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# **Climate change adaptation in the Morogoro Region of Tanzania: women's decision-making participation in small-scale farm households.**

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## **Abstract**

This article estimates factors influencing the adoption of eighteen household and individual-level adaptation practices among small-scale farmers in the Morogoro Region of Tanzania. Using a unique dataset of 343 married women, logistic regression analysis is used to examine adaptation practices ranging from agricultural to coping and livelihood diversification strategies. Specifically, we investigate the role of wives' intrahousehold decision-making participation in adaptation decisions. Drawing on the literatures of intrahousehold bargaining and agricultural technology adoption, we argue that although extrahousehold factors are important determinants of households' adaptation behaviour, adaptation outcomes can also be different when decided by husbands or by wives. We find that when wives are more involved in intrahousehold adaptation decision-making, they are also more likely to choose to be engaged in non-farm income-earning activities, and their households are more likely to plant cover crops and drought-resistant crops. We argue that in general Tanzanian smallholders' adaptation options are limited and their intrahousehold bargaining sets relatively narrow, leaving little room for differing intrahousehold adaptation preferences, especially in the case of quasi-public household goods.

## **Keywords**

Gender, intrahousehold relations, decision-making, climate change adaptation, Tanzania

## **1. Introduction**

In this article, we address the question of whether and how wives' intrahousehold decision-making participation is related to farm households' adaptation behaviour. Specifically, we ask whether and how wives' participation in household adaptation decisions is correlated to the (agricultural) adaptation strategies that are (or are not) adopted in their households. If wives have more voice in adaptation decisions, will their households adopt different adaptation strategies? We investigate this relationship between intrahousehold decision-making and adaptation for 18 specific adaptation practices, ranging from agricultural practices to coping strategies and non-farm income-earning activities.

This study relies on a cross-reading of different streams of literature: first, literature on agricultural technology adoption, and second, the literature on intrahousehold bargaining. Firstly, the agricultural technology adoption literature has focused mainly on extrahousehold factors as determinants of adoption. One key determinant discussed in the literature is the barrier of access to material resources,

in other words, there often is a wealth effect making innovations and technologies – such as fertilizers, and improved seeds – more easily available to those who have better access to material resources (Ling & Manfred, 2016). Similarly, studies have emphasized high transaction costs (Minten, Koru & Stifel, 2013) and credit constraints (Binswanger & Sillers, 1983; Croppenstedt, Demeke & Meschi, 2003) as a barrier in adopting or purchasing farm inputs. Other studies established the role of formal education (Croppenstedt, Demeke & Meschi, 2003) and agriculture-specific education through farmer field schools and extension services (Kaliba et al. 2000), highlighting the importance of human capital and access to knowledge. Other pivotal factors are access to networks or social capital (Beyene & Kassie, 2015; Lambert et al., 2014; Pamuk, Bulte & Adekunle, 2014; Ramirez, 2013). Furthermore, all of these elements interact and may differ throughout the process of technology adoption. For example, Lambert et al. (2014) found that in the Democratic Republic of Congo, farmers' awareness of fertilizers was determined by their educational level as well as their social capital. However, their decision to try out fertilizers for the first time was influenced by the availability of extension services, while *continued* adoption depended primarily on capital constraints (Lambert et al. 2014). Moreover, there are some studies that have focused on gendered adoption of agricultural technologies and innovations. For example, Doss and Morris (2011) found that the gendered adoption of improved seeds and fertilizers was caused by gendered differences in access to the required inputs, such as land, labour, and extension services.

Secondly, within the intrahousehold literature, studies have shown the importance of the intrahousehold dimension in various domains. In particular, studies have investigated the influence of who is the decision-maker within the household (decision-making mechanism) on outcomes such as the household's expenditure pattern. In some studies, wife's income is used as a proxy of her intrahousehold decision-making power. In this regard, Gummerson and Schneider (2013) find that in South Africa, higher income shares by wives are correlated to higher shares of household expenditure on food, and less expenditures on alcohol. In a similar vein, Phipps and Burton (1998) found that when wives' incomes increase, households spend more on child care, while they do not find husbands' incomes to be associated to higher child care expenditures. Studies on health outcomes<sup>1</sup> have established, for example, that compared to husbands, wives are more likely to allocate (hypothetical) vaccines to daughters (Whittington et al., 2008 on Thailand). Lampietti (1999) found that Ethiopian husbands and wives have different preferences with regard to the decision to purchase a (hypothetical) vaccine (but do not have different preferences for bednets). Lampietti suggest this difference might be due to the fact that bednets are a *quasi-public household good*, as more than one household member can use the bednet. Vaccines, on the other hand, are a private good that has to be allocated to one specific household member. Lampietti hereby suggests that spouses are more likely to have the same preferences when it comes to quasi-public household goods, since no choice has to be made about who specifically to allocate the good to.

The intrahousehold bargaining strand of research has shown that intrahousehold decision-making is influential in a range of outcomes, ranging from budget allocations, to children's education and health outcomes. We therefore want to look at the role of intrahousehold decision-making in determining outcomes in households' climate change adaptation behaviour in Tanzania. It is reasonable to assume the existence of intrahousehold effects, as men and women (and thus spouses) experience climate change differently, through gendered perceptions of climate change and gendered access to information about climate change, weather forecasts and agricultural information in general (see e.g.

Twyman, Green et al., 2014; Mnimbo et al., 2016; Goh, 2012; Quisumbing, Kumar & Behrman, 2011). Furthermore, research has shown that the impacts of climate change on men and women are different (see e.g. Denton, 2002), as well as adoption rates of adaptation strategies and practices (Twyman, Green et al., 2014; Huynh & Resurreccion, 2014; Guloba, 2014; Van Aelst & Holvoet, 2016). Moreover, benefits and costs that are associated with adaptation strategies are also likely to be gendered, e.g. in terms of labour and time investments, financial impact, etc. Husbands and wives' preferences with regard to the adoption of climate change adaptation practices are therefore likely to be different in some regards. To date, a range of studies have looked at adaptation through a gender lens, but few studies have investigate the specific *intrahousehold* factors that play a role with regard to adaptation behaviour (see e.g. Ngigi, Mueller & Birner, 2016 for an exception). Nevertheless, we also draw upon a significant number of studies that have indicated the importance of intrahousehold decision-making in related fields such as natural resources management (Doss & Meinzen-Dick, 2015), the uptake of agricultural innovations (Mutenje et al., 2016; Singh, Squire & Strauss, 1986), and irrigation (Lecoutere & Jassogne, 2016).

