilanenge va chisisi. (I am now going to ask you about household issues. Please remember that all questions are confidential and will not be shared with anyone beyond the research team.)[8]

C1. (***Read the following to the respondent***): ***Nyengo zinyake tawanthu tikukhumbanga wovwiri kufumira kuwanyithu kuti tivwirike.*** People sometimes look to others for companionship, guidance, assistance, or other types of support. Could you tell me how often each of the following kinds of support is available to you when you need it?					
C1a. ***Kasi nkhalinga ako mukuchezga nawanyinu ntchezgo izo imwe mukukondwa nazo? (Give example, such as playing bawo.)*** How often do you have someone to have a good time or do something enjoyable with?	All of the time	Most of the time	Some of the time	Almost None of the time	Never
C1b. ***Nkhalinga ako mukuwanga na mnyinu wakuti mukumphalilangako masuzgo yinu ndipo wakumuvwirani mayanoyano***? How often do you have someone to confide in, talk with about yourself or your problems, and get advice?	All of the time	Most of the time	Some of the time	Almost None of the time	Never
C1c. ***Nkhalinga ako mukuwana uyo wakumutoleraniko kuchipatala panji kumumuvwiraniko na ndalama panji chakulya pala mwaskuzgika?*** How often do you have someone to take you to the hospital or give you money or food if you need it?	All of the time	Most of the time	Some of the time	Almost None of the time	Never
C1d. ***Kasi nikalinga ako mukuwanga na wanyinu awo wakumulongolani chitemwa na lusungu?*** How often are you in the company of someone who shows you love and affection?	All of the time	Most of the time	Some of the time	Almost None of the time	Never

Introduction: ***Sono nkhukhumba kumanya za uyo wakulamulira pa banja linu.*** Now I'd like to ask you about decision-making in your household.	1 = self 2 = spouse 3= Both

[8] Adapted from Humphries et al. 2012, Pandey et al. 2012 and Story and Burgard 2012.

			4= Sons 5=Daughters 6= Other members of the family 7= Other (specify)	
C2 ***Ninjani wakulamula mbeu za kupanda na malo ghakhe?*** Who usually decides what and where to plant?				
C2 ***Ninjani wakulamula mbeu zakuti muguliske?*** Who usually decides what farm products to sell?				
C3 ***Ninjani wakulamula vyakukhumba kugulika pa banja (ngati feteleza)?*** Who usually makes decisions about major household purchases (e.g. fertilizer)?				
C4 ***Ninjani wakulamula kugula vyakukhumbikila pa banja dazi na dazi (ngati sopo na mchere?*** Who usually makes decisions about purchases for daily household needs (e.g. soap and salt)?				
C5 ***Ninjani wakulamula kuti mungaluta kukachezga kwa ŵabale ŵinu?*** Who usually decides about visits to your family or relatives?				
C6 ***Ninjani wakulamula pala mungatolapo gawo pa vitukuko vyakulekalekana muchigawa chinu?*** Who usually decides whether you can participate with different local organizations?				
C7 ***Ninjani wakulamula kuti ŵana ŵasambire sukulu?*** Who usually decides about your children's education?				
C8 ***Kasi mwankazi winu wangapanda mbeu zilizose kwambula kuti mwazomelezga?*** Can your wife (*or you if it is the woman*) ever decide to plant crops on her own?			Yes	No
C9 ***Kasi mwanakazi winu wangaguliska mbeu pa yekha?*** Can your wife (*or you if it is the woman*) ever decide to sell crops on her own?			Yes	No
C10 ***Kasi mwanakazi winu wanganjira bungwe lililose kwambula kuti mwamuzomelezga?*** Can your wife (*or you if it is the woman*) ever decide on her own to join an organization such as a village bank?			Yes	No
C11 ***Kasi mwanakazi winu wangaluta kukawona ŵabale kwambula kuti mwazomelezga?*** Can your wife (*or you, if it is the woman*) ever decide to visit family or friends outside the village on her own?			Yes	No
C12 ***Kasi mukuvwilapo pa kupewerera ŵana?*** Do you (*or your husband*) ever help with child care?			Yes	No
C12b [If yes], ***Pa nyengo zilinga pa mwezi?*** how often per month?	Daily	Frequently	Rare Occasions	Never

C13 ***Kasi mungakondwa kuti mwanakazi winu wali na udindo mu bungwe lililose ndipo lamusankha kuti wakawone ivyo mabungwe ghanyakhe ghakuchita kudela linyakhe?*** Would you (*or your husband*) be comfortable with your wife being in a leadership position in an organization, that led her to travel away from home?			Yes	No

C14 ***Kasi namwe mukuphika chakurya cha banjalinu?*** Do you (*or your husband*) ever help with food preparation?	Yes		No	
C14b [If yes], ***Pa nyengo zilinga pa mwezi?*** how often per month?	Daily	Frequently	Rare Occasions	Never
C15 ***Kasi namwe mukuchapa vyakuvwala?*** Do you (*or your husband*) ever do the laundry?	Yes		No	
C15b [If yes], ***Pa nyengo zilinga pa mwezi?*** how often? (write any details provided):	Daily	Frequently (3-10 times)	Rare Occasions	Never

C16 ***Nyengo zinyake mwanalume wakwiyanga na vinthu ivyo muwoli wake wakuchita. Kasi imwe mukughanaghana kuti ntchakwenelera kuti mwanalume watimbe muwoli wake pa vifukwa ivi:*** Sometimes a husband can get irritated or annoyed by things that his wife does. Do you think a husband is justified in hitting or beating his wife in the following situations[9]:		
C16a ***Pala wagulisya mbewu panji vinyake kwambula kumuphalira mfumu wake?*** She sells something (like crops) without telling him?	Yes	No
C16b ***Pala wanyeska chakurya?*** She burns the food?	Yes	No
C16c ***Para wakana kugonana nayo?*** She refuses to have sex with him?	Yes	No

[9] Adapted from Pandey et al. 2012.

<table>
<tr><td>C17 Kasi imwe muli kubatimbapo bagholi binu/Kasi imwe muli kutimbikapo na afumu winu mu sabata zinayi izo zajumpha? Did you (or your husband) beat your wife in the last four weeks? C17b Pala enya, niphaliraniko umo vikawira? If yes, can you tell me more about the situation? (write all details down)</td><td colspan="2">Yes</td><td colspan="2">No</td></tr>
<tr><td>C18 Walipo uyo wakumwa mowa munyumba mwinu? Does anyone in the household drink alcohol? If so, who? [if no, go to end of survey]

Banjani? ___________________________</td><td colspan="2">Yes</td><td colspan="2">No</td></tr>
<tr><td>C19. Wakumwa kalinga pa sabata? [If someone drinks] Can you estimate how often per week this person usually drinks?</td><td>Daily</td><td>Frequently</td><td>Sometimes</td><td>Never</td></tr>
<tr><td>C20. Kasi kamwelo ka mowa kasinthapo muvyaka vitatu vyajumpha? Has the consumption of this person changed in the past 3 years?</td><td colspan="2">Yes</td><td colspan="2">No</td></tr>
<tr><td colspan="5">C21 Nchivichi icho mukuwona chasintha? Ngati pali kusintha mukuwona ngati ndi chifukwa chani? If so, why do you suppose it has changed?</td></tr>
</table>

Now I have finished my questions. Thank you very much for your patience and information.

Appendix C: Malawi Farmer-to-Farmer Agroecology Endline Survey

<u>**Informed Consent. ENUMERATOR, PLEASE READ THE FOLLOWING TO THE RESPONDENT**</u>

Zina lane ndine_________. nkupanga kafukufuku wakukhwaskana na mbewu zakupambanapambana na dongo. Nkhugwira ntchito pamoza na Chipatala cha Ekwendeni, Kalongonda, Chancellor College na Department ya Geography ku Western University na University ya Manitoba ku Canada. Nkukhumba kumanya umo kupandandilo ka mbewu zakupambana pambana zikovwilira kusintha dongo na mabanja yinu. Sono nkhukhumba nimulongosolerani umo vikhalirenge pa kuchezga kwithu. Muwe wakumasuka kufumba mafumbo nyengo yiliyose. Vidumbirano vithu vizamuvwira kusanga nthowa zakuti tisangilenge chakurya chinandi. Ivo tisangenge pa vidumbirano ivi vilembekenge ndipo vamusangika ku office ya Kalongonda ku chipatala cha Ekwendeni. Sono nati nimufumbani pala mwanozgeka kuti ningamufumbani.

Na umo mwazomelezgera kuti nimufumbani mafumbo, nkukhumba timanyepo na umo mukulimira. Nitolenge pafupifupi 1 hour kumufumbani za kalimiro kinu na kasangiro ka chakurya pa banja pinu. Mazgoro ghose agho mungatipa ngakukhumbikwa. Nyengo yiliyose muwe wakumasuka pala mundakhumbe kulutilizga vidumbirano vithu.

Palije wovwiri wuliwose wakuti timpasaninge pakutolapo lwande pa kafukufuku uyu, kweni vidumbirano vithu vizamovwira imwe, muzi winu, charu chithu na vyaro vyakuwalo kusanga nthowa ziwemi zakusangira chakurya chinandi na kusazgiramo vundira mudongo.

Paŵenge chisisi chikulu pa nkhani yose iyi tidumbiraninge pano, ine, imwe na wa ku office ndise timanyenge, sono muleke kopa kuti ivi tidumbiranenge pano vamufumiraso panyake.

Sono mukuzomerezga kutolapo lwande pa kafukufuku uyu? ENYA YAYI

Muwe wakumasuka kufumba mafumbo mukati mwa vidumbirano panji pa umaliro. Pala mukukhumba kumanya vinandi va kafukufuku uyu mungakafumba ku Kalongonda ku chipatala cha Ekwendeni panyake mungayowoyeskana na Lizzie Shumba Pala mungakhumba ningamulekerani pepala ili. Tawonga chifukwa chakuzomera kuti nichezge namwe.

(English translation of informed consent: My name is _____. I am working in collaboration with Ekwendeni Hospital, the Soils, Food and Healthy Communities project, Chancellor College, the Department of Geography at the Western University and University of Manitoba in Canada. We would like to understand more about your family and farming practices. I would like to ask you if I might interview you, and I'd like to explain more about what will be involved. Please feel free to ask any questions at any time. The results from this study will be used to inform future initiatives aimed at improving farmers' food security. We will write up the results of the study and will make the results available at the Soils Food and Healthy Communities Project at the Ekwendeni Hospital.

