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Managing risk under climate change in Kenya

Multiple shocks, poverty, gender, and potential for group-based approaches

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Abstract

Climate change and related shocks are major challenges facing agricultural performance, poverty reduction efforts, and economic growth in developing economies. Managing risks is vital because climate change and shocks lead to depletion of assets, loss of livelihoods and reduce pathways to diversify income. Besides, there is a widespread agreement that climate change impacts are not gender neutral. This study aims to contribute to the development of effective policies that assist households in managing risks under climate change through assessing the coping capacities and the impact of multiple shocks on household assets and poverty transitions, applying a panel data set of 360 households in rural Kenya. The study aimed to identify what kinds of assets are most effective in empowering and building resilience of poor rural households and communities under accelerating climate change. The study finds that households and individuals count on two major coping strategies to smooth their consumption level, namely adjusting their livestock portfolios and borrowing from groups. The latter strategy is particularly important for asset-poor and female-headed households in safeguarding their already low asset base.

Through applying a unique intra-household survey involving 156 couples in rural Kenya, this study examines how husband and wife within the same household perceive climate risks, undertake adaptation strategies, access productive resources and participate in group-based approaches. The findings indicate that options for adapting to climate change closely interplay with husbands' and wives' roles and responsibilities, social norms, risk perceptions and access to resources. A higher percentage of wives were found to adopt crop-related strategies, whereas husbands employ livestock- and agroforestry-related strategies. There are gender specific climate information needs, trust in information and preferred channels of information dissemination. Further, it turned out that group-based approaches benefit husbands and wives differently. Group-based approaches provide avenues for diversifying livelihoods and managing risks for wives, while they are pathways for sharing climate information and adaptation ideas for husbands. Social groups help husbands and wives to enhance their welfare through accumulating vital types of capital and improving food security outcomes. Lastly, by applying a value-based approach, this thesis shows that men's and women's intrinsic values may on one hand promote climate change adaptation, but on the other hand, hinder the uptake of specific climate-smart practices in addition to encouraging unsustainable adaptation behavior.

The key policy interferences for fostering resilience against multiple shocks involve designing livestock protection policies and scaling-up group-based approaches. There is also a need for sharing of climate and agricultural information through easily accessible channels by both men and women, such as information, communications and technologies (ICTs) as well as an effective agricultural extension system. There is a need for policies that nurture and strengthen social capital and group-based approaches for men and women at community level. Furthermore, organizations that are involved in development interventions and climate risk management will require to work together with group-based organizations that reflect gender reality on the ground in order to effectively support men's and women's specific abilities to manage risks and improve well-being outcomes in the face of accelerating climate change.

Zusammenfassung

Der Klimawandel und damit in Verbindung stehende Schockerlebnisse stellen große Herausforderungen für die landwirtschaftliche Leistungsfähigkeit, die Armutsbekämpfung und das Wirtschaftswachstum in Entwicklungsländern dar. Risikomanagement ist hierbei zentral, weil Klimawandel und Schockerlebnisse zu einer Minderung des Vermögens, einem Verlust der Existenzgrundlage und verringerten Möglichkeiten zur Einkommensdiversifizierung führen. Außerdem ist allgemein anerkannt, dass die Folgen des Klimawandels nicht gender-neutral sind. Diese Studie hat zum Ziel, einen Beitrag zur Ausgestaltung von Politikmaßnahmen zu leisten, um Haushalte beim Risikomanagement im Zuge des Klimawandelszuunterstützen. Anhand eines Paneldatensets mit 360 Haushalten wurden Bewältigungsstrategien und Auswirkungen mehrfacher Schockerlebnissen auf das Vermögen von Haushalten und Armut im ländlichen Kenia bewertet. Die Studie ermittelt, welche Kapitalarten am effektivsten sind, um arme Haushalte und Gemeinden zu ermächtigen sowie deren Resilienz angesichts eines fortschreitenden Klimawandels zu stärken. Die Ergebnisse der Studie zeigen, dass Haushalte und Individuen zwei Bewältigungsstrategien anwenden, um ihre Konsumlevel aufrechtzuerhalten: Anpassung der Zusammensetzung von Viehbeständen und Kreditaufnahme über Gruppen. Letztere Strategie ist insbesondere wichtig für arme Haushalte und Haushalte mit weiblichem Vorstand, um deren ohnehin schon niedriges Vermögen zu sichern.

Die Studie basiert auf Umfragen mit 156 Paaren, welche auf Intra-Haushaltsebene durchgfeführt wurden, um zu analysieren, wie Männer und Frauen im gleichen Haushalt klimatische Risiken wahrnehmen, Adaptionsstrategien verfolgen, Produktivkräfte mobilisieren und gruppenbasierte Ansätze nutzen. Die Ergebnisse zeigen, dass die Möglichkeiten zur Anpassung an den Klimawandel ein Zusammenspiel aus Risikowahrnehmungen, Rollen, Verantwortlichkeiten, sozialen Normen und Zugang zu Ressourcen von Männern und Frauen darstellen. Ein höherer Prozentsatz der Frauen wendet pflanzenbauliche Strategien an, während Männer Strategien verfolgen, welche mit Tierhaltung oder Agroforst-Systemen in Verbindung stehen. Es gibt einen Unterschied im Hinblick auf Gender, was die Bedürfnisse bezüglich klimarelevanter Informationen, Vetrauen in diese Informationen und bevorzugte Kanäle zur Verbereitung von Informationen angeht. Des Weiteren haben gruppenbasierte Ansätze unterschiedliche Nutzen für Männer und Frauen. Während gruppenbasierte Ansätze für Frauen Möglichkeiten zur Diversifizierung von Existenzgrundlagen und des Risikomanagements bieten, stellen sie für Männer Optionen dar, um klimarelevante Informationen und Ideen zur Anpassung auszutauschen. Durch die Anhäufung wichtiger Arten von Kapital und durch Ernährungssicherung unterstützen soziale Gruppen Männer und Frauen dabei, ihren Wohlstand zu verbessern. Letztendlich zeigt ein wertebasierter Ansatz, dass bestimmte intrinsische Werte von Männern und Frauen Anpassungsstrategien an den Klimawandel fördern können, während eigennützige Werte die Anwendung klimabewusster Praktiken behindern und somit nachhaltiges Anpassungsverhalten hemmen.

Entscheidende Politikmaßnahmen, um aufgrund von mehrfachen Schockerlebnissen die Resilienz zu stärken, umfassen den Schutz von Viehbeständen und eine Verbreitung von gruppenbasierten Ansätzen. Es ist außerdem erforderlich, klimarelevante und landwirtschaftliche Informationen über für Männer und Frauen einfach zugängliche Kanäle, wie beispielsweise durch Informations- und Kommunikationstechologie (IuK) und ein effektives landwirtschaftliches Beratungssytem, bereitzustellen. Politikmaßnahmen, die Sozialkapital und gruppenbasierte Ansätze für Männer und Frauen auf Gemeindeebene fördern, sind unabdingbar. Außerdem sollten Organisationen, die sich mit Entwicklungsinterventionen und klimabezogenem Risikomanagement befassen, auf gruppenbasierte Ansätze zurückgreifen, welche die Genderwahrnehmungen vor Ort widerspiegeln, um die spezifischen Fähigkeiten von Männern und Frauen zu erweitern, damit diese Risiken bewältigen und im Zuge des fortschreitenden Klimawandels ihr Wohlergehen verbessern können.

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Abbreviations and Acronyms

AU	African Union
COP	Conference of the Parties
DFID	Department for International Development
EACCCMA	East African Community Climate Change Master Plan
FAO	The Food and Agriculture Organization of the United Nations
GAAP	Gender, Assets and Agricultural Programs
GDP	Gross Domestic Product
GGCA	Global Gender and Climate Alliance
GoK	Government of Kenya
HDI	Human Development Index
IAD	Institutional Analysis and Development
IFPRI	International Food Policy Research Institute
IPCC	Intergovernmental Panel on Climate Change
IUCN	International Union for Conservation of Nature
KARLO	Kenya Agricultural and Livestock Research Organization
KIPPRA	Kenya Institute for Public Policy Research and Analysis
KNBS	Kenya National Bureau of Statistics
Ksh	Kenya shillings
MDGs	Millennium Development Goals
MEC	Means-End Chain
MTP	Medium Term Plan
NCCAP	National Climate Change Action Plan
NCCRS	National Climate Change Response Strategy
NHIF	National Hospital Insurance Fund
NSPC	National Social Protection Council
NSPP	National Social Protection Policy
NSSF	National Social Security Fund
OECD	Organization for Economic Co-operation and Development
PRSP	Poverty Reduction Strategy Paper
PSNP	Productive Safety Net Program
SDGs	Sustainable Development Goals
SEI	Stockholm Environment Institute
SSA	Sub-Saharan Africa
UN	United Nations
UNEP	United Nations Environment Program
UNFCCC	United Nations Framework Convention on Climate Change
WB	World Bank

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1. Introduction

1.1 Background and research problem

Climate change is a global challenge that threatens livelihoods and undermines efforts for overcoming hunger, poverty reduction, gender equality, and environmental sustainability. Sub-Saharan Africa (SSA) is extremely susceptible to adverse impacts from climate change and variability, attributable to low adaptive capacity, low investment in infrastructure, low levels of physical and human capital, high rates of poverty, over-reliance on rain-fed agriculture and lack of a coherent climate policy. IPCC (2014) reported that climate change and variability exacerbates prevailing inequalities, susceptibilities, and poverty for communities, households, and individuals. The Global Risks Report 2017 emphasizes that environmental-related risks especially extreme weather events remain to be prominent creating a global crisis and that these risks are interrelated with other risks, namely, conflict, economic, and migration (World Economic Forum, 2017). On account of various climatic and economic risks and shocks affecting livelihood and economy in Africa, the African Union (2014) draw attention on the need for strengthening resilience against these shocks. The World Development Report 2014 further accentuates the need for managing risks as a vital pathways for reducing vulnerability, strengthening resilience and for fostering economic growth and development (World Bank, 2014). Understanding how to foster resilience to the impacts of changing conditions is crucial because rural livelihood systems must cope and adapt to threats and shocks.

Although there is growing policy interest on the impacts of shocks on welfare outcomes and assets in developing countries, studies centering on the effects of multi-shocks on a wide range of welfare outcomes and household asset portfolios are rare. Understanding how multiple shocks affect asset portfolios is crucial because productive assets held in the household determine the level of income, enable coping capacity, recovery and resilience against future shocks (DFID 2001; Miller et al. 2011). Further, most households and individuals in developing economies have limited assets to help them reduce vulnerability to climate risks and shocks. However, much remains to be erudite concerning what kinds of assets are most effective in empowering poor households and communities in managing risk under climate change. Occurrence of shocks to individuals, households and communities leads to depletion of asset through distress sales, physical damage/death, loss of livelihood and a few alternatives to diversify income. Households therefore forego their future investment in health, nutrition, and education of their children. This leads to a long-term low human development trap and intergenerational poverty with the infinite struggle to cope with shocks and climate risks, besides low investment undertakings to build up livelihood resilience in the future (World Bank, 2014).

To lessen the adverse impacts of climate change and variability, local farmers have adjusted to harsh weather conditions and have already developed coping strategies over time. However,

much remains to be learned about how men and women are adjusting to harsh weather conditions and why they are taking up specific climate-smart agricultural practices. The interplay between gender and climate change is of policy relevance and has received great international attention and primacy in the international agenda. Further, there is extensive literature on adaptation to climate change in the realm of developing nations.[1] Nevertheless, studies on adaptation to climate change and variability often miss out more nuanced gender perspectives or their empirical approaches simply permit a comparison of male-headed and female-headed households. Hence, as of now, there is limited empirical evidence on how gender at the intra-household level influences the adaptive capacities of men and women. For instance, collective and bargaining approaches necessitate interviewing husbands and wives independently and call for intra-household analysis to facilitate a better understanding of gender-differentiated perceptions, adaptive capacity, and uptake of climate-smart agricultural practices. Gender-differentiated approach is crucial because husband and wife within the same household have diverse ability to make timely decisions on adaptation responses and are likely to respond differently to the impacts of climate change. Besides, men and women respond to risks/shocks differently and their asset portfolios are used to cope with different shocks (Rakib & Matz 2014; Kumar & Quisumbing 2014). Furthermore, in their different gender and social roles, climate adaptation instruments, policies and measures are likely to affect men and women differently. Indeed, this thesis provides an innovative perspective in terms of examining gender-based behavioral differences of husband and wife within the same household, and using improved understanding to develop climate adaptation policies for these gender groups.

Further, substantial empirical evidence indicates that gender disparity exists in access to resources, information and access to agricultural inputs (see FAO 2011; Peterman et al. 2014 for a review). Access to power and control over assets are vital pathways to upsurge income and empower individuals to escape from poverty, reduce vulnerability, adapt, and build resilience to accelerating climate change and variability. In spite of policies and interventions supporting gender equality and empowering women's inclusion in governance, gender disparity remains a worldwide challenge. To improve their fallback plans and to obtain better access to resources and improve their bargaining power and improve welfare, the poor and women draw upon social capital and 'group-based approaches'. Evidence shows that institutional innovations enhanced through group-based approaches promote inclusive rural transformation through improved access to market, finance, natural resources, infrastructure, information and knowledge and strengthened participation in policy landscapes (IFAD, 2016). Nevertheless, there has been little attention to gender-differentiated potential of group-based approaches in the context of improving men's and women's adaptive capacity, ability to manage climate risk and protect household assets. A research gap exists with respect to what kinds of groups are most effective

[1] (see Grothmann & Patt 2005; Deressa et al. 2009; Below et al. 2012; Bryan et al. 2013; Di Falco & Veronesi 2013; Pérez et al. 2014).

in terms of empowering men and women in the face of fast-track climate change. Understanding the potential for gender-differentiated group-based approaches is relevant for policy formulation and program design, particularly while targeting development programs through social groups in developing countries like Kenya.

Against this background, the study, which was conducted in rural Kenya, addresses the following objectives:

1. To assess what types of shocks prevail in rural agrarian settings, to examine the strategies undertaken by households to cope with these shocks and to investigate how multiple shocks affect households' asset portfolios and poverty transitions.
2. To examine husbands' and wives' adaptation measures, adaptive capacity in the domain of differentiated access to household resources and to investigate the potential for gender-differentiated group-based approaches in strengthening men's and women's ability to manage risk and fostering welfare outcomes in the wake of accelerating climate change.
3. To examine the motivations men and women have for taking up various climate-smart agricultural practices through systematic mapping in order to depict farmers' decision-making processes.

This work is relevant for climate change policy and for advancing quantitative research approaches. The Kenya National Climate Change Action Plan (2013 – 2017) recognizes that prevalence of drought and water scarcity increases prevailing gender inequalities in poverty, insecurity and increases the socio-economic burden for women (GoK 2013: 49). The blueprint, however, barely pinpoints how to institutionalize gender as a key factor, integrate different social roles and responsibilities of men and women, and how to integrate gender-responsive strategies in the adaptation framework. Research is hence needed to inform policy makers on gender-responsive practices that are based on needs and interest of both men and women, practices that can lessen labor burden for women and on adaptation technologies that are available and affordable to both male and female farmers. This thesis therefore presents evidence-based findings to better guide a gender-responsive, gender-transformative, equitable, and sustainable action plan to adapt and mitigate the impacts of climate change. In spite of social groups being an innovative solution to access institutions and influence local governance structures, empower asset accumulation, reduce poverty and improve welfare outcomes, much remains to be learned about gender-differentiated social capital formulation and benefits, and what kind of groups are most effective for men and women while targeting developmental programs. This kind of information is of policy relevance for institutions and development partners that target programs and interventions through group-based approaches and community-based organizations.

1.2 Policy, governance and institutional arrangements

This section presents policy and institutional arrangements that the government and development partners have put into place in order to address the challenges of shocks, poverty, gender inequality and climate change in Kenya and other developing economies. It draws attention to gaps in policy and relevance of our research. In section 1.2.1, we highlight the poverty and pro-poor growth policies and challenges facing their implementation, while Section 1.2.2 identifies social protection policies and programs that are being implemented in order to protect citizens and vulnerable groups against negative impacts different types of shocks and threats. As will be shown later in Chapter 2, in spite of pro-poor growth policies and social protection programs, our data suggest that incidents of shocks, especially less prevalent shocks like crime is likely to worsen poverty status and loss of assets. Lastly, the section highlights the strides made in fostering gender equality in agriculture and in climate change policy. We specifically identify gender equality and climate change policies, programs and projects that are already being implemented, and point out what needs to be improved. We argue that despite the efforts and promising gender equality policies and programs, gender inequality persists in access to resources and decision-making as will be shown in Chapter 3. There is therefore a need for understanding men's and women's perspectives, while promoting climate-smart adaptation strategies.

1.2.1 Economic growth and poverty reduction policy

The strategies to reduce poverty in Kenya include the Poverty Reduction Strategy Paper (PRSP) launched at the beginning of 2000, corresponding to Millennium Development Goals (MDGs). The PRSP provides an outline for strategies and measures to reduce poverty while at the same time gearing economic growth and recovery (GoK, 2001). The implementation of PRSP was faced with various challenges including a mismatch between the policy and national budget, and poor political and economic governance in regards to fighting corruption. In 2007, the government unveiled the 'Kenya Vision 2030,' which targets to transform the economy into a technologically advanced (industrial) middle-income nation by the year 2030. Three main pillars—economic, social, and political—ground the Vision 2030. The economic pillar focuses on enhancing sustainable annual Gross Domestic Product (GDP) growth of 10 percent. In the first Medium Term Plan (MTP), covering 2008-2012, the government unveiled the economic stimulus program to tackle poverty and hunger. The program aimed at provision of resources to purchase agricultural seeds (rice and maize), rehabilitation of irrigation schemes, water harvesting in arid and semi-arid regions and establishment of fishing ponds as alternative sources of food and livelihood. The government also increased its attention towards enhancing safety nets, cash transfers and development of the livestock sector in arid and semi-arid regions as a strategy to reduce poverty and social exclusion (IMF, 2012). The second MTP for 2013-2017, focuses on the implementation of the newly devolved government structures and the role of county and national government, infrastructure development, job creation for youths and reduction of persisting high rates of

poverty. The success of pro-poor policies are hampered by "frequent droughts and changing rainfall patterns owing to climate change" (IMF 2012: 11). In spite of strong macro-economic policies, pro-poor policies and poverty reducing strategies, poverty remains a tenacious national wide challenge up until now. According to 2009 Kenya Population and Housing Census (KPHC), the national poverty incidence in Kenya stands at 45.2 percent, which is a slight improvement from 46.6% of Kenyans living in poverty in 2005/06 (Kenya National Bureau of Statistics, 2014). Indeed, poverty is mostly prevalent in rural areas estimated at 50.5%, whereas urban headcount ratio stands at 33.5% (ibid). In Chapter 2, our data suggests that incidents of shocks worsen poverty rates, which differ with agro ecological zones. Hence, policies for tackling susceptibility, risk management, and poverty reduction ought to be region- specific.

1.2. 2 Social Protection Policy

In Kenya, the threat of vulnerability and exposure to shocks is extremely high, worsened by high levels of poverty (GoK 2012). The Kenyan constitution articulates the 'right to social security for all,' while Vision 2030 in its social pillar seeks to promote 'social equity and cohesion in a secure and clean environment'. The pillar highlights the need to invest in marginalized regions (arid and semi-arid), communities with highest poverty prevalent, youth, women and disadvantaged groups (persons with disability, orphans and vulnerable children and elderly). The National Social Protection Policy (NSPP) unveiled in 2012 aims at protecting individuals against the impacts of adverse shocks on consumption, support individuals to manage risks and shocks, mitigate workers and their dependent against income shocks, such as illness, and promote investments in physical and human capital. The policy interventions hence help households and individuals from falling into poverty due to shocks, reduce the threat of post-employment poverty and build livelihood resilience through capacity building to break the cycle of intergenerational poverty and enrich inclusive growth (GoK 2012). The policy focuses on addressing governance challenges of duplications of roles, inefficiency, and misuse of resources through upholding synergies and assimilation amongst social protection actors and stakeholders. The NSPP includes three components—social assistance, health insurance and social security (GoK 2012), which are interconnected as shown in Table 1.1.

The component of social assistance includes non-contributory social cash transfer programs and safety net programs. The major social cash transfer programs consist of Urban Food Subsidy Cash Transfer, Persons With Severe Disabilities Cash Transfer, Older Persons Cash Transfer, Cash Transfer programme for Orphans and Vulnerable Children and the Hunger Safety Net Cash Transfer (see NGEC 2014 for a review of these programs). Besides the cash transfer programs, other protection measures include emergency response and recovery programs such as food distribution and food relief. The social cash transfer is more effective in reducing poverty, vulnerability, and food insecurity than emergency response programs that aims to protect peoples' lives in times of crises (GoK 2012). While food distribution programs and safety net

programs are vital emergency responses, integrating these program strategies with alternative sources of livelihood and employment through micro-finance and capacity-building programs would speedily shift men and women out of poverty, accumulate wealth and build resilience against risk in future.[2] This approach is feasible through group-based approaches as shown in Chapters 2 and 3.

Table 1.1: National social protection policy components and their interventions

NSPP components	Policy interventions
1. Social assistance	Social cash transfer programs Agricultural input transfer General food and distribution – school feeding programs Public worker programs – food or cash for work Community-based social assistance
2. Health insurance	National Hospital Insurance Fund (NHIF) Hospital fee waivers – maternal care, kids under 5 years Private medical insurance Community-based welfare organizations Health and nutrition programs – school feeding programs Health insurance subsidy programs – poor households with orphans
3. Social security	National Social Security Fund (NSSF) Occupational Pension Scheme Civil Service Pension Scheme Mbao pension Private pension schemes Public worker programs

Notes: The programs are contributory and non-contributory. The policy components are interrelated and complement each other.

Sources: Authors' elaboration

The Kenya constitution articulates the right to health insurance for all that is attainable through contributory National Hospital Insurance Fund (NHIF) programs. The NHIF has an obligation to empower all Kenyans access affordable medical care and protect the population against health shocks and expenditures (USAID 2014). The NHIF targets all populations and it is obligatory for all salaried workers, however, it suffers adverse selection through voluntary membership for self-employed individuals and labor force in the informal segment. In spite of the government's effort to improve access to universal health programs, the key challenge remains to enlarge contributory program to reach out informal sector, the poor populations in rural and informal settlements as well as vulnerable communities such as pastoralists populations (USAID 2014;

[2]Most of the cash transfer programs are demonstrating a positive impact on protecting poor households from sliding into chronic poverty, act as a safety net during extreme events, boost food security, increase enrolment in school, access to medical care, and enhance gender equality. The majority of beneficiaries of Persons with Severe Disabilities Cash Transfer are men, while women are the main recipients of the Older Persons Cash Transfer, Cash Transfer programme for Orphans and Vulnerable Children programs (NGEC 2014).

Bonfrer & Gustafsson-Wright 2016).[3] Other government health interventions include hospital fee waivers for kids less than five years, free maternal care in all government hospitals and free treatment for Tuberculosis (TB) and malaria. Besides, private health insurers and micro-health insurance play a vital role in providing health insurance, but it excludes the poorest populations who are mainly in rural, geographical remote areas and in the informal settlements. Encouraging alternative access to health strategies such as group-based health care approaches would be crucial pathways to the rural poor in safeguarding against heath shocks.

The social security component involves the National Social Security Fund (NSSF) that is a contributory scheme for the personnel in the formal employment. The NSSF offers opportunities for the employers and workers to plan for their retirement to escape falling into poverty and vulnerability in old age. The members of NSSF program are also eligible for retirement benefits, withdrawal benefits, migration benefits and survivor's disability benefits. The key challenge of NSSF is governance challenges, including inefficient management of funds with very high overhead costs and lack of inclusiveness. Similar to NHIF programs, NSSF has low coverage levels for the informal sector and poorest populations. For instance, women who are barely in the formal employment are likely to be left out of the pension scheme. The government has however taken a number of reforms to increase coverage of pension scheme to self-employed population and workers in the informal sector. For instance, the scheme has come up with a mobile-based transfer system 'Mbao Pension Plan' under the Retirement Benefit Authority Scheme aiming at encouraging membership of low earning population and workers in informal employment (GoK 2012b). Other pension schemes in Kenya include occupational pension scheme, civil Service pension Scheme, and private pension schemes.

To counter the governance and coordination challenges in the implementation of social protection programs, the government has put into place the National Social Protection Council (NSPC) to govern and coordinate the implementation of social protection programs. Besides, county and sub-county committees oversee the social protection programs at the county level. Other institutions providing social protection interventions include the private sector, non-state actors, community-based organizations, and households; however, they are restricted in scope and coverage. The government has recognized the role of informal community organizations and family assistance (group-based approaches) in providing social assistance to the local communities and the need for strengthening these approaches (GoK 2012). The study argues that group-based approaches is essential in identifying the most needy individuals and groups, hence addressing the governance challenges of elite capture while targeting the social protection programs in Kenya.

[3]By 2014, NHIF had only covered 16 percent of the informal sector population, who are often inactive with irregular contributions (USAID 2014).

1.2.3 Gender, agriculture and climate change policy

Climate change and its impacts cut across different domains of economy, sectors, and the environment and threaten the realization of sustainable development globally. For instance, in Kenya, the agricultural production is decelerating due to climate change. The gross value added growth of the agriculture sector declined by 1.3% in 2013 due to "depressed performance of both the long and short rains" (Kenya National Bureau of Statistics, 2014: 137).[4] According to the government of Kenya, climate has become "extreme, and harsh weather is now the norm" (GoK 2013: 2). Climate change impacts coarsely hit smallholder farmers who depend on rain-fed agriculture as a source of earnings, food, and livelihood and have low adaptive capacity. Besides, there is widespread consensus that climate change impacts are not gender neutral. Gender disparities in access to resources, information, and knowledge, different economic and social roles of men and women make them experience and respond differently to climate change.

At global level, the United Nations Framework Convention on Climate Change (UNFCCC) barely acknowledged gender aspects in the climate change framework. Nevertheless, substantial progress and efforts is noteworthy in the inclusion of gender perspectives in climate change governance. In 2005, the Conference of the Parties (COP 11) provided a platform for women to lobby for the enclosure of gender-lenses in all vital aspects of climate change measures. Through UN Climate Change Conference, the Global Gender and Climate Alliance (GGCC) was formulated and unveiled in 2007 to ensure gender-responsive climate change governance, policies and initiatives at the national, regional and global realms. Besides, in 2013, Warsaw Climate Change Conference offered a section on 'Women for Action on Climate Change' to promote gender-balance in decision making, capacity building programs and leadership positions in climate conventions, protocols and frameworks. The recent UNCOP20 in Peru 2014, advocated for gender-balance in governing bodies, decision-making, promote gender parity, and empower women as key agents of climate action. In spite of international declaration, policies and efforts upholding gender equality and women participation in climate governance, there is still low and insufficient representation of women in climate change governing agencies (Bob & Babugura, 2014). There is as low as 30 percent or extreme of 11-13 percent female representation in leadership for members under the UNFCCC and Kyoto Protocol (UNFCC 2013). Further, the UNFCCC has established the Green Climate Fund that aims to secure and allocate funds for adaptation and mitigation projects in developing country Parties. The critical question is how these projects are influencing gender equality, empowering men, and women in addition to promoting sustainable development. The *Environment and Gender Index* indicates that Kenya is

[4]The Kenyan economy is dependent on the performance of the agricultural sector. The agricultural sector contributes 24% to the GDP directly and constitutes 27% of the GDP through forward and backward linkages (GoK, 2010a). The sector contributes towards job creation, food security and achievement of development goals such as Kenya's Vision 2030 and the Millennium Development Goals (Kenya National Bureau of Statistics, 2014).

poorly integrating gender in national environmental policy ranking at 50th position out of 72 appraised nations based on 17 indicators in 2013 survey (IUCN, 2013).

At regional level, climate governance includes emergent East African Community Climate Change Master Plan (EACCCMP), policies, and frameworks that guide long-term regional climate change adaptation and mitigation measures. The EACCCMP (2011-2031) recognizes the role of gender in adaptation framework and advocates mainstreaming gender aspects in climate interventions, foster women's access to information and inclusion in decision-making and climate governance at different levels to promote long-term climate responses (EAC, 2011). In the cognition of vulnerability and threats of climate change, the government of Kenya obligates to safeguard the sustainability of climate systems as articulated in the UNFCCC and promotes mitigation through low carbon development mechanisms according to the Kyoto Protocol. The government unveiled the National Climate Change Response Strategy (NCCRS) in 2010, which is the first blueprint to guide nationwide strategies towards adaptation and mitigation actions (GoK, 2010b). However, the NCCRS barely acknowledge gender perspectives in climate change strategies. In 2013, the government launched the National Climate Change Action Plan (NCCAP) aimed at addressing vulnerability to climate change in the country. The NCCAP (2013-2017) focuses on the implementation of adaptation and mitigation strategies by ensuring low-carbon climate resilient development pathways (GoK, 2013).[5] The NCCAP recognizes the need for a policy framework to implement the NCCRS.

According to GoK (2010a) there is no coherent policy or law to tackle climate change threats in a coherent manner. Besides, a stakeholder analysis shows that there are many stakeholders and organizations involved in climate change adaptation in Kenya. Nevertheless, the level of involvement and influence of these organizations varies, and face challenges of coordination, fragmentation and duplication of roles (M. Ngigi, Okoba, & Birner, 2013). These governance challenges call for a coordinating entity amongst several stakeholders, organizations as well as different levels of government in order to ensure effectual climate change adaptation framework (Aberman et al. 2015; Ngigi, Okoba, and Birner 2013). There is however, hope with the National Climate Change Framework Policy 2014 and Climate Change Bill that was signed into law in 2016. The legal framework aims to coordinate coherent and effective actions to promote sustainable and resilient economy, low carbon development and protect citizens' well-being, protect their assets, and prosperity of the country in the face of rapidly changing climate. The policy purposes

[5]The NCCRS/NCCAP highlights the importance of agricultural sector in stimulating development outcomes related to food security, poverty reduction, and climate mitigation. Adaptation options related to crop sectors includes mainstreaming agricultural information, climate change information, scaling-up adaptation options (drought tolerant high-yielding crops, water harvesting, index-based weather insurance, and agro-forestry). In livestock production, the adaptation actions include promoting livelihood diversification (camels, indigenous poultry, beekeeping, rabbits, emerging livestock - quails, guinea fowls, ostriches etc.), grazing management systems, fodder banks, and price stabilization schemes and strategic livestock based food reserves, breed selection for diverse regions and requisite for early warning systems and livestock insurance among others.

to promote research and technology on the appropriate responses and differentiated impacts of climate change as well as integrate indigenous knowledge in research and development. To improve governance and participation, the policy recognizes the core value of education and public awareness in climate change impacts and responses and integrates knowledge on crosscutting policy such as gender and inclusion of vulnerable groups. The policy highlights the requisite for knowledge management, gathering and organizing information and making information accessible to numerous recipients through creating climate information hubs at both national and county levels.

The constitution of Kenya aims to promote equal rights and opportunities for men and women in entirely spheres of society interaction. The NCCAP and Climate Change Act therefore, recognize the importance of gender as a crosscutting policy issue in climate change responses (Gok 2014a; GoK 2016). The Climate Change Act pinpoints the need to "mainstream intergenerational and gender equity in all aspects of climate change responses" (GoK, 2016: 183). The policy further articulates the need for collaborating with vulnerable communities and groups, including women and youths to realize the effective implementation of the policy. The success and implementation of climate policy, however, depend on well-coordinated governance structures at national, county, sub-county, local, and household strategies against the impacts of changing climate. Climate Change Act (2016) targets to formulate the National Climate Change Council (NCCC) to spearhead advisory and coordination of different entities, stakeholders, sectors, and different levels of government on matters concerning adaptation and mitigation of climate change (GoK 2014a; GoK 2016). For instance, NCCC has a mandate to coordinate gender-responsive and gender-balanced awareness programs and public participation in climate change programs both at the county and national regimes.

However, the council, climate policy and other climate frameworks will oblige to address governance challenges in (i) mainstreaming crosscutting policies in sectoral policies (ii) coordinating and harmonizing different stakeholders and different levels of the government (iii) recognizing the role of local organizations in climate responses and building resilience to climate change. Gender and climate change are both crosscutting policy concerns. These crosscutting policies involve fragmented sectors, ministries and institutions and different levels of governments that asks for coordination of gender and climate responses amongst these actors. The change in the governance structures and the introduction of national and county governments pinpoint the requisite to improve consistency and coordination of climate and gender-smart responses between the different levels of the government.[6]The critical concern is whether these sectors and county governments have the capacity to mainstream and institutionalize gender and climate change, as a crosscutting policy concern in its functions. Great

[6]The devolved system of governance is likely to present prospects to improve governance through enabling mainstreaming climate-smart and gender-smart responses in county level and facilitating active collaboration of grassroots organizations, women, and citizens in the climate change governance.

consideration is obligatory on gender mainstreaming often referred as 'smart economics' or 'governance feminism' because of bureaucracy exercise that is likely to limit essential change and possibility of snowballing prevailing gender inequality (Chant & Sweetman, 2012). This calls for gender-responsive policies in order to attain gender equality. This thesis argues that social capital created through group-based approaches are central in promoting climate responses and resilience, at the same time, bridging the gender gap in access to resources. In Chapter 3, we presents that these kinds of institutional innovations are essential engine for promoting low-carbon practices, including afforestation, development of agroforestry systems and uptake of improved energy saving stoves. Group-based development approaches are also essential in fostering training and awareness of climate impacts and improving community climate governance through addressing gender norms and traditions that obstruct women from taking up or even scaling up climate-smart agricultural practices.

In spite of policies and interventions supporting gender equality and empowering women's inclusion in governance, gender disparity remains a worldwide challenge. According to the *Global Gender Gap* rankings, Kenya is closing the gender gap with notable improvement in ranking from 78th position in 2014 to ranking at the 63th position out of 144 reviewed countries in 2016 (World Economic Forum, 2014, 2016). However, Kenya is among the poor performers with the 116th rank in education attainment and the 83th rank in health and survival in 2016 ranking (World Economic Forum, 2016). The gender policies and interventions in Kenya include National Policy on Gender and Development of 2000, the Gender policy of 2011, the formation of a Gender Directorate in 2013,[7] the establishment of 'gender-desks' and the provision of 30 percent female representation in all government agencies. The government has also created empowerment interventions for women and marginalized groups through the Youth and Women Enterprise Fund and social cash transfer programs.

1.3 Conceptual framework

The conceptual framework of the study focuses on inter-linkages of climate change, gender, institutions, and well-being outcomes. The framework summarizes the key literature, assumptions, and objectives of the study. Previous frameworks that articulate the interactions between gender, livelihoods and institutions include the Sustainable Livelihoods Framework (SLF) (DFID, 2001), which elaborates the interaction of vulnerability to shocks, its impact on livelihood assets and welfare outcomes. Besides, the IPCC climate change framework links impacts, adaptation and mitigation against climate change and development pathways (IPCC, 2001). Another framework is the Institutional Analysis and Development (IAD) developed by Ostrom

[7]The Gender Directorate has two key departments: Economic Empowerment and Gender Mainstreaming under the Ministry of Devolution and Planning.

(2005), with the main focus on institutions[8] in social-ecological systems. Lastly, a more recent framework, include, the IFPRI Gender, Assets and Agricultural Programs (GAAP), which elaborates the link between assets and well-being outcomes with a gender lens (Meinzen-Dick et al., 2011). However, none of these frameworks has explicitly captured gender, assets, institutions, and climate change risks. This study adopts a framework developed by IFPRI that draws on the fore mentioned frameworks. Figure 1.1 illustrates the conceptual framework of intersection of climate signals/shocks, assets, gender and well-being outcomes. Most importantly, this framework is crucial in understanding differentiated and gendered responses to climate change and variability, with a special focus on the ultimate role of innovative institutions 'group-based approaches', personal values, access to appropriate information and prominence of asset accumulation in tackling vulnerability, building resilience and adaptation processes. The framework also captures the impact of climate shocks on well-being outcomes.

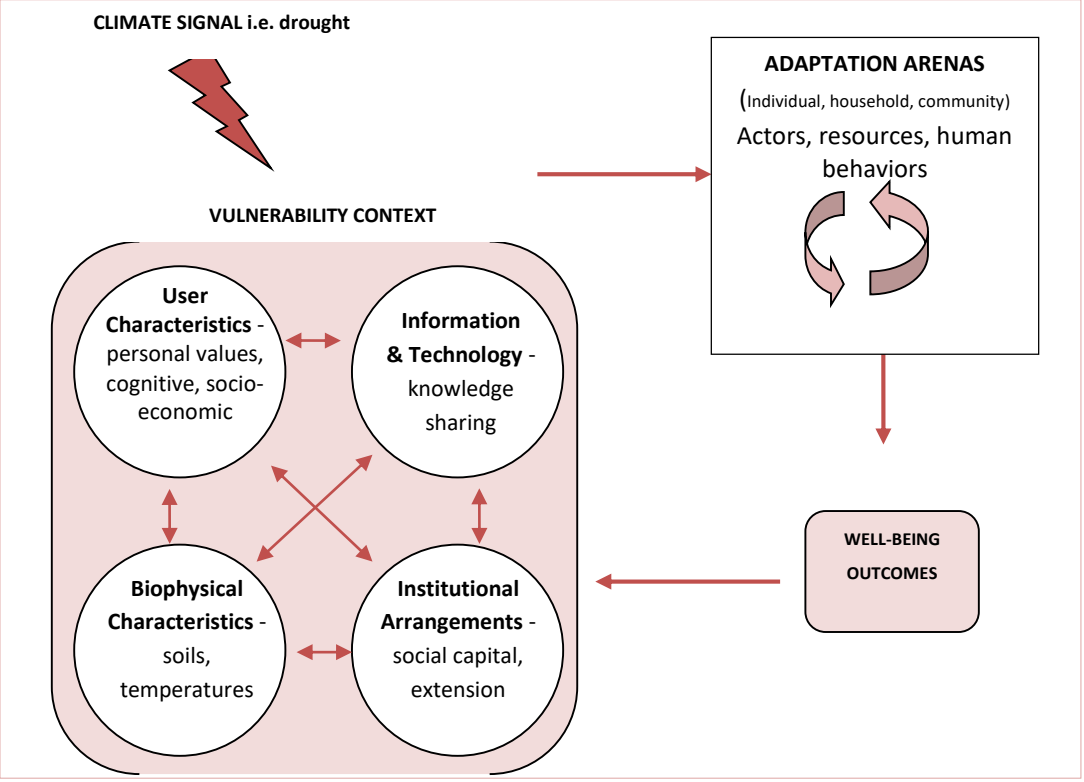

Figure 1.1: Interaction of gender, assets, and climate change

Source: Adopted from Bryan & Behrman 2013.

The climate signal consists of long-term variations in average climate variables and volatility. These signals include a change of timing, frequency, magnitude of climate variables, hence profound erratic precipitation, and incidence of drought, flooding, and hailstorms. According to

[8]Institutions are the governing rules of law, policies, cultural norms, traditions, strategies and inclusion (Ostrom 2005).

Smithers & Smit (1997), the response of the system or actors to the climate signals depends on the stimulus such as intensity and magnitude of the event. More extreme climate events/signals may require interventions of the national, regional, or international community. In Kenya, incidents of drought are the major climate signal affecting rural households (Ngigi et al. 2015). The study illustrates how climate signals influence well-being outcomes and how men and women perceive different indicators of climate signals.

The study examines gender-differentiated vulnerability context that includes interaction of four components, namely user characteristics, biophysical characteristics, institutional arrangements, and information and knowledge sharing. First, user characteristics include the factors that make actors, households, or individuals more vulnerable in the domain of changing climate. These comprise of assets at disposal, gender, sources of livelihood and personal values in decision-making processes. For instance, the gender of an individual or household head may determine how the impacts of climate change are experienced and hence influence adaptive capacity. The term gender implies different social relations and power dynamics between men and women. Gender is defined as "social, cultural, and psychological traits linked to males and females through particular social contexts" (Lindsey 2011: 4). The study conceptualizes gender and its interaction with resources, institutions, information, perceptions of climate risks and adaptive capacity. Indeed, gender inequalities in control over productive assets and social and economic roles make women more sensitive and vulnerable to the negative impacts of climate risks (World Bank, 2011). According to Nelson (2011) gender inequalities are worsened in deprived, marginalized or vulnerable households and communities with limited capacities and resources to tackle the effects of climate change. Aelst & Holvoet (2016) study shows that in rural Tanzania, marital status determines women's access to adaptive strategies, whereby widows and female divorcees are underprivileged to access agricultural water management practices. Further, while the personal values and motivations of different actors may have a positive effect on adopting climate-smart agricultural practices, due to changing climate conditions there could be irreconcilable conflicts or unfavorable tradeoffs between values. For example, it will be difficult for women to pursue achievement or benevolence values, while at the same time sustain conservation values as conferred in Chapter 4.

Information and knowledge sharing is the second component of the vulnerability context that determines ability of individuals and households to adopt appropriate responses. This component also needs to be studied in a gender-differentiated way. Climate information is crucial because it empowers different actors to manage long-term risks and respond appropriately thus increasing their resilience to climate change. Climate information also demands to be accurate, relevant and accessible, and farmers need to trust the information they acquire for it to be useful (Vogel & O'Brien 2006; McOmber et al. 2013). In Kenya, insufficient and inappropriate climate information, knowledge and data impede climate adaptation and research (GoK 2014: 26). A research gap exists with respect to gender-specific climate information needs and preferred channels of

information for men and women. It is also not clear about how men and women trust the information they receive from different sources such as media and extension agents and how the information they acquire influence their adaptation decisions. Chapter 3 addresses this gap in knowledge.

Institutional arrangements are the third component of the vulnerability context. Adapting to climate change and managing risks depend on the institutional environment in which the risks or shocks take place. Institutions affect how actors perceive, are impacted and how they respond to climate risks. Institutional innovations[9], such as social capital and group-based approaches could help individuals, households and communities share knowledge, accumulate assets and build resilience to climate change (Mueller et al. 2013; Ngigi et al. 2015). Social capital implies an important asset produced by group undertakings, that include networks, norms and trust that facilitate participants to work together meaningfully to acquire common objectives (see Jordan 2015). Therefore, social capital is defined as "bonds of solidarity" within a particular group or community (Portes & Landolt, 2000). Group-based approaches imply a forum for people or communities to participate in decision-making processes in a collective ruling for solutions to difficulties, risks, and shocks facing them. The study conceives group-based approaches as a sub-component of social capital, which builds both reactive and proactive resilience to climate risks. Social capital and group-based approaches, besides, govern community assets and facilitate access to key resources such as information and financial services. Indeed, social capital facilitate recovery after extreme climate events and enhance adaptive capacity, hence improving welfare outcomes (W. N. Adger, 2003; W. N. Adger et al., 2009; Bezabih, Beyene, Zenebe, & Borga, 2013). According to Adger et al. (2005) different institutional arenas restrain local adaptation. In Chapters 3 and 4, the study point out how informal institutions (traditions and social norms) are likely to obstruct female farmers from embracing climate-smart agricultural strategies. Chapter 3 provides emerging evidence on the potential for gender-differentiated group-based approaches in managing climate risks.

Biophysical characteristics are the fourth component in the vulnerability context. According to the conceptual framework, biophysical characteristics capture vulnerability or sensitivity of ecological and physical systems to the climate signals, and they determine the ultimate magnitude and impacts of extreme events, besides delineating the natural limits to adapting to climate (Brooks 2003: 4). Households depending on environmental-based resources for their livelihood are more likely to be vulnerable and experience adverse impacts of a changing climate (Alexander et al. 2011). The geographical location is likely to increase vulnerability and exposure to specific climate-related threats as well as other non-climatic shocks as shown in Chapter 3.

[9]A process of changing rules or norms in order to improve a situation with a positive outcome.

The adaptation arena is essential for determining how the interaction between climate signals and the vulnerability context finally determines well-being outcomes. The action arena captures actors, their resources, and their behavior, which can be studied at the individual, household and community levels. Up-take of adaptation strategies and climate-smart agricultural practices may improve well-being outcomes, reduce vulnerability to future risks and increase resilience to adverse climate threats (IPCC, 2001; World Bank, 2013). Resilience implies an approach that strengthens capacity to cope (reactive resilience), adapt (proactive resilience) and endure adverse events arising from climate-related stress (see Jordan 2015). The interaction of factors in the vulnerability context influence actors' adaptive capacity. Adaptive capacity involves strategies that reduce vulnerability to climate stress and depends on societal changes, perceived risks, policy and institutional frameworks (Keys, Thomsen, & Smith, 2014). Adaptation may happen at different levels, from local to national levels. The adaptation arena of this study focuses largely on individual and household level, with minor lens on community level.