This article investigates the relationship between women's intrahousehold decision-making participation on climate change adaptation, and their adoption of adaptation practices. Presenting an example from Tanzania, the study starts with a description of the study area and the main climatic challenges faced in the region (section 2). Section 3 presents the methodology and operationalization of the variables. This is followed by the findings section (section 4) which first outlines the descriptive statistics and next provides an analysis of the relationship between wives' voice and households' adaptation strategies. Section 5 and 6 offer a discussion and concluding section.

## **2. Description of the study area**

This study covers four villages in the Morogoro Region of Tanzania: two rural villages in Morogoro Rural District (Sinyaulime and Kiwege) and two peri-urban villages in Mvomero District (Changarawe and Vikenge). Within each district, the selected villages are highly comparable. However, some differences exist between the villages in the different districts. For example, the villages in Mvomero District are close to Mzumbe University and many students are living in the villages (especially in Changarawe). This also creates quite some opportunities for casual employment for local villagers, e.g. catering, maintenance, security work. In all villages, however, the majority of the population relies on subsistence farming (87.3% of our random sample across the four villages). There are somewhat higher levels of commercial farming in Vikenge (11.6%) and Changarawe (6%), compared to 4.9% in Sinyaulime and merely 3.4% in Kiwege. In Kiwege, there seem to be least opportunities for non-farm income-earning activities, as only 2.5% of the sample indicates that farming is not their main livelihood activity, compared to 7% of the sample in Vikenge and Sinyaulime and 10% in Changarawe. Farmers in the rural villages have easier access to forests and natural resources to sustain their livelihood, e.g. timber for charcoal production and wild fruits and vegetables. Farmers across the four villages grow similar crops, including maize, rice, cassava, yams, vegetables, millet, sesame and fruits like banana. Furthermore, joint household farming plots are the common farming system in the Morogoro Region and specialization along gender lines in farming tasks is relatively limited (researcher's field observations; Mollé and Mtenga 2000; Englert 2008).

In terms of gender and household relations, the majority of marriages across the villages are monogamous, also among Muslim households. Nevertheless, polygamous marriages do occur and men in monogamous marriages frequently have a '*nyumba ndogo*' (literally 'small house': i.e. long-term girlfriends outside of marriage). There are on average 2.4 children below the age of 18 living in married women's households. In none of the villages do norms prohibit women from working outside of the home.

In the peri-urban villages at least part of the village is connected to the electricity network. These villages also have better access to health care services (at least two health facilities) and education (3 primary schools and 2 secondary schools). In Kiwege and Sinyaulime, distances to school are much greater, as there is only one primary school in Kiwege and one school building (that is not in use) in Sinyaulime. A secondary school can be found in the neighbouring village Ngerengere. Health facilities are also more sparse, as there is only one health centre in Kiwege, and a small hospital in neighbouring Ngerengere.

Climatic challenges that the area is facing are increasing unpredictability of already highly variable rainfall and uncertain effects of future climate change. The area has a bimodal rainfall pattern, and is faced with more concentrated rainfall in shorter time spans. Some projects mention the possibility of a transformation towards a unimodal rainfall pattern and less rainfall. Overall, the area is facing a warmer and longer dry season (especially main July-September) and a decreasing flow of the Ruvu River (IPCC, 2014; United Republic of Tanzania, 2007, 2014; Paavola, 2008).

### **3. Methodology**

Data collection was conducted by the first author, in the context of PhD research, and included both a survey questionnaire and qualitative interviews on intrahousehold decision-making with regard to climate change adaptation. Data and research findings are triangulated through combining these mixed methods. The questionnaire data were collected between July and September 2014 from a total sample of 846 respondents, of which 343 are married women. These 343 married (or cohabiting) women form the subsample that we investigate in this article. We took a random sample of households involved in farming activities, and considered proportionate representation of all subvillages by estimated population number to ensure spatial representation. Six local enumerators were trained by the first author and carried out the questionnaire interviews in Kiswahili. Qualitative interviews were carried out by the first author and a translator. In each village about 8 households were purposively selected (Devers & Frankel, 2000) out of those households who participate in the questionnaire. The semi-structured interviews were performed with both spouses of these households individually, and dealt with the subject of their adaptation strategies and intrahousehold decision-making process on climate change adaptation and livelihood strategies.

Our research findings can be expected to hold for other rural parts of Tanzania that face similar climatic conditions, as well as similar socio-economic and gender relations. In particular, this means other parts of the Wami-Ruvu River Basin and the Morogoro Region.

In this article, we investigate the subsample of married and cohabiting women that were questioned in the quantitative survey. Via logistic regression analysis, we estimate 18 regression models in which each time one adaptation strategy serves as the dependent variable. Logistic regression model assumptions were confirmed to hold, and multicollinearity tests were unproblematic. The continuous variable 'age' violated the assumption of linearity for some adaptation strategies, and in this case a

categorical variable was used. A typical problem in logistic regression analysis is empty cells (i.e. very few or no observations in certain categories of a categorical variable), causing inflated standard errors and odds ratios. This was a problem in some of the logistic regression models, and we chose to either present the inflated estimates when they did not inflate  $R^2$ , as the rest of the parameters are not affected; or leave out the explanatory variable that posed the problem of empty cells, when there was evidence of the variable inflating  $R^2$ , and in this case we just mention the importance of the variable in the text.

### **3.1. Operationalisation of independent variables**

The dependent variable, in each regression analysis, is operationalised as the adoption of a specific adaptation practice and has value 0 in case of non-adoption of the practice and value 1 in case of adoption. The 18 adaptation practices in this study were selected after literature review on the region (e.g. Below et al., 2012; Paavola, 2008) and after a first phase of primary data collection in the form of group discussions with (separate groups of male and female) farmers. See table 3 for an overview of the 18 adaptation practices and adoption rates (descriptive statistics in findings section).

