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Gender Differences in Climate Change Risk, Food Security, and Adaptation

A Study of Rural Households' Reliance on Agriculture and Natural Resources to Sustain Livelihoods

Byela Tibesigwa, Martine Visser, Lori Hunter, Mark Collinson, and Wayne Twine

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Abstract

Climate and weather variability in sub-Saharan Africa disproportionately leave female-headed households food insecure. However, the extent and reasons for these gender differences are, thus far, not well understood. This study examines gender-food-climate connections using longitudinal data from rural households in north-eastern South Africa. Results confirm gender distinctions in that male-headed households are more food secure. Importantly, however, female-headed households are not a homogenous group. Participation in agriculture and utilisation of natural resources narrows the male-female consumption gap to 10.3% amongst de jure female-headed households – those with female heads who are single, widowed, divorced, or separated. Yet, these land-based practices are associated with a greater male-female gap (27.4%) amongst de facto female-headed households – married female heads who are married, but whose husbands are away. Further, and contrary to expectation, weather-related crop failure threatens food security in both male- and female-headed households, but less so amongst de facto female-headed households, who remain more dependent on remittances.

Key Words: gender, climate change, subsistence farming, natural resources, food security, adaptation, livelihoods

JEL codes: Q12, Q18, Q54

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Gender Differences in Climate Change Risk, Food Security, and Adaptation: A Study of Rural Households' Reliance on Agriculture and Natural Resources to Sustain Livelihoods

Byela Tibesigwa, Martine Visser, Lori Hunter, Mark Collinson, and Wayne Twine*

1. Introduction

Women in sub-Saharan Africa who head[1] small-scale subsistence farming[2] households are considered "to be the poorest" (Buvinic and Gupta 1997: p.266) and "more food insecure" (Mallick and Rafi 2010: p.593). This is likely to worsen in light of increasing climate and weather variability (IPCC 2014). For rural sub-Saharan Africa, there are two fundamental reasons why climatic conditions will potentially impinge on food security.[3] One, small-scale farm households are heavily reliant on rain-fed agriculture to supplement household dietary

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[1] It is stated that female headship has been on the rise (Bongaarts 2001; Horrell and Krishnan 2007); however, there is little statistical evidence. The World Bank indicators show the following data for female headship for sub-Saharan Africa: Benin, 22.9% of households are headed by women. In Burundi and Cameroon, woman headship is 26.8% and 25.5% respectively. In Ethiopia, 26.1% are women, while in Gabon the figure is 30%. In Malawi, 28.1% are women, 35.6% in Mozambique, 33.3% in Rwanda, 24.8% in Senegal, 24.4% in Tanzania, 29.5% in Uganda and 44.6% in Zimbabwe. Only 17.3% of the heads of households are women in Guinea; in Cote d'Ivore, only 18.0%; and, in Burkina Faso, the figure is 9.5%. See http://data.worldbank.org/indicator. According to Statistics South Africa, approximately 41.9% of South African households are headed by women. Overall, it appears that female headship is lowest in Western Africa and highest amongst the Southern Africa countries.

[2] Although the statistics are somewhat scarce, Due and White (1986) indicate that 25%-35% of female heads of households in Africa are small-scale farmers. Gladwin et al. (2001) note that 50% of women farmers are heads of households, while Horrell and Krishnan (2007) state that, in Zimbabwe, 40% of the households are headed by women who live on rural communal land.

[3] Household food security is defined as 'year-round access to an adequate supply of nutritious and safe food to meet the nutritional needs of all household members' (WB 2008: p.12).

requirements[4] (Kotir 2011). Two, small-scale farming has low adaptive capacity, mainly due to the high poverty levels that typify small-scale farmers (Kates 2000; Schulze 2010). It is not surprising, therefore, that the present consensus, renewing old sentiments on gender and agriculture, is that there is a critical need to acknowledge gender-differentiated climate impacts and to promote gendered climate mitigation strategies as related to agriculture and livelihoods in order to improve food security (Skutsch, 2002; Deaton 2002; Nelson et al. 2002; Demetriades and Esplen 2008; Ibnouf 2011).

As we are reminded by Lambrou and Piana (2006), for instance, who document the following statement from COP-11, 'Gender… and poverty are interrelated and create mutually reinforcing barriers to social change' (Lambrou and Piana 2006: p.3). Indeed, although the impact of climate and weather variability on the food security of small-scale subsistence farm households has received increased attention over the years (see, e.g., Dercon and Krishnan 2000; Deressa et al. 2009; Gbetibouo and Ringler 2009; Di Falco et al. 2011; Kabubo-Mariara and Kabara 2014; Tibesigwa et al. 2014a), to date, relatively less is understood about gender and climate change (Deaton 2002; Nelson et al. 2002; Lambrou and Piana 2006; Demetriades and Esplen 2008; Babugura 2010; Kakato et al. 2011; Arora-Jonsson 2011). Against this backdrop, we address gaps and build on current studies by providing new evidence in at least four ways. First, we investigate the role of agriculture and natural resources in the food security of male- and female-headed households. Second, we go a step further by establishing whether the impact of weather-related crop failure on food security is gender neutral, i.e., whether it affects male- and female-headed households equally. Third, we compare de facto (married women whose husbands are away, e.g., migrant workers or men who have abandoned the family) and de jure (single, widows, divorced, separated) female headship. Fourth, unlike most studies, our study is based on a quantitative approach using a longitudinal study of subsistence farm households.

We use longitudinal data on small-scale subsistence farming households in the Agincourt Health and Demographic Surveillance System (AHDSS) site in a rural region of Mpumalanga Province in South Africa. Although the second largest economy in Africa, South Africa still faces numerous challenges in meeting the Millennium Development Goals, and to this end has declared rural development a key national priority (DEA 2011). Rural South Africa is

[4] It is estimated that 85% of Africans live in rural areas and either depend on agriculture directly through food or income generation or indirectly through farm labour income, and that food security is highly correlated to agriculture production (Gladwin et al. 2001).

characterised by endemic poverty, food insecurity, environmental degradation, and high human densities due to the historic settlement patterns imposed by apartheid, combined with weather and climatic variability (DEA 2011). Further, in South Africa, close to 50% of households are headed by women, and according to Schatz et al. (2011), this pattern is connected to apartheid, historical patriarchy and the HIV/AIDS epidemic. Furthermore, well-documented gender inequalities in South Africa make rural women particularly vulnerable to livelihood shocks, including extreme weather events (DEA 2011).