The well-being outcomes draw upon adaptation decisions and actions of different actors. The interaction of shock signals, the vulnerability context, and the action arena ultimately determine the well-being outcomes affected by different climate signals. Climate signals and other shocks affecting individuals or households are likely to have a negative effect on welfare. The climate signal or shock affects well-being through loss of income, livelihood assets, security, and future welfare investments. Besides, ex-ante adaptation responses that increase resilience against shocks may have positive welfare outcomes, while ex-post coping responses such as selling assets, reduction of consumption and keeping children out of school, would negatively affect well-being outcomes, long-term human capital development, and intergenerational poverty. The current well-being outcomes such as assets and investments in turn determine future vulnerability and resilience to climate risks and decision processes. The framework shows in what ways climate signals or shocks and innovative institutions could affect well-being outcomes. The decision to adapt or not may positively or negatively affect the individual, household or community well-being outcomes. A major aspect of this study is the emerging insights on how gender differentiated group-based approaches improve men's and women's well-being outcomes.

1.4 Research methods

This section describes study sites, differentiated by agro-ecological zones, socioeconomic status, and cultural conditions. The section also illustrates sampling procedure and strategy, methods of data collection, and the kind of data collected to address the study's objectives.

1.4.1. Study location

Data for this study stems from three agro-ecological zones (AEZs) of rural Kenya — humid regions (high potential), sub-humid regions (medium potential), and semi-arid regions (low potential).The

sampled districts included Mukurweini and Othaya (humid regions), Gem and Siaya (sub-humid regions) and Mbeere South and Nakuru (semi-arid regions) (Figure 1.2). These districts represent diverse climate, agro-ecological, socioeconomic, and cultural conditions, policy and institutional arrangements, and susceptibility to climate change prevailing in Kenya.

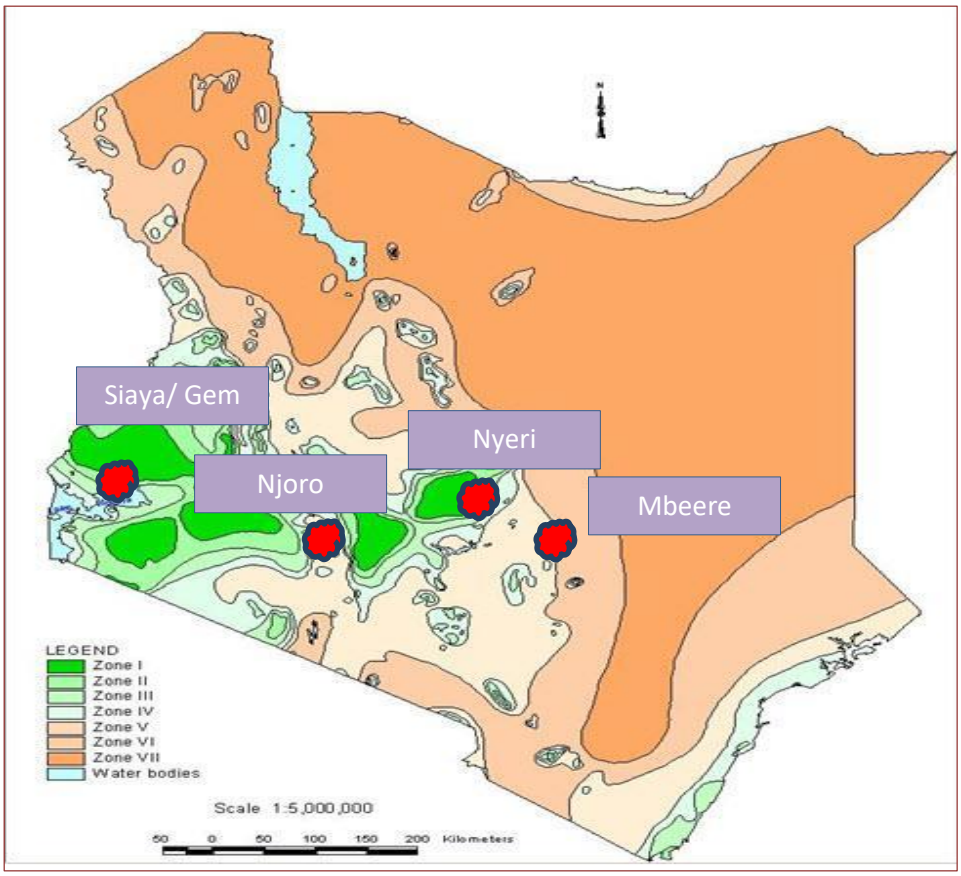

Figure 1.2: Location of study sites, differentiated by the agro-climatic zones of Kenya

Source: Kenya Soil Survey 2008

Mukurweini and Othaya districts are located in the humid regions, often referred as 'highlands'. This region has a high potential in agriculture, predominantly for dairy production and high-value cash crops, particularly horticulture, coffee and tea. Hence, the region is often referred as a high potential zone. The region has an average rainfall ranging from 1000 to 1600 mm per annum. This region is experiencing an increasing temperature, unpredictable rainfall, floods, invasive species, and frost mainly affecting tea and coffee. Besides, the zones have good access to local and urban markets. Mukurweini and Othaya districts are in the jurisdiction of Nyeri County government that experience poverty incidence ranging between 25-34 percent (Kenya National Bureau of Statistics, 2014). Worth mentioning, the level of poverty is lower in comparison to other regions, such as sub-humid and semi-arid regions as shown in Chapter 3.

Siaya and Gem districts represent the sub-humid region with an average agricultural potential. In addition, the region experiences low agricultural productivity due to declining soil fertility, soil erosion, and climate variability. The rainfall ranges from an average of 1100 to 1800 mm per annum. Siaya and Gem districts are under the jurisdiction of Siaya County government. The county is characterized by high poverty incidences ranging between 35-44 percent (Kenya National Bureau of Statistics, 2014). The county is located on the shores of Lake Victoria and experiences increasing humid temperatures, hence high incidence of malaria. It has the highest incidences of HIV/AIDS and vulnerable orphans living with HIV/AIDS (GoK, 2008; Kenya National Bureau of Statistics, 2013), and its population has low life expectancy (Juma et al. 2013). In addition, Siaya County hosts numerous national and international non-government actors helping the community to reduce poverty and support the vulnerable groups such as orphans and widows. For instance, the county hosts the agricultural carbon project, through Vi Agroforestry that supports farmers adopt sustainable soil management practices and agroforestry.

Mbeere South and Njoro districts fall under the semi-arid regions with low agricultural potential due to frequent dry spells and climate variability, which adversely affect economic activities in these areas. Marginal farming, livestock keeping, and wheat production are the main agricultural activities in these regions. These regions experience an average rainfall of 500 to 1400 mm annually. The Mbeere South district is under the jurisdiction of Embu County government. The poverty rates for Mbeere South district stand at 41 percent (Kenya National Bureau of Statistics, 2014). The Njoro district is located in Nakuru County with levels of poverty ranging 45-54 percent (ibid). It is a multi-ethnic region that often experience incidences of ethnic conflicts and the region were worse hit by the 2008/09 post-election violence.

1.4.2. Data and sampling frame

A mixed-methods research approach was applied for data collection. The methods consisted of household surveys (panel and intra-household cross-sectional survey), focus group discussion (FGD), and the use of an innovative laddering interview approach. Secondary climate data on temperature and rainfall complemented the panel and cross-sectional data. Besides, the study involved building on a panel data where the International Food Policy Research Institute (IFPRI) and the Kenya Agricultural and Livestock Research Organization (KARLO) carried out the first wave of data collection in 2009. Figure 1.3 below visualizes the sampling strategy for the quantitative component of the study.

The first wave of data collection involved stratified sampling strategy aiming at a wider range of climatic, agro-ecological, socioeconomic and cultural conditions, policy and institutional arrangements, and susceptibility to climate change (Bryan et al. 2013). The second wave of data collection involved a random and probability proportion to size sampling procedure of the total sample. The 2012 survey randomly sampled 360 out of the 557 households to revisit and re-

interview. Ultimately, the analyses were based on a balanced random panel sample of 360 households to address the objective one of the study. Panel data set increases the degrees of freedom and reduces the problem of collinearity and endogeneity across explanatory variables, hence it improves efficiency of econometric estimates, but heterogeneity bias should not be ignored.

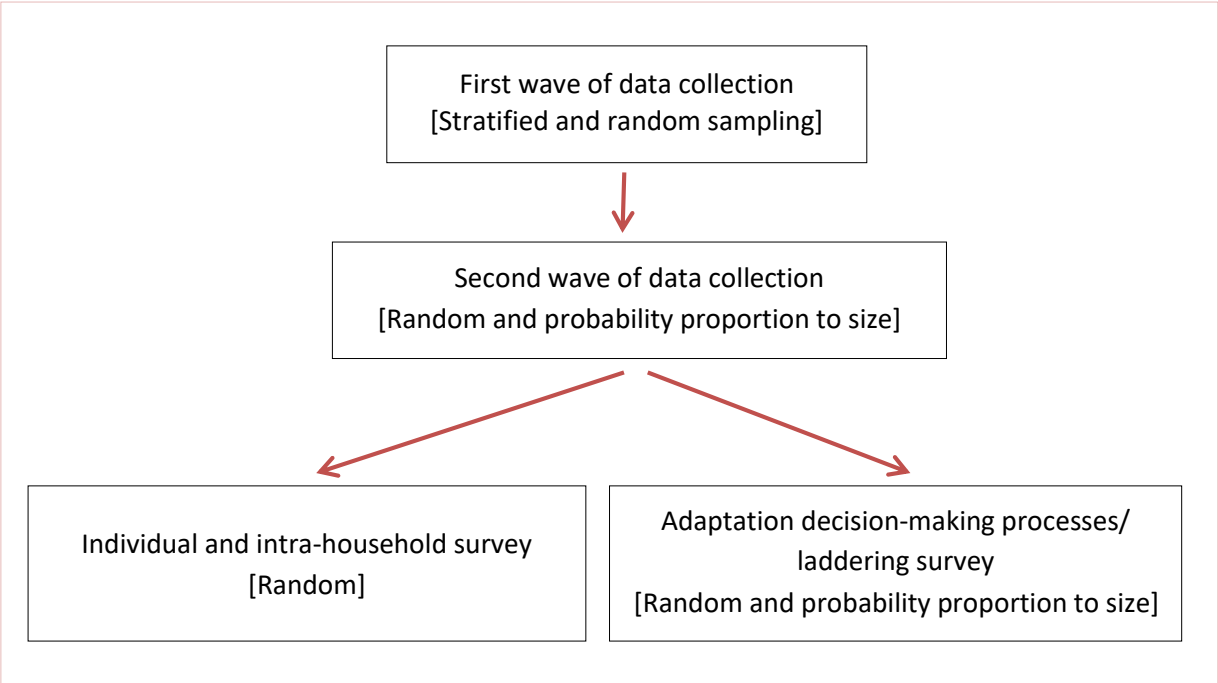

Figure 1.3: Sampling procedure for quantitative component of the study

Sources: Authors' elaboration

Further, the study randomly sampled 156 households out of 360 households in the second survey to be considered for the intra-household survey. This involved individual- and intra-household level data, generated by interviewing husbands and wives independently. Intra-household interviews were carried out on parallel time, whereby couples were not allowed to consult or communicate with each other. The study used a random sample of 156 pairs of spouses within the same household, making 312 respondents in total, to address objective two of the study. This approach captured intra-household dynamics and the interplay between husband and wife within the same household in access to resources, risk perceptions, adaptation strategies, and gender-differentiated potential of group-based approaches in enhancing welfare. The second wave of data collection took place between June and August 2012.

The Laddering interviewing approach (Reynolds and Gutman 1988) collected data on farmers' intrinsic values and motivations men and women have adopting climate-smart strategies i.e. adaptation decision-making processes. The study targeted a simple random sample derived from a list of 360 households, who had taken part in the 2012 household follow-up survey, in the

second wave of data collection (see Fig. 1.3). A random and probability proportion to size sampling procedure, i.e. relative to the population of the farmers in a given zone, derived a random sample of 60 farmers. Overall, the laddering study interviewed 19, 21, and 20 farmers in humid, sub-humid, and semi-arid regions, respectively. The means-end chain approach (Reynolds and Gutman 1988; Russell et al. 2004) hierarchically mapped men and women's decision-making processes concerning the uptake of climate-smart agricultural practices.

Qualitative research comprised of gender-disaggregated focus group discussion (FGD) carried out in all study sites to supplement the household survey. The FGD protocol included modules on perceptions, adaptations, potential for group-based approaches and institutions in enhancing men's and women's adaptive capacity and building assets. Random selection of the FGD participants with the help of field facilitators and local leaders ensured a wider representation and diverse views of farmers. Hence, selection of FGD participants considered different age groups, social status as well as members and leaders of social groups. Overall, FGD involved seven women focus groups and eight men focus groups, making 15 FGDs in total.

1.5 Outline and overview of the thesis

This section presents an outline of the thesis and gives a preview of the major findings.

Chapter 2 evaluates objective one of the study by examining what types of shocks prevail, what strategies are undertaken by households to cope with shocks, and what impacts of multiple shocks on households' asset portfolios and poverty transitions occur. This Chapter is based on the two waves of the panel data set. The chapter places special attention on the ultimate role of livestock portfolios and group-based approaches for building resilience in the face of multiple shocks and accelerating climate change. The findings show that climatic shocks negatively affect households' livestock portfolios —apart from small ruminant and non-ruminant livestock due to their higher adaptive capacity. Subsequently, households and individuals count on two major coping strategies to smooth their consumption level, namely adjusting their livestock portfolios and borrowing from groups. These findings indicate that the key policy interventions for fostering resilience against multiple shocks involve designing livestock protection policies and scaling-up group-based approaches. These policies can augment poor households' recovery and resilience in the face of rapidly changing climate.

Chapter 3 examines objective two of the study and contributes to a limited but growing literature on the intra-household dynamics of climate change adaptation. The chapter presents interesting intra-household gender analyses where husbands and wives within the same household respond similarly or differently to questions on risk perceptions, adaptation options, access to information and participation in group-based approaches. The findings show that options for adapting to climate change closely interplay with husbands' and wives' roles and responsibilities, social

norms, risk perceptions and access to resources. Consequently, a higher percentage of wives adopt crop-related strategies, whereas husbands take up livestock- and agroforestry-related strategies. Besides, there is a gender disparity in access to resources, gender-specific climate information needs, where men and women prefer to receive agricultural, and climate information in particular channels, which in turn influence their agricultural decision-making processes. Further, it turned out that group-based approaches benefit husbands and wives differently, where wives diversify their sources of livelihood, whereas husbands mostly benefit through sharing climate information and adaptation ideas. As a result, social capital index influences husbands' decision to uptake climate-smart technologies. Social groups help husbands and wives enhance their welfare through accumulating vital assets such as livestock, durable assets, human, natural, financial and social capital. These findings point out those policy interventions that rely on group-based approaches should reflect gender reality on the ground in order to amplify men's and women's specific abilities to manage risks and improve well-being outcomes in the wake of accelerating climate change.

Chapter 4 aims to contribute to the emerging body of literature on cognitive and socio-psychological aspects of climate change. The study employed an innovative means-end chain approach in order to elicit the cognitive structure of the farmers' decision-making processes underpinning their adaptive behaviors. The study argues that importance of values in adaptation framework, their trade-offs and gendered preferences are often disregarded due to lack of knowledge by policy makers, hence if better understood can trigger effective policies. Findings suggest that some of intrinsic values could worsen existing gender and social inequalities, whereas other self-perceived values could impede sustainable adaptation practices. Hence, study highlights that irreconcilable conflicts between values exist due to changing climate conditions. It will be difficult for women committed to conservative values to pursue achievement or benevolence values at the same time. Similarly, male-differentiated values suggest a need for a trade-off of their self-enhancement values that oppose universalism values that promote environmental sustainability and welfare for all. Gender differences in intrinsic values and adaptation responses therefore ask for a gender lens and other social considerations into national adaptation plans.

Lastly, Chapter 5 discusses the findings in comparative perspective and presents conclusions and policy implications of the study.

2. The role of livestock portfolios and group-based approaches for building resilience in the face of accelerating climate change: An asset-based panel data analysis from rural Kenya[10]

Abstract

This study examines the impact of multiple shocks on household assets and their implications for poverty in Kenya by analyzing two waves of a panel data set of 360 rural households in three agro-ecological zones. To control for unobserved heterogeneity, a household fixed effects model was employed. One major finding is that climatic shocks negatively affect households' livestock holdings —apart from small ruminant and non-ruminant livestock because they are more resilient to climate change. Consequently, households rely on two major coping strategies to smooth their consumption level: (1) adjusting their livestock portfolios, and (2) borrowing from group-based approaches. The latter strategy is particularly important for asset-poor and female-headed households in safeguarding their already low asset base. The findings suggest that livestock protection policies, such as diversification of livestock portfolios, promotion of fodder banks and index-based livestock insurance, are substantial to protect the poor households' asset bases. Hence, scaling-up and reinforcing of group-based approaches would augment poor households' recovery and resilience against multiple shocks in the face of accelerating climate change.

Key words: multiple shocks, livestock, group-based approaches, poverty, rural Kenya

[10]The shorter version of this chapter is published in a peer reviewed ZEF-Discussion Papers on Development Policy No. 205. Co-authors are Dr. Ulrike Mueller and Prof. Regina Birner.

2.1 Introduction

Frequent and concurrent shocks are a key challenge to agrarian settings in developing economies. According to the World Bank (2001) exposure and vulnerability to multiple shocks push households to poverty. Lack of adequate, suitable and affordable insurance arrangements put households at a greater risk in the occurrence of shocks (Dercon et al. 2005). Indeed, climate and weather shocks are projected to escalate in frequency and impact in the coming years due to climate change where worse-off households are highly susceptible (Baez, Fuente, & Santos, 2010). Evidence indicates that climate change exacerbates shocks affecting rural households including production, health, price and crime shocks (Kabubo-Mariara & Karanja 2007; Brown 2014; Blakeslee & Fishman 2014). On account of various climatic and economic shocks affecting livelihood and economy in Africa, the African Union (2014) draw attention for strengthening resilience against these shocks. The World Development Report (2014) further accentuates the need to manage risks as vital pathways for reducing vulnerability, strengthening resilience and for economic growth and development (World Bank, 2014). Resilience implies an approach that strengthens capacity to cope (reactive resilience), adapt (proactive resilience) and endure adverse events arising from climate-related stress (Jordan 2015). Livelihood resilience is the ability of households or individuals to sustain or improve their livelihood prospects and well-being outcomes in the face of environmental, social, economic and political shocks (Tanner et al., 2015). IFAD (2016) points out the need for enhancing resilience in rural areas by acquiring new assets and capabilities. Therefore, understanding how to foster resilience to the impacts of changing conditions is crucial because rural livelihood systems must cope and adapt to threats and shocks. Our research points that livelihood broadening through diversifying livestock production systems and through institutional innovations, particularly group-based approaches present promising pathways to lessen adverse effects and build livelihood resilience to future shocks.

There is increasing policy interest in the impacts of shocks on welfare outcomes and assets in developing countries (Béné, Devereux, & Sabates-wheeler, 2012; Bui, Dungey, Nguyen, & Pham, 2014; Demont, 2013; Stefan Dercon et al., 2005). Studies focusing on the effects of multi-shocks on a wide range of welfare outcomes and household asset portfolios are, however, rare (see Dercon et al. 2005; Quisumbing & Baulch 2013). The study argues that selective analyses of shocks on household welfare or assets may lead to loss of crucial information necessary for designing effective social protection and pro-poor growth policies. Although there has been substantial research about shocks and assets, much remains to be learned on what kinds of assets are most effective in building livelihood resilience in the face of multiple shocks. There is also insufficient evidence on the interaction of shock on assets and the poverty transitions in Kenya. Radeny et al. (2012) and Bonfrer & Gustafsson-Wright (2016) studies also in rural Kenya for example present idiosyncratic shocks and their impact on well-being, but overlooked the importance of covariant shocks. In addition, the impact of covariate and idiosyncratic shocks on intangible capital, particularly social capital created through group-based approaches has not been sufficiently

assessed. Therefore, this study draws attention on a wider range of shocks including less prevalent shocks affecting different households' asset portfolios and well-being. It identifies what kinds of assets are most effective in fostering livelihood resilience in the face of accelerating climate change.

Against this background, the study, which was conducted in rural Kenya, addresses the following objectives:

a) To examine what types of shocks prevail in rural agrarian settings
b) To analyze which strategies are adopted by households with different socio-economic characteristics in order to cope with predominant shocks
c) To identify the major determinants for undertaking these coping strategies and to assess their poverty reduction potential
d) To investigate how multiple shocks affect households' asset portfolios and poverty transitions

The study applied a micro-econometric approach using two-waves of a panel data set stemming from six districts in three agro-ecological regions of rural Kenya. Special attention extends to the interaction of a wider range of shocks to bridge the identified gap by presenting empirical evidence on the impacts of multiple shocks on asset portfolios. Different kinds of productive assets held in the household determine the level of income (DFID 2001), govern coping capacity, recovery and resilience against future shocks (Miller et al., 2011) besides facilitating moving out from poverty (Baulch 2011) as compared to approaches that focus on increasing consumption and income (Meinzen-Dick et al., 2014). The study draws attention on the role of different kinds of livestock held in the household in enhancing livelihood resilience against multiple shocks. For example, livestock portfolios are substantial poverty-reducing strategy for households and economic growth in Kenya (IGAD, 2013; KIPPRA, 2013). Besides, livestock—oxen and donkeys 'draft livestock'—provide draught power that increases agricultural productivity in rural areas through ease of transport. Furthermore, small livestock, such as poultry rearing, guarantees far-reaching gender and social equality implications primarily for women's role in food and nutrition security,[11] livelihood diversification and economic empowerment in the midst of fast-tracking climate change. Our research indicates that different kinds of livestock are likely to be affected by shocks and climate change differently. Small livestock are able to withstand feed and water scarcity, heat stress and are able to withstand harsh climatic environments (Bati 2013) thus building livelihood resilience of households to drought and other extreme conditions. Further, the study extends special attention to the role of social capital created through group-based

[11]In African setting, in particular Kenyan, women have a crucial role to produce food and ensure household has required food and essential nutrients. Poultry rearing is mostly women venture and they have autonomy over the proceeds or decision on consumption especially on eggs and meat.

approaches in enhancing coping capacities and building livelihood resilience of poor- and female-headed households in rural agrarian settings.

Understanding factors undermining poverty reduction efforts is important because in spite of Kenyan robust pro-poor policies and remarkable macroeconomic growth, poverty incidence remains a nationwide challenge (Kenya National Bureau of Statistics, 2014). For instance, poverty levels are mostly prevalent in rural areas estimated at 50.5% as compared to 35.5% for urban environs (ibid). This asks for a better understanding of factors undermining transition out of poverty in rural settings.

Findings of the study indicate that sale of livestock is the major coping strategy against shocks, particularly for the asset-rich households. Conversely, asset-poor and female-headed households depend on borrowing from social groups to insure and build their resilience against shocks. The study points out that participating in group-based approaches is essential coping strategies for building resilience to shocks and other changing conditions. Evidence suggests that formal health insurance and universal health care program safeguarding against potential financial implications of shocks are lacking in informal sector and among poor rural households in Kenya (USAID 2014; Bonfrer & Gustafsson-Wright 2016). Our data therefore suggest that group-based welfare associations in rural areas could partially manage health shocks by insuring medical and funeral expenses (in case of death) of their members or their family members. Through this approach, affected households transfer their risks and insure their asset portfolios, hence, enabling their resilience against multiple shocks in the face of escalating climate change. However, our findings also show that effectiveness of group-based approaches is likely to weaken in the incidents of extreme events such as drought, flooding, and crime. Hence, there is a need for strengthening group-based approaches in times of adverse events. The study concludes that underplaying idiosyncratic shocks, such as health, crime, socio-political and market shocks may result in not only substantial loss of livestock portfolios, but also losses of other household assets including effectiveness of group-based approaches, agricultural productivity, and income that consequently worsen levels of poverty in rural settings. The findings of this study hence got a far-reaching labor, gender, and poverty implications.

2.2 Shocks, assets and poverty: evidence from the literature

The sustainable livelihood framework (SLF) represents an approach of relating shocks and coping capability and connecting assets and income. The SLF framework elaborates the interaction of vulnerability to shocks and its impact on assets and welfare outcomes. DFID (2001: 45) defines shocks as “sudden events that have a significant impact on livelihoods.” The ‘sudden events’ could be negative shocks and positive events. There are different types of shocks including natural disasters (covariant), market shocks, economic shocks and idiosyncratic shocks (Dercon et al. 2005; Baulch 2011; Oviedo & Moroz 2014). Most of these shocks hit the a household in concurrent

and successive manner causing a great loss to the household (Oviedo & Moroz, 2014). Positive events could include positive income shocks such as remittances (money received by the household from relatives working away from home), receiving dowry, and positive rainfall shocks, among others. The study treats remittance as the only positive event.

The bases for empirical analysis of shocks in development economics include consumption smoothing theory, asset, and poverty dynamics. The consumption-smoothing principal indicates that worse-off households are less capable to cope with different categories of shocks such as natural disasters, illness and economic shocks (Stefan Dercon, 2004; Stefan Dercon et al., 2005; Kazianga & Udry, 2006). Poor households have fewer assets and often encounter problems of imperfect markets, particularly in access to insurance and financial markets (Dercon 2002). Evidence in developing countries suggests that non-poor households dispose of assets to smooth their level of consumption (Dercon 2002; Carter et al. 2007; Heltberg & Lund 2009; Béné et al. 2012), while poor households sacrifice their consumption to protect their assets (Kazianga&Udry 2006).

Shocks have a negative impact on individual and household well-being. Shocks impact negatively the consumption of poor households, i.e. for food consumption (Webb et al. 1992; Dercon et al. 2005) or non-food expenditures (Asfaw & Braun, 2004; Wagstaff, 2007). Several studies have shown that health shocks (illness and death) reduce consumption and its growth. Dercon et al.'s (2005) study shows that health and drought shocks reduced consumption by 9 percent in Ethiopia. In a similar vein, Beegle et al. (2008) show that households that experienced drought or illness in Tanzania reduced consumption by 7 percent. Weather shock exposes kids to nutritional deprivation and stunting growth (Alderman, 2011; Yamano, Alderman, & Christiaensen, 2005) leading to a long-term low human development trap (UNDP 2014). Friedman et al. (2011) show that market shocks especially increased during the food crisis of 2008 resulted to a reduction in caloric intake of Pakistani households by 8 percent whereas urban households were worse-off than the rural households were. Other studies show contrary findings that health shocks have no significant effects on consumption (see Islam & Maitra (2012) for Bangladesh and Genoni (2012) for Indonesia). In addition, socio-political conflict reduces households' income, current food consumption and impact human capital negatively (Justino 2011; Dupas & Robinson 2012). Dupas & Robinson (2012) study shows that 2007/08 socio-political shocks in Kenya forced women to engage in risky sexual behavior in order to generate income that could result into long-term health implications such as HIV-AIDS or other sexually transmitted diseases. The literature also indicates that extreme shocks are likely to weaken social capital and networks. Fuente (2008), study demonstrates that covariant shocks worsen persistence in poverty, which leads to time available for households to engage in social relations. Group-based community safety nets are also likely to disintegrate due to incidence of extreme events (Bernier & Meinzen-Dick 2014).
Carter & Barrett (2006) developed the hypothesis of 'asset poverty trap' highlighting the importance of productive assets in facilitating households' movement to a lower or upper

equilibrium over time. There is a substantial literature, which examines this hypothesis in South Asia (Naschold, 2012; A. R. Quisumbing & Baulch, 2013) as well as in Sub-Saharan Africa (Mogues 2011; Carter and Lybbert 2012; Giesbert and Schindler 2012). The findings of research on the poverty trap hypothesis, however, differ depending on the geographical disparities. While most studies in Sub-Saharan Africa[12] demonstrate the reality of poverty traps, similar studies in South Asia[13] draw unique equilibrium because of the presence of well-functioning factor markets. Further, loss of assets and vulnerabilities to shocks that lead to a reduction in consumption levels result to long-term low human development trap (UNDP 2014). Poverty is multidimensional, and asset framework could insufficiently address poverty transitions overtime. Indeed, high poverty levels and income losses exacerbate in fragile and unstable environments or in extreme events. Extreme events related to climate change, worsen household poverty and inequality for communities, households and individuals in developing economies (see Little et al. 2006; Carter et al. 2007; Bui et al. 2014; Thiede 2014). Market shocks —food price inflation likewise increase the poverty levels of the poor households (Vu & Glewwe 2011, for Vietnam). Quisumbing & Baulch (2013) demonstrated that covariant and idiosyncratic shocks reduce ability of households to accumulate assets over time in Bangladesh.

There is a gap in knowledge on the impact of a wider range of shocks on households' asset portfolios. There is also inadequate attention to wider range of assets categories, which may be affected differently by different shocks and which may have different implications for household well-being. The literature review indicates that the impact of covariant and idiosyncratic shocks on group-based approaches has not been sufficiently evaluated and that most studies are based on intuitive arguments in this regards. There is also a gap in the literature on what types of assets are most effective in enhancing resilience in the face of accelerating climate change. To address this knowledge gap, this study provides a robust analysis on impact of multiple shocks on household assets by analyzing two waves of a panel data set of 360 rural households. The study empirically points out what kinds of assets are most effective in promoting resilience against multiple shocks. This kind of information is necessary for designing effective social protection programs and formulating pro-poor growth policies.

2.3 Data and sampling procedure

This study uses two-waves of a panel data set of households in three agro-ecological zones (AEZs) of rural Kenya —the semi-arid regions (low potential), sub-humid regions (medium potential) and humid regions (high potential). The sampled districts included Mbeere South and Nakuru (semi-arid regions), Gem and Siaya (sub-humid regions) and Mukurweini and Othaya (humid regions). The International Food Policy Research Institute (IFPRI) and the Kenya Agricultural and Livestock

[12]See Carter et al. (2007) for Ethiopia, Barrett et al. (2006) for Kenya, Carter & Lybbert (2012) for Burkina Faso.
[13]See Quisumbing & Baulch (2013) for Bangladesh, Kurosaki (2013) for Pakistan.

Research Organization (KARLO) collected the first round of data in 2009/2010, whereas a random sample of the same households were re-visited and re-interviewed in 2012 by the research team.

The first wave of data collection involved a stratified sampling strategy aiming at a wider range of climatic, agro-ecological, socioeconomic and cultural conditions, policy and institutional arrangements, and susceptibility to climate change (see Bryan et al. 2013 for details). The second wave of data collection targeted a sample size of 360 households out of 557 households interviewed in 2009/10 survey attributable to financial and logistical restraints. Sampling involved a random and probability proportion to size sampling procedure of the total sample. Ultimately, the analyses were based on a balanced random panel sample of 360 households to address the study's objectives.

The survey instruments for 2009 and 2012 included modules capturing information on household assets, livestock holdings, income sources, demographics (age, gender, education level, household size) and institutional factors (group-based approaches, access to extension services, access to credit etc.). They also included modules on adaptation measures undertaken, production data, access to information, credit, and market access. The questionnaire was designed to capture the shocks affecting the household, coping strategies and the monetary loss from incidence of multiple shocks. Table 2.1 presents the definition of key variables and descriptive analysis for the periods 2009 and 2012. Total income was computed by summing up income from numerous sources, including farm income, non-farm income sources, sale of assets, gifts, pension, savings, and income from entrepreneurial ventures. The monetary values for 2012 were deflated using Kenyan consumer price index (CPI)[14] taking CPI for 2009 as the base category year. Following SLF, we identified livelihood assets held by the household, including natural capital (land), financial capital (income and access to credit), consumer durable assets, agricultural durable assets, livestock holding in TLU and social capital created through group-based approaches (membership in social groups). Following Filmer & Pritchett (2001) and Moser & Felton (2007), we applied principal component analysis (PCA) to compute an asset-based index, such that

$$A_{it} = \sum_{n=1}^{n} W_{1n} d_{nit} \qquad (1)$$

[14]The CPI for 2012, by the time of survey was 133.06 and the CPI for 2009 was 100, applied as the base year.

Where A_i is the household asset index for the i^{th} observation at time t, d_{ni} is the type of assets in n^{th} dummy variable, i.e. n=1,..,N and W_{1n} is the weight of the asset index (factor components).[15] The study developed an index for consumer and agricultural durable assets.[16]

Table 2.1: Definitions and summary statistics of the key variables for the period 2009-2012

		2009 (N=360)		2012 (N=360)		Diff. in Mean (T-test)
Variables	Definitions	Mean	Std. Dev.	Mean	Std. Dev.	
Household size	Number of persons in the household	5.37	0.14	5.15	0.14	-0.22
Dependency ratio	Ratio of dependents, <15years and >64years	0.79	0.04	0.84	0.05	0.05
Age in years	Age of the household head	56.14	13.00	57.94	13.03	1.79
Total TLU	Tropical livestock units owned by the household	3.99	4.33	5.36	5.50	1.55***
Total annual income in Ksh '000	Total household income in Ksh '000, in 2009 prices	95.05	126.88	151.97	165.96	56.93***
Access to credit†	Access to credit from informal or financial institutions	0.44	0.50	0.57	0.50	0.06
Consumer durable asset	Indices of consumer durable assets	0.30	0.17	0.34	0.14	0.04***
Farm assets	Indices of farm tools and machinery assets	0.57	0.13	0.58	0.09	0.01
Social amenities	Indices of access to social amenities	0.47	0.14	0.54	0.14	0.07***
Land in acres	Land size in acre	16.09	26.54	4.00	6.46	12.09***
Crop extension service†	Access to crop extension service	0.53	0.50	0.83	0.38	0.30***
Livestock extension service†	Access to livestock extension service	0.44	0.50	0.67	0.47	0.23***
Social capital (group-based approaches)†	If any of the household members belongs to any social group	0.76	0.43	0.93	0.26	0.17***
Safety nets†	Received food aid or participated in food or cash for work programs	0.18	0.38	0.20	0.40	0.02
Remittances†	Money sent home by relatives working away from home	0.27	0.02	0.59	0.02	0.32***
N	Number of observations	360		360		

Notes: Superscript † presents variables in binary format. Ksh represents Kenya shillings. Superscript * presents significance at the 10% level, ** at the 5 % level, ***at the 1% level of t-test estimates of mean comparisons.

Source: Authors' computations centered on the survey data.

[15]The analysis considered factors with the Eigen-values >1. The Kaiser–Meyer–Olkin (KMO) verified sampling adequacy and Bartlett's test of sphericity correlation assumption of the PCA. For a single asset index, summation and normalization employing $Asset\ index = \frac{X - min_x}{max_x - min_x}$ of PCA components, on a scale of 0–1 was done.

[16] Assets considered for consumer durables include car, motorcycle, television, mobile, refrigerator, radio and mobile phone, while agricultural assets considered 19 types of assets, including farm tools, machinery and engine generator.

The Tropical Livestock Units (TLU) quantified an extensive range of different livestock portfolios in a consistent manner.[17] The study disaggregated livestock portfolios into poultry (chicken, fowl, duck, turkey), small ruminant and non-ruminant livestock (rabbits, pig, goats/sheep), cattle (cows, bulls, heifers, calves), and draft livestock (oxen and donkeys). This analytical approach straightens the effects of shocks on diverse livestock portfolios. Livestock is the main source of food, income, employment in rural areas and contribute to agricultural productivity increment through provision of draught power and organic fertilizer.

Following SLF, we related livelihood assets to predict household income. However, SLF does not provide strong guiding principle on how to map livelihood assets into income. Hence, the study adopted Carter & May (2001) to predict household income against livelihood assets. Regression results of observed income against assets indicate that household income depends on household headship, level of education, land size, livestock portfolios, consumer durables, and access to basic facilities as shown in Table 2.2.

Table 2.2: Pooled regression results of reported income against livelihood assets in 2009 and 2012

Variables	Coefficients	Standard Errors
Age	-0.001	0.004
Male headed household	0.212*	0.111
Household size	0.027	0.020
Primary education or above	0.295*	0.171
Land values	0.168***	0.043
Basic facilities in index	0.578*	0.356
Agricultural durable asset index	0.054	0.450
Consumer durable asset index	1.734***	0.336
Total TLU	0.016*	0.009
Access to credit	0.027	0.098
Group-based approaches	0.154	0.138
Remittance	-0.136	0.106
Constant	-0.764	0.634
F-test (1, 706)	59.58***	
R-squared	0.12	

Notes: *** (P<0.01), ** (P<0.05) and *(P<0.10). The livelihood assets were used to predict household's income.
Source: Authors' computations centered on the survey data.

Table 2.3 presents a summary and asset dynamics for the period 2009 and 2012. The asset dynamics show that there is a progressive growth in all household assets. There is remarkable growth, particularly for small livestock, financial capital and group-based approaches, which could

[17] The TLU conversion factors used are as follows: bulls = 1.2, oxen = 1.42, cattle = 1.0, goats/sheep = 0.2, poultry = 0.04, rabbits = 0.04, pigs = 0.3, donkeys =0.8, ducks/turkey/geese = 0.03.

imply the likelihood of households' ability to recover after the 2008 to 2009 drought. There is also a notable increase in preferences for small livestock because of its liquidity and substantial adaptive capacity to changing climate conditions. Consumer and agricultural assets reported a minimal rate of growth. Land size reports a drastic decline by 25 percent annually. The Kenyan new constitution (2010) advocates equal rights for both boys and girls on the inheritance of their parents' land and other properties, which could lead to subdivision of land. Other factors driving sub-division of land and pressure on agricultural land in Kenya includes population growth, change in land use and infrastructure developments especially thriving real estate sector in most part of the country.

Table 2.3: Asset dynamics for 2009-2012 periods

Assets	2009 (Mean)	2012 (Mean)	Growth rate (%)	Average asset growth/year
Poultry	0.30	0.43	0.43	0.14
Small livestock	0.93	1.56	67.74	22.58
Cattle	2.43	3.18	30.86	10.29
Draft livestock	0.63	0.79	25.40	8.47
Total TLU	3.99	5.54	38.85	12.95
Land size	16.09	4.00	-75.14	-25.05
Consumer durable asset index	0.30	0.34	13.33	4.44
Agricultural durable asset index	0.57	0.58	1.75	0.58
Basic facilities index	0.47	0.54	14.89	4.96
Household income, Ksh'000, in 2009 prices	103.40	151.97	46.98	15.66
Credit access[†]	0.44	0.57	29.55	9.85
Social capital[†]	0.76	0.93	22.35	7.46
N	360	360		

Notes: [†]Variables are in binary format. Ksh represents Kenyan shillings.
Source: Authors' computations centered on the survey data.

2.4 Descriptive results

This section presents descriptive findings on the types of shocks affecting households in agrarian settings between 2009 and 2012. The section shows that shocks differ across agro-ecological regions, economic status, and gender of the household head. The section also focuses on coping strategies undertaken by households with different socioeconomic characteristics in 2009 and 2012. Lastly, this section identifies poverty levels for different groups, such as gender of household head and geographical regions.

2.4.1 Types of shocks prevailing in rural Kenya

Table 2.4 presents different categories of shocks, their definitions, and the prevalence in percentage in 2009 and 2012.

Table 2.4: Shocks experienced by Kenyan rural households in2009 and 2012 (percentage of responses)

Shock	Definitions	Proportion of households reported shock (%)		Diff. in prevalence (%)	Overall prevalence between 2009 and 2012
		2009	2012		
Overall shock	If the household is affected at least by one shock	100.00	99.17	-0.83	99.58
Number of shocks (Mean)	The total number of shocks reported by the household	2.80	2.21	-0.59***	1.40
Climatic shocks					
Drought	Inadequate rain and prolonged dry spell	87.22	51.11	-36.11**	69.17
Erratic rain	Uneven and erratic rain	38.89	44.17	5.28	41.53
Hailstorm	Heavy rainfall with hail	12.50	16.39	3.89	14.44
Frost	Solid deposition of water vapor from humid air	1.11	8.61	7.50	4.86
Flooding	Too much rainfall that cover land with water and results to overflowing of water bodies such as dams, rivers, streams	5.83	3.61	-2.22	4.72
Animal health	Livestock diseases	15.83	13.06	-2.78	14.44
Crop pests	Loss of crop before harvest due to pest infestation	22.22	25.56	3.33	23.89
Loss of crop harvest	Loss of crop during storage	5.00	4.17	-0.83	4.58
Non-climatic shocks					
Illness	Illness of a family member	22.22	17.50	-4.72*	19.86
Death shock	Death of a family member	13.06	12.22	-0.83	12.64
Market shock	Increase in input prices, the decline in output prices, no market for output and poor seed quality	24.72	13.06	-11.67**	18.89
Crime shock	Theft of cash, crops, livestock or other assets	14.44	8.61	-5.83**	11.53
Socio-political shock	Violence, ethnic conflicts, social discrimination	13.61	1.11	-12.50	7.36
Personal shocks	Loss of employment, separation/ divorce, dispute in the family, imprisonment	3.00	1.20	-1.80	2.10
Positive shock					
Remittances	Money sent home by relatives working away from home	26.94	58.61	31.67**	42.78
N	Number of observations	360	360	720	720

Notes: *Prevalence presents the percentage of responses of households affected by shocks. Prevalence of shock was self-reported.[18] Multiple answers reported.

Source: Authors' computations centered on the survey data.

[18] Self-reported shocks may suffer from representation 'attributions of causality' by responding households instead of the actual occurrence of the events or from 'selection attrition'. However, this is mostly a problem for cross-sectional data (Hoddinott & Quisumbing, 2003).

The findings show that almost all households (99.6%) have been affected by at least one major shock during the survey periods between 2009 and 2012. Further, households reported multiple concurrent shocks, with the average count across all rural households being 2.51, while some households experienced more than six incidences of shock. Our data suggest that drought and erratic rain are the most prevalent and severe climatic shocks affecting households in rural Kenya resulting in low agricultural productivity, decline in income and food insecurity. Drought incidence was more prevalent in 2009, reported by 87 percent of households as compared with 51 percent in 2012.

Health shocks (illness and death) are the major idiosyncratic shocks (32.4%) affecting rural households. Crime and socio-political shocks were prevalent in 2009, since the first round of data was collected a year after post-election violence of 2008. Besides, market shocks affected 24 percent of households in 2009, as compared to 13 percent of households in 2012. This finding could be explained by the fact that the survey of 2009 corresponded with the period of global food crisis, while the follow-up survey of 2012 was carried out after the 2011 drought and high food prices in Kenya.

To examine the severity of shocks on households' well-being, we asked respondents to examine how difficult it was to address the specified shock and how widespread was the reported shock. The study further asked respondents to estimate systematically the amount of loss of income and asset from the shock reported by the household in 2009 and 2012. The severity findings show that households perceived that climatic shocks especially drought was wide spread and affected most households in the village and district levels (68%), while idiosyncratic shock only affected few households in the village. Indeed, 74 percent of the households perceived that it was very difficult to address climatic shocks in 2009 and 2012. Besides, the findings of the study show that occurrences of shocks led to tremendous loss of income with health (illness and death), frost, drought, erratic rains and socio-political shocks reporting highest loss of income (See Table 2A-1 in the Appendix). Furthermore, rural households perceived that occurrences of shocks also led to food insecurity and loss of assets (see Table 2A-7 in the Appendix). The description results are in line with regression analysis in Section 2.5.2 that shows that there was causality between types of shock and assets such that occurrences of shocks resulted to adverse effects on different types of assets.

2.4.1.1 Shock prevalence across wealth quintiles

To examine the effect of shocks on poor and rich households, the study disaggregated household welfare levels into asset and income quintiles (1st-deprived quintile, 2nd quintile, 3rd quintile, and 5th-well-off quintile). Cross-tabulation and Chi square (X^2)[19] results show that the poorest

[19]A chi square (X^2) statistical test examines the significant differences of frequencies in one or more categories of comparison.

households in the community are more likely to experience a higher impact of drought considering both asset and income quintiles (x^2 P-value<0.001) (See Table 2A-2 in the Appendix). The asset-quintiles demonstrate a higher likelihood of hailstorms and frost affecting the better-off households (x^2 P-value<0.05). Likewise, income-quintiles show that the occurrence of frost is likely to affect better-off households (x^2 P-value<0.001). Farmers possessing a larger piece of land under coffee or tea production are more likely to experience higher impacts of frost. Those households endowed with more assets are likely to experience theft of their properties, i.e. crime shocks (x^2 P-value<0.05). Households with lower income-quintiles are prone to social shocks, i.e. discrimination from social settings or political shocks, such as violence or civil disputes (x^2 P-value<0.05).

