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Gender differences in climate change perceptions and adaptation strategies: an intra-household analysis from rural Kenya

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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 group-based approaches as coping strategies. The data stem from a unique self-collected and intra-household survey involving 156 couples in rural Kenya, where husbands and wives were interviewed separately. 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 employ livestock- and agroforestry-related strategies. Besides, there are gender-specific climate information needs, gendered trust of 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 options for husbands. Social groups help husbands and wives to enhance their welfare through accumulating vital types of capital such as livestock, durable assets, human, natural, financial and social capital. 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 must reflect gender perspectives on the ground in order to amplify men's and women's specific abilities to manage risks and improve welfare outcomes in the wake of accelerating climate change.

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

JEL classification: D13, J16, Q54

1. Introduction

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 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 on 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 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, as of now, there is limited empirical evidence on how gender at the intra-household level influences the adaptive capacities of men and women.

Further, vast 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'. 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 risk 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 applied unique self-collected and intra-household data 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

The study employed individual- and intra-household level data of 156 pairs of spouses and gender-differentiated focus group discussions (FGDs) to address its objectives. Collective and bargaining approach indicates that an intra-household perspective is 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; Agarwal 1997). 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). Collective and bargaining approach necessitates the need for interviewing household members individually and calls for intra-household analyses. This approach enables identifying gender differences in perceptions, adaptive capacity and uptake of climate-smart agricultural strategies. What is more, collective and bargaining perspective indicates 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. Furthermore, studies considering gender-differentiated social capital formulation and benefits accrued are rare. For example, it is not clear which kinds of social groups are vital while targeting men and women.

The study contributes to the existing literature on climate change by applying a unique self-collected data set and a more nuanced gender analysis in order to shed light on intra-household decision-making. The findings show a slight degree of agreement between couples on how they perceive climate change, reasons for concern, uptake of climate-smart strategies, and how they benefit differently by associating in 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 asset ownership, 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 argues that in spite of women having partial access to essential assets, they draw upon indispensable pathways of social capital and group-based approaches to foster their welfare outcomes through facilitating access to productive inputs and assets that sequentially improve their adaptive capacity and ability to manage climate risk.

2. Intersection of gender, assets and adaptation interventions

This section presents the role of assets in climate change adaptation and in agricultural development. It accents the vital needs for understanding the intersectionality of gender and access to power and to control assets in influencing adaptation needs. Gender equality and intra-household dynamics in access to both tangible and intangible assets are essential in reducing vulnerability, managing climate-related risk 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 in 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, women have limited control over land and property rights. For instance in Sub-Saharan Africa (SSA), women only have rights to use and access land through men, especially in customary land tenure systems (Farnworth et al. 2013:76), while only 3 percent of women own a title deed in Kenya (GoK 2008), hence positioning 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).

Access to agricultural extension services is crucial in achieving food security and increasing agricultural productivity (Davis 2008; Dercon et al. 2009; Ragasa et al. 2012) besides facilitating climate change adaptation (Gbetibouo et al. 2010; Mustapha et al. 2012; DiFalco & Bulte 2013). Ragasa et al. (2012) show that Ethiopian women have limited access to agricultural extension services, information and technology. McOmber et al. (2013) find that women are often left out of information and communication technologies (ICTs) that are crucial in disseminating climate and agricultural information to farmers. This unequal access to extension, information and other forms of communication is likely to affect women's adaptive capacity. 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 gendered 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 that there is 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 and low agricultural productivity (Croppenstedt et al. 2013) besides impacting on women's adaptive capacity. Nonetheless, women easily access informal credit through group-based saving and credit associations, thereby investing credit in productive livelihood activities. With limited access to other crucial assets such as land and credit, new forms of group-based approaches offer novel pathways to access productive assets, particularly for asset-poor and female farmers. Evidence indicates that when women have access 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).

Social capital, so called 'group-based approaches', 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) and adapting to climate change (Nganga et al. 2013; Chen et al. 2014). At community level, social capital supports accumulation of assets, knowledge 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).[1] 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. Besides, 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. Men and women are likely to accumulate different forms of social capital that would apparently have different influences on adaptation to climate change and their welfare.

The reviewed literature pays limited attention to the intersections of intra-household decision-making and access to resources and the potential for gender-differentiated group-based approaches. This study provides a more robust gender analysis using self-collected data on how husbands and wives within the same household perceive climate risks, uptake climate-smart agricultural practices and participate in group-based approaches as a risk-managing tool. The study presents the agreements or concordances among couples on how they perceive climate risks and in turn, uptake climate-smart agricultural practices in order

[1] 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.

to manage climate risk. Besides, gender-differentiated agreement/disagreement between husbands and wives in the same household shows how spouses accumulate social capital differently and in what ways they participate in group-based approaches to improve their welfare differently.

3. Data and sampling procedure

Data for this study was collected from three agro-ecological zones (AEZ) in rural Kenya—the semi-arid, medium potential and high potential zones— between June and September 2012. The sampled districts included Mbeere South and Nakuru (semi-arid zones), Gem and Siaya (medium potential zones) and Mukurweini and Othaya (high potential 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. The study employed a mix of qualitative and quantitative techniques to collect data.