Our assessment is based on robust panel estimation methods and decomposition techniques, coupled with additional robustness tests. In so doing, we observe that de jure and de facto female-headed households have lower per capita consumption, and are more food insecure in comparison to male-headed households. Consumption is lowest amongst de facto female-headed households and this finding is consistent with either objective or subjective measures of household consumption. We also observe that participation in agricultural activities and utilisation of natural resources[5] is statistically significant in boosting the consumption levels of all households, but more so amongst de jure female-headed households. In particular, although male-headed households have higher food consumption (mainly because of their participation in the labour market), agriculture and natural resources activities reduce this male advantage, decreasing the consumption gap between male- and de jure female-headed households from 19.6% to 10.3%. Even so, this relative improvement in food security due to land-based activities is not observed amongst de facto female household heads, partly due to the substantial portion of consumption explained by remittances (36.9%). In measuring the impact of climate and weather variability, we relate gender and food security to weather-related crop failure due to poor rainfall or wind and hail storms. Using this exogenous measure, we find that the presence of weather variability reduces the consumption levels of all households, i.e., both male- and female-headed households, although the effect is greater for male-headed households, and more for de jure female-headed households than for de facto female-headed households. In fact, because de jure female-headed households are mostly dependent on agriculture, continuing climate and weather variability may continue to increase their vulnerability if necessary adaptive measures are not taken. Overall, therefore, this study observed robust evidence of gender differences in climate change impacts on agriculture and food security amongst rural farm households. The remainder

[5] We consider participation in agricultural activities and utilisation of natural resources together. Although beyond the scope of the present study, future research may disaggregate these.

of the paper is structured as follows: Section 2 provides a brief literature review. Section 3 gives a description of the data and the methodology, Section 4 reports estimation and decomposition results, and Section 5 concludes.

2. Climate Change, Food Security and Gender

Several persuasive arguments have been put forth regarding gendered impacts and responses to climate and weather variability. First, there is a somewhat general agreement that in sub-Saharan Africa, as elsewhere in developing regions, women account for a larger proportion of subsistence farmers. For instance, women account for close to 80% of small-scale subsistence farming (e.g., vegetable gardens) in sub-Saharan Africa (Lambrou and Piana, 2006). Buvinic and Gupta (1997) note that women who head households usually choose labour that is more flexible and complements the hours spent on performing multiple household duties and, as a result, they are more engaged in farming. This suggests that women in general, but especially those who head households, are disproportionately vulnerable to climate and weather variability (Deaton 2002; Nelson et al. 2002; Lambrou and Piana 2006; Terry 2009; Babugura 2010). Second, there exists a gender-related economic gap, i.e., female-headed families are run by women earners who often have lower incomes, less access to the job market, and fewer assets than male-headed households (Kossoudji and Mueller 1983; Buvinic and Gupta 1997). Further, female-headed households have less access to credit and extension services. For example, in Malawi, only 25% of farmers' credit club members were women (Due and Gladwin 1991). This implies that their adaptive and mitigative options are lower than those of men (Lambrou and Piana 2006; Carr 2008; Eriksen and Silva 2009).

Third, and related to the first argument, because their role within households is predominantly centered on caring for family members, gathering household necessities and fulfilling domestic roles, women who head households are more likely to take jobs that can fit with their household duties. This typically means lower pay and/or fewer working hours. For instance, participation in farm activities is favoured in comparison to non-farm activities (Buvinic and Gupta 1997). Added to this, female-maintained households are more likely to have a higher ratio of non-workers (Buvinic and Gupta 1997), which leaves them more vulnerable. Fourth, because they often lack secure property rights (Gladwin et al. 2001), most female–headed households depend on common property resources, e.g., farming on communal land or natural resource use. Ultimately, any depletion of these signifies a serious threat to both household food security and livelihoods more generally. Moreover, lack of property rights discourages female heads of households from adopting modern technologies, as found in a study by Tenge et al. (2004). Fifth and related to the above, female heads of households often cultivate on smaller land and often have limited labour available to attend to their farms, which produces lower yields; such yield is often held back for household consumption, while only a little is available for sale (Due and Gladwin 1991). In Malawi, for example, 30% of small-scale farmers are female heads of households who use less than half a hectare of land for cultivation (Gladwin et al. 2001).

Sixth, temporary economic out-migration of men in search of employment, which is prevalent in sub-Saharan Africa (Goldsmith et al. 2004; Jentsch 2006), promotes household headship by the women who are 'left- behind' (Braun 2010; Ibnouf 2011), as well as the use of household plots for agriculture (Horrell and Krishnan 2007). In general, women are less mobile relative to men (Reed et al. 2010) and often remain locked in agricultural activities (Ibnouf 2011). Further, although some women may receive remittances, often these are not adequate for household well-being. Hence, female-headed farming households are more likely to be poor (Buvinic and Gupta 1997). This further increases the 'left-behind' women's dependence on agriculture as they remain to care for the households. Other reasons that may promote the dependence on agriculture include polygamous marriage, which may cause some wives to live in independent households. In Malawi, for instance, Gladwin (1991) found that some women in polygamous marriages who were more favoured by their husbands received fertilizer while others did not. Also, widowed or abandoned women often end up in independent households and take up household headship (Buvinic and Gupta 1997).

As related to climate vulnerability, and as previously noted, there are numerous studies on climate change and food security of farm households (e.g., Christiaensen and Subbarao 2005; Deressa et al. 2008; Hahn et al. 2009; Deressa et al. 2009; Eriksen and Silva, 2009; Dasgupta and Baschieri 2010; Tesso et al. 2012; Kabubo-Mariara and Kabara 2014). Just to mention a few examples, Dercon and Krishnan (2000) measure the variability in consumption of Ethiopian farmers in response to climate change and found that most of the farmers were vulnerable to agriculture shocks. In another, related study, Christiaensen and Subbarao (2005) analysed the impact of weather shocks in rural Kenya and found households in arid areas to be more vulnerable to weather variability. Along similar lines, Deressa et al. (2008), in a regional assessment, measured the vulnerability to climate change in Ethiopia. Unlike their previous study, which was based on a regional analysis, Deressa et al. (2009) used data from a household survey to measure the vulnerability of Ethiopian farmers. Likewise, Dasgupta and Baschieri (2010), in their measurement of vulnerability of rural Ghanaian farmers, found that households that have a higher risk of experiencing shocks are the least prepared to respond to climate change. In analysing the impact of climate change on food security, Di Falco et al. (2011) found substantial differences in food productivity between those who adapt and those who do not adapt. In a similar manner to Deressa et al. (2008), Gbetibouo and Ringler (2009), Hahn et al. (2009), Tesso et al. (2012) and Kabubo-Mariara and Kabara (2014) measured the vulnerability to climate change in South Africa, Mozambique, Ethiopia and Kenya respectively, using indicator approaches. More recently, Tibesigwa et al. (2014b) found agriculture-related shocks to be significant in reducing consumption, and that access to informal social capital and natural resources reduces household vulnerability to weather variability. Although there are compelling arguments that indicate that women are more likely to be food insecure in general, and vulnerable to climate change in specific, little, if any, empirical evidence exists to support this assertion (Nelson et al. 2002; Angula 2008; Lambrou and Piana 2006; Demetriades and Esplen, 2008; Arora-Jonsson, 2011).