2.4.1.3 Shock prevalence across gender of the household head

The 'feminization of poverty' dictates that female-headed households are more susceptible to shocks because of their limited coping capacity, which in turn make them susceptible to poverty. The findings however indicate that both male- and female-headed households are vulnerable to drought, with a reporting of 69 percent and 71 percent, respectively. Male-headed households reported a higher prevalence of crop pest shock. In contrast, female-headed households (both *de facto* and *de jure*)[20] reported a higher incidence of flooding than male-headed households (x^2 P-value<0.10). The *de jure* female-headed households reported highest incidence of death since most of them had lost their spouses (i.e. widows). Female-headed households experienced, on average, a higher number of shocks (2.7) as compared to male-headed households (2.5) (x^2 P-value<0.10). Notably, *de jure* female-headed households reported a higher number of shocks (2.7) than *de facto* female-headed household (2.6).

2.4.1.4 Shock prevalence across geographical regions

Identifying local-specific shocks is paramount in designing location-explicit risk management tools. The results of cross-tabulation and X^2 statistical tests show that while drought shock is comparatively common in all agro-ecological zones, it is more prevalent in semi-arid regions, reported by 78 percent of the households (x^2 P-value<0.001). Further, erratic rains and frost are prevalent in the high potential zones (x^2 P-value<0.05). Flood is prevalent in medium potential zones (6%) and semi-arid zones (7%) regions, while hailstorms shocks are purely prevalent in the medium potential zones (38%) (See Table 2A-3 in the Appendix). Market shocks are more prevalent in the medium potential zone, while crop pest and crop loss after harvest are more dominant in semi-arid regions (x^2 P-value<0.05). Criminal shocks are mostly widespread in medium potential areas. Further, illness and death occurrences are highly prevailing in medium potential zone (x^2 P-value<0.001) because of a higher disease burden, particularly HIV-AIDS and malaria. Social and political shocks were found to be prevalent in the semi-arid areas (Njoro

[20]*De jure* female-headed households comprise women who are widowed, divorced or who are never married, while *de facto* female-headed households include women who are married but whose spouses are currently migrated.

district) attributed to different ethnic groupings, and the region was worse hit by 2007/08 post-election violence.[21]

2.4.2 Strategies adopted by households in order to cope with shocks: The role of assets in ex-post household coping strategies

In occurrence of shocks, households in rural Kenya embrace several coping strategies to smooth their level of consumption and protect their assets. Figure 2.1 presents the percentage of households that reported embracing the strategies to cope with shocks in 2009 and 2012. The findings show that 19 percent of the affected households did not embrace any strategy to cope with shocks, with 21 percent for 2009 and 17 percent for 2012.Households not embracing any coping strategy 'did nothing' against health shocks could imply a forgone health care that could have possible long-term effects on human capital development.

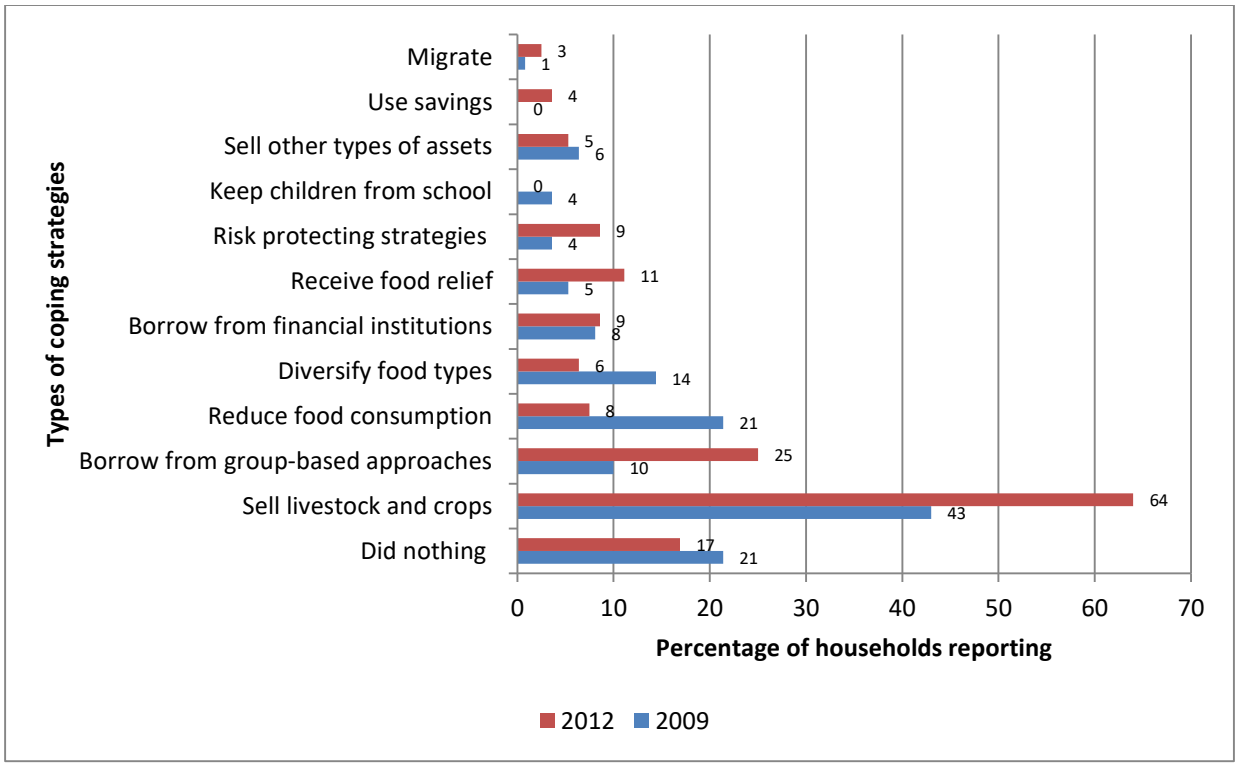

Figure 2.1: Households' ex-post coping strategies in 2009 and 2012 (percentage of households reporting)

Source: Authors' computations centered on the survey data.

Sale of asset including sale of livestock portfolios (cattle, goat, sheep, and poultry) and sale of crop stock was the principal consumption smoothing strategy reported by 43 percent and 63

[21]Multivariate probit models on the drivers of shock exposure show that geographical locations, household headship, and wealth indicators influence vulnerability to shocks. Elderly-headed households and those having kids <15 years of age face increase likelihood of death and illness of family member, respectively.

percent of the households in 2009 and 2012, respectively. Overall, 40 percent of households sold livestock as a coping strategy. Households also disposed of other assets, including land (1%), trees and consumer durable assets (5%) and they used up their savings (2%). In sum, 49 percent in 2009 and 73 percent in 2012 of the affected households adopted risky strategies of disposing of assets to smooth their consumption level. Besides, there is a gender disparity in coping strategy, where 42 percent of male-headed households sold livestock as compared to 31 percent of female-headed households (x^2 P-value<0.10).

The second prime strategy followed by households was borrowing money through group-based approaches, including borrowing from social groups (12% in 2009 and 26% in 2012). Only 8 percent of the households borrowed money from formal financial institutions. The findings also show that 10 percent of households affected by shocks in 2009 borrowed from social groups, as compared to 25 percent in 2012. This finding indicates that group-based approaches are increasingly becoming an essential coping strategy as well as a vital pathway to foster resilience against shocks.

Further, 27 percent of female-headed households borrowed through group-based approaches (social groups) to augment food supply and smooth their level of consumption, as compared to only 16 percent of households headed by men (x^2 P-value<0.010). In sum, descriptive analyses show that group-based approaches are particularly crucial in coping with idiosyncratic shocks such as death (35%) and illness (33%), market shock (23%), as well as covariant shocks such as drought (17%) and erratic rainfall (10%). These findings therefore suggest that with poor coverage of formal health insurance and universal health program and inability to access formal credit in rural Kenya, poor households either forgo health care or rely on informal health insurance instruments such as welfare- and health-oriented group-based approaches.

Findings further show that affected households also sacrifice their food consumption (21% in 2009 and 8% in 2012). This suggests a welfare loss, besides diversifying food intake and reliance on food relief.[22] The study noted with great concern that a higher proportion of female headed-households (20%) reduced their level of food consumption due to incidence of shocks, as compared to 13 percent that of the male-headed households (x^2 P-value<0.10). The findings also show that a very low percentage of affected households embraced risk-protection strategies of acquiring new assets and capabilities including gaining new skills (2%), engaging in income generating activities (2%), acquiring livestock assets (1%), and planting trees (1%).

[22] Food relief is a short-term consumption smoothing mechanism provided by relief agencies, such as governments, non-governmental organizations (NGOs) or religious organizations in the incidences of covariant shocks (e.g., droughts, floods and conflicts).

2.4.3. Poverty dynamics in rural Kenya

Headcount poverty analysis shows that 29 percent of the households and 62 percent of the adult equivalent are living below the poverty line. Cross-tabulations and chi-square analyses indicate that *de facto* female-headed households experience highest incidence of household and adult equivalent headcount poverty at 40 percent and 73 percent, respectively. Contrarily, 26 percent of male- and *de jure* -headed households live below the poverty line and respective adult equivalent at 61 percent and 53 percent (x^2 P-value<0.10), respectively (Figure 2.2). The findings also show that adult equivalent poverty differs across geographical regions where sub-humid regions experience the highest incidence of poverty at 74 percent as compared to 45 and 66 percent for humid and semi-arid regions, respectively in 2009 and 2012 (x^2 P-value<0.001). However, there is a significant decline in adult equivalent poverty levels between 2009 and 2012 by 28 points, 11 points, and 32 points for semi-arid, sub-humid, and humid regions, respectively (See Table 2A-5 in the Appendix).

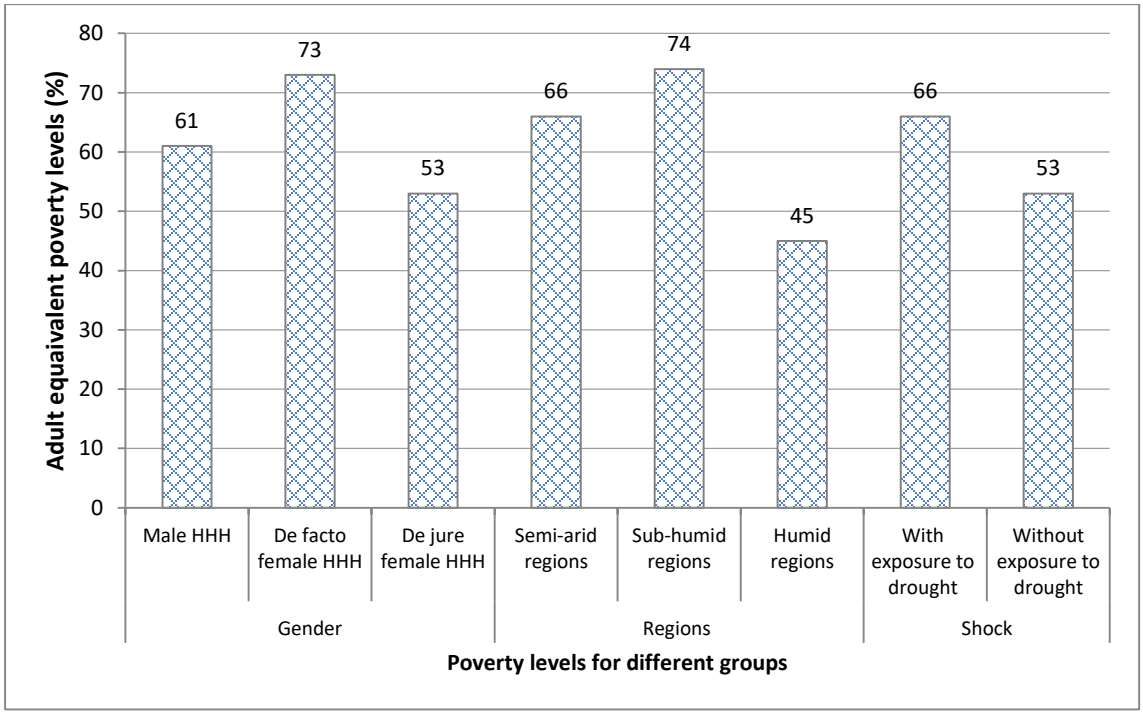

Figure 2.2: Adult equivalent poverty levels for different groups (percentage)
Source: Authors' computations centered on the survey data

The poverty transitions indicate that 17 percent of poor adults escaped poverty while 4 percent of adults fell into poverty. Indeed, there is a decline in poverty levels between 2009 and 2012, however, poverty worsen during the incidences of shock (See Table 2A-5in the Appendix). For instance, the head count index for the adult equivalent exposed to drought implies that 66 percent of them are living below the poverty line, compared to only 53 percent of adult equivalent experiencing poverty when not exposed to the impacts of drought in 2009 and 2012.

2.5 Econometric Results

This section presents the empirical strategy for addressing the study's objectives. The section elaborates the panel Probit and multivariate panel Probit models for estimating probabilities of undertaking coping strategies against shocks. The section also draws attention to panel estimation procedures and explains why a household fixed effects model that controls for unobserved heterogeneity was appropriate for examining the impact of shocks on different types of household's assets. Further, this section elaborates how poverty dynamics were examined using income measures. This section further presents the impact of shocks on household and adult equivalent poverty. Lastly, the section presents the empirical findings.

2.5.1 Empirical strategy

2.5.1.1 Estimating probabilities of undertaking coping strategies

As shown by the description analysis in Section 2.4.2, households embrace several coping strategies based on various factors. This section elaborates the empirical strategy for examining factors that influence the decision to embrace a strategy or a decision to take up several combinations of strategies to cope with shocks facing households.

The probability of the decision to cope or not to cope with shocks relies on the random utility model. Households decide to cope with a shock when the utility of coping is higher than the utility of not coping with incident of shock. Households therefore make an effective decision on available and appropriate strategies to cope with a shock depending on utilities they get from adopting each choice/strategy and depending on their endowments.

First, households decide to cope or not to cope with shocks. Hence, if households decide to adopt a strategy, a panel Probit model that allows for random effects is appropriate to estimate probabilities on observed binary decision on coping strategy as follows

$$C_{it} = \begin{cases} 1(any\ coping\ strategy), & if\ \ {C^*}_{it} = X_{it}\beta + S_{it}\beta + \varepsilon_{it} > 0 \\ 0\ (do\ nothing), & if\ \ {C^*}_{it} \leq 0 \end{cases} \quad (2)$$

Where ${C^*}_{it}$ is a latent decision variable that takes a value of 1 if the affected households made the decision to cope and 0 if no strategy was undertaken. X_{it} is a vector of observed predictor variables that determine the probabilities of undertaking coping strategy. These observed predictors include household characteristics, geographical location, endowment or wealth indicators, and institutional factors (access to extension services and being a member to a social group or group-based approaches). While S_{it} is the vector of self-reported shocks affecting households, β_i presents the vector of coefficients to be estimated for taking up a coping strategy against shocks and ε_{it} is the error term.

Second, households are probable to embrace several coping strategies in a combination of measures. The descriptive findings show that households embraced for one up to six coping strategies to cope with shocks (see Table 2A-6 in the Appendix). These strategies are binary outcomes collected overtime on same households and hence are likely to be correlated. Hence, a univariate standard approach such as panel Probit or panel Logit model that ignores correlation of binary outcomes overtime could result into inefficient parameters, especially when correlation is large (Czado 2000; Cappellari & Jenkins 2003, 2006). This loss of efficiency in estimation process might result in overestimating the parameters and covariate effects. Therefore, an estimation approach that addresses correlation across J-binary coping strategies and across unobservable variables overtime is required.

The multivariate panel Probit model addresses this problem by allowing for correlation structure of binary outcomes overtime (Cappellari & Jenkins 2003, 2006). The study therefore estimated a multivariate panel Probit model by employing the maximum simulated likelihood that delivers good estimates of the underlying model (Cappellari & Jenkins, 2006). The multivariate panel probit model involved the simultaneous estimation of panel Probit models of J^{th} coping strategies adopted in a combination of available measures.

The multivariate panel probit model for the coping strategy i and panel probit equation J at time t, is specified as follows

$$CS^*_{jt} = X^*_{jt}\beta_j + S_{jt}\beta_j + \varepsilon_{jt} \quad t = 1,..,T \text{ and } j = 1,..,J \qquad (3)$$
$$CS_{jt} = 1 \quad \text{if} \quad cs^*_{jt} > 0, \quad 0 \text{ otherwise}$$

Where CS_{jt} presents the outcome for J^{th} coping strategies at time t. The choice of coping strategy depends on same vector of X_{it} and S_{it} as applied in estimating univariate panel probit model. β_j presents the vector of coefficients to be estimated for the J^{th} coping strategy. While ε_{jt} is the error term assumed to be multivariate normally distributed and having unobserved fixed effects α_j (Cappellari & Jenkins 2003, 2006).[23] The multivariate panel probit analysis considered $J = 6$ strategies reported by at least eight percent of the households. These strategies include selling stock (livestock and crop stock), asset disposal strategy (land, use of savings and consumer durables), borrowing from formal financial institutions, borrowing from group-based approaches, food security strategy (relying on food relief, diversifying food intake, and purchasing food) and asset protecting strategy.

2.5.1.2 Estimating the impact of shocks on household assets

[23]The error term has zero mean and variance-covariance matrix σ, where σ on the leading diagonal has a value of 1 and correlation of off-diagonal elements such that $p_{ij} = p_{ji}$, which imply that $p_{ii} = 1$ for entire $i = 1,..,j$.

The natural starting point for examining the impact of shocks on household assets involves estimating the naïve ordinary least squares (OLS) as follows

$$A_{it} = \boldsymbol{X}_{it}\beta + \boldsymbol{S}_{it}\beta + \alpha_i T + \varepsilon_{it} \qquad (4)$$

where A_{it} presents asset or asset indices for household i at time t, and $\boldsymbol{X}_{it}\beta$ is a vector of the predictor variables, including household characteristics, socioeconomic and institutional factors. $\boldsymbol{S}_{it}\beta$ is a vector parameter of self-reported covariant shocks, idiosyncratic shocks and positive shocks that are likely to influence household asset. Assets not affected by shocks suggest that these kinds of assets can withstand adverse effects of shocks and households can adjust their livelihood options thus build livelihood resilience to shocks. $\alpha_i T$ is a time dummy variable and ε_{it} presents both time variant and invariant unobservable errors. However, in panel data analysis, there is probable existence of unobserved factors that could affect the dependent variable (welfare outcomes) and independent variables (multiple shocks). As the naïve OLS estimation procedure ignores heterogeneity across households and village characteristics, it would result in inconsistent and biased estimates.

Alternatively, a random or fixed effects model is appropriate. To select between these two models, the study applied the Hausman test for exogeneity of the unobserved household fixed effects (within) and random effects (between) model. The Hausman test favored the 'within' fixed effects model, which accounts for all time-invariant differences between households and ensure that the estimated coefficients are consistent.

A structural model of the fixed effects is specified as follows

$$A_{it} = \boldsymbol{X}_{it}\beta + \boldsymbol{S}_{it}\beta + \alpha_i T + \lambda_t + \varepsilon_{it} \qquad (5)$$

Whereas the variables are as explained above, this model captures household fixed effects. The λ_i captures fixed effects variables such as village location and household fixed effects. Household fixed effects control for unobserved heterogeneity across households, while village fixed effects control for the average situation of covariant shocks affecting households in a particular village. The study compared the econometric results for both pooled OLS and fixed effect models. The study estimated binary conditional Logit fixed effects for credit and social capital that are in a binary format to assess how shocks are likely to affect them. This model requires no assumptions for correlation between unobserved heterogeneity and covariates (Je M Wooldridge, 2010). The Wald test for the joint impact of multiple shocks on welfare outcomes examined whether covariant and idiosyncratic shocks jointly affect household asset portfolios. The correlation matrix of the predictor variables ascertained whether their coefficients were correlated.[24]

[24]STATA has the option to drop collinear variables during analysis.

2.5.1.3 Estimating the impact of shocks on the household poverty

The study examined how the occurrence of multiple shocks influences household and adult equivalent poverty transitions. To examine poverty levels the study applied income measure of Foster-Greer-Thorbecke (FGT) class of poverty indices namely the headcount, the poverty gap and squared poverty gap (Foster, Greer, & Thorbecke, 1984).[25] The head count presents the percentage of households who live beneath the poverty line. The study defined poverty line to be the households or adult equivalent earning below 1.25 dollars a day.[26]

The next step involved estimating the impact of shocks on household and adult equivalent poverty. Evidence indicates that various econometric and non-parametric approaches have been applied to evaluate the poverty status and its determinants. The Probit, logit and multinomial or ordered logit model have been widely applied to estimate determinants of head-count poverty and poverty transitions (see McCulloch & Baulch 1999; Sikander & Ahmed 2008; Thapa et al. 2014; Mberu et al. 2014). Other approaches include Average Treatment on the Treated (ATT) that begin with counterfactual where households have a welfare outcome with and without treatment — 'with shock incidence' (treated group) and 'without shock incidence' (control group) (see exception of Bui et al. 2014for Vietnam). The ATT procedure requires randomization of the treatment group, which is often infeasible particularly for natural disasters and multi-geographical data like in case of this study, although shocks are anticipated to be 'random.'

This study therefore chose a binary model of the conditional Logit fixed effects, where 1 represents households (or adult equivalent) living below the poverty line and 0 represents non-poor households. The study estimated model to examine how incident of shocks are likely to influence individuals to ascend (or remain in) from poverty, where 1 represents households/individuals who are poor and 0 represents households/individuals that have moved out of poverty. This model controls for unobserved heterogeneity (Je M Wooldridge, 2010).

2.5.2 Econometric findings

2.5.2.1 Drivers for undertaking coping strategies

First column of Table 2.5 presents findings of the panel Probit model of the decision to cope i.e. binary variable of one if the affected households made any type of coping strategy as against doing nothing. The findings suggest that households experiencing erratic rains, hailstorms, and death of a family member are less likely to take action against shocks. Besides, household characteristics, especially dependency ratio and land size, influence the likelihood of undertaking

[25]The FGT income measure of poverty is defined as $HP_{\propto} = \frac{1}{n}\sum_{i=1}^{q}\left[\frac{z-W_i}{z}\right]^{\propto}$ where W_i designates a welfare indicator (income or expenditure) for household i, z denote the poverty line[25], n presents the total households in the sample, q presents the proportion of total poor households, while $\propto$ is a measure of inequality.

[26]The global poverty line was updated since 2015 to 1.90 dollars a day to cater for inflation and high cost of living across the world.

a coping strategy in the face of multiple shocks. Column two to seven presents results of the multivariate panel probit analysis.

Table 2.5: Panel Probit and multivariate panel Probit model results on probabilities of undertaking coping strategies

Variables	**Panel Probit Model**	**Multivariate panel Probit model**					
	Decision to cope	Sell livestock and crop	Asset disposal strategy	Borrow from financial institutions	Borrow from GBA	Food security strategy	Risk protection strategy
Drought	0.078	0.119*	-0.206	-0.078	0.078	0.843***	-0.229
	(0.157)	(0.129)	(0.181)	(0.198)	(0.153)	(0.172)	(0.203)
Erratic rains	-0.353**	0.271**	-0.028	-0.137	0.068	0.624***	0.098
	(0.145)	(0.118)	(0.165)	(0.184)	(0.141)	(0.160)	(0.196)
Hailstorms	-0.941***	0.140	0.492*	0.077	0.113	0.526*	0.637*
	(0.210)	(0.165)	(0.208)	(0.293)	(0.188)	(0.269)	(0.243)
Market shocks	-0.191	0.178	0.598**	0.604***	0.536**	0.208*	-0.030
	(0.169)	(0.129)	(0.184)	(0.177)	(0.160)	(0.137)	(0.209)
Crop pest	0.318**	0.411**	0.170	0.481**	0.269*	0.252	0.013
	(0.163)	(0.121)	(0.169)	(0.185)	(0.1454)	(0.129)	(0.215)
Livestock health	-0.015	-0.019	-0.183	0.187	0.316*	0.012	0.582***
	(0.181)	(0.144)	(0.212)	(0.225)	(0.179)	(0.151)	(0.191)
Crime	-0.029	0.191	-0.149	0.513*	-0.041	0.048	0.496*
	(0.198)	(0.159)	(0.237)	(0.250)	(0.190)	(0.174)	(0.215)
Death	-0.422**	0.191	0.212	0.531**	0.703***	-0.067	0.021
	(0.174)	(0.149)	(0.207)	(0.220)	(0.183)	(0.160)	(0.243)
Illness	-0.240	0.404***	0.429**	0.536**	0.676***	0.312*	-0.052
	(0.168)	(0.126)	(0.189)	(0.186)	(0.153)	(0.171)	(0.214)
Remittance	0.050	0.168	0.014	-0.223	0.299**	-0.016	-0.044
	(0.135)	(0.106)	(0.152)	(0.169)	(0.127)	(0.114)	(0.179)
Age	0.002	0.000	-0.021*	-0.007	-0.002	0.017*	-0.006
	(0.007)	(0.005)	(0.008)	(0.009)	(0.007)	(0.008)	(0.009)
Household size	-0.063	0.017	0.031	-0.070	-0.068*	0.033	0.040
	(0.045)	(0.036)	(0.050)	(0.057)	(0.042)	(0.042)	(0.058)
Dependency ratio	0.120**	0.012	0.015	-0.232*	-0.021	-0.009	0.089*
	(0.073)	(0.059)	(0.088)	(0.112)	(0.070)	(0.065)	(0.092)
Farming experience	-0.008	0.001	0.015*	0.009	0.011*	0.001	-0.006
	(0.006)	(0.005)	(0.008)	(0.008)	(0.006)	(0.005)	(0.009)
Land size in acres	0.186***	-0.180***	0.060	-0.023	-0.202	-0.180***	-0.031
	(0.064)	(0.050)	(0.071)	(0.074)	(0.060)	(0.052)	(0.086)
Livestock TLU	0.008	0.001	0.004	0.018	0.006**	0.013	0.012
	(0.014)	(0.011)	(0.016)	(0.017)	(0.012)	(0.013)	(0.016)
Member to a social group	0.478***	-0.095	-0.086	0.108	0.343*	0.290**	0.107
	(0.157)	(0.138)	(0.198)	(0.223)	(0.187)	(0.144)	(0.238)
Extension service	0.230*	-0.011	0.163	0.075	0.143*	-0.338**	0.226*
	(0.150)	(0.116)	(0.168)	(0.191)	(0.145)	(0.126)	(0.208)
Safety nets	0.451	-0.341	0.408	0.150	0.514	-0.076	0.357
	(0.441)	(0.355)	(0.437)	(0.611)	(0.394)	(0.364)	(0.519)
2nd quintile	0.063	0.102	-0.141	-0.113	0.370*	-0.086	-0.109
	(0.191)	(0.157)	(0.219)	(0.283)	(0.190)	(0.166)	(0.278)
3rd quintile	-0.265	0.257*	-0.127	0.045	0.254	0.141	-0.011
	(0.205)	(0.158)	(0.214)	(0.252)	(0.193)	(0.167)	(0.271)
4th quintile	-0.109	0.212	-0.335	0.204	0.176	0.111*	-0.073
	(0.202)	(0.161)	(0.232)	(0.249)	(0.200)	(0.171)	(0.268)
Richest quintile	0.145	0.094*	-0.219	0.096	0.034	0.117	0.065
	(0.200)	(0.164)	(0.229)	(0.255)	(0.209)	(0.172)	(0.271)
Sub-humid regions	0.401*	-0.083	-0.399*	-0.999***	0.230	0.777***	-0.127
	(0.225)	(0.159)	(0.247)	(0.261)	(0.188)	(0.202)	(0.253)
Semi-arid regions	0.082	0.290**	0.079	-0.666***	0.297*	0.362*	-0.417*
	(0.190)	(0.140)	(0.198)	(0.210)	(0.174)	(0.174)	(0.262)
Household size (bar)	0.087*	0.038	-0.020	0.069	0.074	0.043	-0.066*
	(0.053)	(0.043)	(0.062)	(0.068)	(0.049)	(0.049)	(0.072)
Constant	-0.451	-0.732*	-0.706	-1.214*	-2.291***	-1.018***	-1.262*
	(0.462)	(0.370)	(0.525)	(0.599)	(0.463)	(0.497)	(0.612)
N	720	582	582	582	582	582	582

Notes: The figures in the parentheses and beneath all coefficients are robust standard errors. *** (P<0.01), ** (P<0.05) and *(P<0.10). The Likelihood ratio X^2 (15) = 31.27, P >X^2 = 0.008. The Wald test, X^2(156) = 3626.05, P >X^2 = 0.0000, for multivariate panel Probit model. Wald test significant at the 1% level suggest that explanatory variables significantly expound the variations of response variables in multivariate panel Probit. The poorest quintile was used as a base variable for income quintiles. Humid region was used as a base variable for agro-ecological regions. Mundlak-Chamberlain approach estimated the random model by including the time-average of household size to control for unobserved effects and correlation of the underlying predictors.

Source: Authors' computations centered on the survey data.

The findings indicate that the types of shocks affecting households, not only influence coping strategies, but also the probability of the households selecting numerous strategies to cope with shocks. The findings indicate that households that experience drought, erratic rainfall, hailstorms, crop pest, market shocks, and illness of a family member have a higher probability of adopting asset disposal strategy.

This strategy include sale of livestock and crop stock, using savings and disposing of other types of assets such as land to counter shocks. Reduced purchasing power resulting from market shocks trigger borrowing of credit from formal financial institutions and social groups as well as borrowing from other forms of group-based approaches. Receiving remittances, (positive shock) significantly increase the likelihood of borrowing from group-based approaches because of the enhanced capacity to repay back credit. The findings also show that incidences of drought, erratic rains, hailstorms, and market shocks is more likely to influence households to embrace food security strategy (relying on food relief, diversifying food intake, and purchasing food) to smooth consumption levels. In addition, incidences of hailstorms, animal diseases and crime is likely to influence households in adopting risk protecting strategies such as acquiring new skills, restocking or replacing the asset that was lost or damaged in time of shocks.

Households in the fourth and richest quintiles are more probable to sell livestock and crop stock to smooth their level of consumption and are more likely to adopt food security strategies as compared to poor households. These findings suggest that rich households than poor households are more likely to access food aid, which implies poor targeting of food aid programs and possible influence of elite capture. Findings also indicate that elderly-household heads are more likely to adopt food security strategies, especially depending on food relief to cope with food shortage.

On the contrary, households in lower quintiles have a higher probability of depending on group-based approaches to smooth their consumption because they typically have limited capacity to borrow credit from financial institutions. Besides, households where at least one member belongs to a social group, as could be expected are more likely to borrow from group-based approaches, with 5 percent significant level. The findings also show that membership to social groups is more likely to enhance food security strategy, since household could increase their borrowing power or exchange ideas on how to diversify food intake or through non-reciprocal altruistic through sharing available food amongst the members. These findings suggest that group-based

approaches is vital in building coping resilience, enabling ability to borrow and achieving levels of food security in occurrence of shocks especially for rural poor households. Cross-tabulations and chi-X^2 analyses support our econometric analysis that asset- and income-rich households dispose of assets especially livestock and crop stock, diversify food intake to smooth their level of consumption as well as migrate to urban or other productive areas to search for a livelihood as coping strategy against shocks. In contrast, asset- and income-poor households protect their assets by sacrificing their food intake and keeping their children from schools.

The results further show that geographical locations are likely to influence coping strategies. Affected households in semi-arid regions are more likely to dispose of their livestock and crop stock and other categories of assets such as de-saving to cope with shocks, as compared to households in humid regions. However, households in semi-arid and sub-humid regions have a lower probability to borrow from financial institutions because of their high poverty levels as shown in Section 2.4.3, while households in semi-arid regions are more likely to borrow through group-based approaches, as compared to households in humid regions. Households in sub-humid regions are more likely to adopt food security strategies especially diversifying food intake.

2.5.2.2 Impact of shocks on livestock portfolios

Table 2.6presents the household fixed effects estimation results on the impacts of shocks on poultry, small livestock, cattle, draft livestock and total livestock holdings. The findings indicate that drought negatively and statistically significantly affects poultry, cattle, and overall livestock holdings over time, even though the significance level and units of loss differ across livestock portfolios. Households experiencing drought are more likely to reduce cattle by 0.96 units, poultry by 0.13 units and 1.42 units of total livestock holdings, across time. Erratic rains have a statistically significant effect on disposal of poultry, since different kinds of poultry provide benefits such as a quick source of proteins and are easily convertible into cash to smooth consumption levels during extreme events. Wald tests indicate that drought, erratic rains, and hailstorms jointly affect all livestock portfolios, apart from small ruminant and non-ruminant livestock.

Market risks significantly reduce poultry, cattle portfolio, and total livestock portfolios, while socio-political shocks reduce households' draft livestock portfolio. Negative impacts of shocks on draft livestock could have labor implications, subsequent lower agricultural productivity, and loss of income in rural areas. Illness of family members significantly decreases poultry and draft animals in the household. Poultry does not face indivisibility problems; hence, families could easily sell poultry to raise money for treatment and health care. Wald tests indicate that idiosyncratic shocks jointly affect cattle, but do not jointly affect overall livestock portfolios over time. Nevertheless, joint covariant and idiosyncratic shocks jointly affect all livestock portfolios with the exceptions of small ruminant and non-ruminant livestock.

Table 2.6: Fixed effects regression results on the impact of shocks on livestock assets

Variables	Poultry	Small livestock	Cattle	Draft livestock	Total livestock portfolio
Drought	-0.132**	-0.081	-0.957**	-0.246	-1.416**
	(0.042)	(0.111)	(0.349)	(0.235)	(0.534)
Erratic rain	-0.128***	-0.106	-0.087	0.088	-0.233
	(0.034)	(0.178)	(0.261)	(0.219)	(0.465)
Hailstorm	-0.067	-0.229	-0.129	-0.450	-0.876
	(0.048)	(0.172)	(0.488)	(0.359)	(0.836)
Market shock	-0.085*	-0.288*	-0.531*	0.104	-0.800*
	(0.044)	(0.140)	(0.245)	(0.246)	(0.452)
Illness	-0.070*	0.033	0.177	-0.400*	-0.260
	(0.039)	(0.074)	(0.301)	(0.221)	(0.431)
Death	0.001	0.167	0.048	0.183	0.399
	(0.061)	(0.176)	(0.411)	(0.241)	(0.650)
Crop pest	0.033	-0.031	-0.291	-0.147	-0.436
	(0.052)	(0.138)	(0.269)	(0.217)	(0.468)
Livestock diseases	-0.042	0.366	-0.055	0.044	0.313
	(0.050)	(0.489)	(0.293)	(0.254)	(0.637)
Socio-political shock	-0.149	-0.099	0.087	-0.354*	-0.515
	(0.124)	(0.189)	(0.515)	(0.213)	(0.563)
Crime shock	0.213*	0.490	0.219	-0.075	0.848
	(0.118)	(0.629)	(0.323)	(0.305)	(0.807)
Remittance	-0.019	0.160	0.236	0.023	0.402
	(0.047)	(0.130)	(0.231)	(0.138)	(0.391)
Primary education	-0.005	-0.096	0.145	0.304	0.348
	(0.073)	(0.265)	(0.496)	(0.291)	(0.862)
Age	0.005	0.015*	0.030	0.003	0.054
	(0.004)	(0.009)	(0.027)	(0.019)	(0.048)
Land size	0.035	-0.036	0.297*	0.101	0.397*
	(0.025)	(0.077)	(0.143)	(0.077)	(0.193)
Household size	0.018*	0.023	0.102	0.106	0.250
	(0.009)	(0.0329	(0.092)	(0.070)	(0.178)
Dependency ratio	0.038	-0.056	0.099	0.097	0.179
	(0.025)	(0.080)	(0.183)	(0.186)	(0.372)
Extension service	0.087*	-0.040	0.612*	0.240	0.899*
	(0.041)	(0.100)	(0.241)	(0.184)	(0.369)
Safety nets	0.195*	-0.120	-1.228*	0.019	-1.134*
	(0.093)	(0.255)	(0.513)	(0.251)	(0.663)
Constant	0.107	0.163	0.858	-0.560	0.568
	(0.193)	(0.455)	(1.359)	(1.032)	(2.497)
Household Fixed Effects	Yes	Yes	Yes	Yes	Yes
Village Fixed Effects	Yes	Yes	Yes	Yes	Yes
R-squared (within)	0.073	0.026	0.058	0.043	0.064
F- statistic (19)	2.69***	1.11	2.33**	1.68*	1.86*
Wald test -climatic shocks (3)	6.94***	0.66	3.41*	1.69*	2.67*
Wald test-idiosyncratic (6)	1.28	0.62	.54*	0.82	0.75
Wald test-total shock (9)	3.57***	0.78	1.84*	2.32*	2.04*
N	720	720	720	720	720

Notes: The figures in the parentheses and beneath all coefficients are robust standard errors. *** (P<0.01), ** (P<0.05) and *(P<0.10). Regression included village and time fixed effects. Age squared is included in the model. Estimation considered shocks reported by at least 7% of the households.

Source: Authors' computations centered on the survey data.

Functioning rural institutions, land size, and safety nets significantly increase ownership of poultry over time. Households with access to livestock extension services significantly increase their poultry, cattle, and overall livestock holding. A large household size is likely to increase poultry over time. Households with access to safety net programs, such as food aid, 'food for work' and 'food for assets' programs, are also more likely to increase poultry. However, access to safety net programs is unlikely to protect cattle and overall livestock holdings. Pooled OLS regression results present almost similar findings with that of household fixed effects, apart from higher standard errors. The unique difference in the OLS results is that hailstorms significantly reduce small livestock, while incident of crop pests are more likely to reduce cattle portfolios, while households that had received remittances are likely to increase total livestock holdings.

2.5.2.3 Impact of shocks on household physical, financial assets and group-based approaches

Table 2.7 presents household fixed effects estimation results on the impact of shocks on household consumer durables, agricultural durables, land values, observed income, predicted income, credit and social capital, presented in the subsequent columns. Drought and erratic rains significantly decrease both observed and predicted income because weather shocks results into decline in agricultural productivity and loss of income. Weather shocks affecting livestock portfolios also imply loss of income and employment in rural areas. Likewise, experiencing drought reduces consumer durable assets and households' social capital and participation in group-based approaches. Households experiencing socio-political shocks are likely to reduce their sources of income or lose some or all of its consumer durable assets.

Socio-political shocks –social discrimination or ethnic disputes– could force households to withdraw from associating with other people in communities, thus weakening their social capital and consequently participation in group-based approaches. Incidences of crop pest and illness are likely to trigger borrowing of credit. These results are supported by descriptive analyses that show that 35 percent of the households with ill household members borrowed money through group-based approaches as compared to only 12 percent who borrowed credit through financial institutions. Land is the most important productive asset for rural households. Surprisingly, drought, and market shocks are likely to appreciate the value of land. We could expect depreciating land values due to an extreme weather event; however, there are other underlying factors driving land demand and prices in Kenya. These factors include speculative behaviors, infrastructure development, and decentralization of services to county government and rising of the 'middle-income class'. Further, only five households (0.69%) reported having sold land to cope with shocks, which may explain the unexpected effects of shocks on land.

Table 2.7: Fixed effects regression results on the impact of shocks on households' physical assets, land, financial and group-based approaches

	Household fixed effects model					Conditional Logit fixed effects model	
Variables	Consumer durables	Agricultural durables	Value of land	Observed income	Predicted Income	Credit	Group-based approaches
Drought	-0.025*	-0.009	0.333**	-0.424**	-0.136**	-0.246	-0.637*
	(0.012)	(0.013)	(0.115)	(0.138)	(0.045)	(0.236)	(0.338)
Erratic rainfalls	-0.022*	0.006	0.163	-0.057	-0.101*	-0.091	-0.270
	(0.013)	(0.012)	(0.104)	(0.115)	(0.041)	(0.217)	(0.300)
Hailstorm	0.001	-0.001	-0.247	0.135	-0.029	0.152	0.025
	(0.020)	(0.018)	(0.198)	(0.172)	(0.060)	(0.305)	(0.423)
Market shock	0.012	0.008	0.279*	-0.149	0.003	0.150	-0.154
	(0.016)	(0.011)	(0.112)	(0.130)	(0.049)	(0.234)	(0.314)
Illness	-0.016	-0.002	0.038	-0.042	-0.026	0.484*	0.395
	(0.014)	(0.013)	(0.126)	(0.140)	(0.044)	(0.236)	(0.318)
Death	-0.003	0.012	-0.139	-0.156	-0.010	0.061	-0.237
	(0.015)	(0.014)	(0.151)	(0.139)	(0.049)	(0.274)	(0.367)
Crop pest	0.018*	0.008	-0.072	0.343*	0.050	0.590*	0.308
	(0.011)	(0.009)	(0.113)	(0.137)	(0.033)	(0.235)	(0.338)
Livestock diseases	0.001	-0.003	0.071	-0.185	-0.015	0.077	-0.530*
	(0.015)	(0.012)	(0.121)	(0.162)	(0.050)	(0.256)	(0.336)
Socio-political shock	-0.024*	0.008	0.190	-0.395*	-0.110	-0.387	-0.690*
	(0.018)	(0.016)	(0.135)	(0.226)	(0.073)	(0.431)	(0.467)
Crime shock	0.023	-0.004	0.200	0.142	0.056	0.278	-0.624*
	(0.019)	(0.020)	(0.156)	(0.163)	(0.056)	(0.284)	(0.371)
Remittance	0.004	0.014*	-0.365**	0.060	0.016	0.191	0.831**
	(0.011)	(0.008)	(0.084)	(0.128)	(0.031)	(0.196)	(0.298)
Primary education	0.022	0.019	0.386*	0.460*	0.391***	0.553	0.160
	(0.019)	(0.017)	(0.196)	(0.209)	(0.063)	(0.339)	(0.414)
Age	0.002*	0.001	-0.002	0.010	0.012**	-0.042	0.032
	(0.001)	(0.001)	(0.009)	(0.011)	(0.003)	(0.021)	(0.028)
Land size	0.002	0.017**		-0.037	-0.126***	-0.173	-0.039
	(0.006)	(0.006)		(0.069)	(0.017)	(0.097)	(0.137)
Household size	-0.004*	0.000	0.017	0.061*	0.028**	0.106	0.049
	(0.002)	(0.002)	(0.020)	(0.023)	(0.009)	(0.040)	(0.058)
Dependency ratio	0.000	-0.001	-0.088	-0.17*	0.011	-0.129	-0.044
	(0.007)	(0.005)	(0.063)	(0.071)	(0.022)	(0.111)	(0.151)
Extension service	0.012	0.016*	-0.298**	0.308*	0.113**	0.476	0.850*
	(0.011)	(0.009)	(0.086)	(0.132)	(0.033)	(0.212)	(0.297)
Safety nets	-0.061	0.017	-0.536*	-0.242	0.029	0.933	1.369
	(0.042)	(0.021)	(0.288)	(0.226)	(0.125)	(0.719)	(0.632)
Constant	0.262***	0.482***	12.478***	2.237***	2.212**		
	(0.051)	(0.039)	(0.446)	(0.527)	(0.151)		
Household Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Village Fixed Effects	Yes	Yes	Yes	Yes	Yes		
R-squared	0.044	0.041	13.49	0.094	0.25		
Wald statistic (19)	2.37**	2.70**	3.52*	4.15***	16.61***	46.66***	51.06**
Wald test -climatic (3)	1.89	0.92	3.52*	3.84*	3.91**	1.42	3.62
Wald test-idiosyncratic (6)	1.88*	0.47	0.84	1.99*	1.3	11.87*	12.4
Wald test-total shock (9)	2.28*	0.65	1.89*	2.53*	2.51*	13.58	13.84
N	720	720	720	720	720	720	720

Notes: The figures in the parentheses and beneath all coefficients are robust standard errors. *** (P<0.01), ** (P<0.05) and *(P<0.10). Age squared is included in the models. Value of land is presented in monetary figures. The models estimation considered shocks reported by at least 7% of the households.

Source: Authors' computations centered on the survey data.

Households that had received remittances are likely to increase agricultural assets than those households that had not received remittances. Households, which had received remittances from their relatives abroad or in cities, increase their ability to acquire credit (as shown in section 2.5.2.1), increase income, and participation in group-based approaches. This finding suggests that remittances could enhance the ability to repay the credit borrowed from social groups and perhaps improve regular contributions in social groups because shocks could have affected any other sources of income and or diverted income for household's expenditures.