Descriptive statistics of the independent variables are presented in table 1. Independent variables are based on both theoretical considerations and insights from qualitative, exploratory research in the villages on the factors that influence adaptation in the local context. For example, the importance of knowledge or human capital has been operationalized via the variable 'educational level'. The majority of women in the sample have finished primary education (59.5%), while 30.3% has not had any formal education, and 7% started but did not finish primary education. Only a minority of 3.2% has achieved secondary education or a higher level. We also included a measure of spouses' similarity in educational level, and find that the majority of spouses has the same educational level (56.4%), while 31.9% of wives have a husband that is higher educated than themselves. Furthermore, research has indicated that technology and agricultural adoption depends on a farmers' access to resources. The household's relative resources and welfare are proxied by various variables, including 'type of access to farm land', 'ownership of transport means', and 'degree of farming involvement'. Table 1 indicates that the majority of married women in the sample live in a household that owns land (63.6%), while 15.2% of women live in a household that only has access to farm land through renting. Furthermore, 18.1% of households both own and rent land, while 3.2% of households depend on farm land that they do not own nor rent, i.e. they are allowed to use the land for free, but only periodically. In most of the cases this relates to farm land owned by the military or village government. Ownership of transport means is a relative measure of the household's welfare. About half of women (50.6%) live in a household that owns a bike, 37.2% of wives live in a household that does not own any means of transport (i.e. least well-off households), while 12.2% lives in a household that owns a motorcycle or car (i.e. most well-off households in the sample). With regard to their degree of farming involvement, a majority of 88.6% of women indicate to live in household that depends on farming for subsistence, meaning that they sell less than 50% of their harvest. Smaller groups of households sell more than 50% of their harvest (conceptualised as 'commercial farmers', 8.7%), while 2.6% of the sample respondents indicate that farming is not the household's main activity. Furthermore, we included socio-economic and demographic control variables, such as age, religion, and tribe. About half of wives belong to the Luguru tribe, which originally inhabited the area (54.1%) and more than half of interviewees are Muslim (67.1%). The average age of wives in the sample is 41.32 years. The categorical variable of age shows that the majority of respondents are aged between 26 and 45 years.

[Table 1 here]

### **3.2. Independent variable: decision-making index**

Respondents were asked about who of the spouses made the decision to adopt, or not to adopt, each of the 18 adaptation practices. The decision-making variables are thus reflections of wives' recollection of the past decision-making process. As to avoid social desirable answering, the questionnaire asked about concrete decisions that were made in the household, namely the actual, past decision that was made to e.g. (not) use fast-maturing seeds, (not) plant drought-resistant crops, (not) irrigate the field, etc.

The decision-making index itself was constructed by attributing a score to each of the 18 practices. The household scored +1 for each additional decision in which the wife was involved: that is, if the wife said the decision to (not) adopt practice x was made by herself, or by herself and her partner jointly. A score of -1 was attributed to the household when the husband had made the decision to (not) adopt the practice on his own. When indicated that 'someone else' made the decision, or that no decision was made, the household scored 0. The category of 'no decision' takes into account the possibility that the decision lies outside of the bargaining area (Agarwal, 1997) and is considered as something that is not negotiated or decided about. Consequently, respondents will usually follow what is considered as 'normative', rather than undertaking an active decision-making process. That is, these decisions are in fact 'non-decisions'.

The 18 scores were summed up (to arrive to the decision-making score) and finally transformed into a percentage (the decision-making index). The decision-making index can take values between -100 and +100. Within our sample, the mean value of decision-making index was 65 (out of 100), with a minimum value of -89 and a maximum value of +100. It is important to remember that a higher value of the decision-making index reflects wife's higher voice over or participation in the 18 adaptation decisions. More voice (or participation) does not necessarily mean that the wife makes the adaptation decisions on her own, but could also mean that she makes the decisions jointly with her spouse. (see also findings section, descriptive statistics of decision-making).

A categorical version of the decision-making index was also constructed, based on the decision-making score which ranges from -18 to +18. A score between -18 and -1 should be considered as 'considerable male voice in decision-making', i.e. the husband is the main decision-maker when it comes to adaptation. A score between 0 and 9 should be considered as little decision-making participation by the wife; while a score between 10-14 indicates a 'considerable degree of female decision-making participation' or female voice. Finally, we consider a score between 15 and 18 as a 'high degree of female decision-making participation' (see descriptive statistics in table 2). Overall, women's (joint) participation in household adaptation decisions thus seems substantial.

[Table 2 here]

## **4. Findings**

### **4.1. Descriptive statistics**



Table 3 shows a description of each of the dependent variables, as well as the adoption rates among the married women in the sample. Practices that are frequently adopted are fast-maturing seeds (85% of married women in the sample), cover crops (84.6%), planting drought-resistant crops such as cassava (76.5%), looking for wild vegetables and fruits (81.1%), and mixed cropping (61.8%). The remainder of practices are adopted by less than half of wives. For example, working as a casual farm labourer (33.2%), engagement in non-farm income-earning activities (34.3%), vegetable cultivation (37.9%), hiring casual labourers to work on the household's farm (43.0%) and hiring a tractor to do soil tillage (45.6%). The practices that are less frequently adopted are reliance on food support (15.9%), participation in farmer field schools (16.2%), mulching (20.2%), small-scale irrigation (21.5%), application of manure (25.0%) and fertilizers (25.7%), selling assets to buy food (26.8%) and fallowing (26.9%).

[Table 3 here]

Descriptive statistics of decision-making data are presented in table 4. For each adaptation practice, we present who is the person in the household who made the final decision to adopt (or not to adopt) the practice. Frequencies show that certain practices are more likely to be perceived as a 'non-decision', i.e. something that the spouses themselves do *not* decide upon. This is the case for participation in farmer field schools, application of manure and agricultural techniques such as mulching, as well as reliance on food support. Furthermore, the (non)adoption of certain practices seems to be more likely to be decided by wives, e.g. collecting wild vegetables and fruits, starting vegetable cultivation, wife's involvement in non-farm income-earning activities and her employment as a casual farm labourer. On the other hand, some practices are typically decided by a bigger proportion of husbands only. This is the case for fast-maturing seeds, hiring casual labourers, hiring tractor, and applying manure and fertilizers. However, the adoption of the majority of the practices seems to be decided upon jointly by the spouses. The quantitative data in table 4 thus indicate that joint decision-making is the most frequent decision-making mechanism. Consequently, high scores on the decision-making index are likely to be due to a considerable degree of joint decision-making, rather than sole female decision-making.

[Table 4 here]

#### **4.2. Wives' voice and households' adaptation strategies**

Logistic regression results are presented in the tables in appendix. Out of the 18 adaptation practices, we found evidence that the adoption of three adaptation practices are significantly correlated to women's intrahousehold decision-making power. These three adaptation practices are wife's non-farm income-earning activities, the planting of drought-resistant crops; and the use of cover crops.<sup>2</sup> These three practices and their relation to wives' intrahousehold decision-making participation are described into more detail in section 4.2.2. First, we analyse why some of the adaptation practices are *not* significantly related to women's intrahousehold decision-making participation (section 4.2.1.).