Yet, only a handful of empirical studies examine gender as related to these topics. Agarwal (1997) measures a gender-environment-poverty vulnerability index, a consolidation of gender vulnerability, poverty vulnerability and environmental vulnerability in India. According to Agarwal (1997), women and female children in poor rural households are more vulnerable to environmental degradation, while Gladwin et al. (2001) note that increasing non-farm activities will improve food security levels for women farmers. Thomas et al. (2007), in a qualitative study of small-scale farmers in the South African rural communities of Khomele, Mantsie and eMcitsheni, found that gender affected the type of climate risk perceived by the farmers. They also found that, while men were mostly involved in livestock-keeping, women were mostly crop farmers. In another qualitative study by Babugura, (2010) in the uMzinyathi and uMhlathuze municipalities of Kwazulu-Natal, South Africa, the author found that women were more negatively impacted than men by climate change.

Similarly, in a descriptive study, Omolo (2010) found that women were more vulnerable than men in the rural Turkana region of Kenya. In yet another qualitative study, Kakota et al. (2011) found that exposure and sensitivity to climate risks varied between male and female farmers in the southern and central areas of Malawi. A study by Wanjiku et al. (2007) amongst small-scale farmers in Kenya found that adaptation decisions varied between male and female heads of households. The same finding was observed by Nabikolo et al. (2012) in Uganda. Ibnouf (2011) found that women were the main contributors of household food security; in particular, while men are more likely to migrate, women are mainly responsible for producing and providing household food in Sudan. Other qualitative studies by Vincent et al. (2010) in South Africa and Mengistu (2011) in Ethiopia found female-headed households to be more vulnerable (see also Horrell and Krishnan 2007). Similar observations are made by Nielsen et al. (2012) in the Democratic Republic of Congo and Giesbert and Schindler (2012) in Mozambique. Most recently, Kassie et al. (2014) measured the household food security gap between male and female-headed households in Kenya and found that it was attributed to differences in endowment and characteristics. Overall, this study expands on current knowledge by examining the gender-food-climate connections. We do so using an innovative longitudinal study in rural South Africa focused on livelihoods, including natural resource use.

3. Methodology

3.1 Study Area, Data and Variable Definitions

This study uses household data from the Sustainability in Communal Socio-Ecological Systems (SUCSES) panel study nested in the well-established Agincourt Health and Demographic Surveillance System (AHDSS). The AHDSS site is located in a former apartheid "homeland" region in Mpumalanga Province, South Africa (see Figure 1). The study utilises information from 590 households randomly selected across nine rural villages in the AHDSS site. Currently, SUCSES has three waves (2010-2012) and continues to collect data at regular intervals. The AHDSS is managed by the Rural Public Health and Health Transitions Research Unit of the University of the Witwatersrand/ Medical Resource Council (for details, see Kahn et al. 2012). As previously mentioned, we compare male-headed and female-headed households based on the assumption that household decisions on production, consumption and investment are generally made by the household head[6]. We do take note, however, that this is a simplified assumption, and that there are likely to be gender-based inequalities within households as well (see Geisler (1993) for an elaborate discussion on intra-household gender-based inequalities). Hence, our analysis provides an aggregated picture of gender differences at the household level. Importantly, however, we disaggregate between de jure and de facto female headship. The former refers to female heads who are not married, i.e., single, widowed or divorced, while the latter captures women who are married but are heads of households because their husbands are away for long periods. As a result, both the de jure and de facto heads of households often make household decisions (Due and Gladwin 1991; Kennedy and Peters 1992).

[6] This is borrowed from the literature on household decision-making, which views the household as an enterprise and the head of the household as the manager of that enterprise (see, e.g., Geisler 1993; van der Geest 2004).

Our data show that the average female head of the household is four years older than the average male head of household. The majority of the female household heads (82.1%) are permanent residents of Agincourt, while the male heads are almost evenly split between permanent residents (53.2%) and temporary migrants (46%). The main reason for this temporary migration is employment outside the Agincourt study site. Most male-headed households (58%) have a matric certificate (grade 12). Female heads who have completed grade 12 are in the minority (47%), with the average level of education at standard 4 (grade 6). Most of the males are married (85.1%), while, in contrast, only 10.5% of women are married. The majority of the women who are not married are widows. The average household size is large, consisting of eight members, and appears to be similar for male- and female-headed households.

These households engage in various income-generating activities, one of which is crop farming. Almost all households headed by either males (96.3%) or females (97.2%) engage in crop farming, both to generate food for the household and to supplement household income. However, the majority of the crops produced are consumed rather than sold[7]. Livestock farming is another income-generating activity, but is less common. This activity is more favoured by male-headed households (63.3%) than female-headed households (50%), with cattle, goats and chickens the most common livestock. We also observe that households also utilise natural resources to supplement household diet and generate household income[8]. The use of natural resources appears to be popular in both male-headed (99.6%) and female-headed households (99.9%). Another source of household income is government grants, with the most common being child support grants and pensions. Government grants are prevalent in almost equal proportion between female-headed (89%) and male-headed (81.1%) households. Other income sources include participation in labour activities and remittances from household members residing outside the Agincourt study site.

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7 The most common crops include: maize, bambara, peanut, cowpea, pumpkin and pumpkin leaves.

8 These natural resources include: wood used as firewood or *morotso* (wood furniture) or for wooden carvings and poles. Also common are reeds used for making *nsango* (reed mats). The *marula* plant is also commonly used for its *timongo* (marula nuts) and for making *marula* beer. Wild fruits, e.g., *nkhanyi*, *makwakwa*, masala and *tintoma*, *nkwakwa* (dried monkey orange) also provide a good source of diet. Also common are wild vegetables, e.g., *guxe*, *nkaka*, and *bangala*. Edible insects, e.g., grasshoppers and *masonja* also form part of household diets. Grass is used for thatching and for making *nkukulu wa le indlwini* (grass hand brooms), while the readily available twigs make *nkukulu wa le handle* (twig hand brooms).

Overall, most of the households (83.8%) have experienced some form of a negative household shock (e.g., crop failure or death of a household member) in the past year. A closer examination shows that these shocks have been equally felt by female-headed (84.6%) and male-headed (83.3%) households. Crop failure is the most prevalent type of shock, with 63% and 69% of male-headed and female-headed households having experienced it; this is followed by loss of livestock, serious illness of a family member, death of a family member, job loss and decrease in government grants, while a decrease in remittances is the least prevalent shock in both male- and female-headed households.