Joint significant tests of impact of multiple shocks on assets show that covariate shocks jointly affect observed and predicted income that is a liquid asset. However, idiosyncratic shocks jointly adversely affect consumer durables, observed income, and access to credit. Overall, multiple shocks (covariant and idiosyncratic) jointly affect consumer durables, land values and financial capital. Further, covariate and idiosyncratic do not jointly affect agricultural durable assets because they are not liquid, and are not likely to get quick market in the incidence of economic and weather stress, leaving the household with fewer options for smoothing consumption. Again, only a few farmers reported that they had sold agricultural assets to cope with shocks.

Household's characteristics and institutional factors significantly influence household's asset accumulation. Age as a life-cycle factor is likely to increase consumer durables and financial capital. This finding suggests that elderly-household head could have accumulated physical assets over time. Households with access to extension agents are likely to increase agricultural durable assets, financial and social capital. The findings also show that the size of land and its property rights are likely to increase investment in agricultural assets.

Pooled OLS regression results indicate that drought does not significantly affect consumer durable assets while illness and death of a family member are likely to decrease these assets. In addition, households affected by crop pest are more likely to invest in agricultural assets like manual sprayer that facilitate spraying pesticides on infested field. Our econometric results are in line with self-reported effects of shocks on livelihoods and well-being. The findings show that incidences of shock results in a decline in crop yields, hence food insecurity, loss of income and assets and death of livestock (see Table 2A-7in the Appendix).

2.5.2.4 Implications of multiple shocks on headcount poverty and poverty transitions

Households reported to have experienced shocks are likely to remain poor and are incapable to escape from poverty. Since shocks affect major sources of livelihoods and income, particularly livestock, crop yields and other types of productive assets, they have a negative impact on household poverty. As shown in Table 2.8, incidences of drought exacerbate both household and adult equivalent headcount poverty. Households and individuals experiencing erratic rains are more likely to experience a higher rate of poverty because most of the people living in rural areas depend on rain-fed agricultural production. The prevalence of livestock diseases is likely to

worsen household poverty since livestock portfolios are a significant source of livelihood for the households in agrarian economies. Illness and the foregone income when recipient falls ill influence the likelihood of being poor. Households and individuals experiencing crime and socio-political shocks that affect income and loss of assets are likely to experience higher poverty levels than their counter parts. The security, social and political environment at macro and micro level determine economic productivity, and income of individuals, and in turn the rate of poverty. The findings indicate that individuals experiencing drought, erratic rains, and socio-political shocks have a higher probability of not moving out of poverty. Joint significant tests of climatic and idiosyncratic shocks indicate that shocks jointly exacerbate poverty and undermine the efforts of moving out of it.

Table 2.8: The impact of multiple shocks on household and adult equivalent poverty

Variables	Household poverty	Adult equivalent poverty	Remain poor
Drought	1.354***	0.763***	1.819*
	(0.371)	(0.232)	(0.494)
Erratic rainfall	0.188	0.370*	0.834*
	(0.322)	(0.221)	(0.435)
Hailstorm	-0.007	-0.203	-0.507
	(0.507)	(0.323)	(0.669)
Market shock	-0.228	0.292	0.388
	(0.355)	(0.237)	(0.467)
Illness	-0.293	0.467*	0.925
	(0.438)	(0.244)	(0.692)
Death	-0.170	0.330	-0.252
	(0.434)	(0.286)	(0.631)
Crop pest	-0.488	-0.150	0.289
	(0.355)	(0.227)	(0.499)
Livestock diseases	0.722*	0.460*	0.116
	(0.430)	(0.264)	(0.555)
Socio-political shock	0.626	0.647*	2.686*
	(0.568)	(0.393)	(1.210)
Crime shock	1.022*	-0.331	0.781
	(0.561)	(0.298)	(0.723)
Remittance	-0.518*	-0.265	-1.508**
	(0.300)	(0.190)	(0.439)
Household Fixed Effects	Yes	Yes	Yes
LR chi2(11)	41.14***	33.82***	65.82***
Wald test -climatic (3)	16.01**	11.68**	13.85**
Wald test-idiosyncratic (6)	7.97	11.99*	7.28
Wald test-total shock (9)	23.06**	24.54***	19.21*
N	720	720	530

Notes: The figures in the parentheses and beneath all coefficients are robust standard errors. *** (P<0.01), ** (P<0.05) and *(P<0.10). We only present the variables that interest the study.

Source: Authors' computations centered on the survey data.

2.6 Discussion

The study presents an integrated analysis of multiple shocks affecting households and their impacts on livelihood assets (tangible and intangible assets) and derives implications for poverty transitions for rural households in Kenya. Descriptive results indicate that extreme climate events, particularly drought and erratic rainfall, remain major natural threats to agricultural production, food and nutrition security, loss of income and assets and worsened poverty in Kenya. With accelerating climate change, tackling shocks associated with it is increasingly essential. These findings are similar to what other studies have found in Sub-Saharan Africa (SSA) (see Dercon et al. 2005; Béné et al. 2012; Debebe et al. 2013; Shiferaw et al. 2014). However, studies in South East Asia using a multi-shock approach show contrary evidence, namely health shocks are most intense amongst poorest households (see for example Wagstaff & Lindelow (2010) for Laos and Heltberg & Lund (2009) for Pakistan). Similarly, our findings show that health shocks are the major idiosyncratic shocks that contribute to significant loss of person-hours and foregone income. The study by Bonfrer & Gustafsson-Wright (2016) also in rural Kenya, confirmed that health shocks (illness and injury) are major uninsured idiosyncratic shocks that lead to loss of assets and foregone essential health care. Besides, this study presents further insights on the importance of other less prevalent shocks namely market, crime, and socio-political shocks, which result in to loss of assets, income and worsen levels of poverty in rural settings. These shocks have received limited attention in both Kenya and the SSA region.

In spite of an extensive literature on 'vulnerability and shocks' indicating that worse-off households are more vulnerable to shocks, our evidence suggests that rich households in poorer rural communities are likewise susceptible to shocks, and that their large asset possessions increase likelihood of a larger loss as compared to the poorest households. Richer households are more prone to hailstorms, floods and crime shocks and they sell their assets —livestock portfolios and crops to smooth their level of consumption. Contrary, asset-poor households are prone to drought and socio-political shocks that affect their livelihood. Our data also suggests that poor households in humid regions have greater vulnerability to health shocks. Similar to our study, Kabeer (2015) concluded that poor households face exposure to certain types of shocks such as illness and they have lower possibility of recovery from such shocks. Besides, our findings that asset-poor households protect their assets through reducing their consumption level and relies on group-based approaches is with line with 'economic and consumption smoothing' theory. These findings are supported by Bonfrer & Gustafsson-Wright (2016) study that also concluded that rural households in Kenya, embrace coping strategies that may have possible long-term adverse effects, such as using savings and disposing of assets, particularly, livestock to cope with idiosyncratic shocks. To the contrary, the study by Woodson et al. (2016) shows that rich households receive the benefits of social capital such as improved food security more than poor households.

Furthermore, the 'feminization of poverty' theory implies that female-headed households 'women' are more susceptible to shocks because of their limited coping capacity and ability to recover, making them more susceptible to poverty (see Kabeer 2015; Klasen et al. 2015). The evidence indicates that male-headed households are similarly affected by shocks. However, there are gender-specific shocks. The findings indicate that flooding and the death of a spouse have stronger effects on female-headed households. Our findings are supported by Azad et al. (2014) who also concluded that female-headed households are often victims of flooding and experience a higher incidence of shocks because of the existing social inequalities. Likewise, the death of a husband results to loss of assets by the widow, particularly if she does not have property rights or is affected otherwise by existing norms and traditions. Further, there are gender-specific coping strategies, where women draw upon on borrowing through group-based approaches and reducing level of consumption. In contrast, male-headed households dispose of their livestock to cope with shocks. Besides, *de facto* female-headed households experience the highest incidence of poverty, as compared to *de-jure* -and male-headed households.

Besides, our findings show that group-based approaches are essential coping tool for the asset-poor and female-headed households. Borrowing through group-based approaches is crucial for dealing with illness and death of a family member in addition to dealing with market shocks. Multivariate panel probit analysis points out that group-based approaches influence households' decisions to cope with shocks through enhanced ability to borrow and improved food security strategies. These findings suggest that households could enhance their livelihood resilience through increased borrowing facilitated by participating in group-based approaches. These findings are confirmed by Woodson et al. (2016) study that social capital enhance food security in households affected by shocks in Ethiopia, Kenya, Uganda, Niger and Burkina Faso. The recent literature supports our findings that in the absence of consumption loans, costly formal insurance and credit constraints, group-based approaches facilitate informal insurance and micro-credit, which are important short-term consumption smoothing and asset protection strategies (Fafchamps & Lund 2003; Islam & Maitra 2012; Demont 2013). Similarly, Dercon et al. (2012) empirically show that burial societies *('iddir'*) help households to smooth consumption level in the incidence of idiosyncratic shocks —death and illness. Our findings therefore suggest that group-based approaches are likely to help households become resilient against shocks. This finding is in line with studies that have shown that social capital and group-based approaches are valuable post-shock recovery tool that empowers households to rebuild assets (Mawejje & Holden 2014; Woodson et al. 2016), have positive impact on food security (Woodson et al. 2016) and that builds resilience of rural communities or individuals against extreme events (Bernier & Meinzen-Dick 2014; Woodson et al. 2016; IFAD 2016).

The literature review indicates that the impact of covariant and idiosyncratic shocks on group-based approaches 'social capital" has not been sufficiently evaluated and that most studies are based on intuitive arguments in this regards. This present study found that covariant shocks

jointly do not affect group-based approaches. However, an incidence of drought is likely to weaken group-based approaches. Extreme shocks are likely to weaken social cohesion and social networks as individuals involuntary divert their resources especially time and money to meet their own needs. This is in line with the study by Fuente (2008), which demonstrates that covariant shocks worsen poverty status leading to limited time available for people to participate in social relations. To the contrary, the study by Gebremedhin et al. (2010) indicates that in the highlands of Ethiopia, incidence of shocks strengthen association in social networks. Besides, group-based community safety nets were found to face difficulties of low productive capital in communities and households, low levels of income, sustainability problems and they are likely disintegrate due to incidence of extreme events (Bernier & Meinzen-Dick 2014). Woodson et al. (2016) study suggests that in Africa, social capital is useful in the early phases of persistent covariant shock and coping with its negative effects. This suggests that group-based approaches require strengthening during persistent extreme events through social protection programs — public safety nets. Our findings, however, indicate that safety nets are likely to protect household assets, especially poultry, which are easy to dispose of in time of shocks. Recent studies find that social protection programs improve short-term food security and well-being and protect distress sale of assets to cope with shocks (Béné et al., 2012; Berhane et al., 2013), nonetheless households are inclined to sell assets to cope with shocks in the long-run (Little et al. 2004; Andersson, Mekonnen, and Stage 2011). Our findings suggest that households that had received remittances are likely to enhance their coping capacity by increasing their ability to borrow through group-based approaches, smoothing consumption level and accumulating agricultural assets (see also Mohapatra et al. 2009; Beuermann et al. 2014 for more examples).

The study's findings indicate that livestock is the major coping strategy against shocks, particularly for the asset-rich households. Livestock portfolios, particularly poultry and small livestock are easily convertible to cash or quick sources of protein, hence constituting an essential coping strategy. Besides, distress sales of poultry and small livestock can have gender implications in the sense that these are women's assets and are likely to be the first to be disposed of in the time of crisis. This is because female spouses in the household mainly own and have autonomy over income and products from these livestock portfolios. Our data suggest that small ruminant and non-ruminant livestock are resilient against weather shocks. According to Bati (2013) small ruminants (goats and sheep) have a higher tolerance to water, feed scarcity and heat stress than cattle and they also have a higher offspring survival rate in the midst of harsh weather. Therefore, small ruminants are likely to withstand poor quality feeds, hence, enabling households' coping capacity (reactive resilience) and adaptive capacity (proactive resilience). Hence, diversifying livestock production systems could improve livelihood resilience to weather shocks. Besides, the study provides some insights that livestock assets are affected by socio-political and market shocks that have received limited attention in previous studies.

Although we did not have expenditure data, the descriptive analyses show that households reduce food consumption as a coping response. Households reported that shocks worsened food insecurity, reduced agricultural productivity and income that denotes a welfare loss (see Table 2A-7 in the appendix). Multiple shocks adversely affecting productive assets, reducing ability to access credit and shrink participation and capacity of group-based approaches, subsequently decline household sources of livelihood and income. 'Poverty dynamics' theory indicates households experiencing incidence of multiple shocks or in fragile environment are more likely to remain poor. This is because in agrarian economies, rainfall shortage reduces livestock and crop productivity resulting decline in income that upturn rate of poverty. Recent studies show rainfall shocks and natural disasters (Rodriguez-Oreggia et al. 2010; Bui et al. 2014; Iyer & Topalova 2014; Genoni et al. 2015) and health shocks (Kristjanson et al. 2010; Muyanga et al. 2011; Dang 2011; Radeny et al. 2012) aggravate poverty and inequality in developing economies. Other studies argue that rainfall shocks resulting decline in agricultural productivity and income in dry seasons increase violent and property crimes (Iyer & Topalova 2014, for example). This study contributes the insight that socio-political shocks and crime are equally likely to increase the rate of poverty.

2.7 Conclusions and policy implications

This study examined the impact of shocks on rural households' assets by analyzing a unique two-wave panel data set from Kenya. Vulnerability to shocks and coping strategies differ significantly across wealth groups, agro-ecological regions, and household headship. This suggests that policy actions for tackling susceptibility, risk management, and poverty reduction ought to consider the heterogeneity across these groups. Households are likely to dispose of livestock and crop stocks and to adopt food security strategies to cope with extreme events. These findings indicate a need for emergency social protection policies and short-term interventions to protect household assets. Potential strategies include cash transfers, food relief, and policies that strengthen remittances to foster asset protection and consumption smoothing. These strategies are most important for the asset-poor and female-headed households who relinquish their current consumption level to protect their assets.

Climatic shocks are predominant and affect livestock assets through distress sales and through death. This finding points to the need for far-reaching livestock protection policies. Besides, uptake of poultry and small ruminant and non-ruminant livestock and diversifying livestock production systems is a major step towards building livelihood resilience to weather shocks, climate change and boosting households' food and nutritional security. Poultry and small livestock provide major livelihood benefits during shocks and offer alternative sources of livelihood that are essential during the time of crisis. Poultry and small livestock are able to multiply speedily, are easy to restock and have a higher adaptive capacity. Small livestock rearing has also far-reaching implications for women's livelihood diversification and economic empowerment in the midst of accelerating climate change. Furthermore, in semi-arid regions,

there is a vital need for awareness raising and adoption of index-based livestock insurance that is functioning and demonstrating a positive impact on asset protection and consumption smoothing to the beneficiaries in Northern Kenya (see Janzen & Carter 2013). Besides, fodder planting and conservation through fodder banks should be encouraged to ensure a steady supply of quality feeds during dry spells. These climate-smart measures can be promoted through extension services and farmer's field visit.

This study also concludes that group-based approaches are indispensable pathways for asset poor and for female-headed households to protect their assets and improve food security status in occurrence of multiple shocks. Group-based welfare associations partially manage risks, particularly health shocks by catering for medical or funeral expenses of its members and their family members, hence, insuring household's income and assets. Group-based approaches are also avenues for accessing credit in the midst of shock and are essential for enhancing food consumption strategies. Our study therefore suggests that group-based approaches can help households become resilient to shocks. However, group-based approaches may weaken due to prolonged shocks such drought, crime, and socio-political conflicts. Hence, policies that scale up, strengthen, and improve the capacity of group-based approaches are essential to cope with shocks. Potential pathways towards this include capacity building and training of members of social groups on basic risk management tools, entrepreneurship, and financial management skills. This can consequently enhance risk sharing and risk taking through diversifying livelihoods, hence augmenting rural households' food security, recovery, and resilience in the incidents of multiple shocks in the face of escalating climate change.

In addition, households experience contemporary multiple shocks that asks for effective integrated risk management. The implementation of the devolved system of government in Kenya (IEA 2014) and shock divergence across geographical regions require effective geographically specific risk management policies and geographically specific climate-smart strategies. This necessitates research and training initiatives to ascertain the best risk management and climate-smart strategies suitable for different geographical regions. In spite of covariant shocks being the most important shocks affecting household asset and welfare, underplaying the idiosyncratic shocks such as health, crime and socio-political shocks could result in substantial loss of livestock portfolios, income, reduce the integration of group-based approaches and upsurge poverty levels. Therefore, policy inventions towards enhancing security, social and political stability in the rural setting can enable safety of assets and fortify social cohesiveness and capacity of group-based approaches. In addition, national and sub-nation health policies such as scaling up NHIF, the provision of universal preventive and curative health care and promoting preventive behaviors against HIV-/AIDS and malaria, particularly in areas with high prevalence, are substantial. Besides, private-public investment in medical health insurance and funeral micro-insurance will be essential to reduce the cost concerning health shocks. Reducing vulnerability and building livelihood resilience in the face of multiple shocks is imperative pro-poor growth policies that ease the risk of sliding below the poverty threshold.

Appendix 2A

Table 2A-1: Summary statistics of loss of income due to occurrence of shocks in rural Kenya in 2009 and 2012

Types of shocks	N	Mean (Ksh)	Standard Deviation	Minimum	Maximum
2009					
Drought	264	27,553	55545.30	600	630,000
Erratic rain	100	29,359	66039.26	788	500,000
Hailstorms	40	11,968	15099.99	900	60,000
Frost	3	31,733	50517.46	200	90,000
Flooding	18	14,749	15191.50	1,140	50,000
Animal health	51	16,775	14706.49	900	60,000
Crop pests	68	23,192	47918.55	500	300,000
Loss of crop harvest	14	18,052	19089.59	2,000	60,000
Illness	69	37,631	86872.65	600	570,000
Death shock	23	29,000	28001.49	2,000	120,000
Market shock	64	9,293	9681.10	600	40,000
Crime shock	40	19,630	39290.84	500	225,000
Personal shock	12	38,667	74097.70	1,500	250,000
2012					
Drought	184	67,194	90445.31	3,600	700,000
Erratic rain	157	59,727	92855.24	2,360	724,000
Hailstorms	59	25,186	28412.06	800	175,000
Frost	31	64,086	77216.81	2,500	315,000
Flooding	13	19,529	12048.23	4,000	46,000
Animal health	41	50,373	71369.29	250	320,000
Crop pests	87	42,385	52376.64	1,200	330,000
Loss of crop harvest	14	37,940	53170.41	3,500	160,000
Illness	53	56,783	105466.8	1,700	700,000
Death shock	35	54,686	68601.05	2,000	380,000
Market shock	44	29,968	31839.88	600	148,900
Crime shock	27	22,631	24410.89	2,800	106,000
Personal shock	8	20,313	10010.49	8,500	33,000

Notes: Ksh represents Kenya shillings. The monetary values are in 2009 prices.

Source: Authors' computations centered on the 2009 and 2012 survey data.

Table 2A-2: Shock prevalence across wealth quintiles (percentage)

Types of shocks	Prevalence in asset Quintile					Prevalence income Quintile				
	Deprived quintile	2nd quintile	3rd quintile	Well-off quintile	X^2	Deprived quintile	2nd quintile	3rd quintile	Well-off quintile	X^2
Drought	76.7	73.9	62.2	63.9	13.0**	80.6	70.6	69.4	56.1	25.5***
Flood	5.6	3.3	3.8	6.1	2.1	3.8	5.5	3.8	5.5	1.1
Erratic rain	40	40.6	46.7	38.9	2.7	40.5	38.3	41.7	45.4	2.0
Hailstorm	11.7	7.8	16.1	22.2	16.8***	16.1	14.4	16.1	11.1	2.4
Frost	2.2	7.2	8.8	1.7	13.5**	0.05	3.3	6.7	8.9	15.7***
Market	22.8	19.4	19.4	13.8	4.8	18.9	19.4	19.4	17.8	0.2
Crop loss	3.3	2.7	5.0	7.2	4.9	6.1	2.2	6.1	3.8	4.4
Pest	16.7	19.4	22.8	26.7	3.6	17.8	22.2	27.8	27.8	6.9*
Animal Health	12.2	16.1	14.4	15	1.2	17,8	13.8	13.9	12.2	2.4
Socio-political	7.8	9.4	6.1	6.1	2.0	11.1	7.8	6.1	4.4	6.4**
Criminal	6.7	10	11.7	17.7	11.5**	13.3	7.8	13.9	11.1	4.1
Death	14.4	8.9	12.7	14.4	3.3	14.4	15.0	12.2	8.8	3.7
Illness	15.6	20.6	21.1	22.2	2.9	20.6	21.7	18.9	18.2	0.8
Personal	3.3	3.3	1.7	1.1	3.1	3.9	2.2	1.7	1.7	2.5
N	180	180	180	180		180	180	180	180	

Notes: Figures presented in percentage in the group category. *** (P<0.01), ** (P<0.05), *(P<0.10)

Source: Authors' computations centered on the survey data.

Table 2A-3: Shock prevalence across agro-ecological regions (percentage)

Types of shocks	Humid regions	Sub-humid regions	Semi-arid regions	X^2
Drought	66.2	63.2	77.9	13.9***
Flood	0.9	6	6.9	10.9**
Erratic rain	47.1	38	40	4.6*
Hailstorm	0.4	38.4	2.9	178.4**
Frost	13.8	-	1.6	15.7***
Market	21.3	20.4	15.1	3.5
Crop loss	2.7	4.0	6.9	5.2*
Pest	14.7	15.6	40.8	58.6***
Animal Health	10.7	19.6	12.7	8.6*
Socio-political	2.2	2.8	16.7	47.9***
Criminal	7.1	20.4	6.5	29.6**
Death	8.4	19.6	9.4	16.9***
Illness	17.8	29.6	11.8	25.4***
Personal -loss of employment	3.3	2.4	1.6	1.1
Number of shocks	2.16	2.81	2.51	52.06***
N	225	250	245	

Notes: Figures presented in percentage in the group category. *** (P<0.01), ** (P<0.05), *(p<0.10).

Source: Authors' computations centered on the survey data.

Table 2A-4: Coping strategies adopted by households in order to cope with shocks for 2009 and 2012 (Mean of reported households)

Coping strategies	Overall coping strategies (2009 & 2012)		Coping strategies in 2009		Coping strategies in 2012		Diff. in Mean
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	(t-test)
Did nothing	0.192	0.394	0.214	0.411	0.169	0.376	0.044*
Sell livestock	0.400	0.490	0.319	0.467	0.481	0.500	-0.161***
Borrow from group-based approaches	0.199	0.399	0.133	0.340	0.264	0.441	-0.131***
Reduce food consumption	0.144	0.351	0.214	0.411	0.075	0.264	0.139***
Sell crops	0.140	0.347	0.106	0.308	0.175	0.380	-0.069**
Diversify food types	0.104	0.305	0.144	0.352	0.064	0.245	0.081***
Borrow from financial institutions	0.083	0.277	0.081	0.273	0.086	0.281	-0.006
Receive food relief	0.082	0.274	0.053	0.224	0.111	0.315	-0.058***
Risk protecting strategies	0.061	0.239	0.036	0.187	0.086	0.281	-0.050**
Keep children from school	0.018	0.133	0.036	0.187	0.000	0.000	0.036***
Sell other assets	0.058	0.235	0.064	0.245	0.053	0.224	0.011
Use savings	0.018	0.133	0.000	0.000	0.036	0.187	-0.036***
Migrate	0.017	0.128	0.008	0.091	0.025	0.156	-0.017*
N	720		360		360		

Notes: Multiple answers reported. Figures presented in mean in the group category. *** (P<0.01), ** (P<0.05), *(p<0.10).

Source: Authors' computations centered on the survey data.

Table 2A-5: Adult equivalent poverty levels for different groups in 2009 and 2012(Percentage of households below poverty line)

Different groups		Overall poverty levels (2009 & 2012)	Poverty levels for 2009	Poverty levels for 2012	Diff. in Percentage
Gender	Male HHH	61	77	46	31***
	De facto female HHH	73	74	72	2
	De jure female HHH	53	57	50	7
Regions	Semi-arid regions	66	80	52	28***
	Sub-humid regions	74	79	68	11*
	Humid regions	45	61	29	32***
Shock	With exposure to drought	66	79	53	26***
	Without exposure to drought	53	57	48	9
N		720	360	360	

Notes: *** (P<0.01), ** (P<0.05), *(p<0.10).

Source: Authors' computations centered on the survey data.

Table 2A-6: Number of coping strategies reported by households

Number of coping strategies	Frequency	Percent	Cumulative
0	138	19.21	19.21
1	161	22.24	41.45
2	220	30.56	72.01
3	130	18.06	90.07
4	52	7.22	97.29
5	13	1.81	99.31
6	4	0.56	99.66
7	1	0.14	100
Total	720	100	

Source: Authors' computations centered on the survey data.

Table 2A-7: Household's self-perceived impacts of shocks on their welfare outcomes in 2009 and 2012 (Mean of reported households)

Categories of self-perceived impacts	Overall self-perceived impacts of shocks (2009 & 2012)		Self-perceived impacts of shocks in 2009		Self-perceived impacts of shocks in 2012		Diff. in Mean (t-test)
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	
Decline in crop yields	0.88	0.325	0.89	0.311	0.87	0.337	0.02
Loss of income	0.58	0.494	0.54	0.499	0.62	0.486	-0.09*
Food insecurity	0.45	0.497	0.44	0.497	0.45	0.498	-0.01
Loss of the entire crop	0.20	0.397	0.19	0.396	0.20	0.398	0.00
Death of livestock	0.19	0.392	0.20	0.398	0.18	0.385	0.02
Loss of assets	0.15	0.356	0.18	0.385	0.12	0.321	0.06*
Higher food prices	0.11	0.314	0.22	0.414	0.00	0.053	0.22***
Lack of quality livestock pastures	0.07	0.259	0.02	0.138	0.13	0.331	-0.11***
Water scarcity	0.01	0.105	0.00	0.000	0.02	0.148	-0.02**
N	720		360		360		

Note: Multiple answers reported.

Source: Authors' computations centered on the survey data.

3. Gender differences in climate change perceptions and adaptation strategies: an intra-household analysis from rural Kenya[27]

Abstract

It has been widely acknowledged that the effects of climate change are not gender neutral. However, existing studies on adaptation to climate change mainly focus on a comparison of male-headed and female-headed households. Aiming at a more nuanced gender analysis, this study examines how husbands and wives within the same household perceive climate risks and use group-based approaches as coping strategies. The data stem from a unique intra-household survey involving 156 couples in rural Kenya. The researchers collected data by interviewing husbands and wives separately. The findings indicate that options for adapting to climate change closely interplay with husbands' and wives' roles and responsibilities, social norms, risk perceptions and access to resources. A higher percentage of wives were found to adopt crop-related strategies, whereas husbands employ livestock- and agroforestry-related strategies. Besides, there are gender-specific climate information needs, trust in information and preferred channels of information dissemination. Further, it turned out that group-based approaches benefit husbands and wives differently. Group-based approaches provide avenues for diversifying livelihoods and managing risks for wives, while they are pathways for sharing climate information and adaptation ideas for husbands. Social groups help husbands and wives to enhance their welfare through accumulating vital types of assets and improving food security outcomes. The findings suggest that designing gender-sensitive policies and institutionalizing gender in climate change adaptation and mitigation frameworks, are vital. Policy interventions that rely on group-based approaches should reflect the gender reality on the ground in order to amplify men's and women's specific abilities to manage risks and improve well-being outcomes in the face of accelerating climate change.

Keywords: perceptions, adaptation, group-based approaches, gender, intra-household analysis, Kenya

[27] The shorter version of this chapter is published in a peer reviewed ZEF-Discussion Papers on Development Policy No. 210. A manuscript of this chapter is also published in the Journal of Ecological Economics 138 (2017) 99-108. Co-authors include Dr. Ulrike Mueller and Prof. Regina Birner.

3.1 Introduction

Climate change and related adverse incidents reduce agricultural productivity resulting in decline of income and in hunger, and malnutrition, loss of assets, as well as increase in rates of poverty. The impacts of climate change worsen pre-existing social inequalities specifically for women who are more vulnerable because of limited access to resources and because their livelihood depends on agriculture and natural resources, which are highly susceptible to climate variability (UN Women Watch 2011:1; Alston 2013). To lessen the adverse impacts of climate change and variability, local farmers have adjusted to harsh weather conditions and have already developed coping strategies over time. The uptake of these innovative practices and technologies, nonetheless, depends on individual characteristics, inequalities in household capital endowment and access to rural services including climate and agricultural information (Bohle et al. 1994; Adger et al. 2009; Nelson 2011). In particular, much remains to be learned on how men and women are adjusting to harsh weather conditions and why they are taking up specific climate-smart agricultural practices.

The interaction between gender and climate change has received considerable attention in recent years, especially regarding the susceptibility of women to climate change impacts (Neumayer & Plu 2007; Bynoe 2009; Lambrou & Nelson 2010; Dankelman 2011; Serna 2011; Goh 2012; Alston 2013). For instance, it has been widely acknowledged that the effects of climate change and variability are not gender neutral. Further, there is a far-reaching literature on adaptation to climate change in the domain of developing countries (see Grothmann & Patt 2005; Deressa et al. 2009; Below et al. 2012; Bryan et al. 2013; Di Falco & Veronesi 2013; Pérez et al. 2014). Nonetheless, these studies often miss out more nuanced gender aspects, or their empirical approach only permits comparing male- and female-headed households. Therefore, there is limited empirical evidence on how gender at the intra-household level influences the adaptive capacities of men and women.

Further, substantial empirical evidence indicates that gender disparity exists in access to resources, information and access to agricultural inputs (see FAO 2011; Peterman et al. 2014 for a review). Access and power to control assets are vital pathways to upsurge income and empower individuals to escape from poverty, reduce vulnerability, adapt, and build resilience to accelerating climate change and variability. In spite of policies and interventions supporting gender equality and empowering women's inclusion in governance, gender disparity remains a worldwide challenge. To improve their fallback positions and to obtain better access to resources and improve their bargaining power and welfare, the poor and women draw upon social capital and 'group-based approaches'. Recent studies show that social capital promotes rural livelihoods and access to rural services (Kirori, 2015; Hoang et al. 2016), enhances resilience of households to extreme events and climate change (Mueller et al. 2013; Bernier & Meinzen-Dick 2014; Ngigi et al. 2015). Social capital also promotes recovery from other adverse events (Adger 2003; Adger

et al. 2009; Bezabih et al. 2013; Woodson et al. 2016) and encourages adaptation to climate change (Nganga *et al.*, 2013; Chen et al. 2014). Nevertheless, there has been little attention to gender-differentiated group-based approaches in the context of improving men's and women's adaptive capacity, ability to manage climate-related risks and protect household assets. A research gap exists with respect to what kinds of groups are most effective for empowering men and women in the face of fast-track climate change. Understanding the potential for gender-differentiated group-based approaches is relevant for policy formulation and program design, particularly while targeting development programs through social groups in developing countries like Kenya.

To bridge this gap, the study used unique self-collected intra-household data from rural Kenya to address the following objectives:

a) To assess husbands' and wives' perceptions of climate change and adaptation measures
b) To examine husbands' and wives' adaptive capacity in the domain of differentiated access to household resources and agricultural information
c) To investigate the potential for gender-differentiated group-based approaches in enhancing husbands' and wives' adaptive capacity, managing climate risk and fostering welfare
d) To examine drivers of adoption of climate-smart agricultural practices for husbands and wives

A theoretical approach that assumes intra-household bargaining requires interviewing household members individually and calls for gender-sensitive analyses. Collective and bargaining approaches indicate that intra-household perspectives are important because households rarely operate as a production or consumption unit, but actors have different preferences while making household decisions, distributing resources and when responding to policy initiatives (Alderman et al. 1995). Besides, men and women respond to risks/shocks differently and their asset portfolios are used to cope with different shocks (see Rakib & Matz 2014; Kumar & Quisumbing 2014). Moreover, collective and bargaining perspectives designate that husbands and wives within the same household have different abilities to make timely decisions, such as adaptation decisions and therefore are likely to respond differently to climate change. Hence, the data set used for this study comprises individual- and intra-household level data of 156 pairs of spouses and 15 gender-differentiated focus group discussions (FGDs) to address its objectives. This approach enables identifying gender differences in perceptions, adaptive capacity, and uptake of climate-smart agricultural strategies.

While previous studies have applied quantitative research (see for instance Nam 2011; Di Falco & Bulte 2013) or qualitative approach (Wolf et al., 2010) to access the influence of social capital on adaptation arena, this study goes beyond existing research approaches by employing a mixed-

methods approach. A mixed methods approach provides a more convincing analysis, increases the comprehensiveness of the findings and enhances the understanding of the research problem, by balancing the shortcomings inherent in applying either qualitative or quantitative method (Behrman, Meinzen-Dick and Quisumbing, 2014). Furthermore, studies that consider gender-differentiated social capital formulation and accrued benefits are rare. This study argues that understanding the potential for gender-differentiated group-based approaches are relevant for developing policies that reflect gender reality on the ground in order to strengthen men's and women's capabilities to manage climate risks and improve well-being outcomes in the face of accelerating climate change. For example, it is not clear which kinds of social groups are vital while targeting men and women in rural areas.

The study contributes to the existing literature on climate change by applying a gender-disaggregated data set that allows for a more nuanced gender analysis in order to shed light on intra-household decision-making on adaptation to climate change. The findings show how couples differ in how they perceive climate change and take up climate-smart strategies. The findings also indicate that they benefit differently from being members of group-based approaches. These findings imply that husbands and wives have different abilities in decision-making governed by their different risk perceptions and their different abilities to manage climate risk. Besides, there are considerable gender disparities in ownership of assets, access to information, gender-specific climate information needs, bargaining power and education levels, which could make female spouses more vulnerable to climate change from a feminist point of view. The study indicates that in spite of women having partial access to essential assets, they draw upon indispensable social capital and group-based approaches to foster their well-being outcomes. This is because group-based approaches facilitate access to productive inputs and assets that sequentially improve their adaptive capacity and ability to manage climate risk.

3.2 Relations between gender, assets and adaptation interventions

This section presents the role of assets in climate change adaptation and in agricultural development. The section highlights the vital need for understanding the relations between gender and access to as well as power over assets in influencing adaptation options. Gender equality in access to both tangible and intangible assets is essential in reducing vulnerability, managing climate-related risks and stimulating adaptation decisions, particularly regarding the uptake of climate-smart agricultural practices (Nelson et al. 2002). In the Millennium Development Goals and Post-2015 Development Agenda for attaining Sustainable Development Goals, gender equality has been highlighted as a key strategy for attaining sustainable development (UN 2013; UNEP 2013: 5). However, gender inequality persists in climate change governance and leadership, decision-making arena and in access to social institutions, particularly in developing countries (OECD 2012; UNFCC 2013; Carr & Thompson 2014).

First, secure land tenure is crucial for poverty reduction, agricultural productivity and for stable livelihoods in rural areas of developing economies (Lastarria-Cornhiel et al 2014). Policy reform in land however mostly emphasis on changing land rights for households, and not for entities within the household such as female members of the households (ibid). Women hence have limited control over land and property rights. In spite of land legislation focusing on women's access to land, women repeatedly lack legal know how on their rights or weak enforcement of law or customary norms impede them from claiming their land rights. For instance in Sub-Saharan Africa, women only have rights to use and access land through men, especially in customary land tenure systems (Farnworth et al. 2013: 76). In Kenya, for instance only three percent of women own a title deed (GoK 2008). These situations position women at the periphery of crop production decisions (Skinner 2011). Unequal rights to land not only limit women's ability to access credit, but also restrict their decisions on land use that are necessary to adapt to climate change. Gender inequality also persists in livestock ownership and control of income where men own and control income from large livestock —cattle and draft livestock, whereas women own small livestock — goats, sheep and poultry (Njuki & Sanginga, 2013). Poultry and small livestock promote livelihood resilience to weather shocks and climate change since they multiple quickly and have a high adaptive capacity. Hence, scaling-up production of small livestock is likely to have a positive impact on women's livelihood diversification and household's food security in the midst of accelerating climate change (Ngigi et al. 2015).

Delivery of extension services and climate change information often lacks a gender-lens approach in developing countries. Access to agricultural extension services is crucial in achieving food security, increasing agricultural productivity (Davis, 2008; Stefan Dercon, Gilligan, Hoddinott, & Woldehanna, 2009; Ragasa, Berhane, Tadesse, & Taffesse, 2012) and in facilitating climate change adaptation (Gbetibouo et al. 2010; Mustapha et al. 2012; DiFalco & Bulte 2013). Ragasa et al. (2012) study shows that in Ethiopia women have limited access to agricultural extension services, information and technology. McOmber et al. (2013) study similarly indicates that women are often left out of information and communication technologies (ICTs) that are crucial in disseminating climate and agricultural information to farmers. Empirical evidence in Ghana, Uganda, and Bangladesh indicates that women than men have less access to essential information on climate alerts and cropping patterns (Jost et al., 2016). Hence, women tend to be less adaptive to climate change because of unequal access to extension, climate information, weather patterns, and other forms of communication or since accessible adaptation options incline to increase labor demands for women. However, for climate information to be useful to farmers, it is vital to be accurate, relevant, trustworthy and accessible (Vogel & O'Brien 2006; McOmber et al. 2013). Nevertheless, little is known about how men and women perceive or trust the information they receive from different media, agents and institutions. Besides, a lot more has to be learned on gender-differentiated information needs and what channels of information are effectively reaching out male and female farmers.

Access to financial assets is a catalyst for uptake of innovations, technologies and inputs such as improved seed varieties and agrochemicals (FAO 2011) that are important for adapting to climate change. However, overwhelming evidence indicates differential access to agricultural inputs (Peterman et al. 2014). Female farmers have limited ability to secure loans (FAO 2011) and often have no savings since they spend a higher proportion of their income on the household's food, health and education (Saulière 2011). This has far-reaching consequences on gendered input use, which in turn result in low agricultural productivity (Croppenstedt et al. 2013) thereby negatively impacting women's adaptive capacity (Jost et al., 2016). Nonetheless, women easily access informal credit through group-based saving and credit associations, thus invest credit in productive livelihood activities. With limited access to other crucial assets such as land and credit, new institutional arrangements in form of group-based approaches offer novel pathways to access productive assets and resources, particularly for asset-poor and female farmers. Evidence indicates that when women have access to and control over key productive assets such as land, financial capital, inputs and bargaining power, it translates positively into household's well-being outcomes including food security, children's nutrition, education, health and survival rates, agricultural productivity and conservation of natural resources (FAO 2011; OECD 2012; Farnworth et al. 2013).

This paper focuses on group-based approaches as a strategy to create social capital. It is known from the literature that social capital helps households or individuals in reducing vulnerability and enhancing coping, adaptive capacity and recovery from adverse events (Adger 2003; Adger et al. 2009; Bezabih et al. 2013; Woodson et al. 2016) and adapting to climate change (Nganga et al. 2013; Chen et al. 2014). At community level, social capital supports accumulation of assets, knowledge sharing and building resilience to climate change (Mueller et al., 2013). However, strong social ties may also hamper adaptation options such as soil management practices (Di Falco & Bulte 2013 for Ethiopia).[28] There has been little attention to gender-differentiated group-based approaches in the context of improving men's and women's abilities to manage climate risk, protect assets, and improve welfare. A research gap exists with respect to what kinds of groups are most effective in empowering men and women in the face of fast-track climate change. Men and women are likely to accumulate different forms of social capital that would apparently have different impacts on adaptation to climate change and their well-being.

The literature pays limited attention to the intersections of intra-household decision-making, access to resources and the potential for gender-differentiated group-based approaches. To address this knowledge gap, this study provides a more nuanced gender analysis using self-collected intra-household data on how husbands and wives within the same household perceive climate risks, take up climate-smart agricultural practices, and participate in group-based

[28]Wolf et al.'s (2010) study shows that strong bonding networks are likely to increase vulnerability to heat wave risks to elderly population and reduce tendency to perceive climate risks in UK cities.

approaches as a risk-managing tool. The study presents the similarities or differences among couples on how they perceive climate risks and in turn, take up climate-smart agricultural practices in order to manage climate risk. Besides, gender-related differences between husbands and wives in the same household show that spouses belong to different social groups, hence acquire unique welfare gains from participating in group-based approaches.

3.3 Data and sampling procedure

Data for this study was collected from three agro-ecological zones (AEZs) of rural Kenya—the semi-arid regions (low potential), sub-humid regions (medium potential) and humid regions (high potential) — between June and September 2012. The sampled districts included Mbeere South and Nakuru (semi-arid regions), Gem and Siaya (sub-humid regions) and Mukurweini and Othaya (humid regions). Therefore, the survey aimed at a wider range of climatic, agro-ecological, socioeconomic, and cultural conditions, policy and institutional arrangements, and susceptibility to climate change. For this study, a mix of qualitative and quantitative data collection techniques was used.

The survey involved individual- and intra-household level data, generated by interviewing husbands and wives separately that assured freedom of response on the part of the wives. Intra-household interviews were carried out on parallel time, whereby couples were not allowed to consult or communicate with each other. Overall, a random sample of 156 pairs of spouses were interviewed, resulting in 312 respondents in total. This approach captured intra-household and gender-differentiated data on access to resources, perceptions and adaptation strategies and differential group-based approaches of husbands and wives. The survey questionnaire was carefully pre-tested in villages of the semi-arid region, which had similar climatic and socioeconomic conditions as one of the target study areas. The questionnaire was revised accordingly before being administered. Trained enumerators were employed to collect data. Female interviewers were used to interview wives hence making them comfortable while responding to questions thus increasing the accuracy of the data collected.

Qualitative research involving gender-disaggregated focus group discussion (FGD) was carried out in all study sites to complement the household survey. A FGD protocol included modules on perceptions, adaptations, potential for group-based approaches and institutions in enhancing adaptive capacity and building assets for men and women. Participants of FGD were randomly sampled with the help of field facilitators and local leaders to ensure wider representation and diverse views of men and women. Hence, participants of FGD were of different age groups, social status, members, and leaders of social groups. Overall, FGD involved seven women focus groups and eight men focus groups, resulting in 15 focus group discussions in total. The Focus group interviews were audio-recorded and key points noted in a notebook. Transcription of data followed the FGD protocol and key emerging themes. The study applied a deductive approach to

analyze data, since qualitative research was a smaller component of the broader quantitative survey. Narratives emerging from qualitative data were essential to supplement quantitative information, interpret, and discuss selected results of the quantitative analysis.

Table 3.1 presents the definition of key variables and summary statistics of the intra-household survey respondents. The cross-tabulations analysis of gender and membership in social groups shows that husbands and wives who belong to different kinds of social groups have more access to extension services, farmer field schools, early warning information, credit facilities and bargaining power than non-group members (see Table 3A-1 in the appendix).

Table 3.1: Definitions and summary statistics of the key variables

Variables	Definitions	Wives		Husbands	
		Mean	Std. Dev.	Mean	Std. Dev.
Adaptation decision†	The decision to adopt climate-smart agricultural strategies	0.85	0.362	0.76	0.427
Intensity of adaptation	Total number of adopted strategies	2.44	1.720	2.28	1.960
Social capital	Index of social capital	0.67	0.166	0.71	0.149
Age in years	Age in years	54.48	13.064	62.72	12.833
Years of schooling	Years spent in school	6.19	3.773	7.97	3.871
Number of information sources	The count of the number of the information sources accessed	1.85	1.076	1.91	1.025
Information trust index	CAPCA index of the trust of information from various sources	0.70	0.194	0.65	0.209
Perceptions to Climate change†	Interaction of perceiving increase in temperatures * decrease in rainfall	0.57	0.497	0.60	0.491
Human attitude to climate change	PCA index of the psychological factors	0.88	0.132	0.90	0.072
Early warning†	Access to climate information in the form of early warning	0.26	0.442	0.38	0.488
FFS†	Access to farmer field schools form of extension service	0.42	0.496	0.21	0.410
Household size	Number of household members	4.93	2.450	4.93	2.450
Access to credit†	Access to credit from either informal or formal financial institutions	0.46	0.500	0.51	0.501
Decision of land use†	Consensus decision-making on land use	0.34	0.475	0.23	0.423
Consumer durable assets	PCA index of consumer durable assets	0.12	0.175	0.08	0.150
Agricultural durable assets	PCA index of farm tools and machinery assets	0.14	0.140	0.19	0.107
N	Number of observations	156		156	

Note: Superscripts † presents variables in binary format. ***p<0.01, **p<0.05, *p<0.1

Source: Authors' computations centered on 2012 intra-household dataset

Perceptions of climate change involved asking how male and female farmers have perceived changes in average temperature and average rainfall and other climate indicators over the last ten years. To assess the bargaining power, we asked how decisions pertaining to land use are made, i.e. if there is consensus between husband and wife. Following Filmer & Pritchett (2001) and Moser & Felton (2007), the study applied Principal Component Analysis (PCA) to compute an asset-based index for consumer durables and farm durables using a wider range of assets.[29] Besides, the study applied PCA to create a social capital index (group-based approaches index) consisting of variables on trust, reciprocity, group participation and social support (see Table 3A-2 in the appendix).[30] Trust of information index was defined by how farmers depend on or trust agricultural and climate information they acquire from various sources, which was assessed using a 5-point Likert scale, from 1 = 'strongly distrust' to 5= 'strongly trust.' The study applied Categorical Principal Component Analysis (CAPCA) to develop a trust index of husbands and wives.[31] Intensity of adoption was considered as the number of adopted practices/strategies aggregated at the household level.