##### **4.2.1. Adaptation outcomes independent of wives' intrahousehold decision-making participation**

We could not establish a significant relationship between women's degree of intrahousehold decision-making participation and their (non)adoption of 13 adaptation practices. That is, for these adaptation outcomes we could not reject the null hypothesis that the coefficient is equal to zero. This implies that other factors than the intrahousehold decision-making process determine whether or not the household will adopt the practice or not. This might be because a) it are practices for which husband and wife have fairly similar preferences, e.g. because it are decisions they agree will benefit the household, or b) because they simply do not have a large array of options to choose from and the bargaining set is thus narrow. The former can be understood by investigating farm practices as quasi-public household goods, while the latter is related to coping and the pivotal role of access to resources in determining (non)adoption. Both are described in more detail below.

#### *Farm practices as quasi-public household goods*

Many of the practices we investigated are farm practices. In the research area (Morogoro Region), farms are typically operated at the household level: that is, a household has one or several plots of farm land where all household members contribute (some degree of) farm labour, and the fruits of the household plot belong to the household, rather than to an individual. Consequently, most respondents relied on a strong dominant discourse of household harmony, that usually involved accounts of spouses working together for family development, and emphasis on a couple's common interests. For example, one male respondent in Vikenge stated that:

“We like to listen to each other instead of competing because we are happy when we can do something to advance development [of our family], so we have to be on the same path, so we can agree and make decisions in unity.” (V 0079 husband)

In accordance with this dominant discourse, and couples' common interest in optimizing farm practices, improving livelihood outcomes, and increasing household resilience in the face of climate change, it is not hard to grasp that under these circumstances a couple would have similar preferences for practices that are expected to lead to just that. These farm practices and the resulting benefits could be considered as quasi-public household goods: it is relatively difficult to exclude household members from the benefits of the practices, as household resilience will trickle down to all household members. Nevertheless, it is important to acknowledge that although spouses may agree on adopting certain agricultural adaptation practices, they might not necessarily see eye to eye when it comes to the distribution of costs (e.g. time and labour input) and benefits (e.g. distribution of improved yields). Indeed, Sen (1990) in his Cooperative Conflict model conceptualises the household as an institution where members simultaneously face a problem of cooperation and conflict: respectively adding to total household availabilities, and distributing these total availabilities within the household. Costs and benefits might thus be allocated to household members to varying degrees, as the literature on intrahousehold inequality and unequal resources allocation has by now firmly established, see e.g. Gummerson & Schneider, 2013; Phipps & Burton, 1998. However, it is likely that household members will all benefit to some degree, and therefore have an incentive for cooperation in advancement of farm practices, e.g. through using fast-maturing seeds, irrigating, or applying manure.

Our qualitative evidence furthermore suggests that when spouses are in conflict over adaptation practices, they have innovative and original ways of solving the disagreement. For example, some

couples decide to plant both the crops that the wife and those that the husband prefers, and compare returns so as to 'test which idea has the best outcome'. A man in Kiwege stated that:

"It happened many times, like, I can decide "let me plant these seeds". But she [wife] doesn't want to. Okay. Let us plant both seeds in a different plot. Right now, we do not decide. But later, after harvesting, you will know which seed is best." (K 0094 husband)

Nevertheless, respondents emphasised that in this case, they would still share the yields between them, so their behaviour remained cooperative in essence.

#### *Narrow bargaining set and coping strategies*

We argue that farmers in the study area are facing a *narrow bargaining set*. This means that the possible outcomes of their decision are structured by circumstances outside of the household. Farmers simply do not have many adaptation options to choose from, and several factors influence whether or not they can actually make the decision to adopt a practice or not. Agreement among spouses is therefore more likely, and intrahousehold bargaining consequently less influential in determining the outcome.

In our study, there is relatively little variation in income between villagers, and couples do not have a lot of different adaptation alternatives to bargain about. However, in areas where there are more different adaptation options and/or livelihood strategies available, intrahousehold decision-making is likely to become a more influential factor in affecting adaptation outcomes. Interesting pathways for further research would therefore be to compare areas where farmers possess different ranges of adaptation options or opportunity sets. Spouses' narrow bargaining set is especially reflected in farmers' adoption of 'coping' (rather than adaptation) strategies, and in the pivotal role of access to resources in determining adoption outcomes.

*Coping* practices are undertaken as a way of alleviating current vulnerabilities to the changing climate (and other livelihood challenges), rather than proactively adapting to it in an effort to prevent negative impacts, or than improving the household's adaptive capacity in the face of climate change. Coping generally is curative and points towards a lack of choice: it is something farmers are forced into doing out of poverty or vulnerability. In qualitative interviews, three practices were frequently referred to as coping strategies: looking for wild vegetables and fruits in the bush, reliance on food support, and working as casual farm labourers on other people's plots.<sup>3</sup> For example, one woman stated the following about her household's situation during the last drought they faced:

"Our condition [during the last drought] was bad, but not so much that it pushed us to go find *wild fruits* to eat or to sleep without eating." (S hh016 wife)

Similarly, *food support* was not considered as a reliable strategy. Government food support is infrequent (maximum twice a year), and usually targets at a subgroup of the elderly and sick who cannot work (see also Van Aelst & Holvoet, 2016). Furthermore, all respondents emphasized that the amount of food support was negligible and would sustain a household for only a couple of days. Furthermore, *working as a casual farm labourer* was referred to as something poor farmers are forced

into due to circumstances, but not something they would be likely to actively choose for. One woman stated that:

“I do casual farm labour because I have no other way of life. I have to do it so that we can survive the conditions of life, because I am supporting my mother who is also living in this village with my four grandchildren.” (C 0052 wife)

Quantitative evidence (based on the 18 logistic regressions) seems to confirm that these three practices are a way of coping, rather than adapting, as their adoption is negatively associated with proxies of higher levels of household welfare (or access to resources). We have used three proxies of welfare/access to resources: ‘means of transport owned by the household’, ‘land ownership’ and ‘degree of farming involvement’. We find that when households are better off (i.e. own a bike, or even motorcycle or car; own, rather than rent land; and are less reliant on agriculture for subsistence), they are less likely to adopt the practices of ‘looking for wild vegetables and fruits’, ‘working as a casual farm labourer’, and ‘relying on food support’. On the other end of the spectrum are those practices that households are choosing to adopt when they are better off (more clearly *adaptation* practices), such as using a tractor, irrigating, etc. This is what has been labelled as a ‘wealth effect’ in the literature (see e.g. Ling & Manfred, 2016). While practices in between – along the continuum, or in the table in the middle – show no clear correlation between relative household welfare and adoption.