As our outcome, we use both objective and subjective consumption measures. This is because different measures capture essential but distinct dimensions of food security. Using the two types of measures also offers a robustness check of our results. Our objective measure is household consumption per capita, which includes consumption from various income sources, i.e., labour, agriculture, natural resources, remittances and government grants. This allows us to tease out the contribution of each income source. Using income as a proxy for consumption follows the work of Horrell and Krishnan (2007)[9]. Our subjective measure is households' self-reported experience of food shortage, where 1 indicates experience of food shortage and 0 otherwise. This is derived from the following question: "Over the past 12 months, has your household ever experienced a shortage of food?" Given that household food security is defined as an adequate supply of food for all household members throughout the year (Pehu 2009), our measures provide good proxies for household food (in)security. Our first regressor is weather-related crop failure as a result of poor rainfall or a hailstorm. Hence, this is an exogenous measure and binary in nature, taking the value of 1 if the household experienced a weather shock and 0 otherwise. Lastly, we use a set of covariates that are standard in the literature and that include both household and farm characteristics.

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[9] Various measures have been used to capture household consumption. For instance, Christiaensen and Subbarao (2005) and Gerry and Carmen (2007) use per capita household average expenditure. Similarly, Dercon and Krishnan (2000) use expenditure on food and nutritional adult equivalent scales. In a slight departure, Deressa et al. (2009) use household income. It is worth noting that income is a more volatile measure in comparison to expenditure (Dercon and Krishnan 2000), and hence the attractiveness of using the latter measure as a proxy for consumption in the current literature. However, because households in developing countries are more likely to smooth out their consumption, monthly expenditure is therefore more likely to be equal to monthly income (Deressa et al. 2009; Grimm et al. 2008), and this is more likely to be evident in our research setting.

3.2 Analytical Framework

Our analysis is framed within the demand and production theories following Sign et al. (1986) and Feleke et al. (2005). The framework is based on the consumption of farm households and thus incorporates production and consumption within the utility function. The household utility function is assumed to be twice differentiable, strictly concave and increasing in arguments. Because the farm household is both a producer and a consumer, it is assumed to maximise utility derived from consuming purchased and produced goods, subject to income, farm production and time constraints. For more details, see Feleke et al. (2005). With this background in mind, we estimate equation (1), where y_{it} is household consumption per capita, $\mathbf{X}_{it}$ are household characteristics, and ε_{it} is the random error term.

$$y_{it} = \mathbf{X}_{it}\beta + \varepsilon_{it} \tag{1}$$

Equation (1) will be used to estimate the impact of weather-related shocks. In doing so, we regress crop failure on household consumption per capita and a set of covariates. For robustness, we use pooled-OLS, random-effects and fixed-effects estimated with robust standard errors with clustering at the household level to correct for the correlation between household errors (see Cameron and Trivedi 2005; Petersen 2009). To capture the male-female headship differences and identify the factors that drive these differences, we utilise the Oaxaca-Blinder decomposition technique. According to this technique, gender differences in consumption can be derived by estimating equation (1) separately for male- and female-headed households. The total differential in consumption between male- and female-headed households can then be decomposed using equation (2):

$$\bar{y}_{mhh} - \bar{y}_{fhh} = (\bar{\mathbf{X}}_{mhh} - \bar{\mathbf{X}}_{fhh})\hat{\beta}_{mhh} + \bar{\mathbf{X}}_{f}(\hat{\beta}_{mhh} - \hat{\beta}_{fhh}) \tag{2}$$

where $\bar{y}_{mhh}$ and $\bar{y}_{fhh}$ denote the mean consumption per capita for male- and female-headed households, respectively. $\bar{\mathbf{X}}_{mhh}$ ($\bar{\mathbf{X}}_{fhh}$) is the mean vector of control characteristics for males (females). $\hat{\beta}_{mhh}$ and $\hat{\beta}_{fhh}$ are the estimated coefficients for male- and female-headed households, respectively. $(\bar{\mathbf{X}}_{mhh} - \bar{\mathbf{X}}_{f})\hat{\beta}_{mhh}$ is the explained part of the decomposition attributed to differences in characteristics, while $\bar{\mathbf{X}}_{fhh}(\hat{\beta}_{mhh} - \hat{\beta}_{fhh})$ is the unexplained part, i.e., residual (see Oaxaca and Ransom 1994; Oaxaca and Ransom 1999; and Neuman and Oaxaca 2004 for a detailed description of the Oaxaca-Blinder decomposition technique).

4. Results

4.1 Description of the Data

Table 1 reports the summary statistics of our main variables. Overall, the majority of the sample is made up of male-headed households, followed by de jure female-headed households, while the de facto female-headed households are in the minority. Male-headed households have the highest per capita consumption, while de facto female-headed households have the least. Further, close to half of the de facto female-headed households have experienced food shortages, while only a few de jure female- and male-headed households have experienced food shortages. Also, the majority of the de facto female-headed households have experienced crop failure, while the male-headed and de jure female-headed households have experienced crop failure in almost equal proportions.

4.2 The Role of Agriculture and Natural Resource Use in Food Security

Table 2 reports the Oaxaca-Blinder decomposition results. Panel A shows the results from our objective measure, i.e., the gap in average household consumption per capita (from labour income, government grants and remittances, excluding agriculture and natural resources) between male-headed and female-headed households. Overall, the decomposition, in Table 2, uncovers a positive and statistically significant household consumption per capita gap between male- and female-headed households. The positive sign on the household consumption per capita gap suggests that male-headed households enjoy a statistically significant consumption advantage over female-headed households. This observation mirrors the results of Kennedy and Peters (1992), Maxwell et al. (1999), Horrell and Krishnan (2007) and Nielsen et al. (2012), who found that, in general, male-headed households are better off than female-headed households.

Contrary to expectations, when we disaggregate woman-run households into de facto and de jure (Columns 1 and 2), we find that de facto are worse off than de jure: the male-female gap is 21.9% for de facto but 19.6% for de jure.[10] This is surprising; because de facto female heads are married, one would expect them to be somewhat better off than the single-run households, i.e., de jure female headed-households, but this is not observed. This finding is similar to

[10] When we consider consumption from labour participation only, the consumption gap increases to 30.8%. This suggests that, although government grants and remittances increase the consumption levels for all households, females enjoy a statistically significant advantage over males due to government grants and remittances; by contrast, it seems that labour participation is the key in boosting consumption levels in male-headed households.

Kennedy and Peters (1992), who found the de facto female-headed households to be significantly poorer than male-headed households in Kenya and Malawi. An explanation given by Kennedy and Peters (1992) is that in Malawi the de facto female-headed households were poorer because their husbands migrated to other rural areas for job opportunities, and speculatively did not send back enough remittances to their families.

In Panel B (Columns 3 and 4) of Table 2, we add natural resources and agriculture to household consumption. The results are, indeed, rather similar to Panel A, with the most notable difference being that male-headed households enjoy a lesser advantage in consumption over de jure female-headed households, as evident by a 9.3% decrease in the consumption gap to 10.3% . However, the consumption gap between male-headed households and de facto female-headed households increases by 5.5%ages points to 27.4%. This suggests that male headed households experience an even greater advantage over de facto female-headed households when we consider household consumption from natural resources and participation in agriculture activities.