The survey involved individual- and intra-household level data, by interviewing husbands and wives separately. Overall, a random sample of 156 pairs of spouses was interviewed, making 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. Qualitative research involved gender-disaggregated FGDs carried out in all study sites to supplement the household survey. The study developed a FGDs protocol, including modules on perceptions, adaptations, potential for group-based approaches and institutions in enhancing adaptive capacity and building assets for men and women. The study randomly sampled FGDs participants with the help of field facilitators and local leaders to ensure wider representation and views, including participants in different age groups, social status, members and leaders in group-based approaches. Overall, FGDs involved seven women FGDs and eight men FGDs, making 15 FGDs in total.

Perceptions of climate change involved asking how male and female farmers have perceived changes in average temperatures 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. consensus between husband and wife or otherwise. 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 assets using a wider range of assets.[2] Besides, from PCA a social capital index was developed consisting of variables on trust, reciprocity, group participation and social support (see Table 1A-1 in the appendix).[3] Trust of information index defines how farmers depend on or trust

[2] 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.

[3] The study developed social capital 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.

information they acquire from various sources, which was assessed using a 5-point Likert scale, from 1 = ‘strongly distrust’ to 5= ‘strongly trust.’ Categorical principal component analysis (CAPCA) developed the trust index.[4] The Tropical Livestock Units (TLU) quantified an extensive range of different livestock portfolios in a consistent manner.[5] 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). Intensity of adoption is the number of adopted practices/strategies aggregated at the household level.

[4] Categorical principal components analysis (CATPCA) is appropriate for data reduction when variables are ordinal or in category format, i.e. Likert-type scales. It also incorporates both the nominal and ordinal variables. Unlike the traditional PCA, CAPCA does not assume linear relationships among numeric data nor does it assume multivariate normal data (Linting et al. 2007).

[5] 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.

4. Capturing the intra-household dimension of the data

This paper aims at a more nuanced gender analysis on how husbands and wives within the same household perceive climate risks and group-based approaches as risk-managing tool. The major analytical challenge is not to consider husbands and wives as "separate entities" or to employ an "across" households perspective. Instead, it is important to employ a gender lens "within" households and bearing in mind how the interaction between husbands and wives plays out. The paper explores the degree to which husbands and wives in the same household agree, accord, or respond differently to questions about perceptions of climate change, adaptation options, access and trust of agricultural information and participation in group-based approaches.

To define agreement and concordance of the responses, i.e. the extent husbands and wives within the same household report comparable 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 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 analyses examined if the choice of data affected the magnitude of agreement or concordance of husband-wife answers. The degree of intra-household agreement (whether the wives and the husbands provide affirming responses) was summarized for each response. Besides, individual and household-level variations in the frequency of husbands and wives for each response were calculated.

To capture the intra-household differences and household-level differences in agreement or concordance, 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 significant inter-rater agreement of two or more groups (Viera & Garrett 2005). This estimate fits the dichotomized data, especially to measure whether husbands and wives in the same household have corresponding or diverging perceptions about a jointly experienced phenomenon. Kappa estimate also measures the concordance on the choice of adopting suitable innovations and agricultural strategies in management of crop and livestock and decision in participating in a number of group-based approaches among husbands and wives. Kappa estimates range from negative one to positive one, with a Kappa of one implying perfect agreement and a Kappa of zero inferring agreement by chance or random influence (Viera & Garrett 2005).[6] The Pearson Chi-square estimate of

[6] Kappa estimate of < 0 indicates less than chance 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.

equality, on the other hand, is useful to examine whether the husbands' and the wives' choices are independent of each other and whether the fraction of wives asserting the responses differ significantly from that of the husbands.

5. Findings from gendered intra-household gender analyses

5.1 Gender differentiated perceptions of climate change

Table 1 presents the intra-household analyses of perceptions of average rainfall and precipitation variability and the average temperature over the last 10 years. Both husbands and wives in the same household have perceived changes in climate. The findings show a slight agreement between husbands and wives that average temperatures are increasing (Kappa P-value < 0.10). Further, husbands and wives fairly agree 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 decreased rainfall, while a lower percentage agree on increased rainfall. That means in sum, the perception among spouses is that overall rainfall is decreasing (Kappa P-value < 0.001).

Table 1: 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 the 2012 survey data.

Nonetheless, there is a unique and statistical significance with respect to differences between husbands and wives about perceived changes in erratic rains and early onset of rainfall. A higher percentage of wives perceive incidence of erratic rainfall with profound flooding and early onset of rains as compared to husbands (Pearson $x^2 < 0.10$).

5.2 Gender differentiated concerns of a changing climate

Intra-household concerns indicate that both husbands and wives are worried about the changing climate (Table 2). There is a slight agreement on the reasons for worrying about climate change. In the same domain, husbands and wives both agree that experience of water scarcity increases their worries about climate change (Kappa P-value < 0.05). However, Pearson chi square estimates show statistically significant differences between husbands and wives concerning climate change, whereby wives have a higher risk perception because of deteriorating agriculture productivity (57%) and low fodder availability (43%) as compared to 41 percent and 32 percent of husbands, respectively (Pearson x^2<0.05). Besides, a higher percentage of wives are concerned about the impact of climate change on food security (76%) and increasing rate of poverty (17%), compared to 66 percent and 10 percent for the husbands (Pearson x^2<0.05) respectively. On the other hand, a higher percentage of husbands are concerned with decreasing water availability (27%) as compared to 19 percent of that of the wives (Pearson x^2<0.05).

