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Gender Differences in Climate Change Adaptation Strategies and Participation in Group-based Approaches: An Intra-household Analysis From Rural Kenya

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ABSTRACT

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 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. 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.

1. Introduction

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 and Plu, 2007; Bynoe, 2009; Lambrou and 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 and Patt, 2005; Deressa et al., 2009; Below et al., 2012; Bryan et al., 2013; Di Falco and 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). 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 well-being, the poor and women draw upon social capital created through group-

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based approaches (GBA). Recent studies show that social capital promotes rural livelihoods and access to rural services (Kirori, 2015; Hoang et al., 2016) and resilience of households against extreme events and climate change (Mueller et al., 2013; Bernier and Meinzen-Dick, 2014; Ngigi et al., 2015) as well as recovery from other adverse events (Adger, 2003; Adger et al., 2009; Bezabih et al., 2013). 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 climate change. Understanding the potential for gender-differentiated group-based approaches is relevant for policy formulation and program design, while targeting development interventions through social groups in developing countries like Kenya.

To bridge this gap, the study used unique 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 agricultural information
c) To investigate the potential for gender-differentiated group-based approaches in enhancing husbands' and wives' adaptive capacity and managing climate risk
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). 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. 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. Furthermore, studies that consider gender-differentiated social capital formed through group-based approaches and accrued benefits are rare. For example, it is not clear which kinds of social groups are vital while targeting men and women in rural settings.

2. Conceptual Framework

The conceptual framework of the study focuses on understanding gender differentiated responses to climate change and variability with a special focus on the ultimate role of institutions, such as 'group-based approaches' and access to appropriate information to enhance resilience and adaptation processes (see Fig. 1).

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. In Kenya, incidents of drought are the major climate signal affecting rural households (Ngigi et al., 2015).

As shown in the conceptual framework, certain characteristics make individuals or households (i.e. users of natural resources) vulnerable to climate change and other non-climate risks and shocks. These user characteristics comprise of assets at disposal, perceptions, 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. The main focus is an intra-household perspective, i.e. how husbands and wives within the same household access information, institutions, perceive and adapt to climate change.

Information and knowledge sharing is the second component of the vulnerability context that determines the ability to adopt appropriate

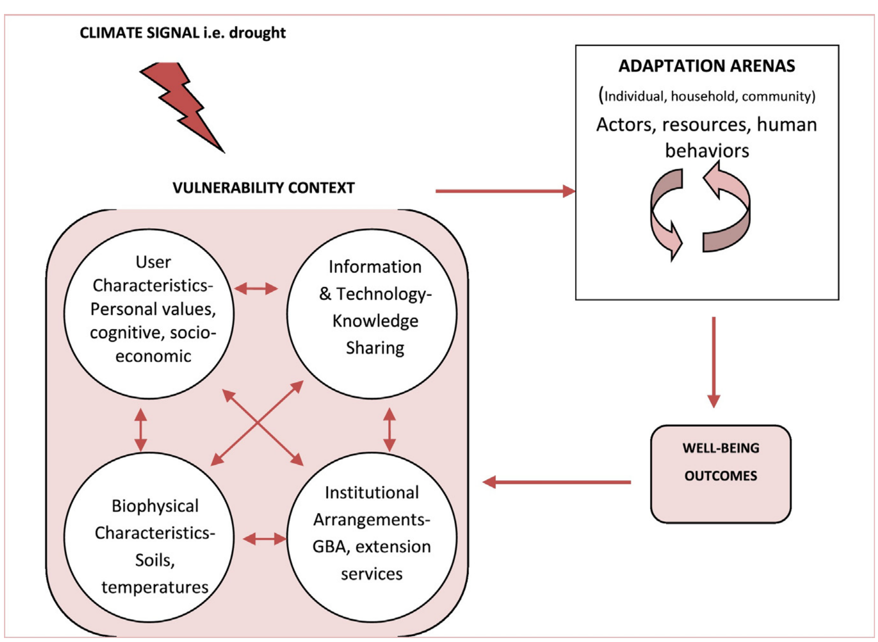

Fig. 1. Interaction of gender and climate change.
Source: adopted from Bryan and Behrman (2013).