There are three main conclusions we can draw from comparing Panel A and Panel B. First, male-headed households appear to be better off while de facto female heads are the worst-off. Second, having access to natural resources and participating in farming increases the consumption levels of all households. However, and third, de jure female-headed households benefit most from natural resources and agriculture, while de facto female-headed households benefit least[11]. Natural resources have been found to be important food supplements in rural South Africa; see Hunter et al. (2007; 2010; 2011) and Twine et al. (2003; 2011).

This finding is consistent with the current assertion in the literature that female-headed households are more likely than male-headed households to depend on and benefit from agriculture for household consumption; see, e.g., Buvinic and Gupta (1997). In this study, we find this to be true amongst de jure female-headed households. Speculatively, and as suggested by past literature, the attractiveness of agriculture for female heads is likely to be due to the flexible hours, which fit well with their many other roles in the household. Somewhat puzzling is the finding from the de facto sample. That is, de facto female-headed households enjoy even less of an advantage, as shown by an increase in the male-female consumption gap in the presence of agriculture and natural resources. This suggests that, unlike the de jure female-headed

[11] Further analysis shows that the male-female head of household consumption gap is larger among heads of households who are pensioners than for non-pensioners.

households, farming and local resources are less utilised and less important in the per capita household consumption of de facto female-headed households.

This could be explained by the following observations: although a high%age of de facto female-headed households engage in agriculture and natural resource use, they cultivate on smaller plots, earn less revenue from these activities and depend more on remittances. More specifically, the data show an almost equal distribution of households that engage in agriculture and natural resource activities, i.e., 95.7%, 97.2% and 97.1% in male-headed, de jure female- and de facto female-headed households, respectively. Also, it appears that male-headed households cultivate on relatively larger plots, as they use both the household yards (55.8%) and plots outside the yards (31.6%), while de jure and de facto female-headed households mainly use household yards only, i.e., 64.9% and 66.2%. Further, the de jure female-headed households earn more per capita revenue (R260.79) from agriculture and natural resource use than either male-headed (R256.30) or de facto female headed households (R188.84). Lastly, Table A.1 in Appendix A[12] shows that the largest share of per capita household consumption for de facto female-headed households comes from remittances (36.9%). Hence, one may argue that, because de facto female heads are married, they may depend more on their absent husbands than on agricultural activities.

We now turn to Table 3, which shows the detailed decomposition of the explained and unexplained part of the consumption gap. More specifically, here we show the contribution of each of the household characteristics to the explained and unexplained part of the consumption gap[13]. As before, Panel A uses household per capita consumption less agriculture and local resource use, while in Panel B we introduce agriculture and natural resources. Panel C shows the results from our subjective measure, i.e., self-reported household experience of food shortage.

Overall, we observe that household size, labour income, education of the head of household, and whether a household has experienced agricultural-related shocks account for the largest share of the explained part of the consumption gap, more so when we use the objective measure. This suggests that normalising these factors will decrease the consumption gap. A

[12] Table A.1 shows that, although agriculture plays a dominant role in household consumption, households diversify their consumption sources by engaging in different activities. Amongst de facto female-headed households, agriculture plays a dominant role, while remittances contribute the most for de jure female-headed households. Male-headed households, on the other hand, engage in almost all activities in equal proportion.

[13] The unexplained part could be a topic for future study.

household's experience of weather-related crop failure has the largest coefficient in this case and is statistically significant, suggesting that this is the main contributor, followed by a household receiving wages, education and household size. The positive signs on crop failure, education and income suggest that these factors have an effect mainly in male-headed households. The negative coefficients on household size, on the other hand, suggest that they play a larger role in female-headed households. Interestingly, we observe that, when we include agriculture/natural resources and grants to consumption (Panel B), the contribution of wages to explaining part of the gap decreases somewhat.

Next, we compare the consumption gap in each year, i.e., 2010-2012, and depict this in Figure 2 and 3, for de jure and de facto female-headed households, relative to male-headed households, respectively. From Figure 2, when we compare de jure female and male-headed households, we see that, when we consider household per capita consumption, less agriculture and natural resource use, we find that the consumption gap is 12.7%, 23.3% and 27.5% for 2010, 2011 and 2012, respectively. However, when we include agriculture and natural resources, we find that the gap is lower: 8.7%, 9.8% and 19.7% for 2010, 2011 and 2012. Take note that a contrasting picture emerges when comparing male and de facto female-headed households (Figure 3). That is, while the consumption gap is large and relatively higher in comparison to de jure female-headed households in 2010 (53.5% without agriculture and 40.4% with agriculture) and 2011 (30.6% and 40.6%), this significantly decreases to -14.0% and -8% in 2012. This indicates that, in 2012, the de facto female-headed households enjoyed a statistically significant consumption advantage over the male-headed households. Take note too that, over time, while the de facto female-headed households are becoming better off, the de jure are becoming worse-off, although agriculture and natural resource use remain as a cushion for de jure throughout the three years, as shown by the differences between the two curves in Figure 2.

4.3 The Impact of Agricultural-related Shocks on Household Consumption

In this section, we investigate the impact of crop failure due to weather variability on the consumption and food security of male- and female-headed households. The three models provide qualitatively similar results, with a few notable differences. First, the coefficients between the pooled-OLS and random-effects models are somewhat similar in size and significance. Second, although the coefficients keep the same sign, the magnitude and significance of most of the coefficients disappear once we introduce the fixed effects (i.e., explanatory power becomes lower). This difference may be attributed to the time-invariant unobservables that are controlled for by the fixed-effects model, but not by the other models. In the current specification, the Hausman test yields χ^2 (15) = 35.75 with a ρ-value of 0.0019, rejecting the null hypothesis that the error terms and the regressors are uncorrelated. Further, under the fixed-effects model, we tested between the log-linear and linear specifications using Akaike information criterion (AIC) and Bayesian information criterion (BIC). The linear model has smaller AIC and BIC, suggesting that it has a better fit. Accordingly, in Table 2, we show the fixed-effects results.

Furthermore, because of the small sample size of the de facto female-headed households, instead of disaggregating the data and running separate regressions, we instead pool the data and introduce interaction effects. In Panel A, we regress weather-related crop failure on consumption without any covariates, while in Panels B and C we introduce the covariates. Column (1) uses the objective measure, while in Column (2) we replace the household consumption per capita with the subjective measure of self-reported food shortage. As mentioned before, this is a dummy variable taking the value of 1 if a household has experienced food shortage, 0 otherwise. The similarities between Columns 1 and 2 are apparent, confirming the negative relationship. That is, first, the weather-related crop failure coefficient is negative and significant, suggesting that households that experience this shock will have lower consumption per capita (Column 1) or experience more food shortage (Column 2). Second, the de jure and de facto female headship coefficient in Column (1) is negative and significant, indicating that female-headed households have less consumption per capita in comparison to male-headed households. This is consistent with our finding in the previous section. We observe that the interaction coefficient between crop failure and de facto female-headed household is positive and significant, indicating that they will be less affected by weather variability. This result becomes more visible when we compare the intensity of crop failure, i.e., instead of using the binary measure we instead use a categorical measure where ‘none’ is indicated by 0 and captures a household that did not experience any crop failure; ‘a little’ is indicated by 1; ‘some’ by 2; ‘most’ by 3; and ‘all’ by 4, capturing a household that lost all crops due to poor rainfall or hail storms. The results are present in Table B.1 of Appendix B.