If you agree to participate in this part of this study, we want to learn from your knowledge and how you are farming. We will be spending about an hour asking you questions about your cropping practices, your diet and other information that affects your family's food security. There is no right or wrong answer to our questions. If you feel uncomfortable at any moment, or would prefer that I not participate/observe certain activities, you can refuse my presence at any time.

There is no direct benefit to you for participating in this part of research; however, it will help you to get to know us and become familiar with our study and provide an opportunity for you to express any concerns that you have regarding your life as a farmer. Additionally, the information gained in this study will benefit your community indirectly. We will share what we learn from your farming practices with local, national and international institutions such that it can be used to inform initiatives for improving food security and soils for smallholder farmers. You will not incur any costs by participating in part of the study other than about an hour spent discussing things with us. You will not receive any payment for this time.

Your participation in this study is completely voluntary and you may refuse to participate or leave the study at any time. If you decide to not participate in the study it will not result in any penalty or loss of benefits to which you are otherwise entitled. Your name will only be recorded to document that you have agreed to participate in this research. It will not be put in any of the project documents to be prepared from this research. Only the research team will have access to the data provided and records will be kept safely in a locked cabinet to which only the research team will have a key, to ensure no one apart from the study investigators can have access to them.

Do you agree to continue with the survey? ☐ **YES**
☐ **NO**

You are encouraged to ask me questions at any time during or after this study. To get in touch with us you can contact the Soils Food and Healthy Communities Project located in the Ekwendeni Hospital in Ekwendeni, Malawi. They will be able to put you in contact directly with me. Thank you for all your help and cooperation with this study.

NOTE TO ENUMERATORS: DO NOT CONTINUE IF THE RESPONDENT HAS NOT SAID 'YES' TO ABOVE.

Informed consent obtained (Please circle) **YES** **NO**

	DATE ACCOMPLISHED	BY WHOM?	
	Day/Month/Year	Name	Signature
Interview			
Data Check			
Data Entry			

PART A: HOUSEHOLD INFORMATION

Instructions: For the questions in Part A, if it is a monogamous household, interview the husband and wife together, if it is a polygamous household, flip a coin to decide which wife should be interviewed. Make it a priority to involve the wife in the discussion. You should conduct the interview at or near the household's main dwelling unit.

TA/Village Area:_______________________ Village: __________________ HOUSEHOLD ID #___

Question	Response
A1 Respondent Name *Dzina la wofunsidwa*	
A2 Gender *Mwamuna/Mkazi*	M ☐ F ☐
A3 Marital Status *Kodi muli pa banja* ***If single, divorced or widowed move to Question A4***	☐ Single *Wosakwatira/Wosakwatiwa* ☐ Divorced *Banja linatha* ☐ Widowed *Anamwalira* ☐ Married *Wokwatira/Wokwatiwa*
A3a If married, are you monogamous or polygamous (*Mulipa mitala?)*	☐Monogamous *Mkazi/Mwamuna modzi* ☐ Polygamous *Pamitala*
A3b If married, what is your spouse's name? *(Ngati muli pa banja dzina la mwamuna/mkazi wanu ndi ndani?)*	
A4. Are you or someone in your household in the MAFFA Project? (*Kodi inu kapena wina pa banja panu pano ali mu bungwe la MAFFA?)*	☐ YES (1) ☐ NO (2) **(CONTROL GROUP)** ***(Sitinakhalepo mu bungwe la MAFFA)*** ☐ NO (3) **(FORMER MEMBER) (*Ayi ndinasiya*)**
A4a. If yes or former member, when did you join? *(Ngati muli kapena munalowako MAFFA, munalowa chaka chanji?)*	Year joined ☐ 2012 ☐ 2013 ☐ 2014
A4b If yes, what is your specific role in MAFFA**?** *(Ngati muli membala muli ndi udindo wanji mu MAFFA?)*	(1) Farmer; (2) FRT Member; (3) Promoter;

No.	Question (*Instructions*)	Possible Responses	Code	
			Husband	Wife
A6.	***Munabadwa liti?*** What year were you born? ***(If don't know, probe using main events e.g. Banda came 1959)***			

A7.	***Kodi munalekela pati sukulu?*** What is your level of education?	No schooling	1	1
		Some primary school	2	2
		Completed primary school	3	3
		Some secondary school	4	4
		Completed secondary school	5	5
		Post-secondary	6	6
		Other (specify)	97	97
		Don't know	98	98
		Refused	99	99
A8.	***Kodi munabadwila m'mudzi muno?*** Were you born in this village?	Yes ***(Skip to A9)***	1	1
		No ***(Go to A8a)***	2	2
A8a.	***Ngati musali mbadwa ya m'mudzi muno, munabweramo liti?*** If you were not born in this village, for how many years have you lived here?	Less than 5 years	1	1
		Between 5 and 10 years	2	2
		More than 10 years	3	3
		Don't know	98	98
		Refused	99	99
A9.	***Kodi inu mwakhala mukulima kwa zaka zingati panokha mosiyana ndi makolo anu?*** How many years have you been farming independently (separate from your parents)?			

PART A Transition (Please read): Tsopano ndikufunsani mafunso okhudzana ndi anthu onse amene mumakhala nawo pakhomo pano; makamaka amene mumadyera limodzi/amene inu mumawasamala. Pamenepa tikuphatikizapo anthu omwe sakhala pakhomo pano nthawi zonse chifukwa akugwilila ntchito kapena kuchita bizinesi kutali koma amabwela nthawi ndi nthawi komanso amathandiza kugula ndi kapezedwe ka zakudya pakhomo pano. (We now will ask a number of questions about your household as a whole. When we say household we mean "one or more people related or unrelated, who live together and make common provision for food. They regularly take all their food from the same pot, and/or share the same grain store or incomes for the purposes of purchasing food" (NSO 1998:120).") [For Enumerator:] *Include everyone who eats and sleeps here; also include 'part time' residents ie family members who work away for part of the year but contribute to household income. Record each person's relationship to household head. Ask current school grade (children); grade on leaving school or never attended school. Ask if any of the adults in the household are not able to work. Ask why? (eg too old, blind, chronically sick etc)* [from Zomba survey, Kambewa).

No.	**Question (*Instructions*)**				**Response**
A10	How many people live in your household? (***Kodi Pakhomo pano, mumakhala anthu angati amene mumadyera Mnkhali imodzi?)*** *Probe to make sure that they are including people who might live in a separate dwelling but share food and farm together, and that they are not including those who do not live in the village but send things home*).				
A11	How many of your household members are under the age of 18 years? ***(Kodi pakhomo pano pali anthu angati amene ali ndi zaka zochepera 18?)***				
A12	How many children in the household go to school? ***(Kodi pakhomo pano ana a sukulu alipo angati?)***				
A13	How many under five year olds live in the household? ***(Kodi ana osapitilira zaka zisanu zakubadwa, alipo angati pakhomo pano?)***				
A14	Do you have any elderly people living in your household, over the age of 65 years? ***(Kodi pakhomo pano mumakhala ndi okalamba opitilira zaka 65?)***				
A15	Do you have any chronically sick people living in the household that need regular care and who cannot actively participate in income-earning or farming activities? If yes, please indicate number. ***(Kodi pakhomo pano pali odwala matenda a mgonagona amene amafuna chisamaliro nthawi ndi nthawi ndipo sangathe kugwira ntchito?)***				
	What are your households' sources of	Possible options:	**Rank (1-3) (1=most important)**	**Estimated amount**	**Code**

A16	income? (Check all that apply) Rank the most important 3 sources of income and estimate the amount your household earns from that income. ***(Kodi ndi zinthu ziti zimene mumapanga kuti mupeze ndalama pa banja panu?*** ***Tchulani zinthu zitatu kuyambira chimene chiri chofunikira kwambiri.)***			**earned in 2016**	
		Sell Pigeonpeas ***(nandolo)***			1
		Sell Soya ***(Soya)***			2
		Sell Groundnuts ***(Mtedza)***			3
		Sell Beans ***(Nyemba)***			4
		Sell SweetPotatoes ***(Mbatata)***			5
		Sell Orange maize ***(Mthikinya)***			6
		Sell tobacco ***(Fodya)***			7
		Sell tomatoes and other dimba vegetables ***(Matimati ndi mbewu zina za kudimba)***			8
		Sell other food crops ***(Mbewu zina zakudya)***			9
		Sell firewood, stones, or other natural resources ***(Nkhuni, miyala ndi zina zachilengedwe)***			10
		Sell pottery, baskets or other craft items ***(Zowumba,miph***			11

		ika, mabasiketi, ndi zina zaluso)			
		Sell clothing, fish or other purchased items ***(Zovala, nsomba, ndi zina za bizinesi)***			12
		Shop ***(Wokala, tiyirumu kapena golosale)***			13
		Employment ***(Ntchito yolembedwa)***			14
		Money sent from relatives living in other places ***(Ndalama zochokera kwa achibale)***			15
		Other (Indicate below): ***(Zina, wonjezerani)***			16
A17	Has there been a change in your family's income in the last 4 years?		Much lower income ***(Zachepa kwambiri)***		**1**