3.4 Capturing the intra-household dimensions of climate change

This section presents the analytical approach to capture intra-household dimensions of climate change. A major analytical challenge is failure to consider husbands and wives as "separate entities" or not to consider an "across" households perspective. Instead, it is important to employ a gender lens "within" households and bearing in mind the interplay between husband and wife. The study hence explores the degree to which husbands and wives in the same household respond similarly or differently (agree or disagree) to questions about perceptions of climate change, adaptation options, access and trust of agricultural information and participation in group-based approaches.

To define similarities and differences in the responses, i.e. the extent to which husbands and wives within the same household report similar or different perceptions and risk behaviors, some statements were re-coded. For instance, perception of climate change involving a four-point Likert scale (1 = 'decrease', 2 = 'increase' 3 = 'remain the same' and 4 = 'don't know') was recoded

[29] Assets considered for consumer durables include car, motorcycle, television, mobile, refrigerator, radio and mobile phone, while agricultural assets considered 19 types of assets, including farm tools, machinery and engine generator.

[30] The study developed a social capital index (group-based approaches index) using PCA such that

$$SC_i = \sum_{n=1}^{n} W_{1n} d_{ni}$$

Where $SC_i$is the social capital index for the i^{th}observation, d_{ni} is the categories of social capital in n^{th} is dummy variable i.e. n=1,.., N, while W_{1n} is the weight of the social capital index (factor components). The study considered factors with the Eigen-values >1 for further analysis.

[31] Categorical Principal Components Analysis (CAPCA) is appropriate for data reduction when variables are ordinal or in categorical format, i.e. Likert-type scales. The CAPCA also incorporates both the nominal and ordinal variables. Unlike the traditional PCA, the CAPCA does not assume linear relationships among numeric data nor does it assume multivariate normal data (Linting, Meulman, Groenen, & van der Koojj, 2007).

as 1 for a perceived 'decrease' or 'increase' and 0 'otherwise'. The responses of causes of climate change, similarly involving a four-point Likert scale of 1 = 'is a cause', 2 = 'might be a cause', 3 = 'is not a cause' and 4 = 'don't know' were recoded as 1 for 'is a cause', and 0 'otherwise'. Since recoding and collapsing categorical data to ordinal data could jeopardize the information acquired, sensitivity analysis examined if the choice of data affected the magnitude of agreement or lack of agreement in the answers of husbands and wives. The degree of intra-household agreement (i.e. the extent to which the wives and the husbands provide affirming responses to the same question) was summarized for each response. Besides, individual and household-level variations in the frequency of answers by husbands and wives were calculated for each response.

To capture the intra-household differences and household-level differences in agreement or lack of agreement, the study applied Kappa statistics (weighted percentage agreement, Kappa estimates, and corresponding P-values) and Pearson Chi-square. The Kappa statistics are often used to examine the significance in inter-rater agreement of two or more groups (Viera & Garrett, 2005). The Kappa estimates fit our dichotomized data, especially when measuring whether husband and wife in the same household have corresponding or diverging perceptions about a jointly experienced phenomenon. Kappa estimates also measures the concordance among husbands and wives in the choice of adopting suitable innovations and agricultural strategies in management of crop and livestock and in the decision to participate in a number of group-based approaches. Kappa estimates range from negative one to positive one, with a Kappa of one implying a perfect agreement and a Kappa of zero inferring an agreement by chance or by a random influence (Viera & Garrett, 2005).[32]

The Pearson Chi-square estimate of equality is useful to examine whether the husbands' and the wives' choices are independent of each other and whether the share of wives asserting the responses differs significantly from that of husbands.

3.5 Descriptive results of gendered intra-household analysis

This section introduces descriptive findings on intra-household perceptions of climate change and differentiated concerns regarding a changing climate. The section focuses on climate-smart agricultural strategies that are implemented by husbands and wives. The section further presents data on gendered access to assets and to agricultural and climate information. The section also deals with group membership. The section draws attention to the potential for gender-differentiated group-based approaches in enhancing adaptive capacity and resilience, building

[32] Kappa estimate of ≤ 0 indicates less than chance agreement (no agreement), 0.01–0.20 slight agreement, 0.21–0.40 fair agreement, 0.41–0.60 moderate agreement, 0.61–0.80 substantial agreement and 0.81–0.99 almost perfect agreement (Viera & Garrett, 2005). Hence, a low Kappa estimate indicates slight or no agreement.

assets, and fostering well-being. Lastly, the section addresses the question whether group-based approaches benefit husbands and their wives differently.

3.5.1 Gender differentiated perceptions of climate change

Table 3.2 presents the intra-household analysis of perceptions regarding average rainfall and precipitation variability and average temperature over the last ten years.

Table 3.2: Intra-household perceptions of climate change

Climate indicators	Wives (% Yes)	Husbands (% Yes)	Difference in % point	Significance x^2 (P-value)	Agreement (%)	Kappa	Significant Kappa (P-value)
Increase in temperatures	69.87	71.79	-1.92	0.709	63.46	0.12	0.073*
Decrease in temperatures	17.31	21.15	-3.85	0.389	70.51	0.05	0.252
Increase in average rainfall	23.08	20.51	2.56	0.709	70.51	0.14	0.044*
Decrease in average rainfall	69.87	71.79	-1.92	0.389	68.59	0.24	0.001***
Change in rainfall variability	93.59	92.31	1.28	0.658	85.90	-0.75	0.827
Erratic rains	45.51	34.62	10.90	0.050*	49.36	-0.42	0.703
Rains come early	33.33	23.72	9.62	0.060*	60.90	0.52	0.025
Rains come late	78.21	76.28	1.92	0.685	66.03	0.03	0.334
Heavy rains	2.56	3.85	-1.28	0.52	93.59	-0.03	0.657
More drought	1.28	1.92	-0.64	0.652	96.79	-0.16	0.579
Increase in malaria occurrence	55.13	49.36	5.77	0.308	63.46	0.27	0.003***
Decrease in malaria occurrence	39.74	41.03	-1.28	0.817	61.54	0.20	0.006***
Increase in livestock diseases from ticks	29.49	25.64	3.85	0.447	62.82	0.07	0.187
Decrease in livestock diseases from ticks	60.26	64.74	-4.49	0.413	55.77	0.06	0.023
N	156	156					

Notes: Superscript * presents significance at the 10% level, ** at the 5% level, ***at the 1% level.

Source: Authors' computations centered on 2012 intra-household dataset

Both husbands and wives within the same household have perceived changes in climate. The findings show a slight similarity among husbands and their spouses regarding the perception that average temperatures are increasing (Kappa P-value < 0.10). Further, husbands and wives report that average rainfall has been decreasing, and incidences of malaria have been increasing (Kappa P-value < 0.001). It is worth noting that a higher percentage of husbands and wives perceive a decrease in rainfall, while a lower percentage perceive an increase in rainfall. Overall, the perception among spouses is that rainfall is decreasing (Kappa P-value < 0.001).

Nonetheless, there is a statistically significant difference between husbands and wives regarding perceived changes in erratic rains and early onset of rainfall. A higher percentage of wives than husbands perceive an increased incidence of erratic rainfall with profound flooding and early onset of rains (Pearson $x^2 < 0.10$). The gendered differences in perceptions further vary with agro-ecological zones. For instance, a higher percentage of females within couples in sub-humid and semi-arid regions perceive changes in long-term rainfall variability over the last ten years. In contrast, a higher percentage of husbands perceive a decrease in average rainfall or precipitation variability in the humid and semi-arid regions. However, a higher percentage of wives than husbands in the sub-humid regions perceive a decreased incidence of average precipitation. Overall, a lower percentage of husbands and wives in sub-humid regions perceive that there is a change in rainfall variability.

3.5.2 Gender differentiated concerns of a changing climate

The results indicate that both husbands and wives are worried about the changing climate. There is a slight similarity in answers regarding the reasons for concerns about climate change. In the same domain, husbands and wives both report that experience of water scarcity increases their concerns about climate change (Kappa P-value < 0.05). Pearson chi square estimates show a statistically significant difference between husbands and wives concerning climate change. The results suggest that wives have a higher risk perceptions regarding deteriorating agriculture productivity (57% of wives are concerned about this problem) and low fodder availability (43% of wives are concerned). The respective figures for the husbands are 41 percent and 32 percent (Pearson x^2<0.05). Besides, a higher percentage of wives than husbands are concerned about the impact of climate change on food security (76%) and on poverty (17%). The figures for men are 66 percent and 10 percent, respectively (Pearson x^2<0.05). On the other hand, a higher percentage of husbands than wives are concerned with decreasing water availability. The figure is 27 percent for husbands and 19 percent for wives (Pearson x^2<0.05) (see Table 3.3).

Further analyses show that husbands and wives perceive their level of knowledge on causes and impacts of climate change differently. Husbands perceive themselves to have an average level of knowledge (Pearson x^2<0.10), while wives perceive themselves as not well informed (Pearsonx^2<0.10) on the causes of climate change and its effects on their livelihood. Husbands and wives perceive that poor farming practices such as degrading water reservoirs and wetlands are the chief cause of changing climate (Kappa P-value <0.05). However, a higher percentage of wives belief that God is the cause of climate change (Pearson x^2<0.01), while husbands perceive poor farming practices as the main drivers for climate change (Pearson x^2<0.10).

Table 3.3: Intra-household concerns and perceptions of climate change

Statements	Wives (% Yes)	Husbands (% Yes)	Difference in % point	Significance x2 (P-value)	Agreement (%)	Kappa	Significant Kappa (P-value)
Attitude towards climate change							
Interest in climate change	86.54	83.33	3.21	0.429	75.00	0.03	0.38
Worried about changing climate	62.82	56.41	6.41	0.249	52.56	0.02	0.41
Reasons for concern							
Food insecurity	75.64	66.03	9.62	0.062*	37.82	-0.04	0.781
Reduced agricultural production	57.69	41.67	16.03	0.005***	46.79	-0.04	0.689
Reduced fodder availability	42.95	32.05	10.90	0.042**	61.54	0.01	0.434
Worsened poverty levels	17.31	9.62	7.69	0.047**	75.64	-0.03	0.666
Increased water scarcity	19.23	26.92	-7.69	0.100*	70.51	0.18	0.012**
Poor health	17.31	19.87	-2.56	0.560	63.46	-0.16	0.978
Loss of income	30.13	25.00	5.13	0.311	60.90	-0.13	0.950
Increased soil erosion	1.92	1.92	0.00	1.000	96.15	-0.02	0.597
Perceived causes of climate change							
God	48.08	32.69	15.38	0.006***	50.00	-0.01	0.570
Poor farming practices	51.92	62.82	-10.90	0.052*	55.77	0.11	0.086*
Cutting trees	85.90	90.38	-4.49	0.220	80.13	0.05	0.245
Planting wrong species of trees	59.62	54.49	5.13	0.360	51.28	0.01	0.457
Pollution	64.10	58.97	5.13	0.352	53.85	0.03	0.364
N	156	156					

Notes: Superscript * presents significance at the 10% level, ** at the 5% level, ***at 1% level
Source: Authors' computations centered on 2012 intra-household dataset

3.5.3 Intra-household climate-smart agricultural strategies in management of crop and livestock

Table 3.4 presents climate-smart practices in crop and livestock management that are implemented by husbands and wives on their own plots or at household level. The findings show that there is a slight similarity among husbands and wives with regard to the decision to take up livestock-related practices (Kappa P-value <0.10). However, there is no similarity among couples in adoption of specific livestock-related practices. Besides, Pearson analysis shows that husbands are slightly ahead when it comes to adaptation measures in the domain of livestock management (54%), as compared to their spouses (52%), though this difference is not statistically significant.

A higher proportion of husbands embrace improved livestock-related management practices such as changes in feeding practices, changes in livestock breeds, and reductions in the number of livestock. Changing the livestock breeds is a high-cost venture that prevents women from adopting the strategy because of their comparable lower resource base. However, the qualitative analysis shows that women diversify livestock portfolios through rearing of small ruminants and non-ruminant livestock as an income generating and coping strategy in order to build livelihood resilience to extreme events. The findings also show that adoption of livestock-based practices

differ across agro-ecological zones. Farmers in the humid regions are changing and supplementing livestock feeds because farmers in this region primarily practice intensive dairy farming. In sub-humid regions, farmers increase livestock holdings and diversify livestock feeds whereas a higher percentage of farmers in semi-arid regions change animal breeds and reduce the number of livestock ('destocking').

Table 3.4: Climate-smart practices in crop and livestock management that are implemented by husbands and wives

Climate-smart strategies	Wives (% Yes)	Husbands (% Yes)	Difference in % point	Significance x^2 (P-value)	Agreement (%)	Kappa	Significant Kappa (P-value)
Intensity of adaptation (count)	2.44	2.28	0.16				
Adaptation in agriculture	84.62	76.28	8.34	0.063*	68.59	0.01	0.436
Livestock adaptation							
Livestock adaptation (overall)	51.92	53.85	-1.93	0.734	55.77	0.11	0.079*
Change in animal breeds	10.90	12.8	-1.90	0.599	80.13	0.05	0.264
De-stocking	18.58	23.72	-5.14	0.267	67.95	0.04	0.294
Diversify livestock feeds	18.59	22.43	-3.84	0.400	67.95	0.02	0.404
Supplementary feeds	5.77	3.85	1.92	0.427	91.67	0.09	0.122
Change in animal portfolio	9.61	6.41	3.20	0.297	85.26	0.01	0.483
Crop adaptation							
Crop adaptation (overall)	82.05	71.78	10.27	0.032*	66.67	0.08	0.165
Change in crop variety	40.48	36.54	3.94	0.485	58.97	0.14	0.046*
Change in crop type	19.23	14.74	4.49	0.291	73.72	0.07	0.183
Increase in land for production	6.40	1.28	5.12	0.019*	93.59	0.15	0.006*
Crop rotation	14.74	11.53	3.21	0.402	7.56	0.02	0.403
Water harvesting	1.28	3.85	-2.57	0.152	94.87	-0.02	0.612
Diversion ditch	5.78	5.78	0.00	1.000	88.46	-0.06	0.778
More irrigation of fields	7.05	2.56	4.49	0.064*	91.67	0.10	0.078*
Soil conservation and management	17.31	10.90	6.41	0.100*	80.77	0.21	0.003*
Agroforestry	8.33	16.03	-7.70	0.038*	80.77	0.11	0.065*
N	156	156					

Notes: Superscript * presents significance at the 10% level

Source: Authors' computations centered on 2012 intra-household dataset

The findings regarding crop-related practices also show interesting similarities and differences. Kappa estimates show that both husbands and wives change crop varieties (Kappa P-value <0.05), increase land under production (Kappa P-value <0.10), expand the portion of land under irrigation (Kappa P-value <0.10), adopt water and soil conservation practices (Kappa P-value <0.001) and take up agroforestry-related practices (Kappa P-value <0.10). These findings imply that husbands and wives both affirmed that they are taking up these practices. However, the findings indicate

that there are substantial differences between husbands and wives in the crop adaptation and management measures, as further detailed below.

A higher percentage of wives (82%) made changes in crop production, as compared to the percentage of husbands (72%) (Pearson x^2<0.10). Further, female spouses adopt more agricultural practices (2.44 practices), as compared to the husbands (2.28 practices) to reduce the risk associated with climate change. A higher percentage of female spouses across all agro-ecological zones engage in soil management strategies (Pearson x^2<0.10). These practices include soil amendment (e.g., use of animal and composite manure), crop rotation and use of cover crops (e.g., sweet potatoes and pumpkin). Interestingly, there is a higher uptake of water harvesting and diversion ditches in semi-arid areas, which could be attributable to a higher incidence of extreme weather events such as drought and water scarcity in these regions. Besides, a higher percentage of husbands adopt agroforestry-related practices as compared to their wives (Pearson x^2<0.05). Agroforestry is a long-term land investment that depends on land ownership and secure land tenure, which is typically higher for men. Moreover, women's low-decision-making power on the use of land (as shown in the subsequent section) could hinder their adoption of agroforestry. However, the qualitative findings show that membership in women's groups encourages the planting of fruit orchards (e.g., avocados and pawpaw) as agroforestry systems. Hence, this strategy allows for diversifying household sources of food and nutrition as well as sources of income.

During FGDs, women in the semi-arid regions indicated that gender roles and norms within the households and the communities are changing. It is the traditionally the women's role to collect water, and to feed the livestock held in the household. However, during water scarcity arising due to extreme droughts, men take up the responsibility of fetching water from distant sources using donkey carts or bicycles. In addition, they also look for distant fodder from the forest or wetlands. These activities act as sources of livelihood for men during dry season who also sell water and fodder to the community members. Besides, male farmers take up food crops that are culturally perceived as 'female crops', such as sorghum, cassava and arrowroots because these crops are resilient to harsh weather. The qualitative findings further show that group-based approaches allow men in the sub-humid zones to address cultural barriers that prevent women from the adoption of some climate-smart strategies such as planting trees and early land preparation.

3.5.4 Gender differentiated access to physical, livestock and human development capital

3.5.4.1 Access to physical capital, livestock and control over land

Figure 3.1 presents findings on the gender-differentiated ownership of household assets. The findings show that husbands own a higher proportion of assets, except for consumable assets. It is interesting to note that husbands and wives jointly own a bigger proportion of large, small ruminant and non-ruminant livestock such as sheep and goats, rabbits and poultry. However,

husbands own and control a bigger percentage of draft animals (oxen and donkey), while wives control poultry.

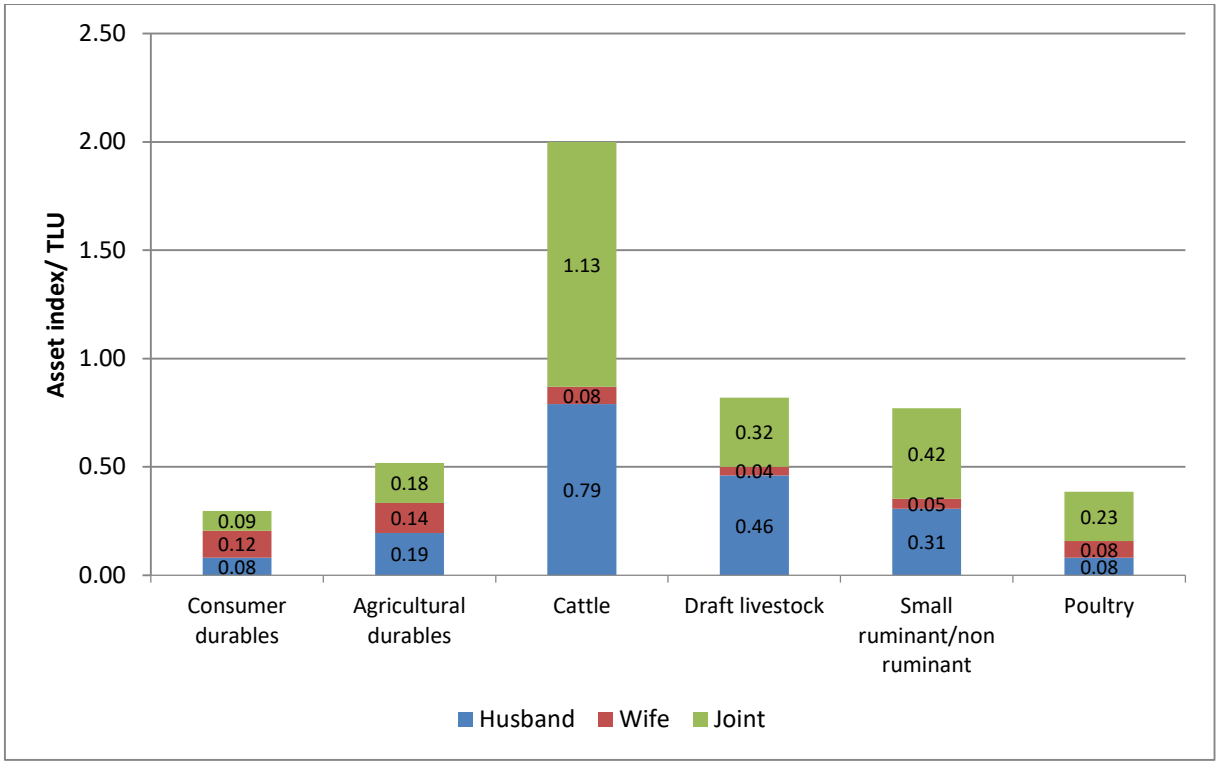

Figure 3.1: Gender-differentiated ownership of household assets
Source: Authors' computations centered on 2012 intra-household dataset

Further, the results show that less than one percent of female spouses make independent decisions on land use. Kappa estimate on decisions about the use of land shows that 61 percent of couples agree that they consult each other on how to use land. However, the overwhelming majority of male spouses make decisions without consulting their spouses (77%), while 34 percent of wives noted that decisions on land use are made in consensus. Interestingly, there is a clear discrepancy in the answers of husbands and wives in the same household regarding the decision-making process on land use.

3.5.4.2 Education and access to finance

Human development is an important asset that provides a buffer against the adverse impact of climate and weather shocks. The results show that husbands have a higher level of schooling (8 years) than wives (6.2 years), implying that husbands have usually at least basic primary education. In the domain of literacy, there is perfect agreement in the answers of couples regarding their literacy levels, indicating that 83 percent of couples could write and read (Kappa P= 0.001). Nonetheless, the analysis shows that a higher proportion of the husbands have a higher

literacy level (94%), than their wives do (80%) (Pearson x^2<0.001). Besides, there is no significant gender disparity in access to credit and the level of savings among husbands and wives.

3.5.5 Access to agricultural and climate information

Table 3.5 presents the findings on gender disparities in access to agricultural and climate information. The results show that husbands and wives have interacted with extension officers during their field visits (60.9%, Kappa P-value <0.05). However, husbands have more access to information on crop and livestock production and more access to extension services than the wives (Pearson x^2<0.001). In turn, wives have more access to weather forecast (Pearson x^2<0.001) and to advice on climate adaptation options. However, a higher percentage of husbands have access to early warning systems for severe or abrupt events such as floods and drought (Pearson x^2<0.05). Information on climate change in the form of early warning systems and seasonal weather forecasts, allows farmers to make well-informed decisions on farming practices, which lowers their vulnerability to climate change.

Table 3.5: Gender-differentiated access to agricultural and climate information

Sources of information	Wives (% Yes)	Husbands (% Yes)	Difference in % point	Significance x^2 (P-value)	Agreement (%)	Kappa	Significant Kappa (P-value)
Agricultural information							
Crop production	89.10	97.44	-8.33	0.003***	86.54	-0.04	0.761
Livestock production	73.08	88.46	-15.38	0.001***	66.67	-0.03	0.684
Access to extension (overall)	59.62	82.05	-22.44	0.000***	54.49	-0.04	0.711
Farmers' field school	42.31	21.15	21.15	0.000***	53.21	-0.03	0.649
Crop extension service	53.21	79.49	-26.28	0.000***	50.64	-0.03	0.651
Livestock extension service	39.74	61.54	-21.79	0.000***	47.44	-0.01	0.521
Farm visit	24.36	45.51	-21.15	0.000***	60.90	0.18	0.006**
Climate change information							
Climate change	87.18	88.39	-1.21	0.745	76.77	-0.08	0.839
Advice to respond to climate change	62.17	58.97	3.20	0.562	49.36	-0.06	0.770
Early warning	26.28	38.46	-12.18	0.022**	53.21	-0.05	0.746
Seasonal forecast	30.13	26.28	3.85	0.450	52.56	-0.17	0.983
Weather forecast	63.46	44.87	18.59	0.001***	49.36	0.01	0.424
N	156	156					

Notes: Superscript * presents significance at the 10% level, ** at the 5% level, ***at the 1% level.

Source: Authors' computations centered on 2012 intra-household dataset

Further analyses show that there are gender-specific preferences of information dissemination channels. For instance, husbands and wives prefer accessing information through group-based approaches, neighbors and meetings with local leaders (Kappa P-value <0.05). Nonetheless,

husbands easily access agricultural information channeled through extension officers (Pearson x^2<0.01), meeting with local leaders (Pearson x^2<0.01) and printed media-newspapers (Pearson x^2<0.005). In contrast, wives prefer accessing agricultural information through radio programs (Pearson x^2<0.10) and group-based approaches (Pearson x^2<0.10).

For farmers to apply agricultural and climate information, the information ought to be truthful, accurate, and reliable. Trust in the information acquired through different channels is likely to influence taking up climate-smart agricultural strategies. Both husbands and wives perceive that the information they acquire through group-based approaches, printed media and extension officers is truthful and reliable (Kappa P-value <0.10). Nonetheless, wives have more trust in information they acquire through extension agents and social groups (t-test P-value<0.10). In contrast, men highly trust information from meteorologists (t-test P-value<0.10) (see Table 3A-3 in the appendix). Besides, husbands and wives indicated that the information they acquire through media (radio programs on agriculture) and extension officers is very influential in their decision-making, especially on crop and livestock production, soil and water management practices, agroforestry, and on the uptake of new agricultural technologies, which are all essential climate-smart adaptation strategies.

3.5.6 Gender differences in the role of group-based approaches for managing climate-related risks

3.5.6.1 Participation in social groups by husbands and wives

In rural Kenya, the groups that households and individuals belong to differ in functions and categories. A substantial similarity in the answers of couples in this domain implies that husbands and wives affirm that they belong to the specified categories of social groups. Most husbands and wives indicate that they belong to a social group (Kappa P-value<0.001). There is a significant difference, however, between couples regarding the level of participation in group-based approaches. A higher percentage of wives (91%) belong to social groups than husbands (81%) (Pearson x^2<0.05) as shown in Table 3.6.

The findings also show that husbands and their spouses belong to different social groups. A higher percentage of husbands belong to community-based organizations (CBOs) as compared to the wives (Pearson x^2 <0.10). Being a member of CBOs enhances political capital and power dynamics within the community and mediates external support and resources that are necessary to build resilience against extreme events. Besides, a higher percentage of husbands belong to farmer's associations (Pearson x^2<0.001) and group-based welfare associations (Pearson x^2 <0.10). In turn, wives are more active in women's groups and micro finance groups. Interestingly, husbands than wives have a higher duration of group membership (t-test P-value <0.10). This could imply that the groups that men belong to are more sustainable. Further, a higher proportion of husbands

belong to mixed-gender groups (heterogeneous groups) as compared to wives who mostly belong to single-gender groups (homogeneous groups) (Pearson $x^2 < 0.01$).

Table 3.6: Participation of husbands and wives in group-based approaches

Group categories	Wives (% Yes)	Husbands (% Yes)	Difference in % point	Significance x^2 (P-value)
Belong to any social group	91.17	80.81	10.36	0.018**
CBOs	16.67	23.72	-7.05	0.100*
Soil and water management	3.21	3.21	0.00	1.000
Farmer groups	8.33	33.97	-25.64	0.000***
Micro finance groups	10.25	6.41	3.84	0.219
Youth groups	1.28	1.92	-0.64	0.652
Women's groups	62.82	8.33	54.49	0.000***
Men's group	0.64	9.62	-8.98	0.000***
Religious group	4.48	2.56	1.92	0.357
Welfare group	17.95	25.00	-7.05	0.100*
At least one group is a mixed-gender group	48.08	75.64	-27.56	0.000***
Duration of group membership in years (mean)	10.12	11.91	-1.79	†0.285
Numbers of groups belonging to (mean)	1.26	1.15	0.11	†0.087*
N	156	156		

Notes: Superscript * presents significance at the 10% level, ** at the 5 % level, ***at the 1% level. † indicate t-test estimates of population-level mean comparisons.

Source: Authors' computations centered on 2012 intra-household dataset

3.5.6.2 Formulation and accumulation of social capital by husbands and wives

Table 3.7 shows how husbands and wives form and accumulate their social capital by connecting to group-based activities. A substantial agreement in the responses of husbands and wives in this domain implies that husbands and wives form and accumulate social capital through group-based approaches in a similar manner.

Husbands and wives affirm that they are willing to participate in disaster management activities (91% in agreement) (Kappa P-value<0.05), that they are willing to contribute both time and labor (89% in agreement) (Kappa P-value<0.001) and that they are willing to participate in other group activities (80% in agreement) (Kappa P-value<0.05). Besides, husbands and wives slightly agree that most people in the community are trustworthy (56% in agreement) (Kappa P-value<0.05) and they affirm to have witnessed sanctions to the community members who are not willing to participate in group-based approaches and community activities (62% in agreement) (Kappa P-value<0.05).

Table 3.7: Formulation and accumulation of social capital for husbands and wives

Proxy of social capital	Wives (% Yes)	Husbands (% Yes)	Difference in % point	Significance x^2 (P-value)	Agreement (%)	Kappa	Significant Kappa (P-value)
Social capital index (mean)	0.68	0.71	-0.03	†0.060*			
Willing to participate in disaster management	91.67	98.08	-6.41	0.010**	91.03	0.10	0.056*
Willing to contribute labor	89.10	97.43	-8.33	0.003***	89.10	0.16	0.005*
Willing to contribute funds for community work	78.85	93.59	-14.74	0.000***	75.00	-0.01	0.536
Involvement in group activities	90.38	83.33	7.05	0.065*	80.13	0.14	0.034*
Work with others in community work	35.90	67.31	-31.41	0.000***	49.36	0.08	0.119
Witnessed sanction	64.10	66.03	-1.93	0.722	62.18	0.17	0.017*
Support from relatives	37.18	36.54	0.64	0.907	53.21	-0.01	0.526
Support from neighbors	36.54	35.90	0.64	0.906	53.21	-0.01	0.563
Support from friends	29.49	17.31	12.18	0.011**	59.62	-0.10	0.915
Trust neighbors with your kids	74.36	78.21	-3.85	0.525	64.10	0.01	0.450
Most people in the community are trustworthy	46.15	50.00	-3.85	0.497	56.41	0.13	0.054*
N	156		156				

Notes: Superscript * presents significance at the 10% level, ** at the 5 % level, ***at the 1% level. † indicate t-test estimates of population-level mean comparisons.

Source: Authors' computations centered on 2012 intra-household dataset

The findings also show that husbands than wives are more willing to cooperate in community activities (67% and 36%, respectively) (Pearson x^2<0.05). Further, the findings indicate that husbands have a higher social capital index (0.71) as compared to the wives (0.68), a difference that is statistically significant at 10% (t-test P value<0.10). Besides, a higher percentage of wives than husbands are willing to participate in group-based activities and have received support from members of social group in the incident of extreme events (Pearson x^2<0.001).

3.5.6.3 The potential for gender-differentiated group-based approaches in enhancing adaptive capacity, building assets and fostering welfare

Group-based approaches provide a platform for sharing climate information, ideas for adaptation and risk management (Table 3.8). A higher percentage of husbands than wives acquire climate information, adaptation ideas, and access to farm inputs through social groups (Pearson x^2<0.01). Cross-tabulations and T-test estimates indicate that husbands and wives belonging to social groups have more access to early warning information (t-test P<0.10) and access to a higher number of sources of information than non-group members (t-test P<0.10) (see Table 3A-1 in the appendix). The qualitative analysis shows that in some cases, group members contribute money to purchase farm inputs (seeds and fertilizer) in bulk, thus enjoying economies of scale and

reducing the transaction costs. Access to information and inputs are the key catalyst for adapting to climate change. The group-based adaptation practices highlighted by men and women include water-harvesting, tree planting, forage banks, while adopting energy saving stoves is purely a women's affair.[33]

Table 3.8: Gender-differentiated linkages of group-based approaches to climate change adaptation and managing climate risk

Benefits acquired through group-based approaches	Wives (% Yes)	Husbands (% Yes)	Difference in % point	Significance x^2(P-value)
Access to climate information	22.44	38.46	-16.03	0.002***
Advice on adaptation options	32.05	46.79	-14.74	0.008***
Access to agricultural inputs	32.05	49.36	-17.31	0.002***
Diversify sources of livelihood	73.72	64.74	8.97	0.086*
Manage risks	80.77	68.59	12.18	0.013**
N	156	156		

Notes: Superscript * presents significance at the 10% level, ** at the 5 % level, ***at the 1% level
Source: Authors' computations centered on 2012 intra-household dataset

Group-based approaches do not work in isolation from other institutions and governance structures. For instance, farmers use demand-driven extension delivery approaches whereby they organize themselves and invite the extension officers for training and advice on appropriate adaptation options and other agricultural development opportunities. Alternatively, extension agents and non-governmental organizations (NGOs), micro-finance and commercial banks work closely with social groups by organizing entrepreneurship /agribusiness trainings, agricultural trainings and when targeting rural and agricultural development programs. These qualitative findings are further supported by cross-tabulation analysis which suggests that group membership enhances husbands' and wives' access to extension services (t-test P<0.10) and farmer field schools (t-test P <0.10) (see Table 3A-1 in the appendix). Therefore, group-based approaches enhance capacity building and human capital development, which not only increases knowledge in adaptation options, but may also add value in agricultural production.

Associating in social groups also offers alternative sources of livelihood diversification and acts as a risk management tool through innovative systems that encourage adaptation to climate change. Women's groups often assist women to diversify their sources of livelihood (Pearson x^2<0.10) and to manage climate (as well as non-climate) risk (Pearson x^2<0.05). These innovative systems

[33]Cross-tabulation analyses show that farmers belonging to social groups are more likely to change crop variety and types, supported by group-based seed acquisition. These farmers besides take up soil and water conservation practices, soil amendment practices, agroforestry and diversify livestock feeds, as compared to non-group members.

include individual and group-based income generating activities, provision of financial facilities and safety net programs. Group-based savings and loans provide informal access to credit that does not only create opportunities to diversify sources of livelihood but also act as insurance in times of shock. Group-based micro-credit facilities also enhance women's ability to build asset portfolios, besides, enhancing their welfare through enabling them to pay school tuitions for their kids and gain autonomy over their proceeds. The findings show that men and women belonging to social groups have more access to credit (t-test $P<0.05$) as compared to non-group members. Group-based asset acquisition helps men and women to build their asset portfolios and welfare. Men and women take part in group-based livestock acquisition, such as poultry, rabbit, dairy goats, cattle, and group-based fish production.[34] Farmers multiply livestock through exchange, passage of offspring and rotating of the male animal for reproduction purposes with the rest of members of social group. Farmers mostly prefer dairy goats to cows because they require less pasture, have a higher adaptive capacity to extreme events such as drought, require less labor and their milk has higher nutritional value. Another way in which social groups enhance women's assets is through collective purchasing of household consumer durable assets such as household appliances, water tanks, cooking stoves, and pots that augment their asset portfolios.

The qualitative findings also show those women's groups rent in land, thereby increasing their access to land and their decision-making authority over the use of land.[35] This kind of arrangement has a far-reaching effect on women's adaptive capacity and welfare with respect to improving their position of household food and nutritional security and diversifying sources of income. Apart from group-based food production, women's groups collectively purchase food stock in bulk and sub-divide it among themselves. This approach increases food security and improves nutritional outcomes, besides augmenting women's saving capacity by reducing the cost of food in the household, bearing in mind increasing food prices and costs of living.[36] Consequently, the savings realized by reducing the costs of food is crucial in investing in supplementary income-generating ventures, accumulating extra assets, and meeting additional family end needs. Group-based welfare associations help men and women to cope with sudden risks, such as illness or death of family members or any other misfortune incidences. A case in point is that group members provide nursing care, provide labor in agriculture, and take over the medical bill for an ailing member. Although most of the groups that farmers belong to are not formed by the explicit function of adapting to climate change, they often divert from their main mandate to address the current and pressing needs of their members. Groups that have micro-credit as their key mandate

[34]The *Wagai integrated farming program (WIFAP)* based in Gem district is a CBO comprising of 125 small groups and with over 1000 members have a group-based fish farming and bee-keeping project. The group also work together with local and international with NGOs such as Vi Agroforestry (trains members on agroforestry, soil conservation and involves members in the agricultural carbon project) and Heifer international (group-based livestock procurement).

[35]A working example is the women's groups in Njoro that collectively rent-in land for demonstration plots and practice group-based conservation agriculture.

[36] A working example is *Ndirithia women group* in Mukurueini district

illustrate this, as they take up other functions such as asset acquisition, agricultural production, welfare and risk management in times of crisis. The evidence collected in this study provides new insights on gender differentiated group-based approaches and it is considerable potential to enable their members to manage climate risk in the face of rapid climate change.

3.6 Econometric Analysis

This section presents the empirical strategy to examine factors that influence the decisions of husbands and their spouses to adopt climate-smart agricultural strategies and the intensity of adoption. The section starts by explaining the choice of model that is appropriate for our research questions and data. The study embraces a *two-part hurdle approach,* where the *first hurdle* is captured in a binary model for husbands' and wives' decision to adopt climate-smart strategies. The *second hurdle* is captured in a negative binomial model that examines the drivers of the intensity of adoption of climate-smart practices, measured in the number of strategies implemented by husbands and wives. The study draws attention to the role that social capital play in influencing husbands' and their spouse's decisions to adapt to climate change. Since social capital is likely to be an endogenous variable, the study applies two-stage Probit Least squares (2SPLS) methodology estimated via a simultaneous approach in the first hurdle. The control function approach together with the Heckman Inverse ratio that controls for endogeneity and selection bias was estimated in the second hurdle. Lastly, the section compares the empirical findings between the models.

3.6.1 Empirical strategy

The study aims to examine factors that influence husbands and wives' decisions to adopt climate-smart strategies and the intensity of adoption. It pays special attention to the influence of social capital created through group-based approaches on the uptake of climate-smart agricultural decisions and the adaptive capacity of husbands and wives. Past studies used multivariate models (Yegbemey et al. 2013) or multinomial logit models (Gbetibouo et al., 2010; Hisali, Birungi, & Buyinza, 2011) to examine the choice among several or multiple adaptation options. Other studies applied binary models for discrete choices (Fosu-mensah, Vlek, & Maccarthy, 2012; Silvestri, Bryan, Ringler, Herrero, & Okoba, 2012). It is taken into account that small-scale farmers are risk averse, and that they adopt numerous feasible practices to reduce their vulnerability to weather variability and climate change. Therefore, small-scale farmers adopt practices concurrently as complements, supplements, or substitutes to cope with their underlying constraints, particularly financial constraints to adopt one large and effective strategy. Multivariate and multinomial models may require grouping adaptation strategies into one category, an approach that could suffer from the 'fallacy of discrete choice' models. In this paper, we adopt a *two-part hurdle approach* to identify both the drivers of husbands' and wives' decisions to adopt climate-smart strategies and the factors that influence the intensity of adoption of these strategies.

In the *first hurdle,* a binary model is appropriate to examine husbands' and wives' decision to adopt (or not to adopt) climate-smart agricultural strategies and practices. A binary model is specified as follows

$$y_{1i} = X'_i\beta + \beta SC_{1i} + \varepsilon_i \qquad (1)$$

Where y_i is the binary dependent variable, X_i is a vector of exogenous variables, including individual demographics, institutional factors, wealth indicators and individual characteristics (As defined in Table 3.1), while β is a vector of coefficients to be estimated. SC_{1i} is a social capital index (group-based approaches index), while, ε_i is the error term. This model follows a cumulative normal distribution and assumes all variables are exogenous.

In the *second hurdle*, we examined the driver of intensity of adoption 'number of adopted climate-smart agricultural practices'. The starting point for count data of intensity of adoption of climate-smart strategies is the use of the Poisson distribution, with conditional mean such as

$$y_{2i} \sim Poisson\ (\mu_i)$$

$$\mu_i = E(y_{i2}|SC_i, X_i, u_i) = \exp(\beta_1 SC_i + X'_i\beta_2 + u_i) \qquad (2)$$

Where y_{i2} presents the intensity of adoption of climate-smart strategies of husbands and wives, and u_i is an error term. The error term induces over-dispersion to generalize the Poisson model to control for over dispersion, which gives the same results as a negative binomial model (Cameron & Trivedi, 2010). This model assumes that $E(u_i|x_i = 0)$ However, some of the elements of x_i and SC_i might be endogenous such that $E(u_i|x_i) \neq 0$. This implies that μ_i is no longer the conditional mean of y_{i2} and the Poisson maximum likelihood estimator will not be an appropriate model that lead to inconsistent results (Windmeijer and Silva 1997; Greene 2009).

3.6.1.2 Addressing endogeneity of social capital created by 'group-based approaches'

A far-reaching literature indicate that social capital is endogenous (Narayan & Pritchett 1999; Aker 2005; Adepoju & Oni 2012). Considering the cross-sectional nature of our data set, social capital index and other variables are likely to be endogenous. Endogeneity may arise due to simultaneity between a regressor and the outcome ('simultaneity bias') or if there is a causal effect between a regressor and the outcome ('reverse causality'). Participation in group-based approaches is a costly affair concerning time, forgone income in terms of time and work or in regular monetary contributions or in kind. Participation in group-based approaches also faces a challenge of 'self-selection' where individuals freely decide to take part or not and their decision to participate in group-based activities are less likely to be 'random'. Further, social capital is likely to be destroyed by extreme events similar to physical capital. Social capital also disintegrated due

to extreme events such as drought as individuals divert resources like time to look for livelihood elsewhere or migrate to look for employment as a coping strategy (Bernier & Meinzen-Dick 2014).

One of the recommended approaches of addressing endogeneity is the use of nonlinear instrumental variable (IV) estimation approach, two stages least square (2SLS) and use of control function or two-stage regression procedure that gives consistent results (Heckman & Navarro-lozano 2004). Previous studies have used various instruments for social capital, including trust (Narayan & Pritchett, 1999; Yusuf, 2008), membership to religious and ethnic groups and years of households residence in a community (Aker, 2005), adopted in (Adepoju & Oni, 2012), duration of membership in social associations and the number of adults in the household (Mawejje & Holden, 2014). If suitable instruments z_i are available, then $E(u_i|z_i) = 0$).[37] Without suitable instruments for social capital, the control function is the alternative appropriate approach. This study adopts the control function approach. The control function approach (CF) gives consistent results in the presence of endogenous regressor (Heckman & Navarro-lozano, 2004; Jeffrey M Wooldridge, 2014) and it takes into account the non-linear interaction between the endogenous term and the error terms (Adepoju& Oni 2012). Unlike the IV approach, CF is estimated with the observed endogenous variables and its residuals in the second stage. If endogeneity of social capital is ignored, the standard single-equation estimator and its coefficients will not be consistent. We applied Smith and Blundell's test approach (1986) to examine the endogeneity of social capital and other variables because of the non-linear nature of our model and dependent variable being dichotomous.[38]

In the *first hurdle,* the analysis is confronted with a problem where one of the endogenous variables is dichotomous (decision to adopt climate-smart agricultural practices), and the second endogenous variable is continuous (social capital). Rivers & Vuong (1988) recommends the use of Ordinary Least Squares (OLS) in the first stage and a generalized-linear Probit model in the second stage. This approach ignores the simultaneity relationship between dichotomous dependent variable and continuous endogenous variables. In this scenario, the most appropriate efficient estimator is the use of Two-Stage Probit Least Squares (2SPLS) methodology estimated via a simultaneous approach unlike the control function which is implemented by single-equation approach (see Keshk 2003 for model specifications).

In the *second hurdle,* the study adopts a control function approach together with the Heckman Inverse ratio to control for both endogeneity and selection bias (Heckman 1979; Wooldridge 2007). The analysis combines the first stage OLS residue of social capital and inverse Mill's ratio in the second stage of count model such that

[37]Two assumptions need to be met for a suitable z_i. First, the u_i and z_i must be mean independent such that $E(u_i|z_i)$ = E (u_i). The second assumption executes a restriction such that $E(y_i|x_i, u_i, z_i) = E(y_i|x_i, u_i)$ implying that regression errors become $E(\mu_i|x_i, u_i, z_i = 0)$.