Continuing with Table 2, when we include household characteristics, in Panel B, we find that, although the statistical significance remains, the size of the coefficients reduce somewhat, hence producing qualitatively similar results overall. Further, Panel B shows that having labour income sources increases household consumption per capita in both male-headed and female-headed households. This is consistent with current studies that have found that having non-farm income substantially increases consumption of farming households (e.g., Reardon et al. 2001; Haggblade 2007; Bezu et al. 2012). In Panel C, we find that the coefficients of the conventional farm inputs – ploughing and labour – are significant and exhibit the expected signs. Interestingly, we observe that whether the head of household spends time working on the farm increases per capita consumption.

So, it appears that, while weather-related crop failure affects both male-headed and de jure female-headed households in somewhat equal proportion, the de facto female-headed households are less affected. Why is it that the per capita consumption levels of de facto female-headed households appear to be more resilient to weather-related crop failure? A plausible explanation, as we observed in the previous section, is that they depend least on agriculture, including its use for household consumption, hence it would make sense that their household consumption would be least affected by crop failure.

In summary of this section, in general, female-headed households have lower consumption per capita in comparison to male-headed households and are more likely to be food insecure. We find that weather-related crop failure affects all households. However, when we disaggregate female headship between de facto and de jure headship, we find that the former is less affected by weather variability.

4.4 Robustness Tests

Our first robustness test involves using an alternative measure of household consumption. Here, we decompose our subjective measure, i.e., self-reported household experience of food shortage, as shown in Panel C of Table 2. We observe that female-headed households, both de jure and de facto, are statistically significantly more likely than male-headed households to experience food shortage, as indicated by the negative gap. This significant difference indicates that female heads experience more food shortages compared to male-headed households. In other words, female-headed households are more food insecure. This finding is qualitatively similar to our findings in Panels A and B, which showed that female-headed households experience lower consumption than male-headed households. Here, we see that they experience more food shortages, which is, in a way, synonymous to lower consumption. Importantly, the gap, i.e., experience of food shortage, is 17.5% among de facto female heads and 31.2% among de jure heads of households. Hence, as before, the consumption gap is higher among the de facto than the de jure heads of households.

In Table 1.C in Appendix C, we perform a further robustness test by exploring alternative functional model specifications. More specifically, we apply the growth theoretical framework (see Dercon 2004; Gerry and Li 2010) and use change in consumption as an outcome. Under this framework, Column (1) of Table 1.C shows regression results using as an outcome change in per capita household consumption (i.e., consumption growth between time *t* and *t-1*). In Column (2), we add as a regressor lagged household consumption (i.e., consumption at time *t-1*) but retain the same outcome. The statistical significance of our coefficients in Columns (1) and (2) remain consistent to the different specification. However, the model specified in Column (2) is likely to be subject to endogeneity bias because of the lagged consumption regressor.

We use the Wu-Hausman test to investigate this further, taking note that the validity of this test relies on the credibility of the instruments (see Wooldridge 2002). We follow existing literature and use lagged values as instruments (e.g., Dercon, 2004), i.e., consumption in time *t-2*. Using this instrument, the Wu-Hausman test gives a ρ-value = 0.0931 and t_ρ =2.81, providing evidence of endogeneity of the lagged consumption. For this reason, we re-estimate the specification in Column (2) using a lagged instrument and provide the regression results in Column (3). Although the coefficients keep the same sign, they are insignificant. However, we fail to reject the possibility of invalid instruments driving this insignificant result. This is because we used the lagged values as IVs under the assumption that ε_{it} is IID over *i* and *t*. However, a priori, it is reasonable to expect the consumption in year *t-2* to affect this year's consumption (*t*), which implies that it is likely to be correlated with the error term. Because invalid instruments produce biased and inconsistent estimators (see Murray 2006), Columns (2) and (3) should be interpreted with caution.

5. Conclusion

The past decade has witnessed a burgeoning of studies on climate change and small-scale farmers' food security, but most have neglected the gender dimensions, leaving this topic a black box. We contribute to the literature by extending the assessment of climate change to the male-female household headship nexus. In our assessment, we use the three-year SUCSES longitudinal study from rural Mpumulanga in South Africa. To shed light on the gender dimension, we use male-headed and de jure and de facto female-headed households, thereby contrasting female-headed households according to whether or not they have a migrant husband potentially sending remittances.

Overall, our study exposes interesting results and allows us to draw six main conclusions. First, we observe a statistically significant consumption gap of 19.6% between male-headed and de jure female-headed households, and this gap is even larger (21.9%) for de facto headship. That is, female-headed households have lower per capita consumption and are more food insecure. Second, participation of male-headed households in labour activities and the fact that males have more education have large contributory effects on the consumption gap. Third, we find that participating in agricultural activities and natural resource use (e.g., wild fruits and vegetables, bushmeat and local fish from the rivers) boosts the consumption levels of all households. However, and fourth, participating in these activities reduces the consumption gap to 10.3% amongst de jure female-headed households but increases the gap to 27.4% amongst the de facto female headed households. This suggests that, although agriculture and natural resources are beneficial to all households, de jure female-headed households receive more consumption advantage by participating in these activities than do male-headed households, while de facto female-headed households receive the least.

Fifth, the consumption gap between male-headed and de jure female-headed households has been increasing over the three years (2010 - 2012), while this gap has been decreasing in the case of de facto female-headed households. Fortunately, however, agriculture and natural resources remain as a great buffer throughout the years, decreasing the gap between male-headed and de jure female-headed households. Sixth, weather-related crop failure also contributes to the consumption gap. We observe that weather-related crop failure affects per capita consumption levels for both male- and de jure female-headed households in almost equal proportion, but less so for de facto female heads. This suggests that, because de jure female-headed households are more dependent on agriculture and natural resources, they are likely to continue to be food insecure in comparison to male-headed households if adaptive strategies are not adopted. From a policy design perspective, the results suggest that policies will be more beneficial, in light of the future prospects of climate and weather variability, if they take a gender response approach. While reliance on subsistence agriculture and wild natural resources buffers de jure female-headed households from food insecurity, it also renders them more vulnerable to climate change and environmental degradation in the long-term.