Table 2: Intra-household concerns and perceived causes of a changing climate

Statements	Wives (% Yes)	Husbands (% Yes)	Difference in % point	Significance x2 (P-value)	Agreement (%)	Kappa	Significant Kappa (P-value)
Attitude about 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 worry							
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
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
Increase in soil erosion	1.92	1.92	0.00	1.000	96.15	-0.02	0.597
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 the 2012 survey data

Further analyses show that husbands and wives perceive differently their level of knowledge on the causes and impacts of climate change. Husbands perceive themselves to have an average knowledge (Pearson x^2<0.10), while wives perceive themselves as not well informed (Pearson x^2<0.10) about the causes of climate change and its effects on their livelihood. Husbands and wives slightly agree 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 beliefs that God is the cause of climate change (Pearson x^2<0.00), while husbands perceive poor farming practices as the main drivers for climate change (Pearson x^2<0.10).

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

Table 3 presents intra-household adaptation to climate-smart practices in crop and livestock management. There is slight agreement between husbands and wives on uptake of livestock-related practices (Kappa P-value <0.10). However, there is no accordance amongst 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 reducing the number of livestock. Changing livestock breed is a high-cost venture that hinders women adopting the strategy because of their comparably lower resource base. However, qualitative analysis shows that women diversify livestock portfolios through the rearing of small ruminant and non-ruminant livestock as an income generating and coping strategy in the incidence of extreme events.

On the other hand, Kappa estimates show that there is no agreement between husbands and wives on uptake of crop-related practices. Furthermore, both husbands and wives agreed that they are changing crop varieties (Kappa P-value <0.05), increasing land under production (Kappa P-value <0.10), expanding the portion of land under irrigation (Kappa P-value <0.10), adopting water and soil management practices (Kappa P-value <0.001) and taking up agroforestry-related practices (Kappa P-value <0.10). This implies that husbands and wives both affirmed that they are undertaking these practices. However, the findings show there is substantial gender differences in crop adaptation strategies between husbands and wives.

Table 3: Husbands' and wives' uptake of listed crop- and livestock related -related agricultural practices

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	0.104*	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 the 2012 survey data

A higher percentage of wives (82%) made changes in crop production, as compared to the husbands (72%) (Pearson x^2<0.10). Further, female spouses adopt more agricultural practices (2.44), as compared to the husbands (2.28) to reduce the risk associated with climate change. A higher percentage of female spouses across all agro-ecological zones engage in soil conservation and management practices as compared to male spouses (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). 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 necessitates land ownership and secure land tenure. Besides, women's low-decision-making power in the use of land (as shown in the subsequent section) could hinder adoption of agroforestry. However, qualitative findings show that women-based crop production in social groups encourages planting of fruit orchards (e.g. avocados and pawpaw) as agroforestry systems; hence diversifying household sources of food and nutrition as well as sources of income.

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

5.4.1 Access to physical capital, livestock and control over land

Figure 1 presents gender-differentiated ownership of household assets. The findings show that husbands have a higher ownership of all 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 shoat, rabbits and poultry. However, husbands own and control a bigger percentage of draft livestock (oxen and donkey), while wives control poultry.