[38]The Smith-Blundell test of exogeneity of social capital indicate that it is endogenous (P-value = 0 .064).

$$\mu_i|X_i, SC_i, \varepsilon_i = \exp(\beta_1 SC_i + X'_i\beta_2 + \lambda_i + \rho\hat{\varepsilon}_i) \qquad (3)$$

The new additional variable, $\hat{\varepsilon}_i$ in the second stage of the model estimation that replaces ε_i with $\hat{\varepsilon}_i$ yields consistent estimates, λ_i corrects for selection bias in the model. A zero-truncated negative binomial model is estimated because it control for over-dispersion, excessive zeroes and provide a better fit of the model (Saffari, Adnan, & Greene, 2012). The study estimated separate models for husbands and wives to evaluate the drivers for their decision to adopt at the same time controlling for household-level unobservable conditions. A robust command addressed potential heterogeneity between the respondents, while correlation analysis ruled out the relationship across variables used in the model.

3.6.2 Econometric results of model that does not account for endogeneity

Table 3.9 presents the econometric results for drivers of adopting climate-smart agricultural practices at individual and household level, without addressing for endogeneity. The findings show that the social capital index has a positive and statistically significant effect on husbands' decision to adopt and on the intensity of adaptation to climate change at both individual and household levels. However, it has a negative and statistically insignificant influence on the decision of the wives. The consensus on the use of land has a positive and statistically significant effect on husbands' decisions to adopt livestock-related practices but negatively influences wives' intensity of uptake of technologies. In addition, education levels influence both wives' and husbands' decisions to take up crop-related practices and wives' education influences household's decision to scale up climate-smart agricultural technologies. Household consumer durable assets influence wives' decision to adopt livestock-related practices.

Access to Farmer Field Schools (FFS) as an approach to disseminate agricultural and climate information has a positive and statistically significant influence on wives' decision to adopt crop- and livestock-related practices and on overall household's decision to adapt to climate change. Besides access to FFS has a positive influence on the numbers of strategies that are adopted by wives and by the households. Further, access to early warning information increases the likelihood of uptake of the crop- and livestock related practices, and overall household's decision to adapt to climate change and uptake of numerous climate-smart agricultural strategies for the husbands and for the households. An interesting and notable finding is the influence of trust in information acquired on the decision to adopt and intensity of adaptation to climate change. The results show that reliable and truthful information statistically influences the wives' decision to adopt crop- and livestock-related climate-smart practices. Access to reliable information also influences taking up several climate-smart agricultural strategies by wives. Human psychological factors such as risk perceptions, worry, and attitude towards climate change positively and statistically significantly influence the decision to adopt and the intensity of adoption of climate-smart agricultural strategies. This finding applies to both husbands and wives.

Table 3.9: Results of the Probit binary model on the decision to adopt and Negative binomial model on the intensity of taking up climate-smart agricultural practices of husbands and wives

	Probit binary model						Negative binomial model			
Variables	Uptake of crop-related climate-smart practices		Uptake of livestock-related climate smart practices		Household decision to adopt climate smart practices		Intensity of uptake of climate-smart practices		Household intensity of uptake of climate-smart practices	
	Wives	*Husbands*	*Wives*	*Husbands*	*Wives*	*Husbands*	*Wives*	*Husbands*	*wives*	*Husbands*
Social capital index of husbands	-	1.324 (0.944)	-	0.787 (0.911)	-	1.374 (0.969)	-	0.728** (0.415)	-	0.605** (0.313)
Social capital index of wives	-0.630 (1.030)	-	-0.610 (0.755)	-	-1.109 (1.074)	-	-0.095 (0.304)	-	-0.344 (0.239)	-
Years of schooling of husbands	-	0.067* (0.040)	-	-0.001 (0.035)	-	0.055 (0.040)	-	0.014 (0.018)	-	0.007 (0.012)
Years of schooling of wives	0.105* (0.056)	-	0.034 (0.039)	-	0.103* (0.057)	-	0.011 (0.016)	-	0.022** (0.012)	-
Age in years of husbands	-	-0.014 (0.012)	-	-0.011 (0.010)	-	-0.015 (0.012)	-	0.008* (0.005)	-	0.003 (0.004)
Age in years of wives	-0.015 (0.017)	-	0.006 (0.011)	-	-0.005 (0.017)		-0.001 (0.005)	-	-0.002 (0.003)	-
Number of information sources of husbands	-	0.147 (0.138)	-	0.007 (0.133)	-	0.197 (0.141)	-	0.030 (0.073)	-	0.058 (0.044)
Number of information sources of wives	-0.151 (0.168)	-	0.117 (0.123)	-	-0.136 (0.172)	-	0.013 (0.051)	-	0.005 (0.035)	-
Trust index- information of husbands	-	0.168 (0.600)	-	-0.475 (0.586)	-	0.289 (0.624)	-	0.081 (0.315)	-	0.008 (0.223)
Trust index- information of wives	2.656** (0.930)	-	1.491** (0.698)	-	1.748* (0.923)	-	0.601* (0.366)	-	0.413 (0.277)	-
Perceive increase in temperatures * decrease in rainfall of husbands	-	0.806*** (0.305)	-	0.683*** (0.267)	-	0.778*** (0.308)	-	0.050 (0.134)	-	0.144 (0.094)
Perceive increase in temperatures * decrease in rainfall of wives	1.001*** (0.338)		-0.007 (0.237)	-	0.787** (0.334)	-	0.324** (0.121)	-	0.110 (0.085)	-
Human attitude to climate change of husbands	-	4.858*** (1.855)	-	6.227*** (2.273)		3.618** (1.883)	-	2.392** (1.223)	-	1.741** (0.693)
Human attitude to climate change of wives	-0.108 (1.153)	-	1.975* (1.228)	-	0.305 (1.165)	-	1.317* (0.678)	-	0.426 (0.370)	-
Early warning of husbands	-	0.872** (0.344)	-	0.548** (0.285)		0.576* (0.341)		0.196 (0.162)	-	0.169* (0.100)
Early warning of wives	0.395 (0.392)	-	0.151 (0.271)	-	0.611 (0.415)	-	0.155 (0.121)	-	-0.054 (0.101)	-
FFS of husbands	-	-0.233 (0.318)	-	0.366 (0.300)	-	-0.059 (0.330)	-	0.258 (0.177)	-	-0.057 (0.113)
FFS of wives	0.895**	-	0.501**	-	0.977*	-	0.441**	-	0.063	-

	(0.396)		(0.268)		(0.409)		(0.127)		(0.096)	
Household size	0.103	-0.032	0.055	-0.015	0.112	0.029	-0.012	-0.015	-0.013	0.000
	(0.074)	(0.060)	(0.053)	(0.052)	(0.075)	(0.061)	(0.023)	(0.023)	(0.017)	(0.018)
Household's access to credit	0.061	0.192	-0.228	-0.310	-0.208	-0.019	-0.116	-0.079	0.008	-0.059
	(0.354)	(0.297)	(0.273)	(0.286)	(0.374)	(0.305)	(0.128)	(0.137)	(0.101)	(0.097)
Household's decision on land use	-0.143	0.140	-0.217	0.701**	0.078	0.327	-0.175*	0.045	0.076	-0.043
	(0.343)	(0.298)	(0.261)	(0.280)	(0.350)	(0.304)	(0.105)	(0.157)	(0.086)	(0.096)
Household's agricultural asset index	-0.304	-0.423	-0.605	-0.125	-0.922	-0.331	0.207	0.095	-0.036	-0.043
	(0.612)	(0.497)	(0.457)	(0.449)	(0.630)	(0.499)	(0.166)	(0.270)	(0.135)	(0.157)
Household's consumer durable assets	1.539	-0.425	1.349**	-0.146	1.210	-0.439	0.177	-0.022	0.260	0.097
	(1.110)	(0.786)	(0.668)	(0.691)	(1.092)	(0.799)	(0.209)	(0.382)	(0.173)	(0.221)
Household's TLU	0.002	0.032	-0.062	0.048	-0.003	0.067	-0.004	-0.023	0.004	0.000
	(0.051)	(0.048)	(0.036)	(0.038)	(0.051)	(0.053)	(0.014)	(0.017)	(0.009)	(0.012)
Household's rainfall*temperature	7.547*	-2.031	9.179**	4.434	8.330*	-3.853	2.818**	2.710**	2.942***	2.457**
	(4.449)	(3.044)	(2.948)	(2.885)	(4.548)	(3.157)	(1.208)	(1.340)	(0.919)	(1.012)
Households located in Sub-humid regions	-4.339*	2.646	-5.130**	-2.147	-4.405(	3.430*	-1.453**	-1.185	-1.450**	-1.112*
	(2.770)	(1.933)	(1.826)	(1.772)	2.821)	(1.980)	(0.719)	(0.843)	(0.570)	(0.625)
Households located in semi-arid regions	-0.661	0.509	-0.865**	-0.203	-0.678	0.808*	-0.232	-0.342	-0.244	-0.153(
	(0.500)	(0.448)	(0.415)	(0.412)	(0.512)	(0.475)	(0.205)	(0.230)	(0.154)	0.165)
Constant	-75.119*	14.240	-92.932**	-49.411*	-82.247*	32.947	-28.667**	-29.062**	-28.057***	-25.199**
	(43.220)	(29.448)	(28.826)	(27.938)	(44.121)	(30.530)	(11.842)	(13.004)	(8.952)	(9.784)
Number of observations	156	156	156	156	156	156	132	119	150	150
Pseudo R2	0.333	0.274	0.179	0.243	0.299	0.25				
Wald chi2 (18)	48.950	50.85	38.580	52.23	39.990	54.71	74.97	34.48	58.14	49.9
Log likelihood							-208.35	-201.608	-297.897	-317.54
Prob>Chi2							0.000	0.011	0.000	0.000

Notes: Corrected and robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1. Humid regions is used as a base variable for agro-ecological regions

Source: Authors' computations centered on 2012 intra-household dataset

Farmers who perceive long-term changes in average temperature and precipitation are more likely to take up climate-smart technologies. Further, households located in the sub-humid regions and semi-arid regions are more likely to adopt climate-smart agricultural strategies, but are less likely to uptake several of these practices, as compared to households in humid regions. This is due to individual's and household's adaptive behavior influenced by different climatic, socioeconomic, and cultural conditions, susceptibility to climate change and different institutional arrangements of diverse agro-ecological regions.

3.6.3 Econometric results of model addressing endogeneity

The Two-Stage Probit Least Squares (2SPLS) model estimated the simultaneous equation model of the decision to adopt and endogenous social capital, while the control function approach and the inverse Mills ratio in Zero-truncated negative binomial addressed endogeneity and selection bias while estimating factors influencing the intensity of adoption (see Table 3.10). The findings of the model addressing endogeneity of social capital show a higher coefficient of social capital than the model that does not address endogeneity. This could imply that social capital is endogenous. Similarly, in the model addressing endogeneity, the social capital index is likely to influence husbands' decision to adopt crop-related practices and household's decision to embrace climate-smart practices. The social capital index also influences household's intensity of adopting climate-smart agricultural practices. There are several reasons that could explain the above observations. First, summary statistics show that a higher percentage of husbands share climate information and advice on adaptation ideas through social groups, while, on the other hand, wives benefit from livelihood diversification and risk management. Second, husbands than wives have a higher rate of participation in community activities and community-based organizations, thus having higher social and political capital. Third, cross-tabulation analysis shows that a higher percentage of husbands are active in farmer's groups and are taking up several climate-smart agricultural practices than non-group members.

An interesting and notable difference of the two models is the influence of trust in information on wives' decision to adopt, while access to numerous sources of agricultural information is less likely to influence husbands' decision to adopt climate-smart practices. These results suggest that wives are less likely to adapt to climate change if they distrust the information they acquire. Trust in institutions expedites understanding and taking up of information and farmers with high-trust index (women) are more likely to use that information and in turn adapt to climate change. These findings are supported by descriptive statistics, according to which wives have a higher trust index, whereas husbands have higher access to information sources. Similar to the results of model that does not address endogeneity, access to farmer's field school is likely to influence the wives' decision to adapt to climate change. Notably, the interaction of perceptions of change in average rainfall and temperature is likely to influence both wives' and husbands' decision to adopt, but wives decision to take up several climate-smart practices.

Table 3.10: Results of the Two-Stage Probit Least Squares on decision to adopt and Heckman's count model on the intensity of taking up climate-smart strategies of husbands and wives

	Two-Stage Probit Least Squares model						Control function and Heckman's count model			
Variables	Uptake of crop-related climate-smart practices		Uptake of livestock-related climate-smart practices		Household decision to adopt climate-smart practices		Intensity of uptake of climate-smart practices		Household intensity of uptake of climate-smart practices	
	Wives	*Husbands*	*Wives*	*Husbands*	*Wives*	*Husbands*	*Wives*	*Husbands*	*Wives*	*Husbands*
Social capital index of husbands	-	3.325** (1.330)	-	1.565 (1.149)	-	3.896*** (1.356)	-	1.596** (0.669)	-	0.983** (0.374)
Social capital index of wives	0.947 (1.065)	-	0.273 (0.918)	-	0.136 (0.952)	-	0.348 (0.441)	-	-0.013 (0.269)	-
Residue (husbands/wives)	-5.865*** (1.848)	-3.684** (1.874)	-2.665 (1.722)	-1.427 (1.604)	-4.677** (1.739)	-4.517* (1.966)	-1.856** (0.753)	-1.273 (0.859)	-1.492** (0.568)	-0.935* (0.508)
Mills ratio (husbands/wives)							-0.880 (0.573)	-2.459*** (0.600)	-0.365 (0.451)	-0.241 (0.387)
Years of schooling of husbands	-	0.075** (0.038)	-	-0.001 (0.034)	-	0.066* (0.038)	-	-0.020 (0.021)	-	0.006 (0.014)
Years of schooling of wives	0.098* (0.060)		0.022 (0.041)		0.098* (0.063)		0.001 (0.016)	-	0.016 (0.013)	-
Age in years of husbands	-	-0.009 (0.011)	-	-0.010 (0.009)	-	-0.009 (0.012)	-	0.014*** (0.005)	-	0.005* (0.003)
Age in years of wives	-0.011 (0.017)	-	0.006 (0.012)	-	-0.002 (0.016)	-	0.001 (0.004)	-	-0.001 (0.004)	-
Number of information sources of husbands	-	0.131 (0.140)	-	0.000 (0.118)		0.180 (0.145)	-	0.033 (0.064)	-	0.036 (0.037)
Number of information sources of wives	-0.148 (0.142)	-	0.138 (0.118)	-	-0.125 (0.154)	-	-0.001 (0.052)	-	-0.014 (0.038)	-
Trust index- information of husbands		0.214 (0.594)	-	-0.459 (0.630)	-	0.362 (0.596)	-	-0.784* (0.426)	-	-0.046 (0.281)
Trust index- information of wives	2.807*** (0.845)	-	1.489* (0.728)	-	1.843** (0.773)	-	0.574 (0.331)	-	0.186 (0.284)	-
Perceive increase in temperatures * decrease in rainfall of husbands	-	0.801** (0.328)	-	0.666*** (0.250)	-	0.779** (0.324)	-	-0.283* (0.170)	-	0.040 (0.106)
Perceive increase in temperatures * decrease in rainfall of wives	1.149*** (0.394)	-	-0.002 (0.238)	-	0.877** (0.338)	-	0.201 (0.146)	-	0.065 (0.121)	-
Human attitude to climate change of husbands	-	5.579** (2.384)	-	6.334*** (2.119)	-	4.377** (2.053)	-	3.010** (1.095)	-	1.899*** (0.569)
Human attitude to climate change of wives	0.023 (0.979)	-	2.017** (0.918)	-	0.428 (0.921)	-	0.680 (0.485)	-	0.141 (0.355)	-

Early warning of husbands	-	0.824** (0.333)	-	0.517* (0.274)	-	0.514 (0.331)	-	-0.217 (0.185)	-	0.140 (0.145)
Early warning of wives	0.225 (0.318)	-	0.093 (0.271)	-	0.482 (0.356)	-	0.034 (0.116)	-	-0.054 (0.108)	-
FFS of husbands	-	-0.378 (0.314)	-	0.313 (0.307)	-	-0.210 (0.328)	-	-0.256 (0.203)	-	-0.037 (0.154)
FFS of wives	0.952* (0.404)	-	0.470* (0.275)	-	1.000* (0.410)	-	0.340*** (0.111)	-	0.047 (0.107)	-
Household size	0.106 (0.082)	-0.028 (0.062)	0.053 (0.050)	-0.018 (0.052)	0.108 (0.076)	0.040 (0.066)	0.009 (0.023)	-0.016 (0.024)	0.004 (0.019)	-0.015 (0.015)
Household's access to credit	0.000 (0.321)	0.117 (0.320)	-0.274 (0.273)	-0.347 (0.297)	-0.249 (0.329)	-0.115 (0.326)	-0.140 (0.122)	-0.181 (0.159)	-0.044 (0.105)	-0.069 (0.096)
Household's decision on land use	-0.320 (0.332)	0.120 (0.322)	-0.283 (0.255)	0.687*** (0.263)	-0.072 (0.318)	0.303 (0.323)	-0.238** (0.115)	-0.195 (0.162)	0.022 (0.091)	-0.058 (0.094)
Household's agricultural asset index	-0.084 (0.577)	-0.488 (0.476)	-0.565 (0.399)	-0.127 (0.489)	-0.786* (0.481)	-0.439 (0.506)	0.047 (0.161)	0.099 (0.229)	0.005 (0.136)	-0.030 (0.130)
Household's consumer durable assets	2.069* (1.023)	-0.480 (0.734)	1.307** (0.583)	-0.183 (0.582)	1.416* (0.887)	-0.555 (0.773)	0.176 (0.184)	-0.100 (0.328)	0.149 (0.176)	0.104 (0.191)
Household's TLU	0.005 (0.049)	0.049 (0.053)	-0.060* (0.032)	0.051 (0.037)	-0.003 (0.052)	0.083 (0.057)	-0.007 (0.012)	-0.026 (0.017)	0.005 (0.010)	-0.004 (0.009)
Household's rainfall*temperature	7.854** (3.651)	-3.545 (2.922)	9.003*** (2.913)	3.910 (2.954)	8.173** (3.587)	-5.956** (3.000)	2.964 (1.163)	0.062 (1.548)	2.359** (0.957)	1.938** (0.900)
Households located in Sub-humid regions	-4.276* (2.284)	3.585** (1.887)	-4.979*** (1.791)	-1.836 (1.843)	-4.090* (2.151)	4.751** (1.955)	-1.704 (0.660)	0.001 (0.976)	-1.236** (0.563)	-0.762 (0.558)
Household located in semi-arid regions	-0.723 (0.463)	0.631 (0.435)	-0.872** (0.398)	-0.161 (0.431)	-0.677 (0.430)	1.005** (0.452)	-0.335 (0.199)	-0.004 (0.244)	-0.242* (0.149)	-0.069 (0.167)
Constant	-79.726* (35.640)	26.679 (28.286)	-91.681*** (28.320)	-44.939 (28.751)	-81.909** (35.132)	50.641* (28.934)	-29.370 (11.562)	-2.375 (14.984)	-21.980* (9.482)	-0.356 (8.701)
Number of observations	156	156	156	156	156	156	132	119	150	150
Pseudo R2							139.31	73.95	80.88	119.81
Wald chi2 (18)							-258.968	-271.26	-319.954	-289.784
Log likelihood (pseudo)	-46.089	-65.219	-87.444	-81.181	-45.187	-61.125	0.000	0.000	0.000	0.000
AIM	0.847	1.093	1.377	1.297	0.836	1.04				

Notes: Corrected and robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1.Humid region is used as a base variable for agro-ecological regions.

Source: Authors' computations centered on 2012 intra-household dataset

Similar to the findings of model that does not address endogeneity, access to and control over consumer durable assets have a positive and significant influence on women's decision to take up new practices and on intensity of adoption, while livestock holding negatively influences husbands' decision to adopt livestock-related practices. The econometric findings clearly show that the interplay between husbands and wives, gender-based access to resources such as access to information, trust, education levels and consumer durable assets influence the decisions of husbands and wives both with regard to the adoption of climate-smart agricultural measures and with regard to the intensity of adoption of these strategies.

3.7 Discussion

While most studies on climate adaptation often neglect gender perspectives or focus on comparing male- and female-headed households, this study applied a more nuanced gender analysis using an individual- and intra-household level data set as well as gender-differentiated FGDs. This approach provides a unique perspective on intra-household gender issues regarding perceptions and adaptive behavior. Although there are some similarities in perceptions of climate-related risk, husbands, and wives have largely different perceptions and concerns regarding climate change. The study shows that there are gendered risk perceptions and worries concerning climate change that in turn influence actor's adaptive behavior. This finding upholds that of Adger et al. (2009) who concluded that men and women perceive and experience risks differently, which limits their adaptation. The existing literature suggests that the gender differences in risk perceptions and concerns about impacts of climate change are due to prevailing social inequality and varying susceptibilities (McCright 2010; Semenza et al. 2011; Safi et al. 2012; van der Linden 2015). Furthermore, our findings indicate that wives pinpoint that climate change is worsening their poverty status especially for women. This is in line with a widespread consensus on the 'feminization of poverty, inequality and susceptibility' in the literature (See Kabeer 2015 and Klasen et al. 2015 for an overview).

Although there are similarities amongst husbands and wives on the uptake of climate-smart agricultural practices, including water and soil conservation practices and agroforestry-based practices, evidence also indicates that couples make independent decisions on which climate-smart technologies they take up. The study's findings suggest that gender-specific uptake of climate-smart agricultural practices depends on gender-specific interaction with access to information, reliability of information, risk concerns and perceptions, institutional arrangements, social relations, gender norms, economic and cultural roles and responsibilities of husbands and wives in the household. For example, a woman in a household has a role to produce food and oversee nutrition outcomes; this may explain the finding that she is more concerned about declining agricultural productivity and food insecurity resulting from climate change. According to Resurrección (2013: 38) women's roles in food production are affected when the agricultural

production deteriorates due to drought and erratic rainfall exposing households to food security risks. Consequently, the findings show that wives adopt practices inclined to crop production to boost food security in the household. It is the role of women to feed livestock, particularly in the central highlands of Kenya (Kristjanson et al. 2010). This may be the reason why wives expressed greater concerns about declining fodder productivity due to frequent dry spells. Hence, women plant forages to lessen their labor burdens of searching for fodder and feeding livestock during dry seasons (see Chapter 4).

Ownership of assets could explain the reason why husbands prefer taking up livestock- and agroforestry-related practices. Ownership of large livestock could motivate husbands to scale up livestock-related practices, such as de-stocking, changing in feeding practices, and changing livestock breeds. Our study is also in line with evidence from SSA and South Asia that existing traditions and social norms govern how women access, control, and accumulate their assets. For instance, insecure land rights, limited access to capital and productive inputs hinder women in taking up climate-smart practices such as agroforestry and conservation agriculture (Farnworth et al. 2013; Oloo et al. 2013; Pérez et al. 201s4). Even though wives have limited access to essential resources to enable them adapt to climate change, our findings suggest that they still spearhead adaptations to climate change at the household level. However, most of the practices adopted by women are short-term and low-cost strategies.

Gender disparity in access to assets, information, and bargaining power over use of land disputes the 'unitary household model' on household decision-making. The unitary household model assumes that household actors or couples operate as a unit. However, individuals in a household have different preferences and this theory vindicates gender inequality in market-based or non-market livelihoods (Seiz, 1995). Therefore, collective and bargaining approaches could often result in to positive welfare outcomes (Doss 2013). Our findings suggest that bargaining power over use of land is less likely to influence wives' adaptive decision and uptake climate-smart practices. This indicates that the husband who is the household head, has an upper hand in decision-making which can be explained by the literature on the 'benevolent dictator', the neglect of human 'agency' and social constructions and norms (Seiz 1995; Agarwal 1997; Kabeer 2001).

The study by Mackay et al. (2010) shows that there is a need for institutionalizing gender in all levels of decision-making processes, an approach termed as 'feminist institutionalism'. The Kenyan government hence in its attempt to institutionalize gender has launched gender-mainstreaming processes in all its ministries. For instance, the Ministry of Agriculture has a 'gender desk' and recognizes the critical role that women play in agriculture. However, our findings suggest that extension services and farmers' training programs are still largely gender-blind. Mbagaya & Anjichi (2007)'s study also in Kenya had a similar conclusion. The conundrum remains how to design institutional processes that consider gender as a key factor and to find out how processes and institutions bring about change that is essential for comprehending both

agency and power. Institutional and governance challenges identified by both qualitative and quantitative analyses include lack of 'trust' in information especially unreliable meteorological information. These factors are likely to obstruct the up-take of climate-smart agricultural strategies.

With regard to land, the Kenyan constitution guarantees the 'elimination of gender discrimination in law, customs and practices related to land and property in land' (GoK 2010b: 42). The provision offers good prospects for addressing human rights and existing gender inequality. The big challenge, however, is how to address the rigid informal institutions and norms that obstruct women's full participation in decision-making and access to resources. Informal institutions such as customary laws, traditions and prevailing norms, confine women's right to access and control over land, creating difficulties for female farmers to make long-term decisions on land use (Namubiru-Mwaura, 2014). Nonetheless, traditions, cultures, and norms are not static but malleable over time. For example, in Siaya and Gem districts, prevailing traditions and norms dictate that women not to own or inherit land after the demise of the husband, thus limiting women's land ownership. One of the female participants in FGD in Gem stated:

> *"We [women] understand our [Kenyan] constitution is pro-women and support women's rights in property inheritance after the demise of the husband. However, we ought to honor our traditions and norms… the son inherits the property [ies] whereas his name appears in the title deed or we [women] embrace joint ownership with the son even if the son is still a minor (…)".*

This study also adds to the literature on the role that group-based approaches can play in promoting climate change adaptation. Our results indicate that group-based approaches are valuable, but one needs to consider that they help men and women differently. According to our study, social groups help building men's and women's assets such as livestock, physical, human, natural, and financial capital, and food security. However, women-only groups depend on prevailing gender norms, their roles and responsibilities, and fallback positions of women in the household and community. For instance, group-based crop production and food acquisition help women enhance their role as a food producer and nutritional overseer in the household. Kristjanson et al. (2012) found that enabling food security is a promising strategy to promote innovations and necessary changes in agricultural practices. This strategy is likely to facilitate uptake of essential adaptation practices such as improved management of crop and livestock in the face of accelerating climate change. Besides, group-based income-generating alternatives are likely to foster women's fallback position through promoting livelihood strategies and building up assets, which in turn increase their intra-household negotiating power.[39] Similar studies in

[39]Wives associating with social groups have a higher intra-household bargaining power over land use and possess higher consumer durable asset base (See Table 3A-1 in the appendix).

Bangladesh show that women's groups enhance women's assets growth. The study's findings suggest that at community level, group-based approaches create a forum for within-community bargaining and participating in the decision-making arena, increase the political voice, and provide a pedestal necessary to address traditions and social norms. A male FGD participant stated:

> *"We [men] are doing our best to address traditions and cultural beliefs that impede women empowerment and adoption of technologies and practices… We encourage men through social groups and local leaders' meetings to allow women to go ahead and initiate innovations and agricultural practices (…)".*

Our quantitative findings suggest that husbands and their spouses are members of different groups. Husbands mostly participate in community-based organization, farmer groups, and welfare groups, while wives participate in women's groups and micro finance groups. Besides, husbands and wives are both active in groups dealing with soil and water management. The study's findings further point out that husbands have a wider network and hence more political and social capital as well as greater participation in community decision-making. These findings could be explained on the basis of pre-existing gender and social norms determining women's roles in the household, including cooking and taking care of kids, which is limiting their mobility and discourages them from joining inter-village social groups and CBOs. Similar to our study, Katungi et al. (2008) found that in Uganda men have more access to social capital as compared to women. Pérez et al. (2014) similarly showed that in SSA, women are more likely to belong to village-level groups, whereas men belong to registered organizations that work beyond the village and hence have greater access to supporting agencies. Besides, our findings show that men mostly belong to mixed-gender groups, whereas women mostly belong to groups comprising only female members. According to Meinzen-Dick et al. (2014) women-only groups are likely to be effective pathways for women empowerment, nurturing self-confidence, as well as strengthening women's intra-household bargaining power particularly in the face of gender inequity. The study by Arora-Jonsson (2014) found that women-only groups provide pathways for lobbying for gender perspectives and the inclusion of women in governance at all levels. However, mixed-gender groups are likely to upsurge women's asset base and provide a forum for public negotiations (Arora-Jonsson 2014). Nevertheless, our findings also suggest that traditional and conservative institutions are likely to be threatened by women's groups that empower women socially, economically and politically.

Our econometric findings are strengthened by cross-tabulation analysis indicating that, as compared to not belonging to a group, membership in social groups increases wives' and husbands' likelihood of adopting to climate-smart agricultural practices (t-test $P<0.10$). It also increases the number of practices that are take up (t-test $P<0.05$) (see Table 3A-1 in the Appendix). Our qualitative analyses show how and in what ways the group-based approaches

improve husbands' and wives' adaptive capacity and well-being. Both our quantitative and qualitative findings show that group-based approaches provide pathways for exchange of information, diffusion of innovations and technologies, improvement of food security and participation in training and development programs for men and women. Therefore, social capital and group-based approaches are very valuable avenues to enabling adaptive capacity and upholding welfare outcomes of men and women.

3.8 Conclusions and policy implications

The results of this study prove that intra-household gender analyses are very useful to identify how husbands and wives within the same household perceive climate risks and how they use group-based approaches as a risk-managing tool. Husbands and their spouses have similar perceptions on several indicators of risks such as an increase in average temperature, a decrease in rainfall, and a rise in incidences of malaria. The survey results point out that husbands and wives take up similar climate-smart practices such as change in crop variety, soil conservation, and management, expanding irrigation fields and agroforestry-related practices. However, the empirical evidence implies substantial differences in adaptive behavior. A higher percentage of wives adopt crop-related strategies such as soil conservation and management, whereas husbands employ livestock- and agroforestry-related practices.

The policy implications of these findings are the need for gender mainstreaming and formulation of gender-sensitive policies and programs in adaptation and mitigation frameworks. These kinds of policies ought to institutionalize gender as a key factor and recognize the different economic and social roles and responsibilities of men and women. Besides, adaptation to climate change will only be effective if strategies are geared towards women's needs and perspectives. For example, an intervention such as soil conservation, especially the use of farm manure, is a labor-intensive strategy that may require the use of draft animals – which are largely under the control of men. Hence, alternative strategies that are more suitable for women also need to be developed. Further, low adoption levels of specific climate-smart agricultural practices of men and women oblige policies that encourage investment in suitable climate-smart practices in crop and livestock management. It is also necessary to inspire the development of innovative adaptation options that address existing gender biases. There is therefore a need for policy interventions towards capacity building and training of men and women on available and suitable climate-smart strategies and technologies. These can be promoted through extension services, farmer's field schools, and encouraging farm visits by extension agents. Further, there is a vital need for policies that support men's and women's ability to take up climate-smart agricultural practices. For example, reliable climate information and improved access to Farmers Field Schools are likely to foster men's and women's ability to invest in climate-smart agricultural practices.
Gender-sensitive governance structures and the inclusion of men and women in decision-making at the household, community and at national level will promote the attention to their different

needs in risk management and in adaptation policies and programs. This will ultimately strengthen the adaptive capacity of men and women. Considering the role of informal institutions in limiting women's adaptive capacity, there ultimately a need for a gender-transformative approach that acknowledges and addresses the conundrum of these institutions their interaction with formal institutions. Without a gender-transformative approach gender inequality and institutional 'path dependency' is likely to persist.

The prevailing gender disparity in access to information and access to extension agents, gender-specific climate information needs, and preferences for information channels call for public and private information providers to employ gender-sensitive information delivery approaches. Besides, sharing of climate and agricultural information through channels that are accessible for both men and women should be encouraged to scale up the adaptation and mitigation of climate change. These may include information and communication technologies (ICTs) as well as an effective agricultural extension system. For example, disseminating reliable and accurate information through channels that are easily accessible is likely to have a positive influence on husbands' and wives' decisions to adopt climate-smart practices, including soil and water management practices, agroforestry, and embracing new technologies that are essential in adapting to the accelerating climate change. Gender equality in access to information can also be enabled through policies and initiatives that involve men and women in extension training. Examples include scaling up gender-sensitive group-based learning, farmer's field school-based approaches, and farm visit extension approaches that are easily reachable by both men and women. In addition, involving men and women in 'training of trainers' programs is likely to bridge the gender gap in access to agricultural information, hence, promoting uptake of climate-smart agricultural practices by both men and women.

Gender disparity in ownership of assets calls for policies that support women's decision-making power at the household and community levels. The study also suggests that there also is a need to rely on different institutional arrangements that foster access to resources. For example, drawing upon alternative and innovative strategies to access vital types of assets can ensure far-reaching implications for gender equality at both community and household levels. Group-based approaches provide such promising alternatives to access key resources. For example, our data suggests that group-based approaches are essential engine for addressing issues related to land rights through collective land acquisition or through leasing for agricultural purposes that in turn increase women's income, food, and nutritional security. Group-based approaches that create a forum for local meetings and discussions could help address traditions and norms that restrict women and foster the role of women in community/household decision-making and in facilitating access to rural services.

Gender-differentiated group-based approaches are relevant in influencing the decision to adapt to climate change and enhance welfare outcomes through accumulating essential productive

capital such as physical (livestock and consumer durables), human (training, access to information, food and nutritional security), natural (joint acquisition of land), financial (micro financing) and social capital. The evidence presented in this study suggests that gender-blind approaches while targeting adaptation and development interventions through social groups can result into marginalizing one gender or increasing prevailing gender inequalities, gender-linked vulnerability, and poverty. Therefore, policy interventions that rely on group-based approaches should reflect the gender reality on the ground in order to amplify men's and women's specific abilities to manage risks and improve welfare outcomes in the face of accelerating climate change. There is also a need for policies that nurture social capital and group-based approaches for men and women at community level. Possible pathways towards this goal include capacity building programs and training in basic entrepreneurship and in risk management skills as well as in effective measures for coping and adapting to climate risks for both men and women.

Appendix 3A

Table 3A-1: Relations between gender, group membership, and key variables (mean)

Key variables	Wives			Husbands			Pooled		
	Non-group members	Group members	Diff. in mean (t-test)	Non-group member	Group members	Diff. in mean (t-test)	Non-group member	Group members	Diff. in mean (t-test)
Adaptation crop†	0.71	0.83	-0.12*	0.53	0.76	-0.23**	0.59	0.80	-0.21**
Adaptation livestock†	0.57	0.51	0.06	0.43	0.56	-0.13	0.48	0.54	-0.06
Adaptation decision†	0.71	0.86	-0.15*	0.63	0.79	-0.16*	0.66	0.83	-0.17**
Intensity of adaptation	2.57	2.42	0.15*	1.43	2.48	-1.04**	1.80	2.45	-0.65*
Perception of climate change†	0.64	0.56	0.08	0.63	0.60	0.04	0.64	0.58	0.06
Age	63.50	53.59	9.91**	63.37	62.56	0.80	63.41	57.81	5.59*
Year of schooling	4.14	6.39	-2.25*	6.57	8.30	-1.74*	5.80	7.29	-1.49*
Farming experience	41.29	30.91	10.38**	30.40	32.09	-1.69	33.86	31.46	2.40
Entrepreneurial experience	0.43	3.16	-2.73*	3.97	2.38	1.59	2.84	2.79	0.05
Credit access†	0.21	0.49	-0.27*	0.30	0.56	-0.26**	0.27	0.52	-0.25**
Information sources	1.36	1.90	-0.54*	1.60	1.98	-0.38*	1.52	1.94	-0.42*
Information trust index	0.76	0.70	0.06	0.60	0.66	-0.06*	0.65	0.68	-0.03
Extension services†	0.14	0.41	0.27*	0.33	0.57	0.24*	0.27	0.49	0.21**
FFS†	0.29	0.44	-0.15*	0.23	0.21	0.03	0.25	0.33	-0.08
Early warning†	0.07	0.28	-0.21*	0.23	0.42	-0.19*	0.18	0.35	-0.17*
Weather forecast†	0.71	0.63	0.09	0.60	0.41	0.19*	0.64	0.53	0.11
TLU	3.01	4.61	-1.59	5.91	4.45	1.46*	4.99	4.53	0.45
Consumer durable assets	0.22	0.29	-0.08*	0.28	0.32	-0.04	0.26	0.30	-0.05*
Agricultural durable assets	0.47	0.51	-0.04	0.58	0.52	0.06	0.54	0.52	0.03
Bargaining power†	0.29	0.35	-0.06	0.10	0.26	-0.16*	0.16	0.31	-0.15*
N	14	142		30	126		44	268	

Note: Superscripts † presents variables in binary format. ***p<0.01, **p<0.05, *p<0.1

Source: Authors' computations centered on 2012 intra-household dataset

Table 3A-2: Summary statistics and factor loadings for social capital index

Indicators of participation group-based approaches	Summary statistics		Rotated loadings				
	Mean	Std. Dev.	Subjective collective action	Social support	Group participation	Cooperatives	Trust
Willing to participate in disaster management	.949	.221	**.927**	.104	.057	-.007	-.004
Willing to contribute labor	.933	.251	**.921**	.035	.015	-.002	.040
Willing to contribute funds for community work	.862	.345	**.701**	-.062	.069	.148	-.037
Belong to the social group	.859	.349	.081	-.014	**.952**	.018	-.020
Involvement in group activities	.869	.338	.052	.029	**.947**	.089	-.015
Support from relatives	.369	.483	.029	**.763**	.037	.156	-.097
Support from neighbors	.362	.481	.048	**.804**	-.087	-.083	.155
Support from friends	.234	.424	-.018	**.880**	.064	-.035	-.036
Work with others in the community for community work	.516	.501	.232	-.119	.048	**.761**	.101
Witnessed sanction	.651	.478	-.074	.151	.055	**.828**	-.117
Trust neighbors with your kids	.763	.426	-.046	.009	-.065	.089	**.801**
Most people in the community are trustworthy	.481	.500	.038	.001	.033	-.106	**.781**
Summary statistics							
Eigenvalues			2.482	2.031	1.760	1.323	1.232
% of the variance explained			20.685	16.928	14.669	11.024	10.263
The total % of the variance explained			73.569				
Mean social capital index (0-1)	.692	.159					
KMO statistics	.571						
Bartlett's Test of sphericity	1276.13						
Approx. Chi-Square (66)	.000						

Note: The Kaiser–Meyer–Olkin (KMO) criterion approves that PCA is an appropriate method to estimate the social capital index. Bartlett's test of sphericity $x^2(66) = 1276.13$, with P-value <0.01, which indicate highly correlation of social capital variables and sufficiently large for analysis. Five components were extracted with Eigenvalue >1, which together explain 73.5% of the variance. Factor loadings of an absolute value >0.3 was selected for the interpretation and classification of the factors (Stevens 2002).

Source: Authors' computations centered on 2012 intra-household dataset

Table 3A-3: Trust in avenue of information (1=strongly distrust, 5=strongly trust) (mean)

	Wives		Husbands		
Trust in sources of information	Mean	Std. Dev.	Mean	Std. Dev.	Diff. in mean (t-test)
Extension agents	4.205	0.885	4.026	0.936	0.179*
Television	3.474	0.953	3.519	0.987	-0.045
Radio	3.821	1.006	3.712	1.003	0.109
Media-Newspaper	3.378	1.031	3.192	1.131	0.186
Internet	2.801	1.025	2.705	1.176	0.096
Friends/ neighbors	3.333	0.882	3.282	0.907	0.051
Social groups	3.949	0.914	3.718	0.942	0.231*
Traders	3.167	0.969	3.000	0.957	0.167
Scientists	3.821	0.926	3.628	1.005	0.192*
Religious leaders	3.635	0.916	3.314	0.963	0.321**
Kenya Meteorologists	3.365	0.964	3.583	0.950	-0.218*
Local leaders	3.365	0.937	3.353	0.982	0.013
N	156		156		

Notes: *** p<0.01, ** p<0.05, * p<0.1

Source: Authors' computations centered on 2012 intra-household dataset

4. What intrinsic values motivate farmers to take-up climate-smart practices in Kenya? Empirical evidence from a means-end chain analysis[40]

Abstract

This study assesses intrinsic values and the motivations farmers have for adopting various climate-smart agricultural practices in Kenya. The qualitative technique of laddering was employed as an interview technique, and means-end chain analysis was used for hierarchical mapping in order to depict farmers' decision-making processes concerning the adoption of climate-smart agricultural practices as well as their envisioned goals and values underpinning these actions. The findings show that farmers decide on measures that improve farm productivity, food security and nutritional outcomes and household income. The study highlights that irreconcilable conflicts between values exist due to changing climate conditions. The findings suggest that it will difficult for women attached to conservative values to pursue achievement or benevolence values. Similarly, male-differentiated values suggest a need for a trade-off between self-enhancement values and its opposing universalism values related to environmental sustainability and welfare for all. Female-specific values such as benevolence could uphold accumulation of assets such as social capital, while conservative values can worsen existing gender and social inequalities. Besides, male-specific values such as self-enhancement is likely to hinder sustainable adaptation behaviors. The findings call for the design of climate change policies and adaptation interventions that take into account farmers' fundamental values and their gendered preferences.

Keywords: Adaptation, agriculture, means-end chain analysis, intrinsic values, gender, social norms

[40]A manuscript of this chapter is accepted for publication in the Journal of Climate and Development. Co-authors include Dr. Ulrike Mueller and Prof. Regina Birner.

4.1 Introduction

Climate change entails increased weather variability and incidences of extreme weather conditions, which affect livelihoods and well-being undermining the sustainable development goals (IPCC, 2012). In Kenya, between 1960 and 2006, the minimum temperature rose by 0.7^{o}C to 2.9^{o}C, while the maximum temperature escalated by 0.1 ^{o}C to 2.1 ^{o}C. This variation depends on the prevailing seasons and agro-ecological zones in the country (GoK, 2013). Rainfall has become uneven and erratic, which has resulted in increasing incidences of floods. Moreover, recurrent and prolonged periods of dry spells are major contributing factors to hunger, water scarcity and loss of livelihoods, hence increasing the vulnerability of rural subsistence farmers (GoK, 2010b; SEI, 2009).

Given that they depend on natural resources and rain-fed food production, subsistence farmers are extremely sensitive to climate change and variability (World Bank, 2013). Further, weather- and climate-related shocks particularly affect individuals, households and communities below the poverty trap threshold (World Bank 2013).[41] In order to reduce vulnerability and improve resilience to extreme weather events, farmers take up climate-smart agricultural practices (Tom, Brian, & Wakhungu, 2013). Climate-smart agricultural strategies include the use of measures that sustain agricultural productivity and incomes, enable climate change adaptation, and reduce greenhouse gas emissions (FAO, 2013). A successful adaptation strategy is any adjustment that moderates risks and vulnerability related to climate change, takes advantage of beneficial opportunities that may arise, and takes into account socio-economic and environmental sustainability (Doria, Boyd, Tompkins, & Adger, 2009).

Adaptation initiatives need to take account of the knowledge and priorities of smallholders in their frameworks. Most of the previous studies on drivers for adapting to climate change focus on socio-economic, political, biophysical, institutional and governance factors (see, for example Neufeldt et al. 2011; Below et al. 2012; Bryan et al. 2013; Löf 2013; Jost et al. 2016). However, despite the fact that weather shocks and climate variability affect assets owned by men and women differently (Angula, 2010; A. Quisumbing, Kumar, & Behrman, 2011), there is limited but growing evidence that gender perspectives influence adaptive behaviors, uptake of climate-smart choices and community-level adaptation initiatives (Patt, Daze and Suarez, 2009; Nelson 2011, Aelst & Holvoet 2016; Ngigi, Mueller and Birner, 2017). A recent study by Aelst & Holvoet (2016) shows that in rural Tanzania, marital status limits women's access to adaptive strategies, whereby widows and female divorcees are unfortunate to access agricultural water management practices. Ngigi et al. (2016) similarly shows that female spouses adopt crop related strategies, including soil conservation and management, whereas husbands adopt livestock- and

[41] Poverty rate in Kenya stands at 33.5% for urban areas and 50.5 % for rural population (Kenya National Bureau of Statistics, 2014).

agroforestry-related strategies. These gender-specific uptake of climate-smart agricultural practices depends on gender 'interaction' with access to information, reliability of information, risk concerns and perceptions, institutional arrangements, social relations, gender norms, economic and cultural roles and responsibilities of spouses in the household (Ngigi et al. 2016). Hence, failure to consider gender relations, perspectives and realities on the ground could negatively affect the effectiveness and sustainability of adaptation and mitigation policies and programs (Kakota et al. 2011; Holvoet and Inber 2014). Despite the fact that the role of actors' cognitive processes, such as attitudes, belief systems, and perceptions about environmental shocks and climate change, has been increasingly acknowledged (Grothmann and Patt, 2005; López-Marrero and Yarnal, 2010; Frank et al., 2011) there is still limited empirical evidence on how gender-differentiated values and beliefs at household or community levels influence adaptive behaviors. This study therefore goes beyond existing research by examining intrinsic values and motivations men and women have for adopting various climate-smart agricultural measures in crop and livestock management.