[Table 5 here]

Indeed, the three ‘welfare’ proxies seem to be relatively influential in determining the (non)adoption of adaptation practices. Looking at the logistic regression results, we find that respondents are more likely to participate in farmer field schools if their household owns a bike (4.4 times as likely compared to those household not owning a means of transport) or owns a motorcycle or car (3.2 times). Similarly, those owning a bike are 2.5 times as likely to use a tractor, more than 2 times as likely to irrigate their farms, and 3.1 times as likely to cultivate vegetables. When a household owns a motorcycle or car, they are more than 3 times as likely to hiring casual farm labourers to work on the land. On the contrary, those owning a motorcycle or car are 82.7% less likely to work as a casual farm labourer. Investigating the effect of land ownership, we find that compared to those owning land (reference category), those who rent land are 74.5% less likely to be engaged in farmer field schools, 68.8% less likely to plant drought-resistant crops, while being 3.6 times more likely to work as casual farm labourers, and 8.9 times more likely to rely on food support. Degree of farming involvement shows us that households that are selling more than half of their harvest are more likely to do fallowing (3.7 times as likely) compared to subsistence farmers. In our sample, none of those household who do not rely on farming as their primary source of livelihood, are reliant on food support, while all of the (11) households that rely on military or government farm land, indicate to go and look for wild vegetables and fruits in the bush.

#### *4.2.2. Adaptation outcomes dependent on wives’ intrahousehold decision-making participation*

##### *Wife’s non-farm income-earning activities*

To further investigate the nature of the correlation of women's intrahousehold decision-making participation and the likelihood of their engagement in non-farm income-earning activities<sup>4</sup> we first interpret the regression parameters. In terms of decision-making score (ranging from -18 to +18), the odds ratio is 1.059, meaning that an increase of the independent variable by one unit – or when the wife participates in one extra adaptation decision – she is 5.9% more likely to choose engagement in non-farm activities. So, compared to a wife who is not involved in any of the adaptation decisions, a wife who is involved in all adaptation decisions is 2.8 times more likely to choose some form of non-farm income-earning activities. Looking at the categorical version of the decision-making variable, we find a significant difference between 'considerable male voice in decision-making' and the reference category 'high degree of female decision-making participation'. Namely, in households where men are more likely to decide on adaptation decisions on their own, wives are 93.8% less likely to be involved in non-farm income-earning activities (odds ratio of 0.062), compared to when the wife is (jointly) involved in all or nearly all adaptation decisions. Furthermore, regression results indicate that wives who are involved in (nearly) all adaptation decisions are 55.4% more likely to work outside of the home than wives with a 'considerable degree of female decision-making participation'.

We argue that compared to farm practices, which are in our study villages more of a quasi-public household good, this is less the case for spouses' non-farm income-earning efforts. Spouses' personal earnings have a clear 'private' character, allowing for (the visibility of) conflict over cooperation. Nevertheless, most households would pool their resources and a dominant discourse of cooperation remains pronounced. At the same time, there are households who indicated not to pool their resources, and even when they do, spouses' separate contributions to the pool or to household welfare are more visible when earned outside of the house (Sen, 1990). Therefore, spouses are more likely to have different preferences with regard to women's involvement in non-farm activities. As indicated above, we find that women who have more adaptation decision-making power are more likely to work outside of the home. However, note that the two are correlated, but we cannot make claims about causality in cross-sectional research. Insights from additional longitudinal research are required to broaden our understanding of directions of influence.

Nevertheless, a diversity of preferences exist (among both women and men). For example, in the qualitative interviews some women indicated they preferred paid employment or self-employment, while others did not as it adds to their domestic (and agricultural) work burden. Accounts are thus varied: one woman in Changarawe indicated that at first her husband disagreed about her selling food at Mzumbe University, but that she managed to convince him after 'advising him for a long time' until he agreed (C 0048-51). Another woman in the same village, on the contrary, indicated that it was her husband's idea to sell some assets from their house, and to use this money to set up a small business of selling food at Mzumbe University, which was to be operated by the wife. The wife was hesitant at first, but her husband tried to convince her and in the end she agreed. However, at the time of the interview she had stopped the food business due to pregnancy and child care tasks (C 0055). Furthermore, some women indicated they preferred earning their own money, as it gave them the benefit of not having to ask their husbands for money or approval, and therefore prevented sources of conflict within the household. One participant explained:

"Doing small businesses is successful for us. We get some small money and pay for small expenses. Like clothes, doing my hair, the children's school uniforms. I don't have to ask my husband for money anymore." (FG 7F Ki)

Regression results furthermore allow us to distinguish two other elements that facilitate wives' involvement in non-farm income-earning activities. First, we find that those wives who have benefited from at least some formal education are more likely to engage in income-earning activities outside of the house, compared to wives that did not receive any education. Second, those wives aged between 36 and 45 years are most likely to work outside of the house. We argue that younger wives' time is more constrained by child care and domestic tasks, as they might have less opportunities to delegate such tasks.

#### *Planting cover crops and drought-resistant crops*

With regard to cover crops, parameters for the decision-making scores indicate that with each additional decision in which the wife participates, the household is 6.1% more likely to plant cover crops (odds ratio of 1.061). That is, compared to a household where the wife does not participate in any adaptation decision, households where the wife participates in all decisions are 2.9 times as likely to plant cover crops. The categorical variable shows difference in particular between the reference category of 'high degree of female decision-making participation' and the category 'little decision-making participation by wife', with women in the latter category 81.7% less likely to plant cover crops (odds ratio of 0.183).

Mwangi et al. (2015) in their study on Kenya also found that women are more likely to (prefer to) adopt cover crops than men. Although we have no conclusive evidence based on our own research, possible explanations are the fact that they are low input crops that women consider as technologies with high ease of use and demanding little time, that these crops provide women with vegetables, leaves, grains and forage (even when other crops such as maize fail due to bad weather conditions), and that they limit weeding work (Mwangi et al., 2015; Morris and Vankatesh, 2000; Graef et al., 2015).<sup>5</sup> Cover crops thus seem to address challenges such as time constraint that affect women more than men.