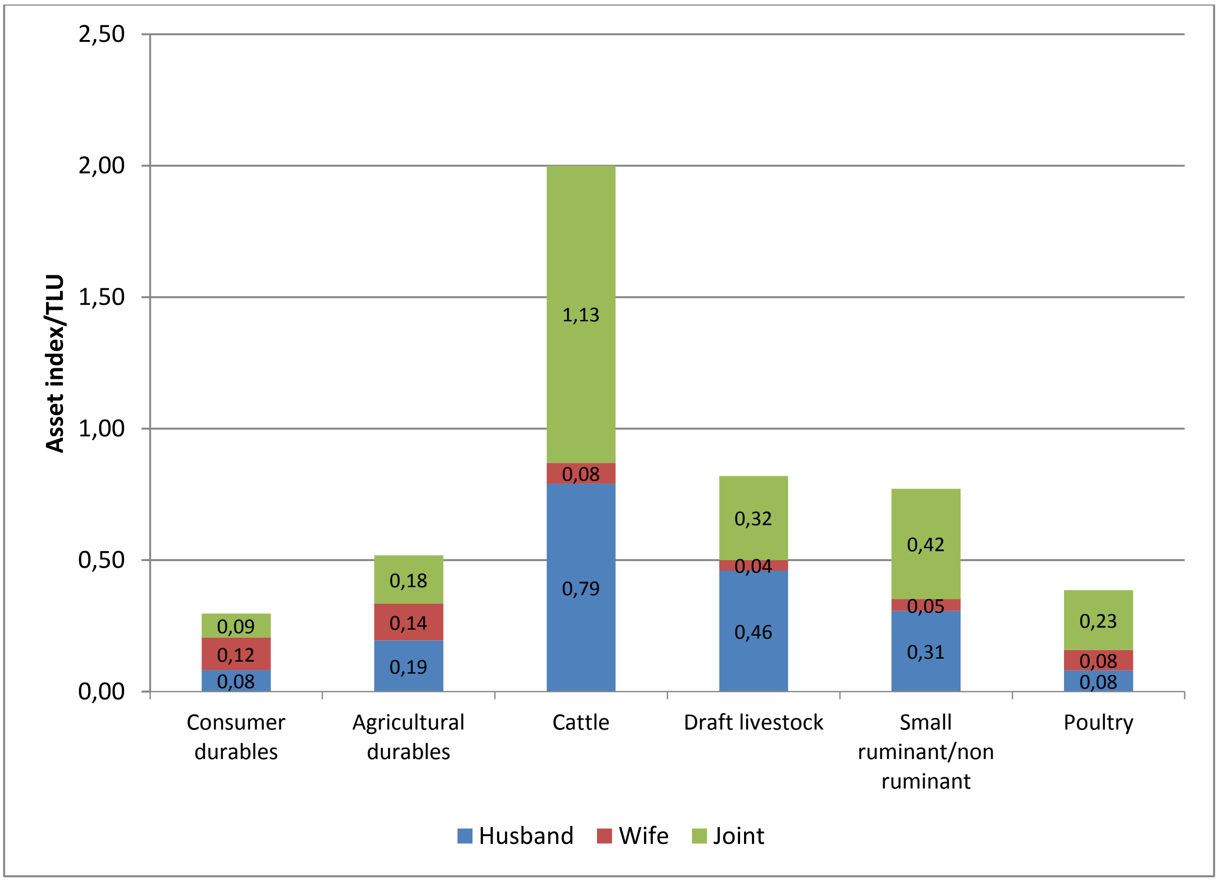

Figure 1: Gender-differentiated ownership of household assets

Source: Authors' computations centered on the 2012 survey data

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 the land shows that 61 percent of couples agree that they consult each other on how to use the land. However, the overwhelming majority of male spouses makes decisions without consulting their spouses (77%), while 34 percent of wives noted that they involve consensus on decision on land use. Interestingly, there is a clear discrepancy among couples in the same household in the decision - making process on land use.

5.4.2 Education and access to agricultural and climate information

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 higher years of schooling (8 years) than wives (6.2 years), implying that husbands have at least completed basic primary education level. In the domain of literacy level, household-level 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).

Table 4 presents gender disparity in access to agricultural and climate information. The results show that husbands and wives fairly agreed to have interacted with extension officers during their field visits (60.9%, Kappa P-value <0.001). However, husbands have a higher access to information on crop and livestock production besides higher access to extension services than the wives do (Pearson x^2 <0.001).

Table 4: 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 the 2012 survey data

On the other hand, wives have a higher access to weather forecast (Pearson x^2<0.001) and have a greater access to advice on the climate adaptation options. On the other domain, 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). Climate change information, in the form of early warning systems and seasonal weather forecasts allows farmers to make well-informed decisions on farming practices, which lower their vulnerability to climate change. Further analyses show that there exist gender-specific preferences of information dissemination channels. For instance, husbands and wives slightly agree that they prefer accessing information through group-based approaches, neighbors and local leader meetings (Kappa P-value <0.05). Nonetheless, husbands easily access agricultural information channeled through extension officers (Pearson x^2<0.01), local leader meetings (Pearson x^2<0.01) and printed media-newspapers (Pearson x^2<0.005), while wives prefer accessing agricultural information through radio programs (Pearson x^2<0.10) and group-based approaches (Pearson x^2<0.10).

Nevertheless, 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 agree 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 a higher trust level of the information they acquire through extension agents and social groups (t-test P-value<0.10), while men highly trust information from meteorologists (t-test P-value <0.10) (see Table 1A-2 in the appendix). Besides, husbands and wives agreed 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 uptake of new technologies, which are necessary in taking up adaptation strategies.

5.5 Gender differentiated group-based approaches in managing climate-related risks

5.5.1 Participation in social groups for the husbands and wives

In rural Kenya, groups which households or individuals belongs to differ in function and category. A substantial agreement between the couples in this domain implies that husbands and wives affirm that they belong to specified categories of social groups. Husbands and wives fairly agree that they belong to any social group (Kappa P-value<0.001). There is a significant population-level difference between the couples in participating in group-based approaches. A higher percentage of wives (91%) belong to social groups, as compared to the husbands (81%) (Pearson x^2<0.05). Nonetheless, a higher percentage of husbands belong to community-based organizations (CBOs) as compared to the wives (Pearson x^2<0.10) (Table 5).

Associating in 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). Interestingly, husbands have a higher duration of group membership than the wives do (t-test P-value <0.10), which could imply sustainability of groups that men belong to. 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 5: 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 groups	0.64	9.62	-8.98	0.000***
Religious groups	4.48	2.56	1.92	0.357
Welfare groups	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 for population-level comparisons.
Source: Authors' computations centered on the 2012 survey data.

4.5.2 Formulation and accumulation of social capital for husbands and wives

Table 6 shows how husbands and wives formulate and accumulate their social capital by connecting in group-based activities. A substantial agreement between the couples in this domain implies that husbands and wives formulate 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), willing to contribute their time and labor (89% in agreement) (Kappa P-value<0.001) and 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 sanction for the community members who are unwilling to participate in group-based approaches (62% in agreement) (Kappa P-value<0.05).

Table 6: 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	0.9154
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 for population-level comparisons.

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

The population-level difference between the couples shows that husbands rather 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 wives (0.68), statistically significant at 10% (t-test P value<0.10). Besides, a higher percentage of wives are more willing to participate in group-based activities and have received support from friends in the occurrence of extreme events (Pearson x^2<0.001).

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

Group-based approaches provide a platform for sharing climate information, adaptation ideas, and risk management (Table 7). A higher percentage of men acquire climate information, adaptation ideas, and access to farm inputs through social groups than the wives (Pearson x^2<0.01). Cross-tabulations and T-test estimates indicate that the husbands and wives belonging to social groups have a higher access to early warning information (t-test P<0.10) and access to numerous sources of information (t-test P<0.10) than non-group members (see Table 1A-3 in the appendix). Qualitative analyses show 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.[7] 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 training, agricultural training and when targeting development programs. These qualitative findings are further supported by cross-tabulation analyses 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 1A-3 in the appendix). Therefore, group-based approaches enhance capacity building and human capital development, which not only increase knowledge in adaptation but also add value in agricultural production.