	(Pali kusintha kotani pa ndalama zimene mumapeza pa banja lanu pano pa zaka zinayi zapitazi?) ***<u>Probe more (Kusintha kotani?)</u>***	A little lower income ***(Zachepa pang'ono)***	**2**
		No change ***(Palibe Kusintha)***	**3**
		A little more income ***(Zachulukirapo pang'ono)***	**4**
	If **NO** skip to question A17b	A lot more income ***(Zachuluka kwambiri)***	**5**
A17a	If there has been a **positive** change, why? (*Write in full response from participant*) ***(Ngati mwayamba kupeza ndalama zochulukirapo chifukwa chiyani?)***	Increased number of crops that I sell ***(Kuchuluka kwa mitundu ya mbewu zogulitsa)***	**1**
		Increased yields ***(Kuchuluka kwa zokolola)***	**2**
		Easy access to markets ***(Misika ya zokolola ikupezeka mosavuta)***	**3**
		Increased land size ***(Ndachulukitsa malo olima)***	**4**
		Improved farming techniques (***Kutsatira njira zamakono za ulimi***)	**5**
		Reduced cost of production (***Kuchepetsa ndalama zogwiritsa ntchito pa ulimi)***	**6**
		Running small scale enterprises (***Ndinayamba bizinesi)***	**7**
		Other (Specify) (***Zina tchulani)***	**8**
A17b	If there has been a **negative** change, why? (*Write in full response from participant*) ***(Ngati mwayamba***	Limited access to markets ***(Kusowa kwa misika)***	**1**
		Low yields ***(Kukolola zochepa)***	**2**

	kupeza ndalama zocheperapo chifukwa chiyani?)	Low prices (***Kutsika kwa mitengo yogulitsira mbeu)***	**3**
		Increased cost of production ***(Kuchuluka kwa ndalama zogwiritsira ntchito)***	**4**
		Natural disasters (Floods and droughts)***(Mavuto ogwa mwadzidzidzi (kusefukira kwa madzi ndi chilala)***	**5**
		Land fragmentation ***(Kugawira ena malo olima)***	**6**
		Loss of employment ***(Kuchotsedwa ntchito)***	**7**
		Illness or death in the family ***(Matenda kapena imfa pa banja lathu)***	**8**
		Someone in the family moved away ***(Kuchoka kwa anthu ena pa banja pathu)***	**9**
		Participating in MAFFA activities reduced my income activities (***Kugwira nawo ntchito za MAFFA kwachepetsa mwai wanga opezera ndalama)***	**10**
		Other (Specify) (***Zina tchulani)***	**11**
A18	Would you say that your fertilizer use in farming has increased, decreased or stayed the same in the last 4 years? ***(Munganene kuti kagwilitsidwe ntchito ka feteleza kawonjezerapo, kacheperapo***	Now use no fertilizer (***panopo sitigwiritsa ntchito feteleza)***	**1**
		Decreased fertilizer use a lot (***Tachepesa kwambiri kugwiritsa ntchito feteleza)***	**2**

	kapena kakhala chimodzimodzi pa zaka zinayi zapitazi?)	Decreased fertilizer use a little ***(tachepesa pang'ono kugwiritsa ntchito feteleza)***	**3**
		Stayed the same ***(Palibe kusintha kuli konse)***	**4**
		Increased fertilizer use a little bit (***Tachulutsako pang'ono)***	**5**
		Increased fertilizer use a lot ***(tachulutsa kwambiri)***	**6**
A18a	If your use of fertilizer has changed, why has it changed? (*please write down exactly what they say, and probe for more details if needed)* ***Ngati kagwiritsidwe ntchito kanu ka feteleza kasintha, zapangika chifukwa chiyani? (Chonde lembani***		
A19	***Kodi chaka chatha munalandira makuponi angati a feteleza?*** Last growing year, in 2016, how many <u>fertilizer</u> vouchers did your household receive?		
A20	***Kodi munalandilako feteleza wina kuposela wamakuponi?*** Did you receive any fertilizer from other sources?	Yes	1
		No	2
		(If NO skip to A21)	
A20a	***Ngati munalandilako anali wambili bwaji_________________________?*** If yes, specify fertilizer type and amount (kg): Type: Amount (kg):		

A21	**ASSETS Does anyone in your household have the following?** ***Kodi pakhomo pano pali amene ali ndi zinthu izi?***	**Yes**	**No**	**#**	**Don't Know**
	Hoe/ Khasu	1	2		98

	Radio /wailesi	I	2		98
	Iron sheets for the roof/malata	I	2		98
	Cellular phone/foni	I	2		98
	Sofa set/mpando wa sofa	I	2		98
	Refrigerator/fuligi	I	2		98
	Plough/plawo	I	2		98
	Bicycle/njinga	I	2		98
	Tobacco press/	I	2		98
	Ox-cart /ngolo	I	2		98
	Motorcycle or car/mthuthuthu, galimoto	I	2		98
	Wheel barrow/wilibala	I	2		98
	Solar electricity/magetsi a sola	I	2		98
	ESCOM electricity/magetsi	I	2		98
	Sewing machine/makina osokera	I	2		98
	Other asset (ask and observe) specifyZina: ____________	I	2		98
	Cattle/Ng'ombe **[enter #]**	I	2		98
	Pigs/Nkhumba [**enter #**]	I	2		98
	Poultry (chicken, doves and/or guinea fowl)/ Nkhuku, nkhanga, nkhunda, abakha**[enter #]**	I	2		98
	Sheep/Nkhosa [**enter #**]	I	2		98
	Rabbits/Kalulu,Mbira [**enter #**]	I	2		98
	Goats /Mbuzi**[enter#]**	I	2		98
	Other livestock /Ziweto zina zomwe sindinazitchule: __________	I	2		98
A22	**Were any assets purchased in the last 4 years due to income earned from MAFFA?** ***Kodi pa zaka zinayi zapitazi mwagulako***			#	

	katundu ndi ndalama zopezeka kuchokera ku ulimi wa MAFFA?				
	Hoe/ Khasu	1	2		98
	Radio /wailesi	1	2		98
	Iron sheets for the roof/malata	1	2		98
	Cellular phone/foni	1	2		98
	Sofa set/mpando wa sofa	1	2		98
	Refrigerator/fuligi	1	2		98
	Plough/plawo	1	2		98
	Bicycle/njinga	1	2		98
	Tobacco press/	1	2		98
	Ox-cart /ngolo	1	2		98
	Motorcycle or car/mthuthuthu, galimoto	1	2		98
	Wheel barrow/wilibala	1	2		98
	Solar electricity/magetsi a sola	1	2		98
	ESCOM electricity/magetsi	1	2		98
	Sewing machine/makina osokera	1	2		98
	Other asset (ask and observe) specify Zina: ____________	1	2		98
	Cattle/Ng'ombe [**enter #]**	1	2		98
	Pigs/Nkhumba [**enter #**]	1	2		98
	Poultry (chicken, doves and/or guinea fowl)/ Nkhuku, nkhanga, nkhunda, abakha[**enter #]**	1	2		98
	Sheep/Nkhosa [**enter #**]	1	2		98
	Rabbits/Kalulu,Mbira [**enter #**]	1	2		98
	Goats /Mbuzi[**enter#]**	1	2		98
	Other livestock /Ziweto zina zomwe sindinazitchule: __________	1	2		98

A23	***Kodi muli ndi malo akulu bwanji olima pa banja panu? [probe for all land, not just cultivated land]*** How much land does your household own? (acres)		
A24	***Munalima maekala ochuluka bwanji chaka chatha 2015-2016?*** How much upland land did your household farm this past year, last rainy season 2015-2016? (acres)		
A25	***Munabwelekako kapena kuchita lendi malo olima chaka chatha?*** Did you rent any land *from* anybody last year?	Yes	1
		No	2
A25a	***Ngati munabweleka kapena kuchita lendi, anali maekala angati?*** If yes, how many acres?	# acres: ________________	
A26	***Kodi munachititsako lendi kapena kubwereketsako munda uliwonse chaka chatha 2015-2016?*** Did you rent out any land *to* others last year?	Yes	1
		No	2
		(If NO skip to A27)	
A26a	***Ngati munabwereketsako, unali maekala angati?*** If yes, how many acres?	# acres: ________________	
A27	***Munalimako mbewu zam'dimba chaka chatha?*** Did you grow crops in a dimba this past season? ***[If no, skip to A28]***	Yes	1
		No	2
A27a	***[If yes], Kodi dimbalo linali maekala angati?*** What was the size of the dimba?	Area cultivated:	
27b	***[If yes],*** What crops did you grow? ***Munalima mbeu zanji?****Enumerator: Probe for all possible crops…*) ***Masamba, tomatoes, anyezi, batatesi, karoti, nkhwani, nyemba, chimanga, nsawawa/kabaifa, mbatata ya kholowa, coco, nzimbe, chigwada/*** Green leafy vegs, tomatoes, onions, potatoes, carrots, pumpkins, beans, maize, sweet peas, sweet potatoes, yams, sugar cane, cassava…	Crops:	

A27c	What methods do you use to water the dimba crops? ***Kodi mumagwiritsa ntchito njira zanji pothirira mbewu zakudimba?***	Diesel pump	1
		Treadle pump	2
		Hand watering	3
		Gravity canals	4
		Deep planting/ residual moisture	5
		Other _____________	97
A28	***Kodi mu chaka chapitachi, inu kapena wina aliyense pakhomo pano, mwa amene mumalima nawo, anadwalako kwa sabata limodzi kapena kupitilira apo moti zinasokoneza kagwiridwe ka ntchito za kumunda?*** In the last year, were you or someone in your household sick for 1 week or more such that it affected your farming activities? ***[If no, Skip to A29]***	Yes	1
		No	2
A28a	***[If yes] Sick Person 1*** ***a. Sanakwanitse kulima kwa nthawi yayitali bwanji?*** How long was the sick household member not farming? b. ***Kodi anthuena apabanja pano anaasiya kulima kuti azisamalira matendawo?*** Were any other household members taken away from farming because of the illness (e.g. to care for the person)? If yes, for how long?______________________ c. ***Anadwala chani?***Can you tell me about the illness***?***		

	Sick Person 2 [if more than one person was sick] ***a. Sanakwanitse kulima kwa nthawi yayitali bwanji?*** How long was the sick household member not farming? b. ***Kodi anthuena apabanja pano anaasiya kulima kuti azisamalira matendawo?*** Were any other household members taken away from farming because of the illness (e.g. to care for the person)? If yes, for how long?______________________ c. ***Anadwala chani?***Can you tell me about the illness***?***
	Sick Person 3 ***a. Sanakwanitse kulima kwa nthawi yayitali bwanji?*** How long was the sick household member not farming? b. ***Kodi anthuena apabanja pano anaasiya kulima kuti azisamalira matendawo?*** Were any other household members taken away from farming because of the illness (e.g. to care for the person)? If yes, for how long?______________________

	c. ***Anadwala chani?***Can you tell me about the illness***?***

A29: AGRICULTURAL QUESTIONS [questions adapted from Crop Diversity survey 2010) A29 Tell me what you planted last rainy season (2015-2016)?