While the motivations of different actors may have a positive effect on adopting climate-smart measures, their values may also represent barriers for sustainable adaptation and development in general (O'Brien, 2009; Eriksen et al., 2011). Although there is research examining values and socio-psychological aspects with respect to climate risk and adaptation (Lorenzoni et al., 2006; O'Brien, 2009; Webber and Stern, 2011; Rogers et al., 2012), these studies mainly focus on industrialized countries. Thus, there is a need for studying intrinsic values that influence climate-smart choices of female and male actors in developing country contexts. Values are desirable goals that drive the selection of actions or strategies to achieve desired outcomes. Hence, the major research question of this study is what intrinsic values male and female Kenyan farmers have for adopting climate-smart strategies.

To promote the sustainability of adaptation interventions the study therefore suggests the need to consider intangible and intrinsic motivations of men and women. Although it could be expected that adaptation programs or policies increase productivity, food security or mitigate effects of climate change, these interventions should be geared to address the needs for men and women. For instance, women farmers are likely to take up measures that address their concerns of agricultural productivity, labour loads and food security in the household (M. W. Ngigi et al., 2017). However, as shown in this study, interventions should not compromise the intrinsic values of food security like taste, nutrition and health or trade-off women's labour efforts. Since women uphold a benevolence value that strengthens social cohesiveness and formulation of social capital, hence, targeting interventions through social groups built on trust, altruism and sharing of knowledge can have far-reaching implications on women's uptake of climate-smart strategies. The study also suggests the need to better understand gender-differentiated values in adaptation frameworks and their trade-offs in order to trigger the formulation of effective policies. Interventions targeting men should consider the trade-offs among competing values that

influence their attitude or action they take under climate change. Hence, the trade-off between men's self-enhancement values that oppose universalism values need to be addressed through economic reward strategies in order to promote environmental friendly practices that in turn protect the welfare of all. Importance of values in adaptation frameworks, their trade-offs and gendered preferences are often disregarded due to lack of knowledge by policy makers, hence if better understood can trigger effective policies.

4.2 Conceptualization of means-end analysis in climate change adaptation

There are several operational approaches to derive actors' motivations for a specific behavior. The Schwartz Value Survey (SVS)[42] and the Portrait Values Questionnaire (PVQ) are commonly used tools to elicit human values (Schwartz, 2012). SVS utilizes a scale of 'importance values' to reveal values, while PVQ involves the use of short verbal portraits, where the respondents equate the portrait to their values (Schwartz, 2012). In-depth interviews have been employed for eliciting public values in relation to climate change adaptation (Wolf, Allice, & Bell, 2013). The priorities and preferences for actions and values, which motivate the behavior to achieve a targeted goal, can also be revealed through a so-called means-end chain (MEC) analysis (Reynolds& Olson 2001).[43] Hence, the study chose the MEC approach because it enables a systematic understanding of farmers' decision-making processes regarding the up-take and scale-up of climate-smart agricultural practices, instrumental in developing effective adaptation initiatives and policies.

The MEC approach is widely used to understand the consumer's goals, attitudes and desires, as well as the structure of such relations in his or her mind as they make purchasing or consumption decisions. It assumes that consumption or any kind of action follows a structural, mental association between means (product attributes) and ends (values or goals) (J. T. Reynolds & Olson, 2001). Further, the MEC approach draws on a hierarchical framework of attributes, consequences, and values (A-C-V). Attributes represent the perceived self-relevant strategies that result in consequences leading to a fulfillment of certain personal values. Every single consequence, in turn, supports one or more values in life. The consequences can be direct, indirect or physiological (Gutman, 1982). Since the study is not interested with qualities or characteristics inherent in a strategy/choice, we modify the hierarchical framework by replacing 'attributes' with 'strategies' to match our conceptualization of the MEC in adaptation research. Hence, our hierarchical framework consists of strategies, consequences and values (S-C-V).

[42]The SVS illustrate two lists of value items that include 30 item describing end-state in 'noun form' and 26 or 27 items describing desirable ways of acting in 'adjective form'. The respondents rate the level of importance using a 9-point scale, with 7 (of supreme important) to 1 (opposed to my values) (Schwartz, 2012).

[43]Gutman (1982) and Reynolds & Olson (2001) advanced the means end chain method which focus on personal construct psychology, which was originally developed by Kelly (1955).

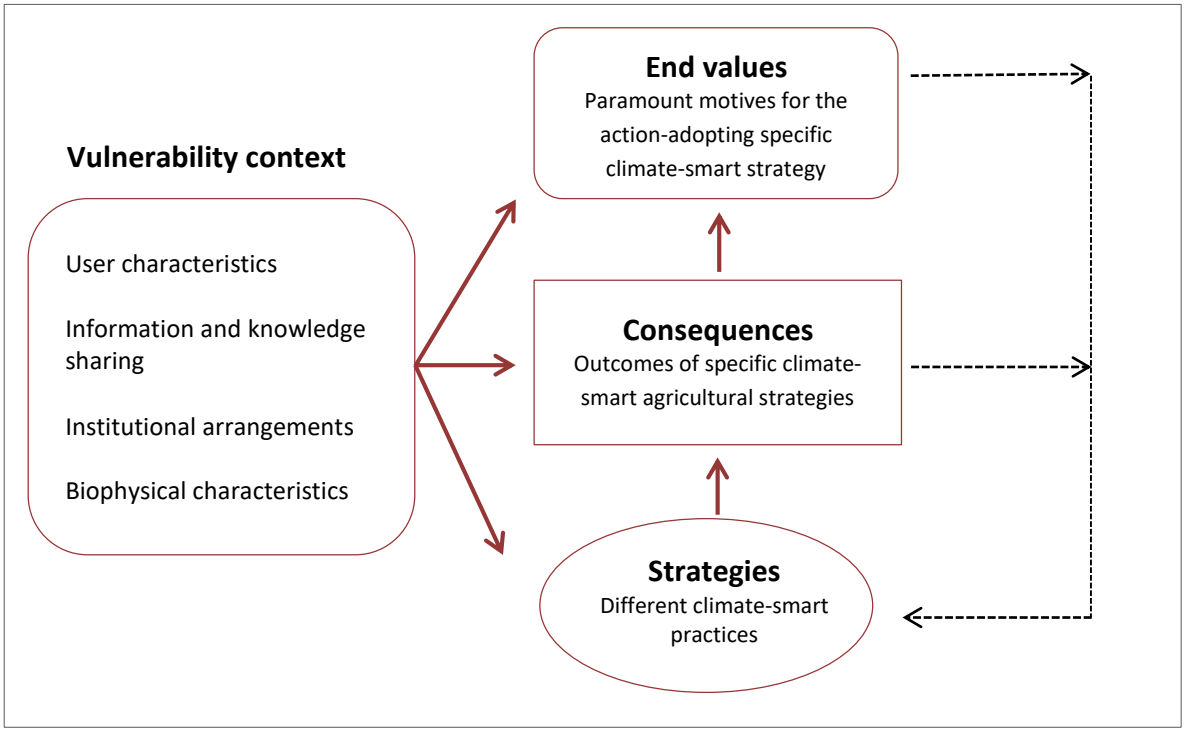

Figure 4.1: Conceptualization of the means-end chain approach in climate change adaptation

Sources: Authors' elaboration

Strategies are plans of actions or solutions to challenges that result in consequences leading to fulfillment of certain personal goals or values. The desired and adopted strategies are instrumental in achieving anticipated consequences and values. The more imperative a particular strategy is, the more significant are the consequences as well as the personal values attached to it (Gutman, 1997). Indeed, farmers maximize their utility in adopting strategies involving mental links between means (agricultural strategies) and ends (personal goals/values). In the adaptation domain, strategies represent the climate-smart practices that farmers have adopted, while the consequences represent the related positive (or negative) outcomes. Further, the aptitude of individuals to cope and adapt to a changing climate is embedded in a vulnerability context that interacts with S-C-V (see Figure 4.1). The vulnerability context consists of user characteristics, information and technology, institutional arrangements and physical characteristics (Bryan and Behrman, 2013). The framework needs to be studied in a gender-differentiated way. For instance, gender is one example of user characteristic that is likely to influence the S-C_V framework. The study conceptualizes that men and women have different economic and social roles and responsibilities, risks perceptions and unequal access to information (M. W. Ngigi et al., 2017) therefore they are likely to have diverging preferences for climate-smart practices (strategies), which in turn lead to different outcomes (consequences) and ultimate values (ends) that motivate their adaptive behavior. The level of exposure or vulnerability to climate risk necessitates that female and male farmers adopt practices, which exploit the positive and lessen the negative consequences of specific risk.

According to Schwartz, values are desirable goals that motivate action and they guide selection of actions, whereas people choose what is good or bad based on consequences it will have on the desired outcomes (Schwartz, 2012). The study therefore conceptualizes values to imply the motivations for adopting a specific climate-smart agricultural strategy. In the MEC approach, values present the end position and are cognitive exemplifications of abstract goals. The Schwartz theory of basic values identifies ten types of basic personal values that are classified into four broad motivational dimensions. These include self-enhancement (achievement and power), self-transcendence (benevolence and universalism), conservation (security, tradition and conformity), and openness to change (stimulation, hedonism and self-direction) (Schwartz, 2012). This study highlights the irreconcilable conflicts between values due to changing climate conditions. Female farmers embrace an early planting strategy to enhance food security based on their role as food provider in the household that in turn promote achievement of goals. However, traditions dictate that male family members are the ones responsible to initiate land preparation and early planting practices. This implies that due to changing climate conditions, it will be difficult especially for female farmers to pursue 'achievement' values while at the same time uphold 'conservation' (tradition) values.

The interlinkages of climate-smart practices, their consequences and end-values represent a knowledge network, referred to as hierarchical value map (HVM). The HVM represents a number of links, widely known as ladders, which connect the strategies and values at different levels of the hierarchies. The HVM illustrates the association of S-C-V by presenting a cognitive or motivational structure, which depends on the underpinning strength of connections between the S-C-V (Bagozzi, Gürhan-Canli, & Priester, 2002). The stronger the preferred S-C-V, the more stimulated the decision-maker (farmer) will be, and the more strongly he or she will be motivated to take a particular climate-smart strategy. The appropriate and effective adaptation actions depend on peoples' goals that are linked to their personal values (W. N. Adger et al., 2009; O'Brien & Wolf, 2010; Wolf et al., 2013). Personal values are, therefore, indispensable elements, which may lead to decisions to adopt (or not adopt) climate-smart agricultural practices. However, adaptive behavior that is motivated by values and interests could lead to increased vulnerability of individuals due to adoption of unsustainable and inappropriate practices with changing climate conditions. Climate change will threaten self-enhancing values such as independence and people with adopt strategies in order to protect it and in turn be happy. Hence, self-enhancement values may oppose universalism values that encourage welfare for all feasible by supporting environmental sustainable behaviors. Besides, farmers may take up practices, for example, excessive use of fertilizer or encroachment of wetlands by planting inappropriate tree species for agro-forestry systems, which may be unsustainable in the end, still these practices could increase their income at a particular period.

A systematic understanding of the decision-making processes of male and female farmers concerning the uptake of climate-smart choices is helpful to formulate effective and responsive adaptation interventions and policies. In order to interpret the prevailing decision-making processes in the domain of crop and livestock management in a gender-disaggregated manner, the qualitative technique of laddering was applied in combination with the MEC-analysis.

4.3 Research approach

This section presents the sampling and data collection procedure for the laddering interviews. The section also elaborates the procedure for the laddering interviews that aimed at eliciting the means-end-chains of farmers. The section also explains the data analysis procedure that enabled a hierarchical presentation of Strategies-Consequences-Values (S-C-V).

4.3.1 Data and sampling procedure

Data for this study was collected from three agro-ecological zones (AEZs) in rural Kenya. These AEZs included humid regions, sub-humid regions, and semi-arid regions. The sampled districts included Mukurweini and Othaya (humid regions), Gem and Siaya (sub-humid regions) and Mbeere South and Nakuru (semi-arid zones). The survey aimed at a wider range of climatic, agro-ecological, socioeconomic, and cultural conditions, policy and institutional arrangements, and susceptibility to climate change. Data was collected between June and September 2012.

Table 4.1: Summary statistics of male and female respondents in the laddering interviews

	Male Farmers (N=36)		Female Farmers (N=26)		Diff. in Mean (T-test)
Variables	Mean	Std. Dev.	Mean	Std. Dev.	
Age (years)	64.25	13.04	55.51	13.07	8.74*
Schooling (years)	8.05	3.56	6.12	3.96	1.93*
Read/Write (1 = yes, 0 = no)	0.91	0.21	0.82	0.39	0.09*
Farming experience (years)	31.17	13.67	29.75	13.89	1.42
Entrepreneurship experience (years)	3.25	6.65	3.46	6.45	-0.21
Household size	4.69	0.22	4.29	0.21	0.40
Total annual household income (Ksh)	149,759	114,954	119,689	112,345	30,070**
Asset index	0.58	0.11	0.41	0.14	0.17
Tropical livestock unit (TLU)	4.21	3.7	3.21	3.63	1.00*
Land size (acres)	5.09	6.67	4.06	6.43	1.03*
Access to credit (1 = yes, 0 = no)	0.61	0.4	0.57	0.5	0.04
Access to extension services (1 = yes, 0 = no)	0.84	0.35	0.62	0.49	0.22***
Number of observations	34		26		

Notes: Ksh represents Kenya shillings. At the time of the survey, 1 US dollar was equivalent to Ksh 84.20. Superscript * presents significance at the 10% level, ** at the 5 % level, ***at the 1% level of t-test estimates of mean comparisons.

Source: Authors' computations centered on the 2012 survey data

The Laddering methodology (Reynolds and Gutman 1988) was used to collect data on farmers' personal values and motivations for adopting climate-smart agricultural technologies. The study relied on a simple random sample derived from a list of 360 households who took part in the 2012 household follow-up survey. A random and probability proportion to size sampling procedure, i.e. relative to the population of the farmers in a given zone, derived a random sample of 60 farmers. Overall, in this laddering study, 19, 21 and 20 farmers were interviewed in the humid, sub-humid, and semi-arid regions, respectively. The sample size used in this work follows the recommendations of other Means-End-Chain (MEC) studies. Russell et al. (2004) and Reynolds & Gutman (1988) endorse a sample size of about 50 respondents in order to incline approximately 125 ladders, while Santosa & Guinard (2011) recommend at least 20 participants for a sub-group investigation, such as gender-disaggregated analysis.

The interviewed male farmers had more access to agricultural extension services and more livestock and assets as compared to their female counterparts (see Table 1). Male farmers had also higher level of schooling and literacy levels (t-test P-value<0.10). Female farmers were found to be younger (55.71 years) than male farmers (64.25 years). It could be expected that older farmers are more inclined to conservation values especially security and tradition, whereas younger farmers may be attached to values linked to openness to change like stimulation and self-direction. Similarly, gender relations could also dictate values, where women are inclined to benevolence and conservation values, whereas men are inclined to a sense of responsibility and power.

4.3.2 Empirical methods

As mentioned above, laddering interviews[44] were used in this study to elicit means-end-chains, which are considered an appropriate method to reveal the mental conceptions of individuals (Bagozzi et al., 2002). The laddering procedure is extensively applied to evaluate people's purchase and consumption behavior in marketing studies (Kangal, 2013; T. J. Reynolds & Gutman, 1988; Santosa & Guinard, 2011). The technique is also used in personal construct psychology (Walker & Crittenden, 2011), organizational and management studies (Bourne & Jenkins, 2005; Rugg et al., 2002), and research on the acquisition of knowledge (Corbridge, Rugg, Major, Shadbolt, & Burton, 1994). Laddering and MEC have likewise been applied, though not widely, to the domain of sustainable ecosystem conservation (López-Mosquera & Sánchez, 2011).

Conversely, the application of the MEC approach in conjunction with laddering to examine farmer's motivational structures in decision-making with respect to agricultural practices is scarce and partial. Salame (2004) examined farmers' motivations for their choice between organic and

[44]Hinkle (1965) developed the laddering technique. A detailed laddering protocol and guidelines was later developed by Reynolds & Gutman (1988)and Gengler & Reynolds (1995).

conventional productions systems in Lebanon. Lagerkvist et al. (2012) examined Kenyan peri-urban farmers' motivation for applying crop protection measures in leafy vegetable farming. Further, Okello et al. (2013) assessed farmers' personal motivations and values in soil fertility practices and management decisions, using MEC analysis in peri-urban Kenya. However, none of these existing studies considered gender-specific differences in motivational structures in the uptake of agricultural practices or actions.

The laddering technique consists of individually in-depth interviews, whereby respondents are encouraged to identify prominent A-C-V (S-C-V) of distinctive alternatives of practices or priorities. The S-C-V is elicited in a hierarchal manner (Reynolds & Gutman 1988). The laddering technique follows either a pencil-and-paper or a face-to-face set-up. There are two forms of laddering approaches, namely 'hard' and 'soft' laddering. Hard laddering uses a sequence of a priori list of S-C-V. In contrast, soft laddering allows the respondents to be more flexible as they develop the S-C-V themselves (ibid.). The latter approach is most appropriate for revealing complex motivational behavior of individuals (J. T. Reynolds & Olson, 2001), especially in adaptation contexts.

This study employed a consistent semi-structured interview technique by combining the components of hard and soft laddering. This approach involved the use of a two-stage laddering procedure. During the first stage, researchers requested the respondents to identify the supreme strategies taken up to cope with changing climate. The researchers were interested in what motivates male and female farmers' decisions to adopt new practices in crop and livestock management. Using the soft laddering technique, researchers in the second stage probed a sequence of questions to respondents, such as "Why is this particular practice/strategy or consequence is of importance to you?" In this way, respondents revealed consequences and personal values for taking up climate-smart measures in the wake of climate change. This methodological approach facilitated the assessment of farmers' intrinsic values for amending agricultural practices and taking up climate-smart measures.

4.3.3 Documentation and data analysis

During the process of data collection, the researcher audio-recorded interviews and sketched the ladders in a notebook. The research team appraised this documentation after every single interview session to make sure that the hierarchical form of S-C-V was followed and that no important aspect was omitted. After transcription of the interviews, the emerging strategies, consequences and values were coded in a systematic manner. Considering the holistic approach of this study, the production practices listed by farmers were sorted into similar but broader categories. The classification of the strategies was guided by the categorization of climate-smart agricultural strategies, according to the Food and Agricultural Organization (FAO, 2013).

This classification process yielded seven categories of climate-smart agricultural strategies related to crop management. These categories include (i) water conservation practices (diversion ditches, benches, irrigation, water harvesting-dams, ponds and tanks for water conservation practices), (ii) soil conservation practices (use of composite manure, mulching, cover crops, crop rotation, terracing and conservation tillage), (iii) change in crop variety (adoption of certified and fast maturing varieties), (iv) crop diversification (root crops, cassava, sweet potatoes, legumes, sorghum, finger millet and indigenous vegetables), (v) agroforestry (woodlots and fruit orchards), (vi) early planting, and (vii) diversified livelihood activities (off-farm employment, entrepreneurship ventures). In livestock management, the study grouped livestock-related practices into five broad categories. These categories include (i) diversified livestock portfolio (small ruminant and non-ruminant livestock and large livestock), (ii) storage of fodder (silage, hay, and maize stover), (iii) cultivation of fodder crops (Napier grass, Rhodes grass and Tick-clover), (iv) diversified livestock feeds (livestock supplements, banana stock and sweet potatoes vines), and (v) change in animal breeds.

The Schwartz's classification of values guided the identification of intrinsic values as elicited by farmers. Data analysis follows the guidelines of Reynolds & Gutman (1988). During data analysis, a so-called "cut-off point" was determined to develop the hierarchical value maps (HVMs) for illustrating the motivational structures of farmers adopting climate-smart agricultural strategies. Hence, concepts were only considered for analysis if the threshold of the chosen cut-off point was attained. According to Costa et al. (2004), a cut-off level allows for a better presentation of information in the HVM. However, the decision on the cut-off point normally implicates a compromise between quantity of data representation and pellucidity of the HVM. It is advisable to opt for a cut-off point that takes into account the prevailing variety of information but also creates maps, which are easy to interpret (López-Mosquera & Sánchez, 2011). Data was analyzed with the *MECanalyst Software* (available at: www.skymax-dg.com), which facilitates the display of MEC data into HVM.

4.4 Results

This section presents the findings on MEC-analysis on motives and values men and women have on implementing climate-smart strategies in crop and livestock management. The section presents hierarchical value maps in a gender-differentiated manner and identifies gender-specific values and decision-making processes in the up-take of different climate-smart strategies.

4.4.1 Hierarchical value maps for crop management

4.4.1.1 Men's motivations for adopting climate-smart practices in crop management

The HVM in Figure 4.2 presents male farmers' decision-making processes for adopting various climate-smart practices in the domain of crop management. The study selected a cut-off level of

eight to display data on the HVM, if at least eight male farmers mentioned the association between two concepts as either a direct or an indirect connection. Five fundamental practices highlighted by male farmers include change in crop variety (74%), soil conservation strategies (63%), water conservation measures (46%), agroforestry (34%) and crop diversification (26%).

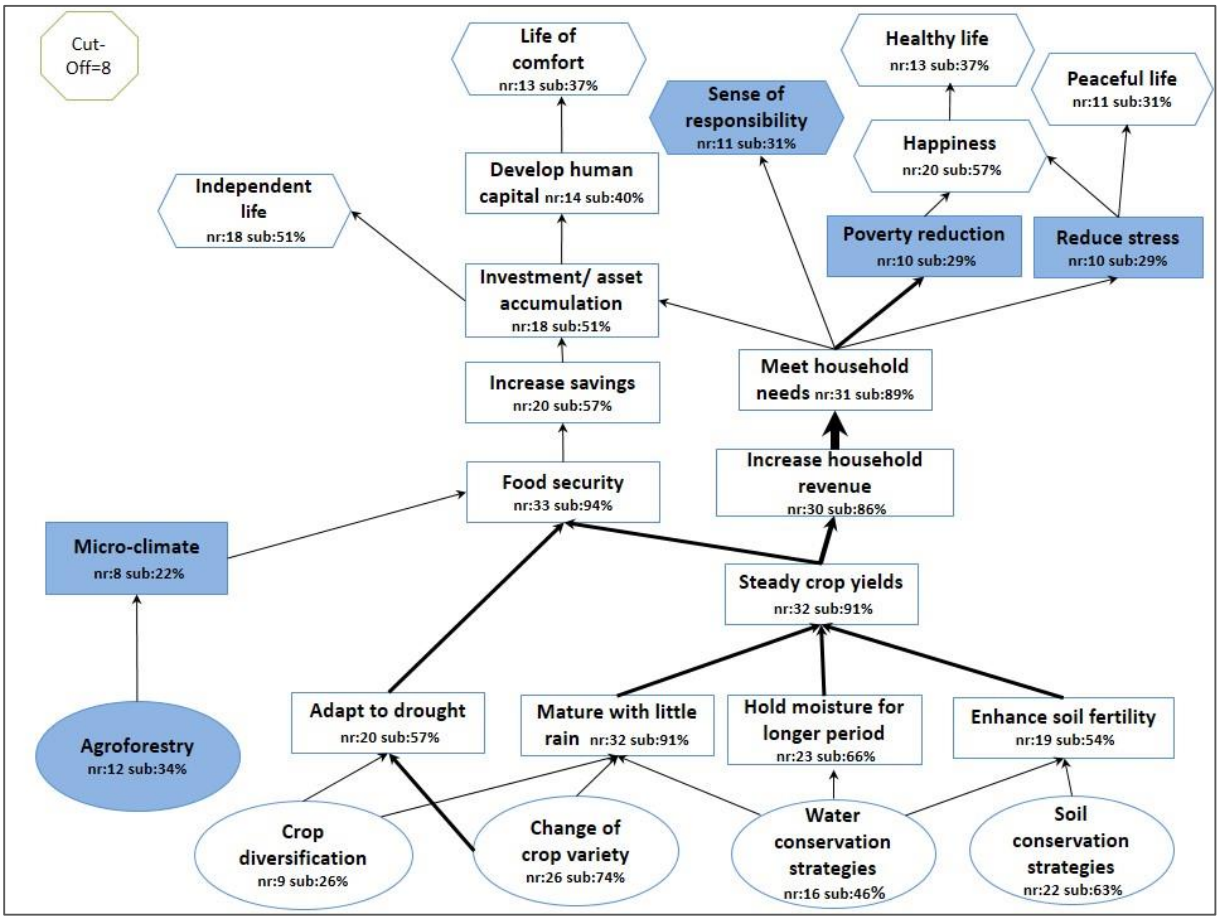

Figure 4.2: The HVM for men's decision-making processes in adopting climate-smart practices in crop management (N=34). The *nr* and *sub* present frequency and percentage of responses, respectively. The oval, rectangle and hexagon shapes present the respective strategies, consequences and values. The shapes highlighted in blue present male-specific differences.

Source: Authors' computations centered on 2012 survey data

Changing crop varieties involves adoption of certified and fast maturing types while crop diversification involves producing various types of crops, such as drought resistant ones, including orphan crops, legumes/ pulses, indigenous and/ or exotic vegetables. Men's motivation for changing crop variety and diversifying crops is that these crops are drought tolerant, adapt to harsh conditions, such as drought, pests and disease infestation (57%), and mature with little rains (91%). This guarantees steady crop yields translating into food security for the household.

Due to changing climate and land degradation, men take up water and soil conservation strategies like water harvesting and use of composite manure. Consequences allied with these strategies include the ability of soils to retain moisture for a longer duration, improvement of soil fertility, and substantial crop growth in the event of little rainfall. A steady crop yield relate into household's food security and increased income. Climate variability is likely to affect the four spheres of food security including availability, access, utilization, and stability. Farmers enhance food availability in the household through increased agricultural productivity or ability to buy food from local markets because of a rise in income. Households' saving capacity or access to resources enhance access to food in sufficient quantity and quality and stability in food supply all times. The ability to attain sufficient nutrition for all household members throughout the season is important because the household will not deprive long-term savings on food consumption. The findings suggest that increase in income help the household to meet family needs (86%), which in turn reduces stress (26%). The core value associated with this MEC is leading a peaceful (31%), happy (57%) and healthy life (37%).

The attribute of adopting agroforestry practices links to the consequences of obtaining an improved microclimate of the area as reported by 22 percent of male farmers. Agroforestry systems with a mixture of perennial and seasonal crops may reduce vulnerability to weather shocks, contribute in land and biodiversity management, and provide various benefits for food security. Fruit orchards contribute to nutritional security directly through the provision of food or indirectly through raising farmers' income. Agroforestry also provides other ecosystem services, such as regulating flooding and carbon sequestration and hence, hence, ultimately contributes to mitigating climate change. However, a point to note is that farmers emphasized the use of appropriate tree species for agroforestry systems, such as *Grevillea Robusta*.[45] Male farmers reported that eucalyptus trees that are fast growing and more profitable are harmful to water catchment areas leading to water scarcity for all. These findings suggest that although agroforestry is a promising climate-smart strategy, tree species require to be carefully selected.

Food security features importantly, because of the adopted crop management practices (mentioned by 94% of respondents), as this strategy leads to increased household savings, which in turn enable investments or entrepreneurial activities, i.e. income-generating enterprises or re-investments in farming. Investments in short and long-term enterprises and accumulation of assets enable households to educate their members and reduce poverty levels. Ultimately, poverty reduction leads to a comfortable life because of improved infrastructure facilities, including electrical connections and piped water. The development of human capital is also associated with the personal value of leading a comfortable life. Male farmers revealed that

[45]*Grevillea robusta* is an evergreen tree suitable for agroforestry systems in the highlands. It is useful for shading, and its leaves are utilized as a forage during dry spells (Muthuri, Ong, Black, Ngumi, & Mati, 2005).

provision of a quality education allows children to be independent in the future. In summary, the values that motivate male farmers to adjust crop production systems include happiness (57%), independence (51%), comfort (37%), good health (37%), peace (31%), and a personal sense of responsibility (31%).

4.4.1.2 Women's motivations for adopting climate-smart practices in crop management

The HVM in Figure 4.3 presents female farmers' decision-making processes for adjusting crop production systems. Compared with the HVM for men, it is characterized by unique female-specific ladders. Change in planting date constitutes a unique strategy preferred by female farmers, reported by 19 percent. Female farmers highlighted that early planting allows faster germination of seeds because seeds, which then benefit from early drops of rainfall and soil moisture. The direct consequence of a shorter germination period is the fast growth of crops that increases yields.

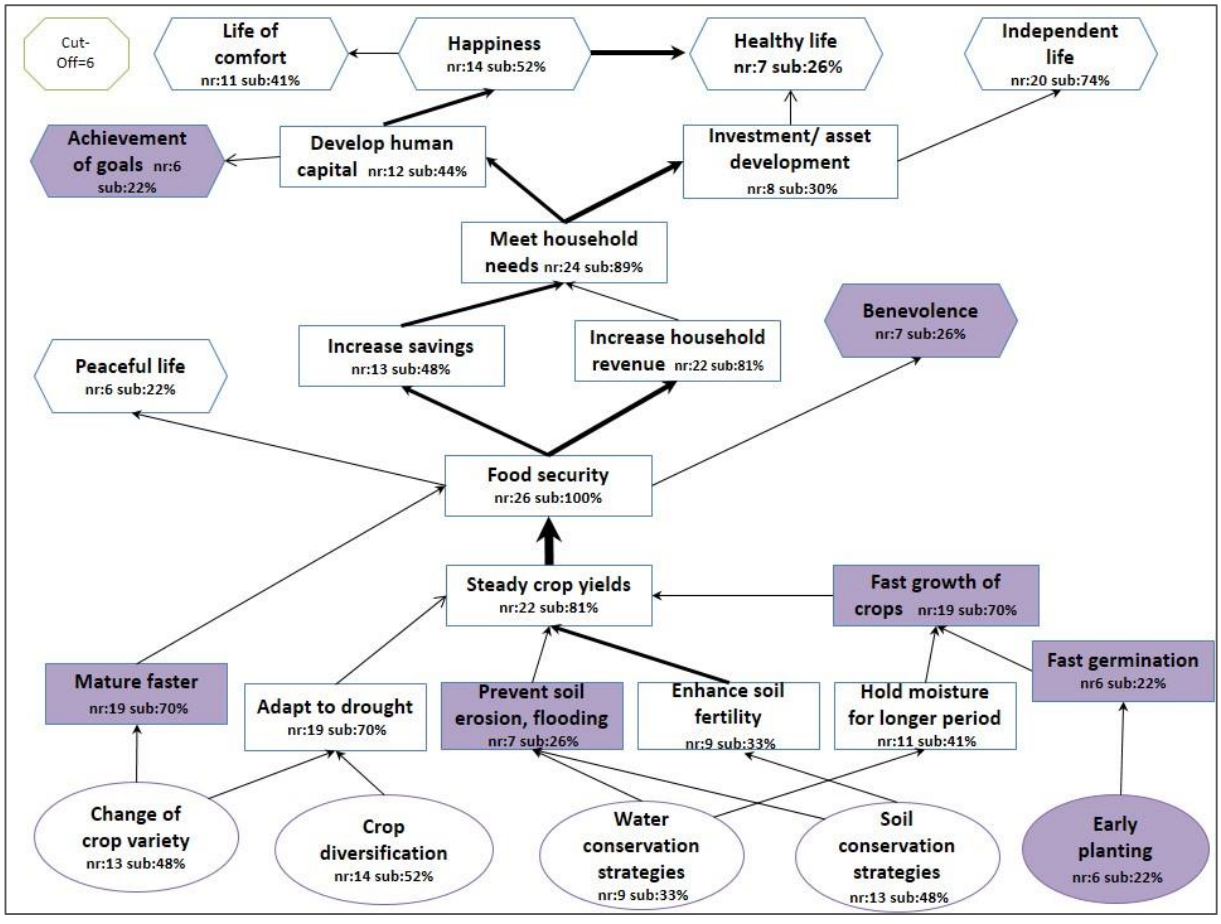

Figure 4.3: The HVM for women's decision-making processes in adopting climate-smart practices in crop management (N=26). The *nr* and *sub* present frequency and percentage of responses, respectively. The oval, rectangle and hexagon shapes present the respective strategies, consequences and values. The shapes highlighted in purple present female-specific differences.

Source: Authors' computations centered on the 2012 survey data

For instance, a female farmer in the sub-humid (Siaya district) region explained:

> "*We [women] know the benefit of early land preparation and planting, and most of the farmers do practice it. This is because the crops take advantage of the first drops of rain that ensure faster germination of seeds. However, women are underprivileged because in this culture, men ought to initiate most of farming practices such as land preparation and planting (…)".*

This statement exemplifies the perceived benefits of early planting that enhances fast growth of crops, steady crop yields and food security based on women's role in the household as food producer. Indeed, all women (sub: 100%) cited the importance of food security achievable through adopting various climate-smart strategies. The cultural context in which women operate could however hinder their uptake of adaptation strategies especially early land preparation and early planting. According to Schwartz's basic and universal values, under changing climate conditions, women's attachment to tradition values could conflict with other values such as benevolence, peaceful life and achievement of goals that are enabled through taking up strategies like early planting and crop diversification that promote food security.

Further, women prefer switching to crop varieties that mature faster and are tolerant to drought. However, there seems to be a trade-off between fast-growing, high-yielding varieties and consumption attributes regarding sensory preferences. Female farmers indicated that the high-yielding varieties of sorghum were less tasty compared to the low yielding local variety. They also revealed that fast-growing and high-yielding varieties of maize were prone pest infestation especially weevils, making it difficult to store and preserve maize for longer durations, considering the importance of food stocks as one of the coping strategies to protect farmers against climate change and food shortage.

Contrary to men's HVM, another unique consequence in women's HVM include the control of soil erosion and flooding by the use of appropriate soil and water conservation strategies, reported by 26 percent of female farmers. The consequence of controlling soil erosion implies that there is minimum run-off of soil nutrients, thus ensuring steady crop yields. The steady crop yields relate to food and nutritional outcomes, which in turn increase household income and savings. This facilitates investment and asset accumulation of human, physical, and social capital. Female farmers also emphasized the need to invest in water harvesting technologies in order to enhance resilience to climate change. They perceived that water harvesting could improve water availability in all seasons and reduce labor burdens for women and girls, as they no longer need to walk long distances to fetch water. This finding presents a female-specific concern.

Taken together, female farmers were motivated to adopt climate-smart agricultural strategies in order to achieve food security, increase their household income, and invest in human capital

development. Specific female values include benevolence (22%) and achievement of goals (22%). Other values similar to men's are independence (74%), happiness (52%), comfort (41%) and good health (26%), but a higher proportion of women than men put more emphasis on the value of an independent life.

4.4.2 Hierarchical value maps for livestock management

4.4.2.1. Men's motivations for adopting climate-smart practices in livestock management

The HVM in Figure 4.4 presents the synthesis of men's decision-making processes in livestock management. The study selected a cut-off level of six to map data on HVM, if at least six male farmers mentioned the association between two concepts as either a direct or an indirect connection.The arrows indicate associations and the strength of the links.The results show that male farmers across the study sites prefer five key strategies of climate-smart practices in livestock management.

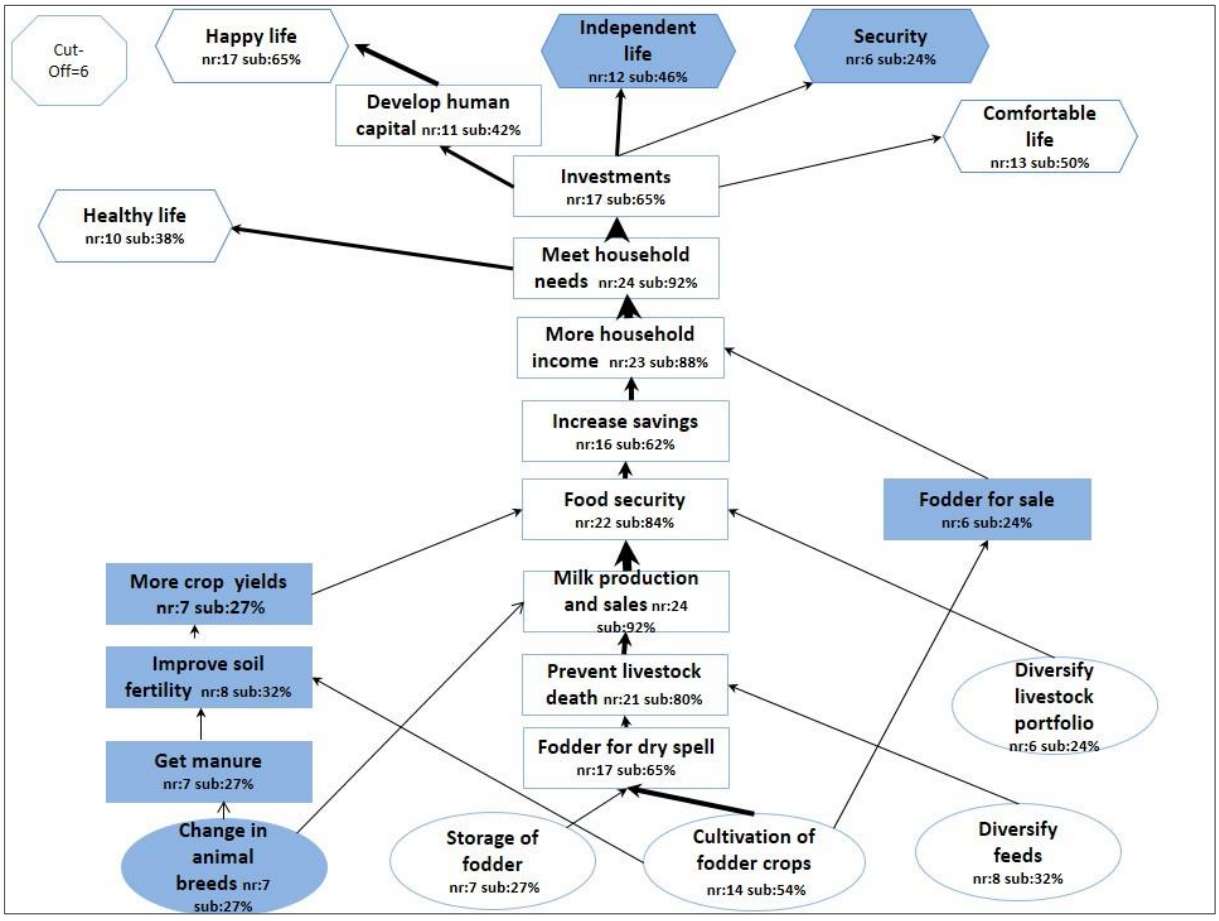

Figure 4.4: The HVM for men's decision-making processes in adopting climate-smart practices in livestock management (N=26). The *nr* and *sub* present frequency and percentage of responses, respectively. The oval, rectangle and hexagon shapes present the respective strategies, consequences and values. The shapes highlighted in blue present male-specific differences.

Source: Authors' computations centered on the 2012 survey data

These include planting of forages/fodder crops (54%), diversifying livestock feeds (32%), storing/conserving of fodder (27%), changing livestock breeds (27%), and diversifying the livestock portfolio (24%). The planting of forages and fodder crops is a dominant practice among male farmers. It involves intensification of Napier grass[46] (*Pennisetumpurpureum*), Rhodes grass (*Chlorisgayana*) and Tick-clover (*Desmodiumuncinatum*). Besides, being a cover crop, clover plant is useful as a biological control of Striga weed (*Strigahermonthica*) in the affected region of Siaya. Planting forages offers good prospects for lowering costs for livestock production and contributing to land management and climate change adaptation. The motivation associated with planting of forages and preserving fodder is meeting the demand for high quality livestock feeds during dry spells (65%), which in turn prevents losses of livestock due to feeds scarcity. A male farmer in semi-arid region (Njoro) indicated:

> "*The drought that we experienced in 2009 was an eye opener for most farmers. Cultivation of fodder crops, such as Napier grass and Rhodes grass, is ongoing. We also preserve maize stovers and make hay and silage because the weather has become unpredictable - we do not want to lose our animals again in the occurrence of drought (…)*"

Cultivation of fodder crops is also associated with the consequence of having more fodder for sale that supplements the household income. Men believe that sufficient and quality livestock feed will increase livestock productivity and sale of milk, reported by 92 percent of farmers. The consequence of increasing livestock productivity interlinks with higher household's income and food security. Diversification of livestock portfolios leads to food and nutritional security. Food availability in the household increases savings allocated towards meeting other basic needs, such as clothing and food. The ability to meet family needs is connected with short or long-term investments, such as purchase of farm inputs. Investments lead to asset accumulation, especially in human capital, through access to higher quality education.

In addition, change in animal breeds is also a desired practice among male farmers (27%). The motivation for changing animal husbandry is to upsurge milk production and sales and to acquire farm manure. The consequence associated with manure availability is to improve soil fertility, which in turn increases crop yields and food security. Increase in agricultural production ensures food availability, whereas a rise in income and savings enhances food accessibility and stability. The ability to obtain an adequate diet for all household members throughout the season is important because the household will not disinvest long-term savings on food consumption.

[46]The majority of farmers use the so-called "tumbukiza" technology (round and rectangular pits or round in trench type) for Napier grass production because this method holds moisture, and the grass regrows faster even with little rainfall (Orodho, 2006). Nyambati et al. (2011) shows that Napier grass under "tumbukiza" technology yields high dry matter than other conventional methods.

The personal value associated with the ability to meet household needs is good health. As cited by male farmers, inability to meet family needs results in reduced happiness and increased family conflicts and hypertension, which in turn deteriorate health. As illustrated in the HVM, the core value of human capital development is leading a happy life (65%). Investment in both short- and long-term ventures is associated with security (24%), independence (46%) and a comfortable life (50%). Security implies that there is safety, harmony, and stability in society. Security as a motivating value is related to the ability to meet future needs, such as medical expenditures. Security at the national level implies that citizens and their possessions are safe from vandalism and theft. An independent life means that a household is able to sustain its expenditures on basic needs especially food and clothing without external assistance from relatives, friends, or neighbors. Male farmers reported that borrowing is connected with shame and failure in life. A comfortable life is linked with a life of adequacy or a financially well-equipped household.

4.4.2.2. Women's motivations for adopting climate-smart practices in livestock management

Women play a major role in livestock production, especially in feeding livestock. The HVM in Figure 4.5 presents the synthesis of female farmers' decision-making processes regarding climate-smart agricultural practices in livestock management, across study sites. A cut-off level of three was selected to display data for the HVM. There is a notable difference between men's and women's motivations for adopting climate-smart practices in livestock management.

First, less than three female respondents mentioned that storing fodder crops is an important attribute, thus dropping it from the analysis. The rest of the strategies are similar to men's HVM apart from the uniqueness of the consequences. However, a higher percentage of men than women prefer genetically improved cattle. On the other hand, female farmers prefer diversifying livestock portfolio especially rearing small animals to boost family income and food security. Female farmers reported that small ruminants and non-ruminant livestock such as rabbits, sheep and goats and poultry easily adapt to climate change (31%). Since small livestock are in the domain of women that enhance their coping ability and resilience to drought and tackle other economic shocks because they can easily be sold for cash, thus increasing women's liquidity. Women reported that decreasing availability of pastures motivate rearing of dairy goats and rabbits. The twofold benefits of small livestock include diversified income sources and food security. A female farmer in semi-arid region of Mbeere South District mentioned:

> *"I started rearing dairy goat(s) because it does not consume much fodder and it copes well in season of low availability and poor quality fodder. It provides the family with milk and income from milk earnings. The goat milk is nutritious and boosts my family's health*"

One distinctive consequence in women's HVM is that they prefer practices that could reduce their labor burdens, concerning the search for livestock feeds. The consequences associated with a

reduced labor loads for women are time to attend to other household chores, such as cooking, care responsibilities or other farming activities with a core value of a good health. This is due to gender relations and gendered roles and responsibilities in the household. The consequences of women able to attend to other farming activities imply saving on labor costs. Other distinctive consequences are productive livestock because of sufficient and quality feeds that ensures more milk production, hence, improved household income.