On the other hand, associating in social groups offers alternative sources of livelihood diversification and acts as a risk management tool through innovative systems to adapt to climate change. The groups that wives belong to often diversify sources of livelihood (Pearson x^2<0.10) and manage climate (non-climate) risk (Pearson x^2<0.05). These innovative systems include individual and group-based income generating activities, provision of financial facilities and safety net programs. Group-based saving and loaning undertakings provide informal access to credit that not only create opportunities to diversify sources of livelihood but also act as an insurance in times of shock. Group-based micro-credit facilities also enhance women's ability to build asset portfolios, besides, enhancing their welfare

[7] 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.

through enabling them to pay school tuitions for their kids and autonomy over their proceeds. The findings show that men and women belonging to social groups have a higher 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. Farmers multiply livestock through exchange, passage of offspring and rotating of the male animal for reproduction purposes to the rest of the group members. Farmers mostly prefer dairy goats 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 social groups enhance women assets is through collective purchasing of household consumer durable assets such as household appliances, water reservoirs, cooking stove /pots that augment their asset portfolios.

Table 7: 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)
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 input	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 the 2012 survey data.

Qualitative findings further show that women's groups rent in land, thereby increasing their access to land and decision on the use of land. This kind of arrangement has a far-reaching effect on women's adaptive capacity and welfare with respect to improving the 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 amongst themselves. This approach increases food security and improves nutritional outcomes, besides augmenting women's saving capacity by reducing cost of food in the household bearing in mind increasing food prices and cost of living. Consequently, the saving realized by reducing 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 insure the medical bill for their ailing member. Although most of the groups that farmers belong to are not formed with 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 having micro-credit as their key mandate, with other functions comprising asset acquisition, agricultural production, welfare/risk management in times of crisis, illustrate this. The evidence highlights new insights on gender differentiated group-based approaches and its starring potential in managing climate risk in the face of rapidly changing climate.

6. Discussion

While most studies miss out gender perspectives or compare male- and female-headed households, this study employed a nuanced gender analysis, embracing individual- and intra-household level data and gender-differentiated FGDs. The findings show that there are gender-specific risk perceptions and worries about climate change that influence adaptive behavior. The gendered risk perceptions and concerns about impact of climate change are due to prevailing social inequality and varying susceptibilities (McCright 2010; Semenza et al. 2011; Safi et al. 2012). Wives pinpoint that climate change is worsening their poverty status which is in line with widespread consensus on the 'feminization of poverty and susceptibility' (see Klasen et al. 2015 for an overview).

The gender-specific uptake of climate-smart agricultural practices depends on 'intersectionality' of 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. A woman in the household has a role to produce food and oversee nutrition status, thus raising higher worries about declining agricultural productivity and higher incidences of food insecurity. Women's roles in food production are affected when the food production deteriorates due to drought and erratic rainfall exposing households to food security risks (Resurrección 2013). Consequently, wives adopt practices inclined to crop production to boost food security in the household. Since it is women's role to feed livestock particularly in central highlands (Kristjanson et al. 2010),wives express greater concerns about declining fodder productivity due to frequent dry spells. Women hence plant fodder crops to lessen labor burdens liable to searching fodder and feeding livestock during dry seasons. Entitlement theory could explain husbands' preference in uptake of livestock- and agroforestry-related practices. Ownership of large livestock could motivate husbands scale up livestock-related practices such as de-stocking, changing in feeding practices and changing livestock breeds. Besides, insecure land rights, limited access to capital and productive inputs could 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. 2014).

Differential access to assets, information and bargaining power over land use disputes the 'unitary household model' on household decision-making that habitually 'rationalize gender inequality' in market-based or non-market livelihood (Seiz 1995). Allowing a bargaining approach is 'ideal' and often has positive welfare outcomes (Doss 2013). Our findings suggest that the household head has an upper hand over decision-making on land use, which could be viewed as 'benevolent dictator' or neglect of human 'agency' and social constructions and norms (Seiz 1995; Agarwal 1997; Kabeer 2001). Agarwal (1997) argues that intra-household bargaining power interplays with other factors, such as economic status, legitimacy of social and legal claims, institutions, support systems, endowments/

entitlement, social norms besides, stability of individual's 'fallback position', often regarded as the 'threat point'.

'Feminist institutionalism' offers solutions to include women in decision-making processes, how to institutionalize gender and the interactions between gender and governing institutions (Mackay et al. 2010). In spite of the Ministry of Agriculture having a 'gender desk' and acknowledging the importance of women in agriculture, service delivery particularly extension services and farmers' training programs - are still gender-blind (see Mbagaya & Anjichi 2007). The conundrum is to design institutional processes that consider gender as a key factor and how processes and institutions bring about change being essential for comprehending both agency and power. Besides, institutional and governance challenges underscored include lack of 'trust' on the information and unreliable meteorological information that is likely to obstruct taking up climate-smart agricultural strategies. Further, the Kenyan constitution that guarantees 'elimination of gender discrimination in law, customs and practices related to land and property in land' (GoK 2010b: 42) offers optimism in addressing human rights and existing gender inequality. The big challenge, however, is how to address the rigid informal institutions and norms that hinder 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. However, traditions, cultures and norms are not static, but malleable over time. A working example, in Siaya and Gem districts, is that prevailing traditions and norms dictate women not to own or inherit land after the demise of the husband limiting women's land ownership. One of the female participants in FGDs in Gem stated that