responses. This component also needs to be studied in a gender-differentiated way. Climate information necessitates to be accurate, relevant and accessible, and farmers need to trust the information for it to be useful (Vogel and O'Brien, 2006; McOmber et al., 2013). In Kenya, insufficient and inappropriate climate information, knowledge and data impede climate adaptation and research (GoK, 2014a). A research gap exists with respect to gender-specific climate information needs and preferred channels of information for men and women.

Institutional arrangements are the third component of the vulnerability context. Local institutions, such as social capital created through 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 created by group-based undertakings, that include networks, norms and trust that facilitate participants to work together meaningfully to acquire common objectives (see Jordan, 2015). Hence, group-based approaches may enable both reactive and proactive resilience against climate risks for men and women.

Biophysical characteristics are the fourth component in the vulnerability context. According to the conceptual framework, biophysical characteristics surrounding households or individuals could determine how they cope with climate change, influence their levels of exposure and their experience of climate and non-climate signals (see Ngigi et al., 2016).

The adaptation arena is essential for determining how the interaction between climate signals and the vulnerability context finally determines well-being outcomes. According to the conceptual framework, the action arena captures actors, their resources, and their behavior, which can be studied at the individual, household and community levels.

The interaction of shock signals, the vulnerability context, and the action arena ultimately determine the well-being outcomes. The well-being outcomes have an important feedback loop with the vulnerability context. 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. These well-being outcomes may be achieved through encouraging savings, providing alternative sources of livelihood strategies and enhancing accumulation of household assets.

3. Data and Sampling Procedure

Data for this study was collected from three agro-ecological zones (AEZs) of rural Kenya. These include semi-arid regions (Mbeere South and Nakuru districts), sub-humid regions (Gem and Siaya districts) and humid regions (Mukurweini and Othaya districts). The study included >70 villages. Data was collected between June and September 2012. 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 and on parallel time. Couples were not consulting or communicating with each other during interview time. Overall, a random sample of 156 pairs of spouses was 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.

Qualitative research involving gender-disaggregated focus group discussion (FGD) was carried out in all study sites to complement the household survey. The FGD participants were randomly sampled with the help of field facilitators and local leaders to ensure wider representation and diverse views of men and women. Overall, FGD involved seven women focus groups and eight men focus groups, resulting in 15 focus group discussions in total. The study applied a deductive approach to analyze data, since qualitative research was a smaller component of the broader quantitative survey. Narratives from qualitative data were used to supplement, interpret, and discuss selected results of the quantitative analysis.

Perceptions of climate change involved asking how husbands and wives have perceived changes in average temperature and average rainfall and other climate indicators over the last ten years. Intensity of adoption was considered as the number of adopted practices/strategies aggregated at the household level. Following Filmer and Pritchett (2001) and Moser and 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. Besides, the study applied PCA to create a social capital index consisting of variables on trust, reciprocity, group participation and social support.[1] Trust of information index was defined by how farmers depend on 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.' Categorical Principal Component Analysis (CAPCA) was used to develop the trust index.[2]

4. Capturing the Intra-Household Dimensions of Climate Change

A 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 the interplay between husband and wife. The study 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 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 and Garrett, 2005). 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 by random influence (Viera and Garrett, 2005).[3] 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.

5. Descriptive Results of Gendered Intra-Household Analysis

This section introduces descriptive findings on intra-household perceptions of climate change and on climate-smart agricultural strategies

[1] 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 ith observation, d_{ni} is the categories of social capital in nth dummy variable i.e. $n = 1,\ldots, N$, while W_{1n} is the weight of the social capital index (factor components). The study considered factors with the Eigen-values > 1 for analysis.

[2] Categorical Principal Component Analysis (CAPCA) is appropriate for data reduction when variables are ordinal or in categorical format, i.e. Likert-type scales. CAPCA 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).