Furthermore, regression results show that wives who are living in relatively better-off households (i.e. households that own a bike) are three times more likely to plant cover crops compared to wives in non-bike-owning households. The analysis also indicates a correlation between living in a household that owns farm land and planting cover crops. Insecure land tenure arrangements thus seem to hinder the use of cover crops.

Considering drought-resistant crops, we find that with each additional adaptation practice in which the wife participates, a household is 5.7% more likely to plant drought-resistant crops (odds ratio of 1.057). So when women have a say in all adaptation decisions, compared to no say at all, their household is 2.7 times as likely to plant drought-resistant crops such as cassava, millet and sorghum. The categorical decision-making variable shows that especially households where the husband makes more decisions about (non)adoption of adaptation strategies, are less likely to plant drought-resistant crops (78.8% less likely, odds ratio of 0.212) compared to the reference category of women who participate in all or nearly all adaptation decisions. Crops like cassava are a typical household food security crop, rather than a cash crop, and a potential consequence is that this crop has become more associated to or preferred by women. Another potential explanation relates to women's different preferences in terms of degree or way of risk-spreading, in this case by planting crops that will still yield even if there is no or little rain. However, more research is needed on (climate change) risk perceptions and risk preferences by gender (see e.g. Doss, McPeak & Barrett, 2008).

Another factor explaining the use of drought-resistant crops is land ownership. Regression results show that wives living in households that own farm land are more likely to plant drought-resistant crops compared to wives that live in households that rent land or have other forms of insecure land tenure.

## 5. Discussion

In this article, we estimated factors influencing the adoption of 18 household and individual-level adaptation practices. Next to key determinants such as material resources, education and village, we provided empirical evidence for the role of intrahousehold decision-making participation by wives. This article illustrates that in the case of the Morogoro Region, Tanzania, extrahousehold factors seem to be the main determinants of whether or not households will adopt agricultural adaptation practices. These factors range from households' access to resources such as land and transport means, their dependence on farming as a primary source of livelihood, socio-economic variables, to the village in which farmers live. The latter might be related to factors such as access to natural resources and farm land, infrastructure, access to water (for e.g. irrigation), access to extension services and agricultural inputs such as improved seeds and fertilizers. Nevertheless, we find that some adaptation practices are used more frequently in households where the wife is more involved in adaptation decision-making. This was the case specifically for women's engagement in non-farm income-earning activities, the use of cover crops, and the switching to drought-resistant crops. This suggests the existence of gendered preferences with regard to these practices and the significant role of women's decision-making power herein. Note that women's preferences for cover crops and drought-resistant crops could have sustainability effects in the context of advancing climate change, as cover crops have been among the suggested technologies to advance conservation agriculture in the Morogoro Region of Tanzania (Graef et al., 2015). We have furthermore argued that Tanzanian smallholder farmers' adaptation options are limited and their intrahousehold bargaining set therefore narrow. This is specifically the case for coping strategies such as relying on food support, looking for wild vegetables in the bush and working as a casual labourer. Moreover, we argue that farm yields are quasi-public household goods and cooperation in terms of (agreeing upon) household adaptation strategies is therefore likely to prevail over conflict. Nevertheless, spousal disagreement and conflict on farm practices do exist, and future research should further investigate issues of distributional justice.

Drawing on intrahousehold bargaining literature, this paper has contributed to the academic literature on agricultural technology adoption and climate change adaptation. Our main contribution to these streams of literature lies in the incorporation of an intrahousehold gender perspective. The household, a gendered decision-making institution, has not yet been comprehensively dealt with in the climate change and technology adoption literature. Nevertheless, the intrahousehold bargaining literature has established that the household does not function as a neutral unit, and that men and women within the household are consequently differently positioned to deal with climate change and possess different adaptation preferences. Our article argues that intrahousehold factors, such as gendered preferences and female bargaining power, should not be overlooked by other disciplines, as these factors can (partially) explain households' adaptation behaviour. Finally, we contributed to the intrahousehold bargaining literature by investigating the *climate adaptation* decision-making domain, a decision-making area that has previously not been studied within feminist economics.

## 6. Conclusions

This article found that households where the wife has more decision-making power are more likely to adapt to climate change by planting cover crops and drought-resistant crops and by female engagement in non-farm income-earning activities. We argue that there are certain gendered preferences with regard to these practices, while spouses' preferences are less diverging with regard to the other (agricultural) adaptation practices investigated. Policy-makers should acknowledge potential differences in adaptation preferences between women and men, as well as the fact that specialisation along gender lines leads them to possess different information and knowledge about crops, agricultural and livelihood practices. Policies should not only ensure the participation of both genders in (agricultural) training, extension services and adaptation decision-making at all policy levels, but also allow women's specific knowledge to inform climate change policies. Such an approach thus demands, in order to prevent inadequate policy outcomes, that the design of policies is effectively informed by rigorous gender-disaggregated needs assessments in which a diverse group of male and female farmers participates. This will lead to better-informed and more effectively targeted climate policies, that can offer the right incentives to different types of farmers so as to stimulate widespread uptake of adaptation policy measures. Future research is also essential to further untangle the relationship between household decision-making processes and adaptation. We suggest it would be useful to focus on areas where the bargaining set is larger, so as more variation in bargaining is visible, as well as to allow for the distinction between sole female and joint decision-making. Furthermore, longitudinal and qualitative research could provide more insights into the causalities and directions of influence, as well as contribute to further disaggregation of data for different categories of women.



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Table 1: descriptive statistics of categorical independent variables (frequency and percentage of married women in each category)

	Village	Means of transport ownership	Land access	Educational level	Educational difference spouses	Occupation (farm involvement)	Tribe	Religion	Age
Changarawe	75 (21.9%)								
Vikenge	85 (24.8%)								
Kiwege	98 (28.6%)								
Sinyaulime	85 (24.8%)								
No transport ownership		125 (37.2)							
Household owns bike		170 (50.6)							
Household owns moto or bike		41 (12.2)							
Household owns land			218 (63.6)						
Household rents land			52 (15.2)						
Household owns and rents land			62 (18.1)						
Free use of land (army)			11 (3.2)						
No education				104 (30.3)					
Some primary education				24 (7.0)					
Primary education finished				204 (59.5)					
Secondary education or higher				11 (3.2)					
Spouses have same educational level					189 (56.4)				
Wife higher educational level					39 (11.6)				
Husband higher educational level					107 (31.9)				
Subsistence farming						304 (88.6)			
Commercial farming (sell more than 50% of harvest)						30 (8.7)			
Main income activity is not farming						9 (2.6)			
Luguru tribe							185 (54.1)		
Non-Luguru tribe							157 (45.9)		
Muslim								230 (67.1)	
Non-Muslim								113 (32.9)	
15-25									52 (15.2)
26-35									96 (28.1)
36-45									85 (24.9)
46-55									43 (12.6)
56-65									35 (10.2)
66+									31 (9.1)
Total (valid n)	343	336	343	343	335	343	342	343	342