"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] through their names appearing in the title deed or we [women] embrace joint ownership with the son even if the son is a minor (…)"

Group-based approaches present vital pathways for wives by promoting their livelihood strategies through group-based entrepreneurship, income generation, training facilities, microfinancing and group-based food and nutritional processes. Therefore, social groups build men's and women's assets such as livestock, physical, human, natural and financial capital and food security. However, women-based groups depend on prevailing gender norms, the role 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. Enabling food security in the household is likely to improve innovations and necessary changes in agricultural practices that is likely to facilitate uptake of essential adaptation practices such as improved management of crop and livestock in the wake of accelerating climate change (Kristjanson et al. 2012). Besides, group-based income-generating alternatives are likely to increase women's fallback position through promoting livelihood strategies and buildup of assets, which in turn increase their intra-household negotiating power. At community level, group-based approaches provide a podium for within community bargaining and participating in the decision-making arena, increase the political voice and provide a pedestal for addressing traditions and social norms. A male FGD participant stated that

"We [men] are doing our best to address traditions and cultural beliefs impeding women empowerment and adoption of technologies and practices… we are encouraging men through social groups and local leaders' meetings to endow women commence innovations and agricultural practices (…)"

Nonetheless, husbands have a wider network, a higher political capital, greater participation in community decision-making and a higher access to social capital than wives do, attributable to pre-existing gender/social norms and women's roles in the household such as cooking and taking care of kids limiting their mobility to inter-village social groups and CBOs. Katungi et al. (2008) comparing male- and female-headed households in Uganda indicate that men have a greater access to social capital as compared to women. Pérez et. al. (2014) similarly show that in SSA women belong to village-level groups, whereas men belong to registered organizations that work beyond the village and hence have greater access to support agencies. Besides, our findings show that men mostly belong to mixed-gender groups (heterogeneous groups) as compared to women. 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 (Meinzen-Dick et al. 2014) and lobby for gender aspects and inclusion of women in governance at all levels (Arora-Jonsson 2014). However, mixed-gender groups are likely to upsurge women's asset base and provide a podium for public negotiations.

7. Conclusions and policy implications

The results of this study show interesting intra-household gender analyses where husbands and wives within the same household agree/disagree in risk perceptions, in the undertaking of adaptation options, access to information and participation in group-based approaches. 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 integrate different social roles and responsibilities of men and women. Adaptation to the changing climate will be effective if strategies are geared towards women's needs and perspectives. An intervention like soil conservation, especially the use of animal and composite manure, is a labor-intensive strategy that may require the use of draft animals. Governance structures, considerations, and inclusion of men and women in the household, community and national level decision-making will promote inclusiveness of their needs and interests in risk management, adaptation policies and programs, hence ultimately fortify their adaptive capacity. There is the ultimate need for a gender-transformative approach that acknowledges and addresses the conundrum of informal institutions, such as gender norms, social norms, cultures and traditions and their interaction with formal institutions, otherwise, remarkable gender inequality and institutional 'path dependency' would persist.

The prevailing gender disparity in access to information and access to extension agents, gender-specific climate information needs and gender-preferences in information channels call for public and private information providers to employ gender-sensitive information delivery approaches. This is viable through 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. Besides, sharing of climate and agricultural information through the easily accessible channels by both men and women such as ICTs, extension agents and group-based approaches should be encouraged to scale up the adaptation and mitigation of climate change. Disseminating reliable and accurate information will influence husbands' and wives' decisions on the uptake of climate-smart practices in the domains of crop and livestock production, soil and water management, agroforestry besides embracing new technologies that are essential in adapting to the accelerating climate change.

Gender disparity in the ownership of assets requires empowering women's bargaining and decision-making power at the household and community level. Drawing upon alternatives and innovative approaches to access resources, particularly through group-based approaches has far-reaching implications for women's fallback position at both community and household level. This is feasible through group-based land acquisition for agricultural production purposes, collective inputs banks and group-based income-generating activities that sequentially surge women's income, food and nutritional security, besides augmenting resilience in the face of a changing climate.

Gender-differentiated group-based approaches are relevant in influencing decisions 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. Therefore, policy interventions that rely on group-based approaches must reflect gender perspectives on the ground in order to amplify men's and women's specific abilities to manage risks and improve welfare outcomes in the wake of accelerating climate change.

Appendix 1A

Table 1A-1: Summary statistics and factor loadings for social capital index

	Summary statistics		Rotated loadings				
Descriptive	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 the 2012 survey data

Table 1A-2: Trust in avenue of information (1=strongly distrust, 5=strongly trust)

Variable	Wives Mean	Std. Dev.	Husband 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

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

Source: Authors' computations centered on the 2012 survey data

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

	Wife			Husband			Pooled		
Key variables	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: Superscript† presents variables in binary format. ***p<0.01, **p<0.05, *p<0.1
Source: Authors' computations centered on the 2012 survey data

References

Adger, W.N. et al., 2009. Are there social limits to adaptation to climate change? *Climatic Change*, 93(2009), pp.335–354.

Adger, W.N., 2003. Social Capital, Collective Action, and Adaptation to Climate Change. *Economic Geography*, 79(4), pp.387–404.

Agarwal, B., 1997. “Bargaining” and Gender relations: Within and beyond the household. *Feminist Economics*, 3(1), pp.1–51.

Ahmed, S. & Fajber, E., 2009. Engendering adaptation to climate variability in Gujarat, India. *Gender & Development*, 17(1), pp.33–50.