[3] 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 and Garrett, 2005). Hence, a low Kappa estimate indicates slight or no agreement.

that are implemented by husbands and wives. It also presents data on gendered access to agricultural and climate information and addresses the question whether group-based approaches benefit husbands and their wives differently.

5.1. Gender Differentiated Perceptions of Climate Change

Table 1 presents the intra-household analysis of perceptions regarding average rainfall and precipitation variability and average temperature over the last ten years. 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 (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 $x^2 < 0.10$).

5.2. Intra-Household Climate-Smart Agricultural Strategies in Management of Crop and Livestock

Table 2 presents climate-smart practices in crop and livestock management that are implemented by husbands and wives on their own plots or at household level. There is a slight similarity among husbands and wives regarding 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. 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 the incidence of extreme events.

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. 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, crop rotation and use of cover crops. Besides, a higher percentage of husbands adopt agroforestry-related practices. In addition, 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.

5.3. Gender Differentiated 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) (see Table 3). 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 $x^2 < 0.05$). Further analyses show that there are gender-specific preferences of information dissemination channels. For instance, husbands and wives prefer accessing agricultural and climate 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 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. 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). 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). Besides, husbands and wives perceived 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

Table 1
Intra-household perceptions of climate change.
Source: authors' computations centered on 2012 intra-household dataset.

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
N	156	156					

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

Table 2
Climate-smart practices in crop and livestock management that are implemented by husbands and wives.
Source: authors' computations centered on 2012 intra-household dataset.

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.

management practices, agroforestry, and the uptake of new agricultural technologies, which are all essential climate-smart adaptation strategies.

5.4. Gender Differences in the Role of Group-Based Approaches for Managing Climate Risks

5.4.1. Participation in Social Groups by Husbands and Wives

A substantial agreement 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 4.

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) (Pearson $x^2 < 0.10$). 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 have a higher duration of group membership than the wives (*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 $x^2 < 0.01$). These findings suggest 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%.

5.4.2. The Potential for Gender-Differentiated Group-Based Approaches in Enhancing Adaptive Capacity, Building Assets and Fostering Welfare

A higher percentage of husbands than wives acquire climate information, adaptation ideas, and access to farm inputs through social groups (see Table 5). 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 <

Table 3
Gender-differentiated access to agricultural and climate information.
Source: authors' computations centered on 2012 intra-household dataset.

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.

Table 4
Participation of husbands and wives in group-based approaches.
Source: authors' computations centered on 2012 intra-household dataset.

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†
Number of groups belonging to (mean)	1.26	1.15	0.11	0.087*,†
Social capital index (mean)	0.68	0.71	−0.03	0.060*,†
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.

Table 5
Gender-differentiated linkages of group-based approaches to climate change adaptation and managing climate risk.
Source: authors' computations centered on 2012 intra-household dataset.

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.

0.10). 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. 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.[4]

Group-based approaches do not work in isolation from other institutions and governance structures. For instance, our findings show that 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 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 $P < 0.10$).

Associating in social groups also offers alternative sources of livelihood diversification and acts as a risk management tool through innovative systems to adapt to climate change. Women's groups often assist women to diversify their sources of livelihood (Pearson $x^2 < 0.10$) and to manage climate and 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 savings and loans provide informal access to credit that does not only create opportunities to diversify sources of livelihood but also acts 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 earnings. The descriptive 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 including group-based livestock acquisition and collective purchasing of household consumer durable assets.

The qualitative findings show that women's groups also rent in land, thereby increasing their access to land and their decision-making authority over the use of land. Apart from group-based food production, women's groups collectively purchase food stock in bulk and sub-divide it among themselves. This kind of arrangement has a far-reaching effect on women's adaptive capacity and well-being with respect to improving their position of household food and nutritional security and diversifying sources of income.

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 illustrate this, as they take up other functions such as asset acquisition, agricultural production, welfare and risk management in times of crisis.

6. Econometric Results

6.1. Empirical Strategy

The study aims to examine factors influencing 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. 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.