#1	***A29a Munalima mbeu zanji muminda imeneyi?*** What crops did you plant in each field last year? Possible crops: Maize/Ngoma Tobacco/Hona Cotton/Thonje Pigeonpea/Nyamodolo Groundnut/skaba Soya Bean/Nchunga Velvet bean/Karongonda Cassava/Vikhawu Bambaranut/Zgama Sorghum/Vidomba Sweetpotato/Mbwete/Mbo holi Irish potato/Katufeni Cowpea/Nkhunde Pearl Millet/Nyauti Finger Millet/Ripoko Tomato/Mapuno pumpkin/Majungo Paprika Rice/Mpunga Mphangwe/Green leafy vegs Other (specify)	*A29b* ***Kodi pa mbeu ili yonse munalimayo munalimalo akulu bwanji?*** What was the area planted for each field? (acres or specify unit)	A29c ***Munakolola zambiri bwanji*** What is the estimated yield of each crop from that field? (specify units)	A29d ***Munadya zambiri Bwanji?*** Did you eat any of the crop (s)?	A29e ***Panaopa mwatsala nazo zambiri bwanji? Ngati mulibe zinatha liti?*** How much do you have left of the crop? **If none, what month did you use up the crop(s)?**	*A29f* ***pa mbeu zomwe munakololazomunagulitsapo zambiri bwanji?*** Did you or anyone in your household sell any of the crops? **If yes, how much did you sell? (kg or specify amount)** (list all crops that they sold).	*A29g* ***Kodi munagwiitsa ntchito feteleza wanji ndipo wochuluka bwanji?*** (if applied fertilizer) what type did you apply and how much?	*A29h* ***Kodi munapangapo njira iliyonse yobwezeletsa chonde mnthaka musanadzale mbewu zanu?Ngati ziri choncho munatsatira njira ziti?*** Did you do anything to improve soil fertility prior to planting your crop? If so, what did you do? (pick all that apply) 1. Grew legumes in the field last year ***Anadzala mbewu zamu gul u la nyemba chaka chatha*** **2.** Buried residue in the field last year ***Anakwilira zinyalala mmunda chaka chatha*** **3.** Planted agroforestry tres ***Anadzala mitengo yobwezeletsa chonde mnthaka*** **4.** Mulching (specify type) ***Anayala mapesi mmunda*** **5.** Prepared box ridges ***Anapanga ngonyeka*** **6.** Planted vetiver grasses ***Anadzara udzu wa Vetiva*** **7.** Applied manure or compost to the field before planting ***Anathila manyowa*** **8.** Other (specify) ***Zina, tchulani***	*A29i* ***Kodi munapangako njira inayiliyonse yothana nditizilombo kapena matenda mumunda wanu? Ngati ndichoncho, ndinjira zanji?*** Did you do anything to deal with pests and diseases in this field so far? If so, what? (Pick all that apply) 1. Intercropped ***Kuphatikiza mbewu*** 2. Rotated the crops ***Kasintha sintha wa mbewu*** 3. Applied tephrosia to the field ***Kuthira jele jele*** 4. Planted repellent plants ***Kudzala mbewu zothamangitsa tizilombo*** 5. Physical killing ***Kupha tizilombo ndi manja*** 6. Applied Herbicides ***Kuthira mankhwala ophera tchire*** 7. Applied pesticides ***Kuthira mankhwala ophela*** 8. Other (specify)

2	**Repeat questions above for all crops cultivated by the household**								

<table>
<tr><td rowspan="3">A30</td><td rowspan="3" colspan="2">Did you receive any seeds from MAFFA over the past 4 years? (Kodi pa zaka zinayi zapitazi munalandilako mbewu yina iliyonse kuchokera ku bungwe la MAFFA?)</td><td colspan="2">Yes</td><td>1</td></tr>
<tr><td colspan="2">No</td><td>2</td></tr>
<tr><td colspan="3">[If not MAFFA member, skip to A33]</td></tr>
<tr><td rowspan="10">A30a</td><td rowspan="10">If yes, check all of the crops which you have received and indicate what year. (Ngati munalandilako, mungandiuzeko mitundu ya mbewu imene munalandilako ndi chaka chomwe munalandilira?)</td><td></td><td>Years Received seed (Zaka zomwe munalandira mbewu)</td><td>Amount Received (Kuchuluka kwa mbewu zomwe munalandira)</td><td>Amount Returned (Kuchuluka kwa mbewu zomwe munabweza)</td></tr>
<tr><td>Yellow /orange maize (Mthikinya)</td><td></td><td></td><td></td></tr>
<tr><td>Pigeonpea (Nandolo)</td><td></td><td></td><td></td></tr>
<tr><td>Groundnut (Mtedza)</td><td></td><td></td><td></td></tr>
<tr><td>Soya beans (Soya)</td><td></td><td></td><td></td></tr>
<tr><td>Beans (Nyemba)</td><td></td><td></td><td></td></tr>
<tr><td>Cowpea (Khobwe)</td><td></td><td></td><td></td></tr>
<tr><td>Finger millet (Mawere)</td><td></td><td></td><td></td></tr>
<tr><td>Sorghum (Mapira)</td><td></td><td></td><td></td></tr>
<tr><td>Sweet Potato (Mbatata)</td><td></td><td></td><td></td></tr>
</table>

		Cassava ***(Chinangwa)***			
		Other (Specify) (***Zina tchulani)***			
A31	Have you shared any MAFFA seed over the past 4 years? ***(Pa zaka zinayi zapitazi mwagawirako mbewu anzanu?)***		Yes	No	
	If yes, check all of the crops which you have shared and indicate what year. ***(Ngati munagawilako anzanu ndi mbewu zake ziti ndipo chaka chiti?)***		Year Shared ***(Chaka chimene anagawirako anzawo)***	Amount Shared ***(Kuchuluka kwa mbewu imene anagawirako anzawo)***	
		Yellow /orange maize ***(Mthikinya***			
		Pigeonpea ***(Nandolo)***			
		Groundnut ***(Mtedza)***			
		Soya beans ***(Soya)***			
		Beans ***(Nyemba)***			
		Cowpea ***(Khobwe)***			
		Finger millet ***(Mawere)***			
		Sorghum ***(Mapira)***			
A32	Have you shared any ideas that you have learned from MAFFA over the past 4 years? If yes, please indicate what you have shared and estimate with		No ***(Ayi)***	Yes: Idea shared ***(Inde. Zomwe***	Number of

<table>
<tr><td rowspan="6"></td><td colspan="2" rowspan="6">how many people. (Kodi pa zaka zinayi zapitazi mwaphuzitsako anzanu zimene mwaphunzira ku MAFFA? Ngati ndi choncho tchulani zomwe munawaphunzitsa, anthu angati?)</td><td rowspan="6" colspan="2"></td><td>munawaphunzitsa)</td><td>People (Ndi anthu angati)</td></tr>
<tr><td></td><td></td></tr>
<tr><td></td><td></td></tr>
<tr><td></td><td></td></tr>
<tr><td></td><td></td></tr>
<tr><td></td><td></td></tr>
<tr><td rowspan="2">A33</td><td rowspan="2">Kodi mumadziwa zomwe inu ndi banja lanu mungachite pothandizila kuti ana azidya chakudya chabwino, chokwanira kuti asanyentchere? Do you know of any ways that you and your family can improve young children's nutrition? (tick all that they mention)

YES (1) NO (2)</td><td>A33a. Methods Tchulani njira</td><td colspan="3">A33b Do you currently use any of these methods? If not, why? Kodi mumagwilitsabe ntchito njirazi/upangiliwu? Ngati ayi, chifukwa?</td><td>A33c Where did you learn about these methods? Munaphunzira kuti?</td></tr>
<tr><td></td><td>Yes</td><td colspan="2">No(Reason)</td><td></td></tr>
</table>

		Eating more diverse foods ***(Kudya zakudya za magulu)***			
		Exclusive breastfeeding ***(Kuyamwitsa mwakathithi)***			
		Feeding young children more frequently ***(Kudyetsa ana ang'ono pafupi pafupi)***			
		Eating more orange colored foods e.g. orange maize, sweet potatoes ***(Kudya zakudya zamawonekedwe a olenji)***			
		Other (specify) ***(Zina, tchulani)***			
A34	***Munadyakochakudya chopangidwa kuchokera ku mthikinya (chayelo)? Tiuzeni kuti ndi zakudya zanji.*** Have you ever eaten foods made with local orange maize? If so, what were they? [list in local language]			Yes	No [if no, skip to A35]
A34a	***Kodi ndiliti limene munadya komaliza zakudyazi?*** How long ago was the last time you ate local orange maize?			[name year]	
A35	***Mu zaka zisanu zapitazi inu kapena munthu wina pa banja lanu analimako chimanga chamakolo cha mthikinya?*** In the last 5 years, have you or anyone in your household ever grown orange maize?			Yes	No ***[if no, skip to 35b]***
A35a	***[If yes]*** How frequently? Circle the years they grew local orange maize ***(Ngati munalimako, zinali zaka ziti?)***			2012-13 2013-14 2014-15	

<table>
<tr><td></td><td colspan="2"></td><td colspan="2">2015-16

[if it includes last year, skip to 36]</td></tr>
<tr><td>A35b</td><td colspan="4">[If not last year] ***Munasiyiranji kudzala chimanga chimenechi?***

Why did you stop growing local orange maize?</td></tr>
<tr><td>A36</td><td colspan="2">***Chimanga chimemechi munachidzala malo okwanira maekala angati?*** How many acres of orange maize did you plant? ***Kodi?***</td><td colspan="2"># acres</td></tr>
<tr><td rowspan="7">A37</td><td rowspan="7">What are the top three reasons why you grew orange maize? (Please rank 1-3) ***(Zifukwa zitatu zofunikira zimene zinakupangitsani kulima Mthikinya?)***</td><td colspan="2">Reason ***(Chifukwa)***</td><td>Rank</td></tr>
<tr><td colspan="2">Increased yields ***(Zokolola zochuluka)***</td><td></td></tr>
<tr><td colspan="2">Reduced seed expenses ***(Kuchepetsa ndalama zogulira mbewu)***</td><td></td></tr>
<tr><td colspan="2">Improved food security ***(Kuwonjezera kupezeka kwa zakudya pa khomo)***</td><td></td></tr>
<tr><td colspan="2">Eating more nutritious maize ***(Kudya chimanga chopeleka thanzi lambiri)***</td><td></td></tr>
<tr><td colspan="2">Early maturing ***(Chocha msanga)***</td><td></td></tr>
<tr><td colspan="2">Other (specify)

(Zina, tchulani)</td><td></td></tr>
<tr><td>A38</td><td colspan="2">Have you sold any orange maize seed or products? ***(Mwagulitsako mbewu ya mthikinya kapena chiri chonse chopangidwa kuchokera ku chimangachi?)***</td><td>Yes ***Inde***</td><td>No ***Ayi***</td></tr>
</table>