Alderman, H. et al., 1995. Unitary versus Collective Models of the household: is it time to shift the burden of proof? *The World Bank Research Observer*, 10(1), pp.1–19.

Alston, M., 2013. Gender mainstreaming and climate change. *Women’s Studies International Forum*, pp.1–8.

Arora-Jonsson, S., 2014. Forty years of gender research and environmental policy: Where do we stand? *Women’s Studies International Forum*, 47(Special Issue on Gender, Mobility and Social Change), pp.295–308.

Below, T.B. et al., 2012. Can farmers ’ adaptation to climate change be explained by socio-economic household-level variables? *Global Environmental Change*, 22(1), pp.223–235.

Bezabih, M. et al., 2013. *Social Capital, climate change and soil conservation investment: panel data evidence from the Highlands of Ethiopia.*, UK.

Bryan, E. et al., 2013. Adapting agriculture to climate change in Kenya: household strategies and determinants. *Journal of Environmental Management*, 114, pp.26–35.

Bynoe, P., 2009. Case Study on the Impact of Climate Change on Agriculture on an Indigenous Community in Guyana. *UNDP Report*.

Chen, H., Wang, J. & Huang, J., 2014. Policy support, social capital, and farmers’ adaptation to drought in China. *Global Environmental Change*, 24, pp.193–202.

Croppenstedt, A., Goldstein, M. & Rosas, N., 2013. Gender and Agriculture. Inefficiencies, Segregation, and Low Productivity Traps. *Policy Research Working, 6370 Paper*, World Bank(February), Washington DC.

Dankelman, I., 2011. Gender and Climate Change: An introduction. Earthscan, London.

Davis, K.E., 2008. Extension in Sub-Saharan Africa: Overview and assessment of past and current models, and future prospects. *Journal of International Agricultural Education and Extension*, 15(3), pp.15–28.

Dercon, S. et al., 2009. The Impact of Agricultural Extension and Roads on Poverty and Consumption Growth in Fifteen Ethiopian Villages. *American Journal of Agricultural Economics*, 91(4), pp.1007–1021.

Deressa, T.. et al., 2009. Determinants of farmers' choice of adaptation methods to climate change in the Nile Basin of Ethiopia. *Global Environmental Change*, 19(2), pp.248–255.

Doss, C., 2013. Intrahousehold Bargaining and Resource Allocation in Developing Countries. *Policy Research Working paper*, 6337(January), pp.1–43.

Di Falco, S. & Bulte, E., 2013. The Impact of Kinship Networks on the Adoption of Risk-Mitigating Strategies in Ethiopia. *World Development*, 43, pp.100–110.

Di Falco, S. & Veronesi, M., 2013. How Can African Agriculture Adapt to Climate Change ? A Counterfactual Analysis from Ethiopia. *Land Economics*, 89(4), pp.743–766.

FAO, 2011. *The state of food and agriculture 2010–2011: Women in agriculture, closing the gender gap for development.* 2011th ed., Rome, Italy.: Food and Agriculture Organization of the United Nations.

Farnworth, C. et al., 2013. *Transforming Gender Relations in Agriculture in Sub-Saharan Africa* S. I. A. N. Initiative, ed., Stockholm, Sweden.: Swedish International Agricultural Network Initiative (SIANI).

Filmer, D. & Pritchett, L.H., 2001. Estimating wealth effects without expenditure data--or tears: an application to educational enrollments in states of India. *Demography*, 38(1), pp.115–32.

Gbetibouo, G.A., Hassan, R.M. & Ringler, C., 2010. Modelling farmers' adaptation strategies for climate change and variability: The case of the Limpopo Basin, South Africa. *Agrekon*, 49(2), pp.217–234.

Goh, A.H.X., 2012. A Literature review of the gender-differentiated impacts of climate change on women ' s and men ' s assets and well-being in developing countries. *CAPRi Working Paper*, 106(September).

GoK, 2010. *The Constitution of Kenya*, National Council for Law Reporting with the Authority of the Attorney General. Nairobi, Kenya.

Grothmann, T. & Patt, A., 2005. Adaptive capacity and human cognition: The process of individual adaptation to climate change. *Global Environmental Change*, 15, pp.199–213.

Kabeer, N., 2001. Family Bargaining. *Elsevier Science Ltd*.

Katungi, E., Edmeades, S. & Smale, M., 2008. Gender, social capital and information exchange in rural Uganda. *Journal of International Development*, 20, pp.35–52.

Klasen, S., Lechtenfeld, T. & Povel, F., 2015. A Feminization of Vulnerability? Female Headship, Poverty, and Vulnerability in Thailand and Vietnam. *World Development*, 71(July), pp.36–53.

Kristjanson, P. et al., 2012. Are food insecure smallholder households making changes in their farming practices? Evidence from East Africa. *Food Security*, 4, pp.381–397.

Kristjanson, P. et al., 2010. Livestock and Women's Livelihoods: A Review of the Recent Evidence. *ILRI Discussion Paper*, 20, pp.1–34.

Kumar, N. & Quisumbing, A., 2014. Gender, Shocks, and Resilience. *2020 Conference Brief 11*, (May).

Lambrou, Y. & Nelson, S., 2010. Farmers in a changing climate, Does gender matter? Food security in Andhra Pradesh, India. *FAO*.

Linting, M. et al., 2007. Nonlinear principal components analysis: introduction and application. *Psychological methods*, 12(3), pp.336–58.