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

$$y_{1i} = X_i'\beta + \beta SC_{1i} + \varepsilon_i \quad (1)$$

where y_{1i} is the binary dependent variable, X_i is a vector of exogenous variables, including individual demographics, institutional factors, wealth indicators and individual characteristics. While β is a vector of coefficients to be estimated, SC_{1i} is a social capital index created by group-based approaches, and ε_i is the error term. This model follows a

[4] 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.

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 agricultural practices is the use of the Poisson distribution, with conditional mean such as

$$y_{2i} \sim Poisson\ (\mu_i)$$
$$\mu_i = E(y_{i2}|SC_i, X_i, u_i) = \exp(\beta_1 SC_i + X_i'\beta_2 + u_i) \tag{2}$$

where y_{2i} presents the intensity of adoption of climate-smart agricultural practices 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 and 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 and could lead to inconsistent results (Green, 2009; Windmeijer and Silva, 1997). 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 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'.

In addition, 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 and Vuong (1988) recommend 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 variables 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, 2014). The control function approach (CF) gives consistent results in the presence of endogenous regressor (Heckman and Navarro-lozano, 2004; Wooldridge, 2014) and it takes into account the non-linear interaction between the endogenous term and the error terms (Adepoju and Oni, 2012). Unlike the IV approach, CF is estimated with the observed endogenous variables and its residuals in the second stage. 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

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

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 controls for over-dispersion and excessive zeroes in the model. 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. We employed robust command to account for heterogeneity between the respondents, while correlation analysis ruled out the relationship across variables that were used in the model.

6.2. Econometric Results

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 6). The econometric findings show that social capital index created by group-based approaches is likely to influence husbands' decision to adopt crop-related practices. Social capital index also influences household's decision to embrace climate-smart practices and 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 have a higher rate of participation in community activities and community-based organizations, thus having higher social and political capital as compared to the wives. 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 as compared to non-group members.

The findings also show that trust in information is likely to influence 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. Besides, 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. The findings also suggest that access to and control over consumer durable assets have a positive and significant influence on women's decision to take up new practices and the 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 level 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.

7. Discussion

This 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.

The study shows that there are gendered risk perceptions regarding climate change that in turn influence actors' adaptive behavior. This finding upholds that of Adger et al. (2009) who conclude that men and women perceive and experience risks differently, which limits their adaptation. The study also shows empirically that gender-specific roles, responsibilities and social norms are linked to differences in risk

Table 6
Results of Two-Stage Probit Least Squares and Heckman's count model on decisions to adopt climate-smart practices for husbands and wives.
Source: authors' computations centered on 2012 intra-household dataset.