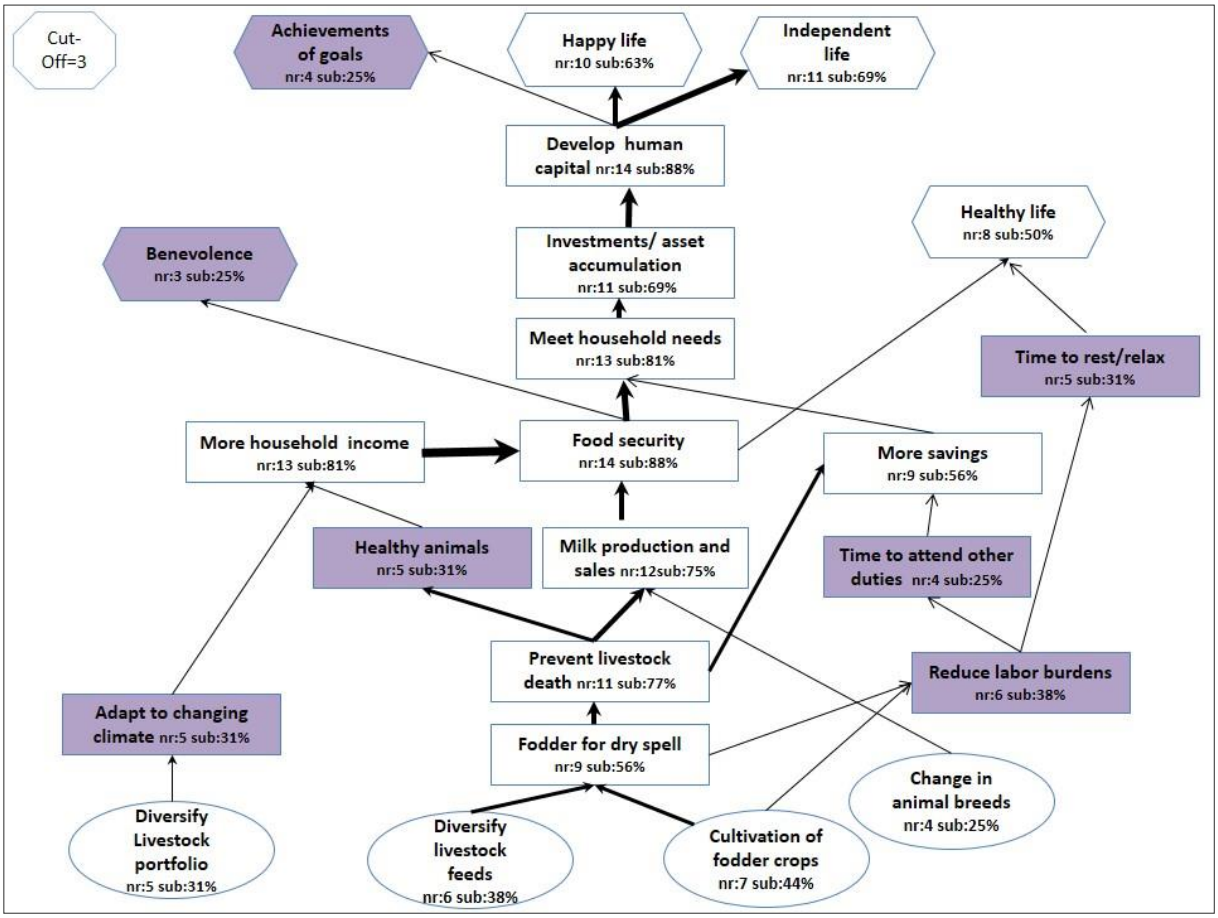

Figure 4.5: The HVM for women's decision-making processes in adopting climate-smart practices in livestock management (N=16). The *nr* and *sub* present frequency and percentage of responses, respectively. The oval, rectangle and hexagon shapes present the respective strategies, consequences and values. The shapes highlighted in purple present female-specific differences.

Source: Authors' computations centered on the 2012 survey data

There are differences in personal values between men and women in the domain of livestock management. Two unique core values include achievement of goals and benevolence reported by 25 percent of female farmers. Achievement of goals refers to personal success through validating an aptitude that concurs with the social standards. In this regard, female farmers value the achievement of life goals through providing quality education to their children and fostering their ability to meet other household needs. This is important considering their low resource base and other prevailing social and gender disparity as shown in Chapter 3. Women inclined the value

of benevolence because it improves the welfare of others, including those with who they are in regular personal contact as well as others based on trust and altruism. Women also value helping the needy and less fortunate in society. Another example benevolence behavior of female farmers involves hiring laborers to work on their famers and pay them in kind, (i.e., food for work).

4.5 Discussion

While previous studies in Kenya showed that financial constraints and institutional factors may hinder adaptation to climate change (Bryan et al., 2013; Silvestri et al., 2012), the present study employed a gender lens in order to analyze the role of intrinsic values as a barrier to the adoption of climate-smart agricultural practices. In particular, it turned out that gender norms and traditions could hinder early land preparation and planting among female farmers because of women's role in household decision-making. The male members of the household (husbands, sons, brothers, or brothers-in-law) because of gender norms are expected to initiate the climate-smart agricultural strategies on the farm. This is because an individual may be unwilling to divert from their traditional beliefs. This finding corresponds to that of Jones & Boyd (2011), who also found that mental beliefs, traditions and norms hinder the uptake of new practices in response to a changing climate. This implies that under climate change, it will be difficult for women attached to traditions to pursue climate-smart strategies such as changing planting date or early land preparation that are perceived to be a male responsibility to initiate these essential measures.

While early planting and controlling soil erosion prevailed as adaptation strategies for female farmers; developing agroforestry systems and storing/conserving of animal feeds was a preferred practices among male farmers in this study. This finding is in line with the study by Kiptot & Franzel (2011), who found that women's participation in agroforestry systems is comparably low because this enterprise is typically a male domain. Women tend to have low access to and control over agroforestry benefits due to a lack of *de facto* property rights, which usually provide incentives for long-term investments on land. Oloo et al. (2013) argues that traditions and norms prevent women from making decisions concerning planting of trees at either the household or the community level in Siaya District. This is because women are required to provide labor in watering and weeding trees, but not allowed to participate in activities pertaining to forestation and tree planting (Oloo et al. 2013). Different roles and responsibilities of men and women were elaborated by the desire of female farmers to reduce the labor burden in livestock management. The study by Kristjanson et al. (2010) supports the findings that in Central and Eastern Kenya, women provide labor in feeding livestock. A higher percentage of men than women prefer genetically improved cattle (see EADD 2009 for a similar finding). In addition, the role of women as food producer and nutritional overseer in the household motivates them to adopt strategies that promote food security and nutritional outcomes such as early planting.

The major similarity between men's and women's motives for adopting climate-smart agricultural practices were steady crop yields, food and nutritional security, increased income and savings, and accumulation of assets. This finding upholds that of Wolf et al. (2013) who concluded that farmers adapt to climate change to be food secure. Our findings suggest that men and women desire to build resilience by investing in income generating activities, reducing poverty levels, and lessening their dependence on agriculture. These findings concur with the overall goal of climate-smart agricultural practices to build resilience and alleviate poverty (Thorlakson & Neufeldt 2012; FAO 2013).

There are mixed results in the literature on gendered intrinsic values. Giacomino & Eaton's (2003) study shows that men ascribe greater value to independence, a sense of responsibility, freedom, and family security. Contrary, Olson & Currie (1992) show that women ascribe family security a core value. Rokeach's (1973) findings suggest that women are oriented towards religious values, such as happiness, benevolence, harmony, and peace. In this study, men and women were motivated by similar intrinsic values to adapt to climate change, namely independence, happiness, comfortable life, and good health. However, male-specific values included security and a sense of responsibility, whereas female-specific values related to the achievement of goals and benevolence. The gender-differentiated values exist because of gender roles in the households. Traditionally, it is the men's role to provide for the basic needs of the family and thus ascribe to the value of independence and family security. To satisfy these personal values, farmers take actions that can minimize the negative consequences of climate change, such as crop loss. These findings are reinforced by protection motivation theory, which asserts that human beings change their behavior to reduce the magnitude of a threat (O'Brien & Wolf, 2010).

The values of leading a happy and healthy life are recognized in the Human Development Index (HDI). However, there are mixed results on measures of happiness concerning economic growth, income and life expectancy (Blanchflower & Oswald, 2011). With respect to climate change, reducing carbon emissions lead to improved happiness, health, and well-being of individuals (Cohen & Vandenbergh, 2008). The realization of a minimum level of income allows households to ensure basic nutrition, housing, education, security levels, as well as self-perceived happiness. This implies that climate change will affect physiological and economic needs, which in turn affect human values, such as health and happiness.

A deeper look into the elicited values revealed that security values could help to avoid conflicts and promote harmonious social relations in the communities. Security may also nurture investments that diversify income necessary to cope with a changing climate. Further, benevolence values could promote cooperation and social capital, which are essential for sharing weather-related information, which in turn could stimulate adaptation to climate change. This corresponds to Schwartz's (2012) finding that self-enhancing values, such as achievement of goals, may motivate individuals to invest in practices, which further help to realize these values.

However, as the findings of this study indicate, it is important to note that self-enhancing values can lead to unsustainable adaptation practices. Although agroforestry is a promising strategy that builds livelihood resilience to drought and floods in Kenya (Quandt, Neufeldt, & Mccabe, 2017) our research indicates that careful selection of tree species is required. Planting inappropriate but profitable tree species for agroforestry systems can foster soil degradation and cause other harmful effects to ecosystems that affect the entire community. Interventions targeting men should consider the trade-offs among competing values that influence their attitude or action they take under climate change. For example, the trade-off between men's self-enhancement values that oppose universalism values through promoting environmental sustainability that protect the welfare of all. Besides, it turned out that in changing climate conditions, it is sometimes a challenge for female farmers to pursue the achievement of goals, while sustaining tradition, hence forcing the revelation of an irreconcilable conflict between two absolute intrinsic values.

4.6 Conclusions and policy implications

This study applied an innovative means-end chain approach in order to elicit the cognitive structure of the Kenyan farmers' decision-making processes underpinning their adaptation strategies to climate change. The findings of this study show that Kenyan farmers adopt several climate-smart agricultural practices to minimize the negative consequences of weather variability. These practices include changes in crop variety and type, soil and water conservation strategies, agroforestry, and changes in animal breeds and animal feeds management. However, poor selection of strategies could lead to loss of welfare for all. Male farmers indicated the need for suitable climate-smart agroforestry system through careful selection of tree species. These findings point the need to promote suitable climate-smart practices for different regions. These practices can be promoted through extension services and awareness creation on available and appropriate climate-smart agricultural strategies that meet the values of men and women.

The fact that differences exist in the intrinsic values of men and women in relation to climate change implies the need to factor gender and other social considerations into national adaptation plans. Although it has been highlighted that conservation values especially traditions may limit the efforts to adapt to climate change, one should also note that traditions are malleable over time. A major concern is how gender norms and traditions that often have asymmetric effects on different groups (van Staveren & Odebode, 2007), can be transformed into equitable institutions. In Kenya, cultural obstacles to climate change adaptation would require that traditional leaders support the empowerment of women in the household and community level. Further, it would be useful to establish public fora to discuss and disseminate gender-specific adaptive strategies. In this way, both men and women would be encouraged to reflect on their specific gender roles and options in adopting climate-smart agricultural practices on their farms. As shown in Chapter 3, institutional innovations especially group-based development approaches provide

opportunities for such fora for addressing gender issues and norms that prevent female farmers from taking up technologies and innovations that are essential for adapting to climate change.

The ultimate motivation of farmers in adapting to climate change is the desire to be independent as well as to lead a healthy, happy, comfortable, and secure life. Both, men and women, desire to improve their livelihoods through savings, investments, and asset accumulation. Since this process needs to be sustainable, complementary pro-poor policies that improve socio-economic conditions, such as promoting livelihood diversification through village savings groups and credit associations, are vital. Although farmers have already pursued various strategies in order to adapt to climate change, there is an urgent need to encourage pro-environmental behavior in line with the sustainable development agenda. This can be done through providing social and economic incentives to farmers that encourage adoption of sustainable climate-smart agricultural strategies that improve long-term food security and deliver more ecosystem services that in turn uphold universalism goals. For example, public policies that focus on climate adaptation and farm productivity can be incorporated with policies that reward conservation practices. Ultimately, individual agricultural practices need to be turned into collective action in order to attain an adaptable society. Thus, policy-makers should highlight social benefits and not only self-enhancing values when it comes to advancing climate change adaptation.

5. General Conclusions and Policy Implications

5.1 Introduction

Climate change and related risks are major challenges facing agricultural performance, poverty reduction efforts, and economic growth in numerous developing economies. Managing risk is a powerful instrument for reducing vulnerability, heightening resilience and for promoting economic growth and development (IPCC 2014; World Bank 2014; World Economic Forum 2017). Managing risks is vital because climate change and shocks lead to depletion of assets, loss of livelihoods and reduce pathways to diversify income. Assets held in the household determine ability to accumulate wealth, build resilience against risks, facilitate escaping out of poverty, and promote the uptake of climate-smart technologies. Besides, there is a widespread agreement that climate change impacts are not gender neutral. Climate change and shocks that affect livelihoods increase prevailing gender inequality efforts and slug empowerment progress (Alexander et al., 2011; European Union, 2012). In addition, gender inequalities in access to resources, gender-specific intrinsic values, gender-specific information and knowledge needs, different economic and social roles of men and women make them experience and respond differently to climate risks, adaptation measures, and policies.

This study aims to contribute to the development of effective policies that assist male and female farmers in managing risks under climate change through assessing the coping capacities and the impact of multiple shocks on household assets and poverty transitions, employing two-waves of panel data in combination with qualitative data from focus group discussions. The study aimed to identify what kinds of assets are most effective in empowering and building resilience of poor rural households and communities under accelerating climate change. Through employing an innovative research approach that aims at a more nuanced gender analysis, this study examines how husband and wife within the same household perceive climate risks, undertake adaptation strategies, and access productive resources. The thesis therefore contributes to the emerging empirical evidence on how the interplay of gender at the intra-household level influences adaptive capacities and uptake of climate-smart agricultural practices. This approach is crucial to better guide the design of gender-sensitive and -transformative climate policies and programs that take different gender aspects into account. Further, the study contributes to the emerging evidence on the potential for gender differentiated group-based approaches towards empowering men's and women's adaptive capacity, ability to manage climate risks, and accumulate household assets, thus fostering welfare outcomes in the face of accelerating climate change. Such information is relevant for designing policies and for guiding development programs that implement interventions through group-based approaches. Lastly, by employing a value-based approach, this thesis presents insights that irreconcilable conflicts between values exist due to changing climate conditions. The study shows how men's and women's intrinsic values may on one hand promote climate change adaptation, but on the other hand, obstruct the uptake

of specific climate-smart practices in addition to encouraging unsustainable adaptation behavior. In the rest of this concluding chapter of the thesis, we present a brief summary of the main results, derive implications for theory, identify avenues for further research, and highlight the policy implications of our findings.

5.2 Summary of the main results with reference to the conceptual framework

In this section, we relate our main findings to the conceptual framework discussed in Chapter 1, Section 1.3. This section revisits the framework for purposes of cross-referencing. This section therefore presents summary of the main results on how the climate signals interact with the vulnerability context, adaptation arena, and how different actors contribute to overall well-being across the different intersections shown in Figure 1.1.

5.2.1 Climate signals

As shown in Figure 1.1, the interaction of climate signals and the vulnerability context is an essential feature of our conceptual framework. Climate signals and shocks pose a risk that requires coping strategies of individuals and households (UNDP, 2008). Although our study focused on climate signals such as drought, erratic rainfall or floods as the major threats for rural livelihood, our findings show that non-climatic shocks are also important risks affecting household assets and impeding the realization of poverty reduction interventions. The results of Chapter 2 indicate that households experience at least one major shock as well as concurrent shocks. These include health shocks (illness and death), loss of crop before harvest due to crop pest infestation, market shocks, socio-political shocks and crime shocks. These shocks or risks destabilize rural agricultural livelihoods, reduce income, restrict sources of livelihoods, expose households to hunger, food insecurity, and malnutrition, possibly push households below the poverty line, and reduce investment in human capital, which could lead to a human development trap.

In Chapter 3, a more nuanced gender analysis was conducted using a unique self-collected intra-household data set. These findings provide important insights on the interface of climate signals and vulnerability context (see Figure 1.1), as they indicate that this interface needs to be analyzed in a gender-differentiated perspective. Our findings indicate that husbands and wives within the same household have similar perceptions on numerous indicators of risk, such as an increase in average temperature, a decrease in rainfall and a rise in incidences of malaria. However, a higher percentage of female spouses perceive more occurrence of erratic rainfall and early onset of rains. Interestingly, husbands and wives living under the same roof have different levels of knowledge on the causes and impacts of climate change and climate signals. Husbands and wives feel that frequent incidences of water scarcity increase their concerns regarding climate change. Nonetheless, women are more concerned about changing climate signals because of reduced agricultural production, food insecurity, low fodder availability, and increase poverty levels. Our findings suggest that women's concerns regarding changing climate depend on their roles and

responsibilities as food and nutrition overseers and labor providers in the household. Recent studies concur with our findings that social norms, cultural constructs, different roles and responsibilities lead to gender differences in perceptions and concerns of climate change, and the environment (see McCright 2010; Semenza et al. 2011; Safi et al. 2012).

The following section presents how vulnerability to climate and non-climate risks determine coping and adaptive capacity of households and the impact of climate change.

5.2.2 Vulnerability contexts

The extent to which a household is affected by the climate and non-climate shocks depends on its vulnerability context (UNDP 2014). According to the conceptual framework presented in Chapter 1 (see Figure 1.1), the vulnerability context comprises four components, namely: user characteristics (demographics, gender, personal values, and socioeconomic factors), institutional arrangements (access to institutions, group-based approaches, norms, and traditions), information and knowledge sharing (access to and trust of information) and biophysical characteristics (climate estimates and agro-ecological regions). The subsequent sub-headings highlight the study's findings on how these four components interact with each other and how they influence vulnerability, adaptive capacity, and well-being.

5.2.2.1 User characteristics

Certain characteristics make individuals or households (i.e. users of natural resources) vulnerable to climate change and other non-climate risks and shocks. This thesis examined who is vulnerable to what shocks and why, looking at the underlying factors (see Chapter 2). Using asset and income quintiles, our findings show that poor households are more vulnerable to drought shocks, while the rich households were found to be more vulnerable to hailstorms and flooding. Depending on the underlying economic factors, poor and rich households cope differently with shock. Our findings suggest that well-off households diversify their food intake, migrate to look for alternative livelihoods and sell their assets to smooth consumption. On the contrary, the poor households sacrifice their consumption and keep their children from school. Evidence shows that keeping kids from school due to shocks leads to long-term low human development trap (UNDP 2014). Our findings further show that as coping strategies against shocks, female-headed households borrow from group-based approaches in which they are member and reduce the levels of consumption. Contrarily, male-headed households dispose of their livestock to smooth consumption. The study concludes that targeting social protection policies and programs should take these differentiated strategies of household in poor communities into account.

In Chapter 3, an intra-household gender lens was applied to better understand the situation within the household and to examine how the interaction between husband and wife influences

the vulnerability and adaptive capacity of household regarding climate risk. Our data suggest that women are likely to be more vulnerable to climate change. This could be explained by their low decision-making power on land use and low access to resources and agricultural information. The findings on the intersection of gender and assets indicate that consumer durables and agricultural assets, access to farmer's field schools and education levels help women adopt climate-smart agricultural practices. Besides, we found that based on women's roles, responsibilities, and their concerns on climate change, they adopt crop-related strategies such as soil management practices, early planting and changing crop types that enhance food and nutritional outcomes in the household. Previous studies in Kenya have shown that financial constraints and institutional factors limit adaptation to climate change (see for example Bryan et al. 2013; Silvestri et al. 2012; Jost et al., 2016). The results of Chapters 3 and 4 contribute to this literature by highlighting how gender norms, traditions, and cultural values obstruct women from taking up climate-smart agricultural practices such as early land preparation, early planting, and tree planting, which could enhance their resilience to climate change. Hence, traditional values and gender norms exacerbate gender-linked vulnerability.

In spite of constraining factors facing women such as low access to resources and information and undermining traditions, our findings suggest that women are key actors when it comes to adapting to climate-smart agricultural practices. However, most of the practices adopted by women are low-cost strategies, which match their low resource base and their roles in the household as food producers and labor providers in agriculture. The recent literature supports our findings that women are chief providers of labor in agriculture in developing nations (see Kristjanson, Waters-bayer, et al. 2010; FAO 2011). The results of Chapter 4 show that women, hence, seek adaptive strategies such as planting forages that lessen their labor loads in searching for quality livestock feeds.

Another important individual characteristic is the role in the decision-making process as well as cognitive and personal values. In Chapter 4, using innovative laddering and means-end chain analysis that has been widely applied in consumer studies to elicit decision-making processes, we illustrate the process by which men, and women make decisions about adopting climate-smart agricultural practices. The findings show that men and women are motivated to adopt climate-smart agricultural practices to reduce vulnerability and increase crop yields, food supply, and nutritional security, amplify income and savings, and overall accumulate assets. The ultimate value of these adaptive behaviors is to enhance their intrinsic values, including self-enhancing values, traditions, and benevolence. Although, these values motivate men and women to adapt to climate change, irreconcilable conflicts between values exist under changing climate conditions. The findings suggest that it will difficult for women attached to conservative values to pursue achievement or benevolence values. Hence, attachment to conservation values by women could worsen existing gender and social inequalities. Our findings also suggest that personal values may in turn encourage unsustainable adaptive behavior, hence, exposing individuals, and

households to future climate risks. For instance, male-specific values such as self-enhancement values could hinder sustainable adaptation behaviors.

5.2.2.2 Institutional arrangements

Institutional arrangements are another important component of the vulnerability context, as shown in Figure 1.1. Functioning rural institutions are important in helping individuals and households to cope with and reduce vulnerabilities to climate risk, as well as non-climate related shocks. Formal rural institutions do not operate in a vacuum; therefore, group-based approaches could complement them in risk management and climate adaptation activities. The results of Chapter 2 show that 18 percent of households experiencing shocks depend on group-based approaches to smooth their level of consumption. The same chapter shows that weather shocks are likely to have a negative effect on social capital and group-based approaches. These findings indicate that while group-based approaches can reduce vulnerability and build resilience against shocks, persistent covariant shocks could require interventions of social protection and safety net programs.

The results of Chapter 3 present the role of gender differentiated group-based approaches in managing risks, sharing information and adaptation options, which in turn strengthen adaptive capacities and resilience of men and women to climate risk. Although this study upholds previous studies, it provides new intra-household insights, especially on how husbands and wives benefit differently from participating in group-based approaches. The findings show that husbands mostly acquire climate information, adaptation ideas, and access farm inputs through social groups. Wives diversify their sources of livelihoods, generate income, and accumulate wealth while at the same time managing risks and building resilience through group-based approaches. Women draw upon alternative and innovative approaches through group-based approaches. These include group-based land acquisition for agricultural production, collective inputs banks, and group-based income-generating activities. These approaches improve women's income, food, and nutritional outcomes and enhance their bargaining power in the household and community level. The findings further show that institutional innovations especially through group-based approaches provide a forum that is useful in addressing traditions and social norms that obstruct women in adapting to climate change.

The results in Chapter 2 further show that rural institutions are essential in risk management. These include agricultural and veterinary agents and financial institutions. Access to extension services is likely to influence investment decisions in poultry and cattle enterprises, even in the midst of shocks. The results of Chapter 3 show that access to farmer field schools and extension services is likely to influence women's adaptation decisions, and the number of technologies they adopt.

In conclusion, group-based approaches and other rural institutions could reduce vulnerability of individuals, households, and communities to risks, increase their coping and adaptive capacity, strengthen resilience, and—importantly—address gender norms relating to men and women.

5.2.2.3 Information and knowledge sharing

Information and knowledge sharing is the third component of the vulnerability context, as shown in Figure 1.1. Our findings indicate that this component also needs to be studied in a gender-differentiated way. The ability to acquire and share knowledge is a major catalyst for adapting to climate change and thus reducing the vulnerability to climate risks and variability (Meera, Balaji, Muthuraman, Sailaja, & Dixit, 2012; Ospina, Bueti, Caisey, & Young, 2012). The results of Chapter 3 suggest that farmers have substantial access to agricultural information and climate information. However, access to information was found to be gender-biased. Our results show that husbands have more access to information on crop and livestock production, extension services as well more access to early warning systems. Their spouses, on the other hand, have more access to climate change information (seasonal and weather forecast), and more access to advice on the adaptation options.

Further, our results show that there are gender-specific climate information needs and preferable channels for accessing agricultural and climate information. In Chapter 3, the radio was found to be the most preferred channel for accessing information for both husbands and their spouses. However, husbands prefer extension agents as a channel for disseminating agricultural information. This chapter also presents the interesting finding that uptake of information acquired via different sources strongly depends on the extent to which men and women trust the information they acquire from these sources. The findings further show that both husbands and wives have more trust of the information they acquire through radio and television programs and extension agents. We argue that low levels of trust and acceptance of information from the Kenya meteorological department could expose men and women to risks and vulnerability. The results of Chapter 3 further show that group-based approaches are essential for disseminating climate information and sharing adaptation options. The evidence indicates that timely and reliable information could facilitate the adaptation process and build resilience to future threats. The use of ICTs such as radio and television programs, mobile phone text messages (SMS), farmer field schools, and —most prominently— group-based approaches are imperative in raising awareness and creating innovative capacities in risk management. In addition, access to information through radio programs on agriculture and through effective agricultural extension system are very influential in husbands' and wives' decision-making regarding crop and livestock management, soil and water management, agroforestry and uptake of new technologies. Information sharing about adaptation options is likely to translate into deepening adaptive capacities and resilience, improving household food security, income, and other well-being outcomes, as well as influencing intrinsic values.

5.2.2.4 Biophysical characteristics

Biophysical characteristics are the fourth component of the vulnerability context in our framework (see Figure 1.1.). According to the framework, biophysical characteristics surrounding households or individuals could determine how they cope with climate change and they influence their levels of exposure and their experience of climate and non-climate signals. The results show that vulnerability to risks, adaptation practices and poverty status vary across regions (Chapter 3&4), which underlines the role of biophysical characteristics. The results of Chapter 2 show that drought is a major shock in semi-arid regions, whereas erratic rainfall is dominant in humid regions. Hailstorm, illness, and death shocks dominate in sub-humid regions. Production shocks such as crop pests, exacerbated by climate change, are predominant in semi-arid regions. The results of Chapter 3 interestingly show that adaptation options differ significantly across geographical locations. Agroforestry and soil conservation technologies are dominant in sub-humid regions. This could be explained by the fact that these regions host a carbon project on sustainable agricultural land management (SALM), spearheaded by Vi Agroforestry (for details see Shames et al. 2012). The project could explain higher adoption tendencies of soil conservation strategies in this region, but the choice of the projects may have been influenced by the particular vulnerability of these zones to soil erosion. Water harvesting and conservation practices are dominating in semi-arid regions, and are essential in reducing vulnerability to drought and water scarcity in this region. Lastly, the results of Chapter 2 show that poverty status diverges significantly across geographical regions, with sub-humid regions recording the highest poverty levels. These findings suggest that programs on managing risks and promoting adaptation to climate change need to consider local-specific vulnerabilities and the ultimate needs of local communities.

5.2.3 Adaptation arena

The adaptation arena is essential for determining how the interaction between climate signals and vulnerability context finally determines well-being outcomes (see Figure 1.1). According to our framework, the action arena captures actors, their resources, and their behavior, which can be studied at the individual, household and community levels. The focus of our study was the individual and household level, and the findings clearly show that analyzing this action arena is essential for understanding why and how climate change leads to different well-being outcomes. As explained earlier in this section, husbands, and wives perceive climate risks differently and subsequently adapt differently to changing climate. The results of Chapter 3 make important contributions to the evolving but still limited empirical evidence on the role that gender and intra-household dynamics play with regard to climate perceptions, knowledge, and adaptation to climate change. The findings of Chapter 3 show that different roles, responsibilities, and

entitlements or ownership of resources by husbands and wives influence how they take up different climate-smart agricultural practices.

The results of Chapter 2 show that coping behaviors vary depending on the wealth endowment of the households and the types of shocks confronting them. Access to safety net programs, including food relief, financial institutions, extension agents, media, and group-based approaches influence the coping and adaptation strategies. The results of Chapters 2 and 3 also provide important insights on the link between the vulnerability context and the action arena (see Figure 1.1). They show that the interactions of households and individuals with institutions, especially group-based approaches influence the individual's and household's vulnerability, adaptive capacities, and their resilience against shocks. Access to institutions and participation in group-based approaches, intermediate the impact of shock signals to individual's and household's consumption levels, food security, loss of assets and subsequent poverty status.

5.2.4 Well-being outcomes

The interaction of shock signals, the vulnerability context, and the action arena ultimately determines the well-being outcomes caused by different climate signals. The well-being outcomes have an important feedback loop with the vulnerability context (see Figure 1.1). Chapter 2 showed that considering a wide portfolio of household assets is important for undertaking investment decisions in the midst of risk and uncertainty and their ultimate effect on well-being outcomes. Livestock turned out to be a particularly important livelihood asset for rural household and protecting households' livestock assets is an important poverty-reducing strategy, both at the household and national level. Chapter 2 further shows that different shocks affect the households' livestock portfolios differently. Climate shocks adversely affect poultry, dairy cattle and draft animals, in contrast, no significant effect was found on small ruminants and non-ruminant animals. Small ruminants and non-ruminant livestock, hence, are particularly important for household resilience to accelerating changing climate. Bati (2013)'s study supports our findings that goats and sheep have a higher adaptive capacity than cattle. Goats and sheep have a higher tolerance to water scarcity, feed scarcity, drought, heat stress and higher survival rate of the offspring (Bati 2013: 98). The adverse impact of shocks on livestock, mainly through distress sales, theft, or physical death of livestock owing to drought, may have negative labor implications for the households. Draft livestock is important for providing draft power and transport services in rural areas (Smith et al., 2013), implying that adverse impact on them will affect the labor productivity and subsequent agricultural productivity, income and food security, which are all important well-being outcomes.

To get a comprehensive understanding on the impact of climate signals on well-being outcomes (see Figure 1.1), one needs to take into account the role of other shocks besides climate. The results of Chapter 2 show that climate shocks adversely affect consumer durables and household

income while political shocks negatively affect financial and social capital. Households experiencing shocks are more likely to reduce food consumption. They are more likely to keep children from attending school that could have a long-term impact on human capital development, which is also critical in terms of ultimate well-being outcomes. Further, our findings show that shocks are likely to undermine poverty-reducing strategies and increase the likelihood of vulnerability to future climate shocks while at the same time reducing livelihood options for the household.

An important aspect of this study is to highlight the role that social capital, created by group-based approaches, can play in influencing households' well-being by safeguarding household welfare through smoothing of consumption and protecting household's assets in the incidence of shocks. Our findings uphold those of (S Dercon, 2002) that group-based approaches are substantial in the absence of formal insurance and incomplete credit market in rural areas. The results of Chapters 2 and 3 shows that group-based approaches are indispensable for addressing idiosyncratic shocks such as illness or death of a family member that affect individual household. The findings of Chapter 3 show that group-based approaches improve adaptive capacity through sharing of information and ideas of adaptation. The results of Chapter 3 presents emerging insights on how gender differentiated group-based approaches improve men's and women's well-being outcomes. This well-being outcome is achieved through encouraging savings and accumulation of household assets such as water tanks, consumer durables assets, livestock, and access to group-based land acquisition. Moreover, group-based food production and food acquisition, improve food and nutritional outcomes in the household. Most importantly, group-based approaches provide alternative sources of livelihood strategies that are vital in managing risks under climate change. However, Chapter 2 also shows that the participation in group-based approaches weakens in the event of drought, crime activities, and socio-political instabilities. Therefore, there is a need to tackle collective action problems and strengthen social capital through capacity building programs such as training and sensitizing communities and households on risk managing strategy tools and on the need for accumulating saving in the good times in order to promote proactive resilience through group-based approaches.

The results of Chapter 4 show that adapting to climate-smart agricultural practices contributes to ultimate intrinsic well-being values such as happiness, security, benevolence and a comfortable life. This is an important contribution to the literature on climate change and well-being, since the role of intrinsic values in adaptation frameworks has received limited attention in previous empirical work. The focus of existing studies has been placed on extrinsic values and mostly motivated by utility maximization theory (see for example Di Falco et al. 2011 for Ethiopia). The evidence of Chapter 4 shows that recognizing intrinsic values in adaptation frameworks could strengthen sustainable adaptation behaviors of individuals and households and, thus, contribute to ultimate well-being for all.

5.3 Conclusions drawn from applying the conceptual framework

Based on the conceptual framework, the following conclusions can be drawn from the study. First, the study provides evidence for the relevance and usefulness of the conceptual framework. The results clearly indicate that studying the interaction between climate signals and the four components of the vulnerability context (user characteristics, information and knowledge sharing, institutional arrangements and biophysical characteristics) makes it possible to better understand vulnerability to risks and shocks, especially if a gender-differentiated approach is used. Likewise, the study highlighted the need to study what happens in the adaptation arenas to be able to understand how, ultimately, climate signals influence well-being outcomes.

Second, the study confirmed previous studies that climatic shocks are indeed a major risk that affects rural households. The study adds to the existing literature by drawing attention to the gender-differentiated pathways by which climatic shocks affect rural households. Importantly, our study provides more detailed insights than previous studies on differences regarding the impact on different livestock species and on livestock management decisions by male and female household members. Our findings underline the importance of adjusting livestock portfolios as a major coping strategy to smooth consumption level, especially for asset-rich households. Female-headed and asset-poor households rely on borrowing from social groups to safeguard their low livestock asset-base. These findings have important implications for policies that can support households in coping with shocks by adjusting livestock portfolios and borrowing from social groups that can be promoted through group-based development approaches.

Third, our study adds to the emerging literature on gender and climate change. The particular value of our contribution can be seen in the very detailed gender-differentiated findings regarding perceptions as well as adaptation strategies. Importantly, we do not only compare male-headed and female-headed households, but also provide in-depth insights with regard to the role of female spouses in male-headed households. We show that interactions within the vulnerability context, especially with regard to institutions and information flows influence how men and women adapt to accelerating climate change and how this affects their well-being/welfare outcomes. We also show empirically that gender-specific intrinsic values, roles, responsibilities, and social norms are linked to differences in risk perceptions, access to resources, and participation in social groups, which influences coping strategies and adaptive behavior, and ultimately the well-being outcome in a gender-differentiated way.

Fourth, our study adds to the literature on the role that group-based approaches can play in promoting climate change adaptation. Our results indicate that group-based approaches are valuable, but one needs to consider that they help men and women differently. In general, group-based approaches provide avenues for building up vital types of capital and improving food

security status of households. For women, group-based approaches are particularly essential pathways for diversifying livelihoods and managing climate as well as non-climate risks.

Fifth, our study adds to the emerging literature on the role of intrinsic values in adaptation framework. Our results highlight that irreconcilable conflicts between values exist due to changing climate conditions. Hence, interventions targeting men and women should consider the trade-offs among competing values that influence their attitude or action they take under climate change.

5.4 Avenues for further research

In spite of assessing differences in the perceptions, the vulnerability to and impact of shocks on households, our data did not allow us to examine to what extent the assets owned by different household members are affected differently by shocks. A further empirical would be useful that shows in detail how different types of shocks affect the assets that are owned jointly and the assets that are owned individually by wives, husbands and other family members. Further, to inform the intra-household targeting of welfare policies and programs, it will be useful to conduct empirical analysis of who is most vulnerable to risks in the household, bearing in mind different roles and responsibilities of members of the household. Our analysis did not focus on the monetary values of different assets, though we were able to develop an asset index using principal component analysis. Considering the monetary values of assets when developing an asset index could give more nuanced view of the wealth indicators of the households. While we got useful insights on the impact of shocks on poverty using income measures, further analysis that focuses on asset-based measures could supplement our findings.

Our study provided important insights on how husbands and wives control assets in the household and what factors influence their adaptation preferences. Future research may be useful to examine how exactly information is shared within the household as this may help to design effective dissemination approaches for agricultural information. Future research may apply an "intersectional perspective" that goes beyond conceptualizing gender as a male-female dichotomy relationship, but takes into account other socio-economic categories, institutional arrangements, social practices, social structures, and cultural factors. Such research may show how these factors cut across gender and power relations (see Carr & Thompson 2014; Kaijser & Kronsell 2014; Moosa & Tuana 2014). Moreover, more evidence that is empirical would be useful regarding the effect of gender-differentiated adaptation strategies not only on the households' livelihoods and welfare outcomes, but also on their agency and their ability to influence power relations. Even though the study shows that, motivated by climate change, men in Kenya nowadays turn to cultivating traditional "women's crops", a closer look will be worthwhile to determine the major reasons for this shift. It might be useful to find out whether switching to these crops is a largely a donor-driven strategy, whether it is driven by the fact that such crops

have become more valuable in the market, or whether this shift indeed implies a move towards more gender equity. Moreover, it will be important to conduct cost-benefit analyses of different climate-smart adaptation options adopted by men and women and to assess their impact on individual and household welfare outcomes in monetary terms. Such studies can inform policy makers in the dissemination of suitable gender-differentiated, sustainable, and profitable adaptation options.

While the study tried to address the problem of endogeneity of social capital and selection bias, employing panel data sets with gender-disaggregated intra-household data could provide more insights into the dynamics of adaptation and reveal how social capital accumulates over time. Moreover, panel data will provide more insights into the dynamics of gender roles in adaptation and mitigation over time. Lastly, we did not exhaust in full detail how different actors in the adaptation arenas interact and influence welfare outcomes. In particular, we focused on the individual and household level. More research will be justified to capture the community level and higher levels. Application of qualitative research tools such as Process Net-mapping could provide more insights into how different actors interrelate, what the flow of information are and how governance challenges may obstruct gender equality and sustainable adaptation to climate change.

5.5 Policy implications

The findings of this thesis have important implications for international, national, and sub-nation policies that deal with the interface of climate change adaptation, gender, asset protection, and social groups. Our finding that drought is predominant shock that adversely affect livestock portfolios points towards a need for more effective livestock protection policies. This finding suggests that diversifying livestock portfolios as well as adopting poultry and small ruminant and non-ruminant livestock. These climate-smart strategies are a major step towards coping with climate risk and, building livelihood resilience against weather shocks, while at the same time improving households' food, and nutrition security. Furthermore, our findings imply a need for raising awareness and promoting the adoption of insurance mechanisms to protect livestock assets against weather shocks. An example is index-based weather insurance mechanisms, such as index-based livestock insurance, which is particularly valuable in the semi-arid regions. There is also a need for promoting the planting of forages, diversifying and substituting livestock feeds and putting up fodder banks to ensure a steady supply of quality livestock feeds during drought and dry-spell seasons. These climate-smart practices can be promoted by agricultural extension services and farmer's field visit.

Our study also highlights that group-based approaches are valuable vehicle in the implementation of climate adaptation policies. For instance, group-based approaches could facilitate livestock multiplication and recovery after drought through collective ways of acquiring, sharing, and or

hiring out of livestock to expedite the diversification of livestock portfolios and the access to livestock that require heavy investments such as draft animals. Moreover, group-based approaches may promote saving-kits and safety nets that can provide alternative consumption smoothing strategies in times of shock. This strategy would also allow households to better protect their assets, instead of disposing of their productive assets in an already de-valued market due to poor market integration in times of extreme events (cf. Brown 2014). Our findings also imply that group-based approaches can promote practices that contribute to climate change mitigation, such as afforestation, expansion of agroforestry systems and uptake of improved energy saving stoves. Group-based approaches also help to provide education and strengthen public awareness regarding climate change. Although the government of Kenya recognizes the role that community-based organizations play for social protection interventions, such organizations are still constrained in terms of resources and scope. Therefore, strengthening such organizations through capacity building programs and linking them with financial institutions and other rural institutions would foster their capacity to help individuals and households build livelihood resilience against shocks.

Our findings on gender differences in risk perceptions, worries, adaptive capacities, and adaptation preferences underline the well-known need for gender mainstreaming of policies for agricultural development. Our findings indicate that gender mainstreaming is particularly important with regard to national and international adaptation and mitigation frameworks. The Kenya National Climate Change Action Plan, so far, does not integrate gender-responsive strategies in responses to the climate change. Although the Climate Change Policy recognizes the need to apply gender-differentiated perspectives in responding to climate change, it is vital to address governance challenges in its implementation and coordination and to build capacity by applying gender lens in policy implementation. These goals will be more effectively achieved by involving women in decision-making and planning processes across all levels of formulating and implementing climate change policies and programs. Low adoption rates of climate-smart agricultural practices by both men and women oblige policies towards awareness raising, training, scaling-up, and encouraging suitable climate-smart strategies in crop and livestock management. It is also necessary to inspire the development of innovative adaptation options that address existing gender biases.

The study's findings also point to the need to acknowledge and address challenges posed by informal institutions (i.e. social norms, cultures and traditions) and transform them to equitable institutions. This is feasible through recognizing within policy frameworks the different societal and economic roles and responsibilities of men and women to enable inclusiveness of their needs and interests in adopting climate-smart agricultural practices. Again, our findings suggest that there is a need to establish public fora to discuss and disseminate gender-specific adaptive strategies. As mentioned earlier, our findings suggest that group-based approaches provide

opportunities for such fora for addressing gender issues and norms that obstruct women from taking up technologies and innovations that are essential for adapting to climate change.

The findings that there is gender inequality in access to information and that there are gender-specific climate information needs and gender-preferences in information channels call for policies that encourage gender-sensitive information dissemination approaches. These can be promoted by scaling up gender-sensitive group-based learning, including climate-smart strategies in farmer's field schools, and encouraging farm visits by extension agents to both reach men and women. In addition, there is a need for sharing of climate and agricultural information through easily accessible channels by both men and women. These include the use of ICTs (radio and TV programs), effective agricultural extension system, and group-based learning opportunities to scale up adaptation strategies.

Gender disparity in access to and control over land points the vital need to strengthen property rights for women. These findings point a need to execute the Kenyan constitution to enable gender equality and female empowerment in Kenya. Besides, gender inequality also necessitates policies towards sensitizing and raising awareness of women's rights and legal framework on property ownership and inheritance. Possible substantial strategies towards this goal include policies on capacity building of women, especially through training programs and promoting access to financial facilities. In addition, there is a need to rely on different institutional arrangements to promote access to resources. For example, drawing upon alternative and innovative institutional strategies particularly through group-based approaches can enable far-reaching implications on women's access to productive resources. In addition, with a growing financial sector in Kenya, group-based approaches are essential pathways for women and other vulnerable groups to access loans from government empowerment programs (e.g., the Women and Youth Enterprise Fund and UWEZO Fund[47]), and from informal and formal financial institutions. Hence, policies that encourage individuals to participate in empowerment programs are indispensable. However, implementation and monitoring of empowerment programs should ensure that the poor women in the society equally benefit. It is also essential to involve women in decision-making in different levels and sensitize men and women about the benefits of participating in social groups to foster access to empowerment programs that are implemented by government and development partners.

Lastly, but not least, scaling-up gender-sensitive group-based approaches could strengthen both men's and women's ability to manage climate risk, accumulate household assets, build resilience against risks and address existing challenges of social inequalities, which will in turn improve well-being outcomes. There is therefore a need for policies that encourage gender-lenses while targeting adaptation and development programs. Potential strategies for this goal include

[47]UWEZO means empowerment

promoting gender-differentiated group-based approaches to ensure that development interventions 'do no harm' by reducing existing gender inequalities as well as reducing gender-linked vulnerability and poverty. However, the growth of social capital and participation in group-based approaches are found to weaken in the incidents of persistent extreme events such as drought, flooding and civil conflicts. There is therefore a need for policies that nurture and strengthen social capital and group-based approaches for men and women at community level. These goals will be more effectively realized by establishing capacity building and training programs for both men and women in risk management, and in suitable measures for adapting to climate risks. In addition, organizations that are involved in development interventions and climate change adaptation will require to work together with group-based organizations and reflect gender reality on the ground in order to effectively support livelihood strategies for both men and women.

From a policy maker's perspective, a comprehensive and systematic approach to managing risk should consider the holistic nature and complexity of vulnerability to different shocks affecting rural livelihoods. To attain adaptation and mitigation goal, at international, national, and sub-national levels, it is important to recognize gender-specific differences and social inequalities, which are linked to the socially determined differences in roles and responsibilities of men and women. Besides promoting poverty-reducing strategies, upholding gender equality, reducing vulnerabilities and strengthening resilience to climate and non-climate risks are important goals for the Post-MDG agenda.

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