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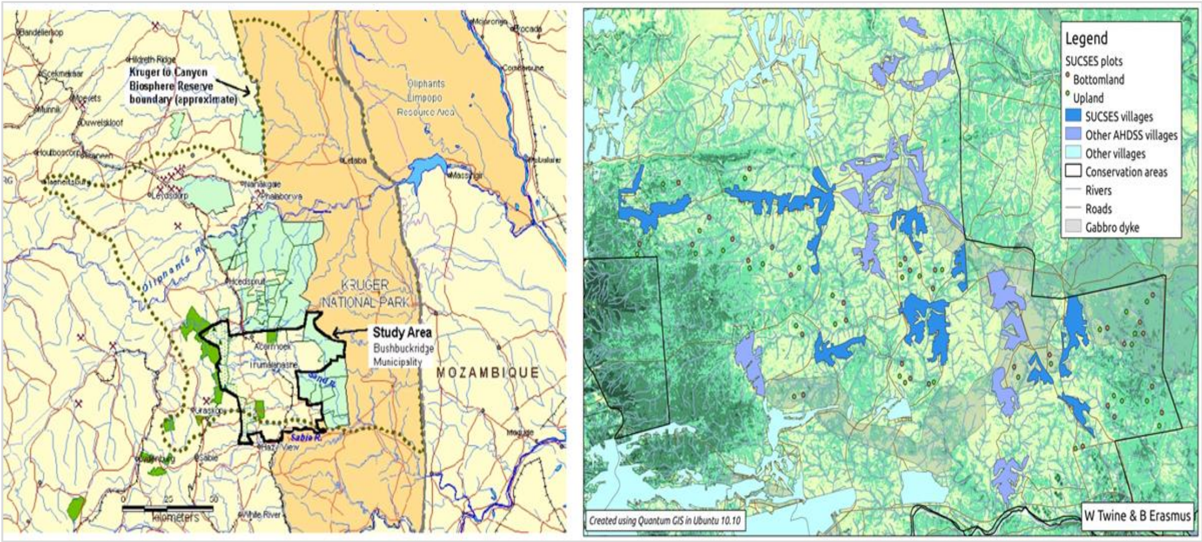
Figures and Tables

Figure 1: Agincourt/SUCSES Map



Source: SUCSES

Figure 2: De Jure Female- and Male-headed Household Consumption per Capita Gap for 2010-2012

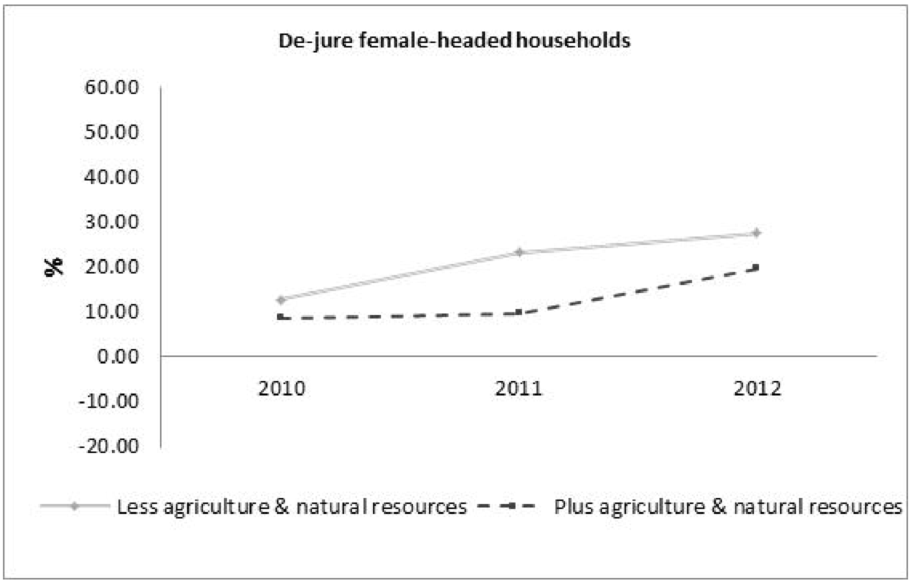


Figure 3: De Facto Female- and Male-headed Household Consumption per Capita Gap for 2010-2012

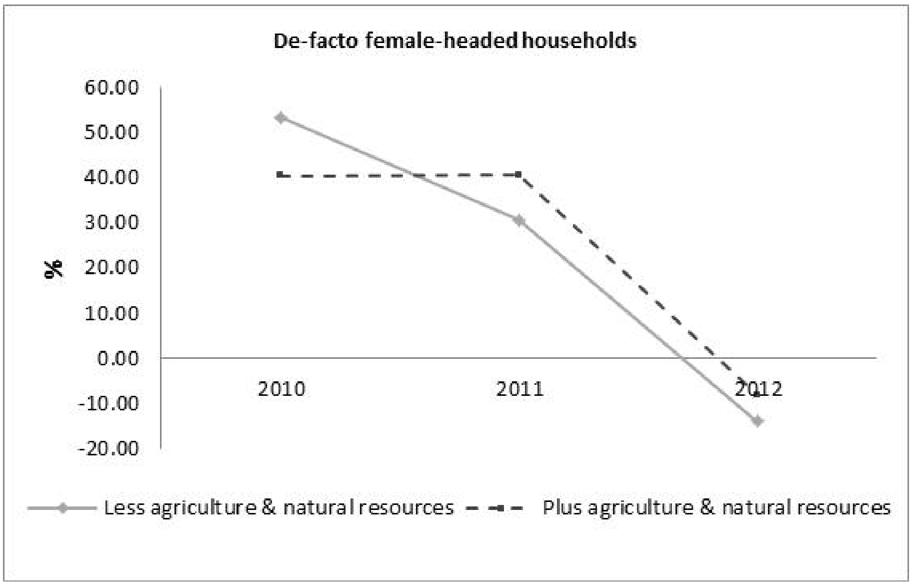


Table 1: Summary Statistics

	Male-headed households	Female-headed households	De jure female-headed households	De facto female-headed households
Observations	970	716	645	71
Household consumption per capita	715.5423	632.1906	647.6531	520.3731
Households' experience food shortage	0.3285	0.3930556	0.3860	0.4507
Crop failure	0.6299	0.6911357	0.6791	0.8169
Head of household age	51.3392	55.96122	56.2465	53.6479
Head of household has education	0.5876	0.4769874	0.4791	0.4507
Number of household members	8.1103	7.740997	7.8171	7.5493
Fertilisers	5.5959	5.4176	4.5798	13.0282
Ploughing	187.0155	180.3366	182.9147	156.9155
Implements	14.4742	11.1257	11.7287	5.6479
Seeds	27.0041	25.1327	24.6558	29.4648
Labour	65.1186	49.9944	51.0465	40.4366
Labour from head of household	0.9024	0.9091	0.9069	0.9286