Source: based on questionnaire data (subsample of 343 married or cohabiting women)

Table 2: adaptation decision-making within the household (categorical variable)

<i>Categories of categorical adaptation DM variable</i>	<i>Frequency</i>	<i>Percentage</i>
High degree of female DM participation [15 ; 18]	117	37.1
Considerable degree of female DM participation [10 ; 14]	125	39.7
Little DM participation by wife [0 ; 9]	53	16.8
Considerable male voice in DM [-18 ; -1]	20	6.3
Total	315	100

Table 3: description of adaptation strategies and adoption rates according to wives

<i>Adaptation strategy</i>	<i>Description</i>	<i>Adoption rate wives</i>	
		<i>%</i>	<i>n</i>
<i>Drought-resistant crops</i>	Planting crops that are able to cope with drought conditions, e.g. cassava, millet and sorghum.	76.5	262
<i>Participate in farmer field schools</i>	On-farm field trials. Participation in farmer field schools (locally known as shambadarasa) to learn to apply new agricultural techniques.	16.2	55
<i>Vegetable cultivation</i>	Cultivating vegetables in gardens during the dry season.	37.9	129
<i>Mixed cropping</i>	Growing two or more crops simultaneously on the same farm plot.	61.8	212
<i>Mulching</i>	Placing a layer of organic – or other – material on the soil to conserve moisture, improve soil fertility and/or reduce weed growth.	20.2	69
<i>Cover crops</i>	Planting crops that improve soil moisture and fertility and/or control weeds and pests.	84.6	289
<i>Fallowing</i>	Ploughing the farm land and leaving it unseeded during at least one growing season.	26.9	93
<i>Work as casual farm laborer</i>	Work as a casual laborer on someone else’s farm land, usually in return for cash but occasionally for food or a share in crop yields.	33.2	113
<i>Non-farm income activities</i>	Engaging in income-earning activities outside the household and farm, such as brick making, charcoal production, own business, wage labor (not including income-earning activities on other people’s farms, see working as a casual laborer).	34.3	117
<i>Food support</i>	Asking for or receiving food support from the government, relatives or friends.	15.9	54
<i>Look for wild vegetables</i>	Searching for wild vegetables or wild fruits balance the diet. These can be found in the bush, forest or by the road side.	81.1	278
<i>Small-scale irrigation</i>	Practicing small-scale irrigation on the farm, e.g. bucket irrigation, hose irrigation or using canals.	21.5	73
<i>Fast-maturing seeds</i>	Using fast-maturing seeds (known as ‘short seeds’ locally) which take less time to mature. Depending on the type of seed, maturing can take e.g. 3 or 4 months.	85.0	291
<i>Hire casual labourers</i>	Hiring casual laborers, usually during farm preparation (soil tillage using the hoe) and/or harvesting.	43.0	147
<i>Hire tractor</i>	Hiring or using a tractor to facilitate or improve soil tillage.	45.6	156
<i>Manure</i>	Applying organic matter to the farm land or crops to improve crop growth and soil fertility.	25.0	86
<i>Fertilizers</i>	Applying non-organic or industrial fertilizers to the farm land or crops.	25.7	90
<i>Sell assets to buy food</i>	Selling assets such as a television, phone or livestock to get money to buy food.	26.8	92

Source: based on questionnaire data (subsample of married or cohabiting women).

Table 4: decision-making process of adaptation decisions (according to wives).

	<i>Decision-maker (according to wives)</i>								<i>Total n</i>
	<i>Wife only</i>		<i>Husband only</i>		<i>Joint</i>		<i>No decision</i>		
<b><i>Adaptation strategy</i></b>	<b>%</b>	<b><i>n</i></b>	<b>%</b>	<b><i>n</i></b>	<b>%</b>	<b><i>n</i></b>	<b>%</b>	<b><i>n</i></b>	
<i>Drought-resistant crops</i>	12.5	43	10.5	36	<b>72.3</b>	248	4.7	16	343
<i>Participate in farmer field schools</i>	14.2	48	6.2	21	32.0	108	<b>47.5</b>	160	337
<i>Vegetable cultivation</i>	<b>27.4</b>	94	7.0	24	<b>51.6</b>	177	14.0	48	343
<i>Mixed cropping</i>	16.1	55	10.6	36	<b>66.0</b>	225	7.3	25	341
<i>Mulching</i>	14.4	49	10.0	34	48.2	164	<b>27.4</b>	93	340
<i>Cover crops</i>	20.2	69	10.0	34	<b>63.3</b>	216	6.2	21	340
<i>Fallowing</i>	7.3	25	8.2	28	<b>67.7</b>	231	16.7	57	341
<i>Work as casual farm labourer</i>	<b>31.8</b>	108	6.2	21	48.5	165	13.5	46	340
<i>Non-farm income activities</i>	<b>36.1</b>	122	8.9	30	42.3	143	12.7	43	338
<i>Food support</i>	12.8	44	8.5	29	<b>54.8</b>	188	<b>23.9</b>	82	343
<i>Look for wild vegetables</i>	<b>73.4</b>	251	1.2	4	15.8	54	9.6	33	342
<i>Small-scale irrigation</i>	14.0	48	8.7	30	<b>57.3</b>	196	19.9	68	342
<i>Fast-maturing seeds</i>	8.5	29	<b>12.3</b>	42	<b>73.4</b>	251	5.8	20	342
<i>Hire casual labourers</i>	7.4	25	<b>12.7</b>	43	<b>64.5</b>	218	15.4	52	338
<i>Hire tractor</i>	5.0	17	<b>13.2</b>	45	<b>66.9</b>	228	15.0	51	341
<i>Manure</i>	6.4	22	<b>11.7</b>	40	<b>57.7</b>	198	<b>24.2</b>	83	343
<i>Fertilizers</i>	5.8	20	<b>12.3</b>	42	<b>64.9</b>	222	17.0	58	342
<i>Sell assets to buy food</i>	11.1	38	9.9	34	<b>64.1</b>	220	14.9	51	343