A39	If yes, please indicate what you sold and how much you earned ***(Ngati munagulitsako, munagulitsa chani ndipo munapeza ndalama zingati?)***	Item: ***Zinthu***	Amount: ***Ndalama anapeza***
A40	***Ngati simunalimeko chinangachi, simunalimeko chifukwa chani?*** If you have never planted local orange maize, why not?		
A41	Compared to 4 years ago, how would you describe your household food security situation? (tick response) ***(Kodi pa zaka zinayi zapitazi mukusiyanitsa bwanji kapezedwe ka chakudya pa nyumba panu pano?)***	Much worse ***Zabvutiratu***	
		A little worse ***Zabvuta pang'ono***	
		Stayed the same ***Palibe kusintha***	
		A little better ***Zasintha pang'ono***	
		Much improved ***Zasintha kwambiri***	
A42	Why? (check all that apply) ***(Chifukwa chiyani?)***		Tick ***Chongani***
	several droughts and floods ***(Kusefukira kwa madzi ndi chilala)***		
	can't afford fertilizer or other inputs ***(Kusakwanitsa kugula feteleza kapena zipangizo za ulimi)***		
	sickness in household (***Matenda)***		
	applying organic material to soil, soil fertility has improved ***(Chonde chinabwelera chifukwa chothira manyowa)***		

	growing a lot more crops ***(Kulima Mbewu zosiyana siyana)***	
	We know different recipes that allow us to have more food, for example we eat bananas, cassava or other foods when we don't have maize. (***Kudziwa kaphikidwe kachakudya mosiyana siyana kuthandizira kuti tikhale ndi chakudya chokwanira, mwachitsanzo timadya nthochi, chinagwa ndi zina ngati tilibe chimanga)***	
	apply good storage management to keep/store crops longer ***Kutsatira njira zoyenerera zakasungidwe ka mbewu kuti zikhale nthawi yaitali kuti zisawonongeke***	
	we are working more together to produce more ***Kugwilira nchito limodzi kuti tikolore zochuluka***	
	My wife/husband and I are deciding things together, it is working well. ***Kupangira ziganizo pamodzi ndipo zikuyenda bwino***	
	other (please list) ***Zina, tchulani***	

HOUSEHOLD FOOD SECURITY [10] Instructions to the Enumerators: For each of the following questions, make sure that you refer to the past four weeks. If the answer is 'yes', explain whether: sometimes (once or twice), often (3-10 times), frequently (more than 10 times). **Pafunso linalilonse mwa mafunso otsatilawa, fotokozani mmene zinaliri pa masabata anayi apitawa. Ngati yankho liri 'ee', fotokozani ngati ndi Mwa apo ndi apo (kamodzi kapena kawiri), nthawi zina (katatu kufikira khumi), kawirikawiri (kupitilira khumi) masabata anayi apitawa.**

[10] The English and Chichewa versions of the Household Food Insecurity Access Scale come from a published, pre-tested and back-translated version done in Malawi (Mtimumi and Geresomo 2006, see http://www.foodsec.org/web/publications/pubshome/fsi4dm-pubsarchive/en/). The Tumbuka version comes from previous HFIAS surveys conducted by the SFHC team.

#	Question (Check only one response). Each of the following questions applies to past 4 weeks.	Never	Rarely (1-2 times)	Sometimes (3-10 Times)	Often (More than 10 times)
A43	***Kodi pa masabata anayi apitawa, munakhalapo ndi nkhawa kuti mukhala ndi chakudya chosakwanira pakhomo panu?*** In the past 4 weeks, were you ever worried that you may not have enough food in your household?	☐	☐	☐	☐
A44	***Kodi pa masabata anayi apitawa, pali wina aliyense pakhomo pano analephera kudya zakudya zimene amafuna kudya chifukwa cha kuchepekedwa?*** [in the past 4 weeks] was there anyone in this household unable to eat the kinds of foods you preferred because of a lack of resources**?**	☐	☐	☐	☐
A45	***Kodi pa masabata anayi apitawa, pali wina aliyense pakhomo pano analephera kudya zakudya zosiyanasiyana chifukwa cha kuchepekedwa?*** In the past four weeks did you or any household member have to eat a limited variety of foods due to a lack of resources?	☐	☐	☐	☐
A46	***Kodi pa masabata anayi apitawa, pali wina aliyense wa pakhomo pano anadyapo zakudya zoti sazikonda chifukwa chochepekedwa?*** In the past four weeks was there any household member who had to eat some foods that you really did not want to eat because of a lack of resources to obtain other types of food?	☐	☐	☐	☐
A47	***Kodi pa masabata anayi apitawa, pali wina aliyense wa pakhomo pano anadya chakudya chochepa chifukwa kunalibe chakudya chokwanira?*** In the past four weeks was there anyone in this household who ate less amount of food [or a smaller meal than you felt you needed] because there	☐	☐	☐	☐

#	Question (Check only one response). **Each of the following questions applies to past 4 weeks.**	Never	Rarely (1-2 times)	Sometimes (3-10 Times)	Often (More than 10 times)
	wasn't enough food?				
A48	***Kodi pa masabata anayi apitawa, pali wina aliyense wa pakhomo pano anadya mopereweza pa tsiku (kangati) chifukwa kunalibe chakudya chosakwanira masabata anayi apitawa?*** In the past four weeks was there any household member who ate fewer times per day because there wasn't enough food?	☐	☐	☐	☐
A49	***Kodi pa masabata anayi apitawa, pali tsiku lina lirilonse lomwe munakhalapo opanda chakudya chirichonse chifukwa chochepekedwa?*** In the past four weeks was there ever no food to eat of any kind in your household because of lack of resources? [<u>make sure all types of food</u>]	☐	☐	☐	☐
A50	***Kodi pa masabata anayi apitawa, pali wina aliyense wa pakhomo pano anagonapo ndi njala chifukwa chakudya chinali chosakwanira? [*** <u>make sure all types of food]</u>**.** In the past four weeks, did you or any household member go to sleep at night hungry because there wasn't enough food?	☐	☐	☐	☐
A51	***Kodi pa masabata anayi apitawa, pali wina aliyense wa pakhomo pano amene anakhala tsiku lonse kapena kugona ndi njala chifukwa chakudya chinali chosakwanira?*** **<u>Probe more to make sure they are not including any food such as cassava, green maize.</u>** In the past four weeks was there any household member	☐	☐	☐	☐

#	**Question (Check only one response).** **Each of the following questions applies to past 4 weeks.**	**Never**	**Rarely** **(1-2 times)**	**Someti mes** **(3-10 Times)**	**Often** **(More than 10 times)**
	who had spent a whole day and night without eating because there wasn't enough food?				
A52	A52 ***Kodi alipo wina aliyense pakhomo pano anakagwilapo ganyu chifukwa panyumba pano palibe chakudya***? Have you or any household member had to do ganyu for food in the past 4 weeks because you have run out of your own food sources?	☐	☐	☐	☐
A53	***Kodi mukungamza kuti chimanga chimene munakolola chaka chatha chidzatha liti***? How long do you expect last year's maize harvest to last? (month) **Month ended or expected to finish:**				

A54 HOUSEHOLD DIETARY DIVERSITY: Mafunso Akudya zakudya za magulu osiyansiyana pakhomo

Read to participant: ***Tsopano ndikufunsani za zakudya ndi zakumwa zimene wina aliyense wa pakhomo pano anadya kapena kumwa dzulo kuyambira pamene munadzuka kufikira nthawi yogona (kupatula zakudya kapena zakumwa zimene munakadya kwina).*** Now I will ask you questions about food stuffs and drinks that any household member ate or drank yesterday from the time he/she woke up until he/she went to bed *(Do not include food or drink taken elsewhere*

A54 ***Kodi dzulo panali wina aliyense wa pakhomo pano anadya kapena kumwa izi?*** (Did any household member eat or drink any of the following yesterday?)

#	***Gulu la chakudya***	***Zitsanzo*/ Examples**	**Yes**	**No**

1	***Zakudya za mgulu la chimanga*** **(Cereals**)	***Chakudya china chilichonse monga : nsima, phala, buledi, supageti, sikono, mtakula, mabisiketi, thobwa, mpunga, mitama, chigumu, chimtuwitsa, mandasi, zitumbuwa, kapena zakudya zinazilizonse zochokera ku mawere, mapira, chimanga, Mpunga, mchewere, tiligu?*** Any food such as Nsima, porridge, bread, spaghetti, scones, biscuits, rice, boiled whole maize grain, sweetbeer, boiled samp, milk scone, doughnuts, maize-banana pan cake, or any food made from finger millet, sorghum, bullrush millet, maize and wheat?	1	0
2	***Zakudya za masamba ndi mizu yokhala ndi vitamini A*** (Vitamin A rich tubers & vegetables)	***Chakudya chinachilichonse mwa izi: maungu, karoti, kapena mbatata za kholowa za chikasu,?*** Any food such as: pumpkins, carrots or sweet potatoes having yellow pigment, including local orange maize? ***[please check here if they indicate that they ate local orange maize]*** ☐	1	0
3	***Mbatata ndi zakudya za mizu zoyera*** **(**White tubers and roots)	***Chinachilichonse mwa izi: mbatata zoyera, chilazi, chinangwa, mbatatesi, koko, kapena zakudya zina zilizonse zochokera ku mizu?*** Any food in the group of: white sweet potatoes, coco yams, cassava, irish potatoes, yams or any white roots and tubers?	1	0
4	***Ndiwo za masamba zobiliwira*** (Dark greenleafy vegetables)	***Ndiwo za masamba zobiliwira kuphatikizapo za ku tchire monga izi: chisoso, luni, bonongwe, chigwada, mtoliro, mpiru (lobo), kamganje, lepu, mnkhwani, chitambe, khwanya, denje***? Relish of dark green leafy vegetables as well as the indgenous vegetables including, Cat's whiskers leaves, Amaranthus, cassava leaves, sweet potato leaves, mastard, rape, local rape, pumpkin leaves, cow peas leaves, bean leaves, denje, black jack leaves	1	0
5	***Ndiwo zina zirizonse za***	***Kapena ndiwo zina ziri zonse za masamba monga izi: Chinese, thelele lobala, kabichi, mabiringanya,***	1	0