Mackay, F., Kenny, M. & Chappell, L., 2010. New Institutionalism Through a Gender Lens: Towards a Feminist Institutionalism? *International Political Science Review*, 31(5), pp.573–588.

Mbagaya, G. & Anjichi, V., 2007. Gender Differences In Agriculture Extension Services And Training Programmes In Western Kenya. *Global Approaches to Extension Practice*, 3(2), pp.122–130.

McCright, A.M., 2010. The effects of gender on climate change knowledge and concern in the American public. *Population and Environment*, 32(1), pp.66–87.

McOmber, C. et al., 2013. Investigating Climate Information Services through a Gendered Lens. *CCAFS Working Paper*, 42.

Moser, C. & Felton, A., 2007. The Construction of an Asset Index Measuring Asset Accumulation in Ecuador. *CPRC working paper*, 87(July).

Mueller, M., Spangler, T. & Alexander, S., 2013. *Community Resilience: Conceptual Framework and Measurement Feed the Future Learning Agenda. Rockville, MD: Westat*, Mustapha, S.B., Undiandeye, U.C. & Gwary, M.M., 2012. The Role of Extension in Agricultural Adaptation to Climate Change in the Sahelian Zone of Nigeria. *Journal of Environment and Earth Science*, 2(6), pp.48–59.

Nelson, V., Meadows, K. & Cannon, T., 2002. Uncertain predictions, invisible impacts, and the need to mainstream gender in climate change adaptations. *Gender & Development*, 10(2), pp.51–59.

Neumayer, E. & Plu, T., 2007. The Gendered Nature of Natural Disasters: The Impact of Catastrophic Events on the Gender Gap in Life Expectancy, 1981–2002. *Annals of the Association of American Geographers*, 97(2), pp.551–566.

Nganga, S.K. et al., 2013. Exploring use of livestock wealth and social capital by pastoral and agro-households in ASALs as insurance against climate change and variability risks : A case study of Samburu District in Kenya. *Invited paper presented at the 4th International Conference of the African Association of Agricultural Economists, September 22-25, 2013, Hammanet, Tunisia*.

Njuki, J. & Sanginga, P.C., 2013. *Women Livestock Ownership and Markets. Bridging the gender in Eastern and Southern Africa..*, London and Newyork: Earthscan Routledge.

OECD, 2012. Tackling the root causes of gender inequalities in the post-2015 development agenda. *Global Thematic Consultation on Addressing Inequalities. The Heart of the Post-2015 Development Agenda and the Future we want for All.*, Paris.

Oloo, J.O. et al., 2013. Influence of traditions / customs and beliefs / norms on women in tree growing in Siaya County, Kenya. *Global Journal of Environmental Science and Technology*, 1(1), pp.1–6.

Pérez, C. et al., 2014. How resilient are farming households, communities, men and women to a changing climate in Africa? *CCAFS Working Paper*, (80).

Peterman, A., Behrman, J.A. & Quisumbing, A.R., 2014. A Review of Empirical Evidence on Gender Differences in Nonland Agricultural Inputs, Technology, and Services in Developing Countries. In A. R. Quisumbing et al., eds. *Gender in Agriculture. Closing the Knowledge Gap*. Washington DC: FAO and Springer Science.

Ragasa, C. et al., 2012. Gender Differences in Access to Extension Services and Agricultural Productivity. *ESSP Working Paper*, 49(December).

Rakib, M. & Matz, J.A., 2014. The Impact of Shocks on Gender-differentiated Asset Dynamics in Bangladesh. *IFPRI Discussion Paper*, (01356).

Resurrección, B.P., 2013. Women's Studies International Forum Persistent women and environment linkages in climate change and sustainable development agendas. *Women's Studies International Forum*, 40, pp.33–43.

Safi, A.S., Smith, W.J. & Liu, Z., 2012. Rural Nevada and Climate Change : Vulnerability, Beliefs, and Risk Perception. *Risk Analysis*, 32(6), pp.1041–1059.

Saulière, S., 2011. Climate change and women farmers in Burkina Faso, Impact and Adaptation Policies and Practices. *Oxfam Reseach Report*.

Seiz, J.A., 1995. Bargaining models, feminism and institutionalism. *Journal of Economic Issues*, 29(2), pp.609–618.

Semenza, J.C., Ploubidis, G.B. & George, L. a, 2011. Climate change and climate variability: personal motivation for adaptation and mitigation. *Environmental Health*, 10(46), pp.1–12.

Serna, J.M., 2011. Drought Assessment Northern Eastern Kenya (Wajir East, South and Mandera). *Northern Eastern Kenya Drought Assessment Report*, (April).

Skinner, E., 2011. Gender and Climate Change Overview Report. *BRIDGE Development Gender, Institute of Development Studies*, (November).

UN, 2013. The Millennium Development Goals Report 2013. *United Nations, New York*.

UNEP, 2013. Embedding the Environment in Sustainable Development Goals. *UNEP Post-2015 Discussion paper*, 1(Version 2).

Viera, A.J. & Garrett, J.M., 2005. Understanding Interobserver Agreement: The Kappa Statistic. *Family Medicine, Research series*, 37(5), pp.360–363.

Vogel, C. & O'Brien, K., 2006. Who can eat information? Examining the effectiveness of seasonal climate forecasts and regional climate-risk management strategies. *Climate Research*, 33, pp.111–122.

Wolf, J. et al., 2010. Social capital, individual responses to heat waves and climate change adaptation: An empirical study of two UK cities. *Global Environmental Change*, 20(1), pp.44–52.