Variables	Two-stage Probit Least squares model						Control function and Heckman's count model			
	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**	–	1.565	–	3.896***	–	1.596**	–	0.983**
		(1.330)		(1.149)		(1.356)		(0.669)		(0.374)
Social capital index of wives	0.947	–	0.273	–	0.136	–	0.348	–	−0.013	–
	(1.065)		(0.918)		(0.952)		(0.441)		(0.269)	
Residue (husbands/wives)	−5.865***	−3.684**	−2.665	−1.427	−4.677**	−4.517*	−1.856**	−1.273	−1.492**	−0.935*
	(1.848)	(1.874)	(1.722)	(1.604)	(1.739)	(1.966)	(0.753)	(0.859)	(0.568)	(0.508)
Mills ratio (husbands/wives)							−0.880	−2.459***	−0.365	−0.241
							(0.573)	(0.600)	(0.451)	(0.387)
Years of schooling of husbands	–	0.075**	–	−0.001	–	0.066*	–	−0.020	–	0.006
		(0.038)		(0.034)		(0.038)		(0.021)		(0.014)
Years of schooling of wives	0.098*		0.022		0.098*		0.001	–	0.016	–
	(0.060)		(0.041)		(0.063)		(0.016)		(0.013)	
Age of husbands in years	–	−0.009	–	−0.010	–	−0.009	–	0.014***	–	0.005*
		(0.011)		(0.009)		(0.012)		(0.005)		(0.003)
Age of wives in years	−0.011	–	0.006	–	−0.002	–	0.001	–	−0.001	–
	(0.017)		(0.012)		(0.016)		(0.004)		(0.004)	
Number of information sources of husbands	–	0.131	–	0.000		0.180	–	0.033	–	0.036
		(0.140)		(0.118)		(0.145)		(0.064)		(0.037)
Number of information sources of wives	−0.148	–	0.138	–	−0.125	–	−0.001	–	−0.014	–
	(0.142)		(0.118)		(0.154)		(0.052)		(0.038)	
Trust index- information of husbands		0.214	–	−0.459	–	0.362	–	−0.784*	–	−0.046
		(0.594)		(0.630)		(0.596)		(0.426)		(0.281)
Trust index- information of wives	2.807***	–	1.489*	–	1.843**	–	0.574	–	0.186	–
	(0.845)		(0.728)		(0.773)		(0.331)		(0.284)	
Perceive increase in temperatures * decrease in rainfall of husbands	–	0.801**	–	0.666***	–	0.779**	–	−0.283*	–	0.040
		(0.328)		(0.250)		(0.324)		(0.170)		(0.106)
Perceive increase in temperatures * decrease in rainfall of wives	1.149***	–	−0.002	–	0.877**	–	0.201	–	0.065	–
	(0.394)		(0.238)		(0.338)		(0.146)		(0.121)	
Human attitude to climate change of husbands	–	5.579**	–	6.334***	–	4.377**	–	3.010**	–	1.899***
		(2.384)		(2.119)		(2.053)		(1.095)		(0.569)
Human attitude to climate change of wives	0.023	–	2.017**	–	0.428	–	0.680	–	0.141	–
	(0.979)		(0.918)		(0.921)		(0.485)		(0.355)	
Early warning of husbands	–	0.824**	–	0.517*	–	0.514	–	−0.217	–	0.140
		(0.333)		(0.274)		(0.331)		(0.185)		(0.145)
Early warning of wives	0.225	–	0.093	–	0.482	–	0.034	–	−0.054	–
	(0.318)		(0.271)		(0.356)		(0.116)		(0.108)	
FFS of husbands	–	−0.378	–	0.313	–	−0.210	–	−0.256	–	−0.037
		(0.314)		(0.307)		(0.328)		(0.203)		(0.154)
FFS of wives	0.952*	–	0.470*	–	1.000*	–	0.340***	–	0.047	–
	(0.404)		(0.275)		(0.410)		(0.111)		(0.107)	
Household size	0.106	−0.028	0.053	−0.018	0.108	0.040	0.009	−0.016	0.004	−0.015
	(0.082)	(0.062)	(0.050)	(0.052)	(0.076)	(0.066)	(0.023)	(0.024)	(0.019)	(0.015)
Household's access to credit	0.000	0.117	−0.274	−0.347	−0.249	−0.115	−0.140	−0.181	−0.044	−0.069
	(0.321)	(0.320)	(0.273)	(0.297)	(0.329)	(0.326)	(0.122)	(0.159)	(0.105)	(0.096)
Household's decision on land use	−0.320	0.120	−0.283	0.687***	−0.072	0.303	−0.238**	−0.195	0.022	−0.058
	(0.332)	(0.322)	(0.255)	(0.263)	(0.318)	(0.323)	(0.115)	(0.162)	(0.091)	(0.094)
Household's agricultural asset index	−0.084	−0.488	−0.565	−0.127	−0.786*	−0.439	0.047	0.099	0.005	−0.030
	(0.577)	(0.476)	(0.399)	(0.489)	(0.481)	(0.506)	(0.161)	(0.229)	(0.136)	(0.130)
Household's consumer durable assets	2.069*	−0.480	1.307**	−0.183	1.416*	−0.555	0.176	−0.100	0.149	0.104
	(1.023)	(0.734)	(0.583)	(0.582)	(0.887)	(0.773)	(0.184)	(0.328)	(0.176)	(0.191)
Household's TLU	0.005	0.049	−0.060*	0.051	−0.003	0.083	−0.007	−0.026	0.005	−0.004
	(0.049)	(0.053)	(0.032)	(0.037)	(0.052)	(0.057)	(0.012)	(0.017)	(0.010)	(0.009)
Household's rainfall * temperature	7.854**	−3.545	9.003***	3.910	8.173**	−5.956**	2.964	0.062	2.359**	1.938**
	(3.651)	(2.922)	(2.913)	(2.954)	(3.587)	(3.000)	(1.163)	(1.548)	(0.957)	(0.900)
Household located in sub-humid regions	−4.276*	3.585**	−4.979***	−1.836	−4.090*	4.751**	−1.704	0.001	−1.236**	−0.762
	(2.284)	(1.887)	(1.791)	(1.843)	(2.151)	(1.955)	(0.660)	(0.976)	(0.563)	(0.558)
Household located in semi-arid regions	−0.723	0.631	−0.872**	−0.161	−0.677	1.005**	−0.335	−0.004	−0.242*	−0.069
	(0.463)	(0.435)	(0.398)	(0.431)	(0.430)	(0.452)	(0.199)	(0.244)	(0.149)	(0.167)
Constant	−79.726*	26.679	−	−44.939	−	50.641*	−29.370	−2.375	−	−0.356
	(35.640)	(28.286)	91.681***	(28.751)	81.909**	(28.934)	(11.562)	(14.984)	21.980*	(8.701)
			(28.320)		(35.132)				(9.482)	
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)							–	−271.26	–	–
							258.968		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.