	masamba (any other vegetables)	***matimati***, . Any kind of relish from leafy vegetables e.g Chinese cabbage, okra, cabbage, egg plants ,tomatoes, onions, green pepper and green beans?		
6	***Zipatso zokhala ndi Vitamini A*** (Vitamin A rich fruits)	***Zipatso zilizonse monga izi: Papaya, mango?*** Any fruits like papaya (pawpaw)?	1	0
7	***Zipatso zina zirizonse*** **(**Other fruits)	***Zipatso zina zirizonse kuphatikizapo zakutchire monga izi: malalanje, manachesi, mandimu, bwemba, nthema, masawo, mapeyala, nthochi, malambe??*** Any other fruits including the indigenous wild fruits e.g oranges, tangerines, lemons, tamarind, elephant fruits, *masawo*, avocado pears, bananas and baobab fruits?	1	0
8	***Nyama*** (Meats)	***Nyama ina iriyonse monga izi: Nyama ya ng'ombe, ya nkhosa, ya nkhumba, ya mbuzi, ya kalulu, mbewa, ya m'tchire, ya nkhuku, bakha, toulukauluka monga nkhunguni, nkhanga, kapena mbalame zina, chiwindi, impso, mtima, kapena nyama yina ya zamkati, kapena chakudya chilichonse cha nyama***. Any meat e.g beef, lanb, pork, goat meat, rabbit meat, mice, wild game, poultry duck, flying insects e.g nkhunguni, guinea fowl or any other bird, liver, kidney, heart, offals or any other meat.	1	0
9	***Mazira*** (Eggs)	***Mazira a mtundu wina uliwonse?*** Eggs of any kind?	1	0
10	***Nsomba*** Fish)	***Nsomba zaziwisi kapena zowuma***? Fresh or dried fish?	1	0
11	***Nyemba, mtedza ndi nthanga*** (Legumes, nuts & seeds)	***Mtundu wina uliwonse wa nyemba monga izi: Nyemba, khobwe, nandolo, nkhungudzu, nsawawa, nzama, soya, mtedza, mphodza, nseula, tchana?*** Any type of beans and peas e.g beans, cow peas, pigeon peas, nkhungudzu, peas, ground beans, soya beans, ground nuts, green gram, custard apple, Nseula, chick peas?	1	0
12	***Mkaka ndi***	***Zakudya zochokera ku mkaka monga: mkaka,***	1	0

	zopangidwa kuchoka ku mkaka (Milk and milk products)	***yogati, chambiko?*** Milk and Food made from milk e.g yoghurt, sour milk?		
13	***Mafuta ophikira ndi a nyama*** **(**Oils and Fats)	***Mafuta ena alionse monga: mafuta ophikira, mafuta ochokera ku nyama, majalini?*** Any type of fats or oils e.g. cooking oil, animal fats and margarine used for cooking or added to food?	1	0
14	***Zakudya zotsekemera*** **(**Sweets)	***Chakudya china chilichonse chotsekemera monga izi: shuga, uchi, zakumwa zosaledzeretsa monga fanta, fizesi, kokakola, sprite, cocopina, zakumwa zothirako shuga, kapena zakudya za sugar monga chokoleti, masiwiti??*** Any sweet, sugar, honey, soft drinks such as fanta, fizzes, cocacola, sprite cocopina, drinks to which sugar was added or sugary foods e.g chocolate, sweets?	1	0
15	***Khofi/tiyi*** (coffee/tea)	***Tiyi wina aliyense, kapena khofi?*** Any tea or coffee?	1	0

A55. ***Mungandiwuzeko za momwe mumaphikila/kaphikidwe ka zakudya zomwe nditatchulezi?***

Can you tell me about any recipes that you use at home for the following crops?

Legume	Recipes Used ***Mmene mumaphikira***		How often in last month? ***Kagati mwezi wathawu?***	
Soybeans/***soya***	1. 2.	3. 4.	1. 2.	3. 4.
Pigeonpea/ ***nandolo***	1. 2.	3. 4.	1. 2.	3. 4.

Legume	Recipes Used ***Mmene mumaphikira***	How often in last month? ***Kagati mwezi wathawu?***
Cowpea/ ***khobwe***	1. 3. 2. 4.	1. 3. 2. 4.
Beans/ ***nyemba***	1. 3. 2. 4.	1. 3. 2. 4.
Local orange maize **Mthikinya**	1. 3. 2. 4.	1. 3. 2. 4.
Sweet potatoes/ ***mbatata***	1. 3. 2. 4.	1. 3. 2. 4.
Cassava/ ***chinangwa***	1. 3. 2. 4.	1. 3. 2. 4.

PART B: FARMING INFORMATION & INDIVIDUAL DIETARY DIVERSITY

Instructions for Enumerator: For the questions in Part B, please interview either the husband or the wife separately, in the case of spousal-couple households. Please flip a coin to decide which adult to interview. (If there is more than one wife, you will have to do multiple flips, once for husband vs wife, and then for each wife e.g. Wife 1 vs Wife 2…) You should conduct these interviews alone with the respondent, with enough distance to ensure they do not hear each other.

Part B questions apply to: (circle one): Man Woman _____(specify if

more than one wife)

(Please read*)**: ***Ndikufunsani mafunso okhudzani ndi zomwe mumadziwa pa nkhani ya ulimi komanso njira zomwe mumapezera upangili wa zaulimi?I would like to ask you a few questions that concern where you get your farming information, what kind of social groups you are in, and other topics. I will start with some questions about farming knowledge and where you get your farming information.

B1	***Kodi ndi chani chomwe mumakhala mukuchiganizila kapena chimakudetsani nkhawa pa moyo wanu?*** ***(***What are your most important concerns when it comes to your life?**)**			
B2	***Nanga pa nkhani ya ulimi ndichani chomwe chimakudetsani nkhawa kapena mumachiganizila kwambiri?*** What are your most pressing agricultural concerns?			
B3.	What are the main ways that you learn new information or solve a problem in your farming? [11] ***B1a. Kodi upangili wa zaulimi ndi malimidwe mumawupeza kuti?*** **(*Circle all that apply, don't read out loud just select based on what they say.*)** Rank the top <u>two</u> sources in order of importance for information that you have used in your own farm. ***B1b. Pa nthowa izo mwazunura muniphalirepo nthowa zikulu ziwiri***		Code	Rank
		Self- experience / observation	1	
		Ask relatives/friends	2	
		Ask other farmers (not relatives or friends)	3	
		MAFFA or FRT member	4	
		Ask a farmers group – list __________________	5	
		Radio	6	
		Television	7	
		Extension agents (agricultural field assistants)	8	

[11] Question adapted from Humphries et al 2012 and SFHC Crop Diversity survey 2010

	izo mukugwiriska nthito pa munda winu? ***(Put rank to the right of the two top-ranked sources)***	Special activities – list (e.g. field day) ________________	9	
		Demonstration trials	10	
		Newspaper	11	
		Shopkeeper	12	
		Other (specify)	13	
B4.	Can you describe 2 types of useful information that you learned from these sources, which you are still using? ***Mungandiwuzeko ndondomeko zaupangili wa za ulimi zomwe munaphunzira kuchokera ku njira zomwe mwatchulazi?***	***(Describe the type of information named)*** 1. 2.		

B5	***Kulingana ndi anthu ena asinkhu wanu mmudzi muno inu mumawona kuti umoyo/nthanzi lanu lili bwanji?*** In general, compared to other people your age, would you say your health is: Excellent, Very Good, Good, Fair or Poor?	Excellent ***ndine wa thanzi kwabasi***	
		Very Good ***ndine wa thanzi ndithu***	
		Good ***ndine wa thanzi***	
		Fair ***choncho***	
		Poor ***sindilibwino kweni kweni***	
		Not Sure ***Sindingadziwe bwino bwino***	
		Refused	
B6	***Kodi inu mumakhutila mutani ndi thanzi la thupi lanu?***	Very Satisfied ***kwambiri***	
		Somewhat Satisfied ***ndine okhutilabe choncho***	

	How satisfied are you with your health? Would you say you are Very Satisfied, Somewhat Satisfied, Not Too Satisfied, or Not At All Satisfied?	Not Too Satisfied ***osati kweni kweni***	
		Not At All Satisfied ***sindine okhutila***	
		Not Sure ***Sindikudziwa***	
		Refused	
B7	***Nu mumawona kuti mumakwanitsa kugwila ntchito zapakhomo pano ndi mphamvu?***How would you rate your ability to handle the day-to-day demands in your life, for example, work, family and farming responsibilities?	Excellent ***opanda vuto lililonse***	
		Very Good ***Kwabasi***	
		Good ***Ndimakwanitsa***	
		Fair ***Choncho***	
		Poor ***Sindimakwanitsa***	
		Not Sure ***Sindingadziwe***	
		Refused	
B8	***Inu mumawona kuti mumakwanitsa bwanji kuthana ndi mavuto ogwa mwazizizi/ osawayembekezela?*** When you have a family or personal crisis, how would you rate your ability to handle the crisis: excellent, very good, good, fair, poor or not sure?	Excellent ***ndimakwanitsa popanda vuto***	
		Very Good ***ndikwanitsa***	
		Good ***ndimakwanitsabe***	
		Fair ***Choncho***	
		Poor ***zimavuta***	
		Not Sure ***sindikudziwa***	
		Refused ***Wakana***	

INVOLVEMENT IN LOCAL ORGANIZATIONS

B9.	***Alipo pakhomo pano amene ali mu kalabu/bungwe la alimi, kopaletivi kapena bungwe lililonse lomwe limathandiza ndi upangili wa ulimi, kuti pabanja pakhale chakudya chokwanira kapena kuti mupeze ndalama, kapena kuti anthu pabanjapo azidya zakudya za magulu?*** Do you or any members of your	Yes	1
		No ***(Skip to C1)***	2
		Don't Know ***(Skip to C1)***	98
		Refused ***(Skip to C1)***	99

	household participate in any community group that helps with agriculture, food security, health/nutrition or income or other group?		
B10.	[IF YES the enumerator should ask the questions in the table], ***Ngati alipo funsani mafunso ali mmunsiwa?*** What group, and please indicate year joined, position, who in the household joined, why they participate.		