Source: based on questionnaire data (subsample of married or cohabiting women)



Table 5: A coping-adaptation continuum: practices (non-)correlated to household's welfare

<i>Coping</i>		<i>Adaptation</i>
<i>Negative correlation between relative welfare and adoption</i>	<i>No clear correlation between relative welfare and adoption</i>	<i>Positive correlation between relative welfare and adoption</i>
Work as casual labourer Food support Wild vegetables	Manure Fast-maturing seeds Drought-resistant crops Mulching Fertilizers Mixed cropping Selling assets (incl. livestock)	Farmer field schools Non-farm income-earning Tractor Irrigation Fallowing Vegetable cultivation Hire casual farm labourers Cover crops

*Source: based on logistic regression outcomes (subsample of married or cohabiting women)*

## Appendix

Table A1: Logistic regression results

	Drought-resistant crops			Non-farm activities			Cover crops		
	B (S.E.)	Exp(B)	Sig.	B (S.E.)	Exp(B)	Sig.	B (S.E.)	Exp(B)	Sig.
<b>Constant</b>	1.859 (0.929)	6.418	0.045	-2.790 (0.920)	0.061	0.002	3.189 (1.165)	24.186	0.006
<b>DM index</b>	0.010 (0.004)	1.010	0.013	0.010 (0.005)	1.010	0.028	0.011 (0.005)	1.011	0.022
<b>Village</b>									
Changarawe (ref)						0.802			
Vikenge				0.381 (0.432)	1.463	0.378			
Kiwege				0.089 (0.521)	1.093	0.864			
Sinyaulime				0.253 (0.491)	1.287	0.607			
<b>Occupation</b>									
Subsistence (ref)			0.527			0.004			0.807
Commercial	-0.351 (0.525)	0.704	0.503	-1.864 (0.700)	0.155	0.008	-0.008 (0.634)	0.992	0.990
Main not farming	-0.774 (0.808)	0.461	0.338	1.715 (0.904)	5.558	0.058	0.764 (1.169)	2.147	0.514
<b>Transport means</b>									
No (ref)			0.558			0.265			0.012
Bike	0.337 (0.323)	1.400	0.297	0.517 (0.322)	1.677	0.109	1.162 (0.402)	3.196	0.004
Moto or car	0.313 (0.523)	1.367	0.550	0.202 (0.483)	1.223	0.677	0.105 (0.550)	1.110	0.849
<b>Education</b>									
No educ (ref)			0.720			0.073			0.071
Some primary	-0.306 (0.593)	0.737	0.606	1.525 (0.596)	4.595	0.010	-0.696 (0.714)	0.499	0.330
Primary finished	-0.406 (0.482)	0.666	0.399	0.689 (0.475)	1.991	0.147	-1.426 (0.595)	0.240	0.017
Secondary or +	-0.994 (0.920)	0.370	0.280	0.820 (0.963)	2.272	0.394	-2.256 (1.028)	0.105	0.028
<b>Educ diff</b>									
Same (ref)			0.237			0.244			0.190
Wife higher	-0.571 (0.473)	0.565	0.227	-0.806 (0.485)	0.447	0.097	0.457 (0.628)	1.579	0.467
Husb higher	-0.580 (0.411)	0.560	0.158	-0.002 (0.413)	0.998	0.996	-0.719 (0.470)	0.487	0.126
<b>Land</b>									
Own land			0.004			0.100			0.000
Rent land	-1.165 (0.420)	0.312	0.006	-0.823 (0.465)	0.439	0.077	-0.730 (0.530)	0.482	0.168
Own and rent land	-1.130 (0.378)	0.323	0.003	0.312 (0.409)	1.366	0.446	-1.829 (0.433)	0.161	0.000
Free but insecure use	-1.413 (0.779)	0.243	0.070	-0.501 (0.861)	0.606	0.561	-1.581 (0.893)	0.206	0.077
<b>Tribe</b> Luguru ref	-0.989 (0.321)	0.372	0.002	0.289 (0.298)	1.335	0.332	-0.714 (0.383)	0.490	0.062
<b>Religion</b> (non-muslim ref)	0.667 (0.325)	1.949	0.040	-0.160 (0.326)	0.852	0.625	0.475 (0.382)	1.608	0.214
<b>Age</b> (continuous)	-0.004 (0.012)	0.996	0.745				-0.016 (0.015)	0.984	0.289
15-25						0.030			
26-35				0.820 (0.473)	2.270	0.083			
36-45				1.057 (0.485)	2.878	0.029			
46-55				0.416 (0.583)	1.517	0.475			
56-65				-1.244 (0.949)	0.288	0.190			
66+				0.261 (0.739)	1.298	0.724			
Model statistics	R <sup>2</sup> Nagelkerke: 0.201 -2 Log Likelihood: 281.330 Chi <sup>2</sup> model: 42.758 *** N = 301			R <sup>2</sup> Nagelkerke: 0.249 -2 Log Likelihood: 323.397 Chi <sup>2</sup> model: 59.321 *** N = 301			R <sup>2</sup> Nagelkerke: 0.262 -2 Log Likelihood: 211.313 Chi <sup>2</sup> model: 49.488 *** N = 301		

## Endnotes

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<sup>1</sup> See also Richards et al. (2013) for literature review of studies that investigate the relationship between intrahousehold decision-making, women's bargaining power and outcomes in child health.

<sup>2</sup> Note that there is also some indication of a positive correlation between the intrahousehold decision-making index and the adoption of the practices of mixed cropping and selling assets (including livestock) to buy food. However, the model fit for the practice 'selling assets' is weak, suggesting that none of the household-level explanatory variables sufficiently explain why households are (not) relying on the selling of assets as a strategy. Other factors are at play. The model for 'mixed cropping' shows poor explanatory power and model fit. Therefore, we should be cautious about interpretation of the significant correlation in these two models.

<sup>3</sup> These three coping practices are also incorporated in the quantitative analysis and are therefore mentioned here. However, during qualitative interviews many other coping strategies were discussed. These ranged from digging traditional wells, to prostitution, and being forced to eat grain chaff which would normally be fed to livestock.

<sup>4</sup> See also Eriksen, Brown and Kelly (2005) on spouses non-farm income-earning activities and livelihood diversification as an adaptation strategy in Tanzania.

<sup>5</sup> We would also like to thank the reviewers for this suggestion.