perceptions, access to resources, and participation in social groups influences coping strategies and adaptive behavior, and ultimately the well-being outcome in a gender-differentiated way. For example, a woman in a household has a role to produce food and oversee nutrition outcomes, hence she is more concerned about food insecurity resulting from climate change (see Ngigi et al., 2016). Furthermore, 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., 2014).

The study by Mackay et al. (2010) shows that there is need for institutionalizing gender in all levels of decision-making processes, an approach termed as 'feminist institutionalism'. The Kenyan government 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 and Anjichi's (2007) study 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 qualitative and quantitative analysis include access to information, lack of 'trust' in information and unreliable meteorological information. These factors are likely to obstruct the up-take of climate-smart agricultural strategies.

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. 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. These determine 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. Besides, our findings show that men mostly belong to mixed-gender groups, whereas women mostly belong to groups comprising only female members. The study's findings also 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. The literature supports our findings that women-only groups are likely to be effective pathways for women empowerment and to lobby for gender perspectives and the inclusion of women in governance at all levels (Bernier and Meinzen-Dick, 2014; Arora-Jonsson, 2014). Nevertheless, our findings suggest that traditional and conservative institutions are likely to be threatened by women's groups. 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. It also increases the number of practices that are taken up. In general, group-based approaches provide avenues for building up vital types of capital such as livestock, durable assets, human, natural, financial, and social capital. For women, group-based approaches are particularly essential pathways for diversifying livelihoods and managing climate as well as non-climate risks. Therefore, gendered group-based approaches are strong entities to manage climate risks, build resilience, enhance food security and reduce rural poverty.

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. The survey results point out that husbands and wives take up similar climate-smart practices such as change in crop variety. However, the empirical evidence implies substantial differences in adaptive behavior. The policy implications of these findings are the need for formulation of gender-sensitive policies and programs in adaptation and mitigation frameworks. 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.

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. The study also suggests that there also is a need to rely on different institutional arrangements that foster access to resources. Group-based approaches provide such possible alternatives to access key resources.

Gender-differentiated group-based approaches are relevant in influencing the decision to adapt to climate change and enhance well-being/welfare outcomes through accumulating essential productive capital. 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 and strengthen group-based approaches through capacity building programs and training in basic entrepreneurship and in risk management skills for men and women at community level.

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