Organization Name *(Dzina la Bungwe)*	**Year joined (*Chaka chimene analowa)***	**Position with organization (*Udindo mu bungwe)***	**Why do you participate? (*Chifukwa cholowela)***	**Who joined? *(Analowa ndani wanu?)***

SECTION C: SOCIAL SUPPORT and GENDER RELATIONS

Note to enumerator: the following questions are quite sensitive. Please assure the respondent that all identities are kept confidential and will not be shared with anyone. <u>Please say to respondent:</u> *Tsopano ndikufunsani mafunso okhudzani ndi mmene mumakhalila pakhomo pano (kapena pabanja lanu). Ndikutsimikizileni kuti zomwe titakambilane pano ndizachinsinsi ndipo palibe amene atadziwe za zomwe takambilana pano.* (I am now going to ask you about household issues. Please remember that all questions are confidential and will not be shared with anyone beyond the research team.)[12]

[12] Adapted from Humphries et al. 2012, Pandey et al. 2012 and Story and Burgard 2012.

C1. (***Read the following to the respondent***): ***Pali nthawi zina zomwe munthu umafuna munthu wina kuti akuthandizeko nzeru, maganizo kapena kumudandaulira kumene. Mungandiwuzeni kuti ndikangati kamene munapezako chithandizo chotere?*** People sometimes look to others for companionship, guidance, assistance, or other types of support. Could you tell me how often each of the following kinds of support is available to you when you need it?					
C1a. ***Kodi ndi kangati kamene mumapeza munthu amene mumakhala ndi nthawi yocheza kapena kupanga zinthu zomwe inu mumakonda limodzi?*** How often do you have someone to have a good time or do something enjoyable with?	N***thawi zones*** Always ☐	N***thawi zambiri*** Most of the time ☐	***Nthawi zina*** Sometimes ☐	***Mwa apo ndi apo /*** Rarely ☐	***Never*** ☐
C1b. ***Kodi ndi nthawi zochuluka bwanji zomwe mumapeza munthu okhuthululirana naye zakukhosi***? How often do you have someone to confide in, talk with about yourself or your problems, and get advice?	☐	☐	☐	☐	☐
C1c. ***Kodi ndi nthawi zochuluka bwanji zomwe mumapeza munthu okutengelani kuchipatala mukadwala, kukupatsani ndalama kapena chakudya mukachepekeledwa??*** How often do you have someone to take you to the hospital or give you money or food if you need?	☐	☐	☐	☐	☐
C1d. ***Kodi ndi nthawi zochuluka bwanji zimene mumakhalandi munthu okuwonetsani chikondi?*** How often are you in the company of someone who shows you love and affection?	☐	☐	☐	☐	☐

C2. ***Tsopano ndikufunsani za mmene mumagwirizanirana kapena kumanga mfundo zosiyana siyana zokhudzana ndi kakhalidwe,***	1= self 2 = spouse

umoyo ndi zina pa banja lanu. Now I'd like to ask you about decision-making in your household.	3= Both 4= Sons 5=Daughters 6= Other family members 7= Other (specify)	
C2a ***Kodi amane amapanga ganizo kapena kukhala ndi ulamuliro pa za mbewu zimene zoti zilimidwe ndi komwe zidzalidwe pabanja pano ndani?*** Who usually decides what and where to plant?		
C2b ***Kodi amene ali ndi ulamuliro pazokolola zomwe mungagulitse ndi kagulitsidwe kake ndani??*** Who usually decides what farm products to sell?		
C2c ***Kodi amene ali ndi ulamuliro pa nkhani yogula zinthu zikuluzikulu (monga njinga, wailesi, cell phone, feteleza, malata) pakhomo pano ndani?*** Who usually makes decisions about major household purchases (e.g. fertilizer)?		
C2d ***Kodi amene ali ndi ulamuliro pa nkhani yogula zinthu zomwe mumagwiritsa ntchito tsikunditsiku pakhomo pano (monga sopo) ndani?*** Who usually makes decisions about purchases for daily household needs (e.g. soap)?		
C2e ***Kodi amene ali ndi ulamuliro pa nkhani yoti mukachezere achibale ndi anansi ndani??*** Who usually decides about visits to your family or relatives?		
C2f ***Kodi amene ali ndi ulamuliro pa nkhani yoti muzitengapo mbali ndi kulowa m'magulu osiyana siyana kaya a zaulimi, azosunga ndalama, zachitukuko, zaumoyo, ndani?*** Who usually decides whether you can participate with different local organizations?		
C2g ***Kodi amene ali ndi ulamuliro pa nkhani nkhani ya maphunziro a ana anu?*** Who usually decides about your children's education?		
C3 ***Kodi akazi anu angaganize mwaokha za mbewu zome zidzalidwe ku munda?*** Can your wife (*or you if it is woman*) ever decide to plant crops on own?	Yes	No
C4 ***Kodi akazi anu angaganize mwaokha zogulitsa zokolola?***Can your wife (*or you if it is the woman*) ever decide to sell crops on her own?	Yes	No

C5 ***Kodi akazi anu angaganize mwaokha zolowa nawo mu gulu losunga ndalama.*** Can your wife (*or you if it is the woman*) ever decide on her own to join an organization such as a village bank?	Yes	No
C6 ***Kodi akazi anu angaganize mwaokha kukayendera achibale omwe sakhala mmudzi mwanu numo osakuuzani?*** Can your wife (*or you, if it is the woman*) ever decide to visit family or friends outside the village on her own?	Yes	No
C7 ***Kodi abambo amathandiza kusamalira ana pakhomo pano?*** Do you (*or your husband*) ever help with child care?	Yes	No
C7a ***[If yes] Pa nyengo zilinga pa mwezi?*** how often per month? (circle response) (write any details provided):	Daily Frequently Rare Occasions Never	
C8 ***Kodi abambo, mungakhale opanda vuto lirironse akazi anu atakhala pa udindo mu bungwe lomwe ali membala?*** Would you (*or your husband*) be comfortable with your wife being in a leadership position in an organization, that led her to travel away from home?	Yes	No
C9 ***Kodi inu kapena amuna anu amathandiza kuphika zakudya zapakhomopano?*** Do you (*or your husband*) ever help with food preparation?	Yes	No
	Daily Frequently Rare Occasions Never	

C11 ***: Nthawi zina mwamuna amakwiya kapena kunyansidwa chifukwa cha zomwe mkazi wake wachita. Mukuganiza kuti ndi kololedwa kuti mwamuna amenye mkazi wake wake zinthu ngati izi zikachitika?*** Sometimes a husband can get irritated or annoyed by things that his wife does. Do you think a husband is justified in hitting or beating his wife in the following situations: (adapted from Pandey et al. 2012)		
C11a ***Akagulitsa zokolola mwayekha osawawuza mwamuna wake?*** She sells something (like crops) without telling him?	Yes	No
C11b ***Akapseleletsa ndiwo?*** She burns the food?	Yes	No
C11c ***Akakana kugonana ndi mwamuna wake?*** She refuses to have sex with him?	Yes	No

C12 ***Kodi bambo akunyumba akumenyanipo pamasabata anayi apitawa??*** Did you (*or your husband*) beat your wife in the last four weel C12a ***Ngati ndi choncho, chinachitika ndi chani kuti akumenyeni/muwamenye?*** If yes, can you tell me more about the situa		
C13 ***Kodi pali amene amamwa mowa pakhomo pano?*** Does anyone the household drink alcohol? If so, who? ***[if no, go to C14)*** ***Kodi pali amene amamwa mowa nyumba mwanu?*** _______________		
C13a. ***Ngati wina amamwa, kangati pa sabata?*** [If someone drinks] (you estimate how often per week this person usually drinks?		
C13b. ***Kodi pali kusintha kuli konse pakamwedwe pa zaka zitatu zadutsazi*** Has the consumption of this person changed in the past 3 yea		
C13c ***Ngati pali kusintha mukuwona ngati ndi chifukwa chani? [if y*** it has changed?		
C9a [If yes], ***Ngati ndi choncho, ndikangati?*** how often per month? (circle response) (write any details provided):		
C10 ***Kodi amuna anu amachapa zovala?*** Do you (*or your husband*) ever do the laundry?	Yes	No
C10a [If yes], ***Ngati ndi choncho, ndikangati?*** how often? (circle response) (write any details provided):	Daily Frequently Rare Occasions Never	

Now I have finished my questions. Thank you very much for your patience and information.

Appendix D: Curriculum Vitae

Name: Moses Mosonsieyiri Kansanga

Education and training

Sept 2016 — Aug 2020	PhD Candidate, Department of Geography University of Western Ontario, Canada Dissertation: Examining the impact of participatory agroecology on social capital, sustainable land management and nutrition in smallholder farming communities in Malawi
Jan 2018	Certificate in University Teaching and Learning University of Western Ontario
Aug 2014 — June 2016	MPhil. Development Geography University of Bergen, Norway Dissertation: Examining the livelihood and environmental impacts of agricultural mechanization in northern Ghana
May 2015 — Sept 2015	Lead Auditor, Environmental Management Systems (ISO 14001, ISO 19011-2011 and OSHAS 18001:2007) Global Training and Certification Services, (GTACS).
Aug 2009 — June 2013	B.A. (Honours), Geography and Resource Development, with Political Science University of Ghana

Teaching and professional experience

Instructor (GEOG2131B) Winter Term, 2020 University of Western Ontario	Course Title: Geography of the Natural Environment Duties: Designed course syllabus, delivering weekly lectures and assigning weekly readings. Student evaluation includes a quiz, two in-class writing tests and a final writing project on a selected topic.
Guest lecturer, Research Methods in Geography	Guest lecturer August 2016, 2018 & 2019 (Principles of Ethnographic Research).
Teaching Assistant Western University Aug 2016 — Aug 2020	Teaching weekly tutorial sessions, and guest lecture presentations; moderating online and in-class discussions, holding office hours and proctoring; and grading of student papers, quizzes and final examinations. Courses TA'ed include: Environment and Development Challenges; Research Methods in Geography; Geography of Canada; and Geography of Africa South of the Sahara.

Environmental Consultant HS+E Consulting Ghana Limited (Part time) July 2013 till date	Led the successful execution of Environmental Management reports (Environmental and Social Impact Assessment Reports, Environmental Management Plans) and Environmental Compliance Audits for several organizations in Ghana including the Ghana Ports and Harbours Authority, Ministry of Agriculture, Millennium Development Authority (acting on behalf of the government of the United States of America) and the Japan International Cooperation Agency.
Research Assistant, University of Ghana Aug 2013 — July, 2014	Led data collection on the environmental impacts of landfills in the Upper West Region. Also held tutorials for undergraduate courses: Resource Analysis, Disaster Risk Prevention and Introduction to Geography

Publications

1. **Kansanga, M. M.,** Ahmed, A., Kuusaana, E. D., Oteng-Ababio, M., & Luginaah, I. (2020). Of waste facility siting and relational geographies of place: Peri-urban landfills, community resistance and the politics of land control in Ghana. *Land Use Policy*, 96, 104674. DOI: https://doi.org/10.1016/j.landusepol.2020.104674
2. **Kansanga, M. M**., Luginaah, I., Bezner Kerr, R., Lupafya, E., & Dakishoni, L. (2020). Beyond ecological synergies: examining the impact of participatory agroecology on social capital in smallholder farming communities. *International Journal of Sustainable Development & World Ecology*, 1-14. DOI: https://doi.org/10.1080/13504509.2019.1655811.
3. Antabe, R., **Kansanga, M.,** Sano, Y., Kyeremeh, E., & Galaa, Y. (2020). Utilization of breast cancer screening in Kenya: what are the determinants? *BMC Health Services Research*, 20(1), 1-9. https://doi.org/10.1186/s12913-020-5073-2
4. **Kansanga, M. M**., Mkandawire, P., Kuuire V., & Luginaah I. (2019). Agricultural mechanization, environmental degradation, and gendered livelihood implications in northern Ghana. *Land Degradation & Development*. DOI: https://doi.org/10.1002/ldr.3490.
5. **Kansanga, M. M**., & Luginaah, I. (2019). Agrarian livelihoods under siege: Carbon forestry, tenure constraints and the rise of capitalist forest enclosures in Ghana. *World Development*, 113, 131-142. DOI: https://doi.org/10.1016/j.worlddev.2018.09.002.

6. **Kansanga, M. M**., Arku, G., & Luginaah, I. (2019). Powers of exclusion and counter-exclusion: The political ecology of ethno-territorial customary land boundary conflicts in Ghana. *Land Use Policy*, 86, 12-22. DOI: https://doi.org/10.1016/j.landusepol.2019.04.031.
7. **Kansanga, M. M**., Andersen, P., Kpienbaareh, D., Mason-Renton, S., Atuoye, K., Sano, Y., & Luginaah, I. (2019). Traditional agriculture in transition: examining the impacts of agricultural modernization on smallholder farming in Ghana under the new Green Revolution. *International Journal of Sustainable Development & World Ecology*, 1-14. DOI: https://doi.org/10.1080/13504509.2018.1491429.
8. **Kansanga, M. M**., Antabe, R., Sano, Y., Mason-Renton, S., & Luginaah, I. (2019). A feminist political ecology of smallholder agricultural mechanization and evolving gendered on-farm labour dynamics in Ghana. *Gender, Technology and Development*. (Accepted and in production). https://doi.org/10.1080/09718524.2019.1687799.
9. Konkor, I., **Kansanga, M. M**., Sano, Y., Atuoye, K., & Luginaah, I. (2019). Risk-taking behaviours and timing to first motorbike collision in the Upper West Region of Ghana. *Journal of Transport & Health*, 12, 105-114. DOI: https://doi.org/10.1016/j.jth.2019.01.001.
10. Konkor, I., **Kansanga, M. M**., Sano, Y., Antabe, R., & Luginaah, I. (2019). Community perceptions and misconceptions of motorcycle accident risks in the Upper West Region of Ghana. *Travel Behaviour and Society*, 15, 157-165. DOI: https://doi.org/10.1016/j.tbs.2019.03.001.
11. Konkor, I., Sano, Y., Antabe, R., **Kansanga, M. M**., & Luginaah, I. (2019). Exposure to mass media family planning messages among post-delivery women in Nigeria: testing the structural influence model of health communication. The European *Journal of Contraception & Reproductive Health Care*, 1-6. DOI: https://doi.org/10.1080/13625187.2018.1563679.
12. Antabe, R., Sano, Y., Anfaara, F. W., **Kansanga, M. M**., Chai, X., & Luginaah, I. (2019). Antenatal Care Utilization and Female Genital Mutilation in Kenya. *Sexuality & Culture*, 1-13. DOI: https://doi.org/10.1007/s12119-019-09595-6.
13. Haruna, U., **Kansanga, M. M**., & Galaa, S. (2018). Repositioning traditional birth attendants to provide improved maternal healthcare services in rural Ghana. *The International Journal of Health Planning and Management*. DOI: https://doi.org/10.1002/hpm.2779.
14. **Kansanga, M. M**., Andersen, P., Atuoye, K., & Mason-Renton, S. (2018). Contested commons: Agricultural modernization, tenure ambiguities and intra-familial land grabbing

in Ghana. *Land Use Policy*, 75, 215-224. DOI: https://doi.org/10.1016/j.landusepol.2018.03.047.

15. **Kansanga, M. M**., Braimah, J. A., Antabe, R., Sano, Y., Kyeremeh, E., & Luginaah, I. (2018). Examining the association between exposure to mass media and health insurance enrolment in Ghana. *The International journal of health planning and management*. DOI: https://doi.org/10.1002/hpm.2505.
16. Kpienbaareh, D., **Kansanga, M. M**., & Luginaah, I. Examining the potential of open source remote sensing for building effective decision support systems for precision agriculture in resource-poor settings. *GeoJournal*, 1-17. DOI: https://doi.org/10.1007/s10708-018-9932-x.
17. Haruna, U., **Kansanga, M. M**., & Galaa, S. (2018). Examining the unresolved conundrum of Traditional Birth Attendants' involvement in maternal and child health care delivery in Ghana. *Health Care for Women International*, 1-19. DOI: https://doi.org/10.1080/07399332.2018.1540006.
18. **Kansanga, M. M**., (2017). Who you know and when you plough? Social capital and agricultural mechanization under the new green revolution in Ghana. *International Journal of Agricultural Sustainability*, 15(6), 708-723. Doi: https://doi.org/10.1080/14735903.2017.1399515.
19. **Kansanga, M. M**., Atuoye, K., & Luginaah, I. (2017). Same problem, conflicting 'truths': rethinking the missing links in forest degradation narrativization in Ghana. *African Geographical Review*, 1-13. DOI: https://doi.org/10.1080/19376812.2017.1415814.
20. Chai, X., Sano, Y., **Kansanga, M. M**., Baada, J., & Antabe, R. (2017). Married women's negotiation for safer sexual intercourse in Kenya: Does experience of female genital mutilation matter? *Sexual & Reproductive Healthcare*, 14, 79-84. Doi: https://doi.org/10.1016/j.srhc.2017.09.003.

Peer Reviewed Book Chapters

1. **Kansanga, M. M**., Kpienbaareh, D., Bezner Kerr, R., Shumba, L, Lupafya, E., Laifolo, D., Hickey, C., Katundu, M., & Luginaah, I. Agroecology for health: exploring the impact of participatory agroecology on household health in the context of smallholder agriculture. Kuuire, V., & Bisung, E. (Eds.) *Health Geography in sub-Saharan Africa: Development-Health Nexus*. Springer Global Perspectives on Health Geography Series. (Accepted).

Conference presentations and participations

July 2019	International Medical Geography Symposium (IMGS), New Zealand. Presentation title: *The impact of agroecology on household production and dietary diversity: evidence from a five-year intervention project in Malawi.*
April 2019	American Association of Geographers, Conference. Washington Presentation title: *Agrarian livelihoods under siege: Carbon forestry, tenure constraints and the rise of capitalist forest enclosures in Ghana.*
April 2019	American Association of Geographers, Conference. Washington. Presentation title: *Community perceptions and misconceptions of motorcycle accident risks in the Upper West Region of Ghana.*
October 2018	Canadian Association of Geographers of Ontario Conference (CAGONT), Toronto. Presentation title: *Correlates of exposure to media family planning messages among post-delivery women in Nigeria.*
October 2017	Canadian Association of Geographers of Ontario Conference (CAGONT), Kingston. Presentation title: *Enrolment in Ghana's National Health Insurance Scheme: The Role of Mass Media.*
May 2017	Canadian Association of Geographers (CAG) Conference, Toronto. Presentation title: *Who you know and when you plough? Social capital and agricultural mechanization in the northern savannah of Ghana.*
April 2017	American Association of Geographers (AAG), Boston, MA. Presentation title: *Disappearing staples and intra-familial land grabbing: Emerging dynamics of smallholder agricultural mechanization in Ghana.*
October 2016	Canadian Association of Geographers of Ontario Conference (CAGONT), Waterloo. Presentation title: *Smallholder Agricultural Mechanization in the northern savannah of Ghana: Implications on Agricultural Land use and Production Patterns*.

Honours, awards and funding

May 2018	Co-Applicant: Elrha Grant for Research in Humanitarian Crises Settings. Applicants: UNFPA (Principal Applicant): Dr. Aline Umubyebye, University of Rwanda (Principal Investigator): Dr. Isaac Luginaah, Western University; Dr. Anne Golaz, University of Geneva; Dr.

	Jonathan Calbayan, United Nations High Commissioner for Refugees (UNHCR).
	Value: We received a Seed Grant of £10,000 from Elrha after initial screening of proposals to fund full proposal development activities.
2016 — 2020	Western Graduate Scholarship, Western University — $35,000 per year for four years.
2019	Alan Philbrick Graduate Scholarship in Cultural Geography Western University. Value — $1,600.
2018	Africa Institute Graduate Student Research Award, Western University. Value — $1,500.
2017	Michael Troughton Graduate Student Bursary, Department of Geography, Western University. Value — $1,500.
2017	Graduate Research Award Fund, Faculty of Social Science, Western University $750.
2015	Nordic Africa Institute Research Grant, Sweden. Value: $5,000.
2014 — 2016	Norwegian Government Quota Scheme Scholarship, University of Bergen, Norway. Value: NOK 97,850 ($14, 000) per year for two year.

SERVICE

2018 till present	Peer reviewer for several journals including: *World development*; *Environment Development & Sustainability; Land Use Policy; Journal of Cleaner Productions*; *Cities*; Rural and *Community Development*; and *African Geographical Review*.
Jan 2019 till present	Volunteer Instructor (Grade 4), GALM Weekend Homework Club for London and Middlesex area. London, ON.
2019 — 2020	Student Coordinator Ghana Association of London and Middlesex.
2016 till present	Member of graduate student committees including; Bursaries and Subsidies Committee, and International Students Issues Committee.
Feb 2015 — Feb 2016	Secretary of International Students Union of Norway.

Mar 2012 — May 2013 National President, Tertiary Institutions Network of the Ghana National Disaster Management Organization (NADMO).