Table 2: Average Household Consumption per Capita Gap and Decomposition

	Objective measure: Household consumption per capita				Subjective measure: Self-reported Food shortage	
	Panel A: w/o consumption from agriculture and natural resources		Panel B: with consumption from agriculture and natural resources		Panel C: household food Shortage	
	(1) De jure	(2) De facto	(3) De jure	(4) De facto	(5) De jure	(6) De facto
Male-headed household	0.0764***	0.0764***	0.114***	0.114***	0.328***	0.328***
	(0.00345)	(0.00346)	(0.00567)	(0.00568)	(0.0164)	(0.0164)
Female-headed household	0.0614***	0.0596***	0.102***	0.0828***	0.386***	0.451***
	(0.00364)	(0.00417)	(0.00559)	(0.00535)	(0.0207)	(0.0476)
Household consumption gap	0.0150***	0.0168***	0.0117	0.0312***	-0.0575**	-0.122**
	(0.00501)	(0.00539)	(0.00795)	(0.00778)	(0.0261)	(0.0502)
	19.6%	21.9%	10.3%	27.4%	17.5%	31.2%
Explained	-0.000544	0.00272	-0.00711***	-0.000564	0.00893	-0.0193*
	(0.00119)	(0.00202)	(0.00249)	(0.00262)	(0.00584)	(0.00993)
Unexplained	0.0156***	0.0141**	0.0188**	0.0318***	-0.0665**	-0.103**
	(0.00527)	(0.00554)	(0.00926)	(0.00829)	(0.0265)	(0.0511)

- Robust Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

Table 3: Detailed Decomposition

	Objective measure: Household consumption per capita								Subjective measure: Self-reported food shortage			
	Panel A: w/o consumption from agriculture and natural resources				Panel B: with consumption from agriculture and natural resources				Panel C: Household food Shortage			
	(1) Explained	(2) Unexplained	(3) Explained	(4) Unexplained	(5) Explained	(6) Unexplained	(7) Explained	(8) Unexplained	(9) Explained	(10) Unexplained	(11) Explained	(12) Unexplained
Head of household age	4.56e-05	-0.0986	0.00192	-0.179	-0.0115	-0.357**	0.00331	-0.395*	-0.00330	1.680**	-0.0332**	-2.622
	(0.00567)	(0.128)	(0.00393)	(0.150)	(0.00775)	(0.168)	(0.00643)	(0.233)	(0.0310)	(0.667)	(0.0166)	(2.330)
Head of household age2	-0.00590	0.0576	-0.00390	0.105	0.00244	0.221**	-0.00913	0.263**	0.0257	-0.823**	0.0347***	1.121
	(0.00584)	(0.0668)	(0.00337)	(0.0767)	(0.00769)	(0.0880)	(0.00613)	(0.116)	(0.0306)	(0.329)	(0.0131)	(1.154)
Head of household has education	0.00198***	0.00575	0.00282***	0.00922*	0.000541	-0.00174	0.000371	0.00595	-0.00855***	0.0489	-0.00490	-0.0548
	(0.000560)	(0.00549)	(0.000831)	(0.00515)	(0.000867)	(0.00827)	(0.00147)	(0.00730)	(0.00309)	(0.0303)	(0.00487)	(0.0539)
Number of household members	-0.00106***	-0.0170	-0.00242***	-0.0103	-0.00235***	-0.0125	-0.00265***	-0.0184	0.000573	-0.0197	0.00123	-0.112
	(0.000229)	(0.0134)	(0.000478)	(0.0136)	(0.000496)	(0.0241)	(0.000735)	(0.0239)	(0.00103)	(0.0572)	(0.00230)	(0.122)
Income source: non-labour	3.99e-05*	-0.0125	-0.000201	0.00109	6.39e-05**	-0.0171	-0.000432	0.00831	1.07e-05	0.00153	-6.74e-05	0.0154
	(2.40e-05)	(0.0116)	(0.000298)	(0.0142)	(2.61e-05)	(0.0144)	(0.000389)	(0.0181)	(0.000142)	(0.0856)	(0.00161)	(0.295)
Income source: labour	0.00336***	0.00827	0.000923***	0.0116*	0.00284***	0.00560	0.00133***	0.0249**	-0.000168	0.0169	7.52e-05	0.0116
	(0.000201)	(0.00525)	(6.54e-05)	(0.00684)	(0.000229)	(0.00828)	(0.000137)	(0.0101)	(0.00104)	(0.0286)	(0.000319)	(0.0729)
Crop failure	0.000839***	-4.08e-05	0.00281**	-0.0267**	0.000940**	-0.0103	0.00476**	-0.0476***	-0.00421***	0.00312	-0.0142**	0.283**
	(0.000251)	(0.00685)	(0.00122)	(0.0107)	(0.000389)	(0.0103)	(0.00219)	(0.0143)	(0.00119)	(0.0340)	(0.00582)	(0.117)
Total	-0.000701	0.0156***	0.00195	0.0148**	-0.00707***	0.0187**	-0.00244	0.0335***	0.0101*	-0.0676**	-0.0164*	-0.106*
	(0.00113)	(0.00529)	(0.00155)	(0.00586)	(0.00252)	(0.00942)	(0.00254)	(0.00916)	(0.00547)	(0.0277)	(0.00877)	(0.0552)
Constant		0.0722		0.103		0.190**		0.192		-0.975***		1.251
		(0.0699)		(0.0750)		(0.0912)		(0.118)		(0.351)		(1.193)

- Robust Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

Table 4: Impact of Shocks on Per Capita Consumption: Male-headed and Female-headed Households

	Panel A: Without Covariates		Panel B: With HH Characteristics		Panel C: With Farm Inputs	
	(1) Objective measure : HH per capita consumption	(2) Subjective measure: Food shortage	(3) Objective measure : HH per capita consumption	(4) Subjective measure: Food shortage	(5) Objective measure : HH per capita consumption	(6) Subjective measure: Food shortage
Crop failure	-0.0407***	0.0862**	-0.0234**	0.117***	-0.0256**	0.132***
	(0.0108)	(0.0365)	(0.00952)	(0.0371)	(0.0106)	(0.0383)
De jure head	-0.0387*	-0.0793	-0.0329*	-0.0526	-0.0324*	-0.0264
	(0.0208)	(0.0913)	(0.0181)	(0.0907)	(0.0185)	(0.102)
De facto head	-0.0816***	0.239	-0.0780**	0.285	-0.0873**	0.420**
	(0.0296)	(0.210)	(0.0321)	(0.202)	(0.0342)	(0.193)
Crop failure* De jure head	0.00756	0.0291	0.00855	0.0280	0.00719	0.0271
	(0.0150)	(0.0585)	(0.0139)	(0.0571)	(0.0138)	(0.0594)
Crop failure* De facto head	0.0494*	-0.390*	0.0652**	-0.368*	0.0632*	-0.434**
	(0.0281)	(0.200)	(0.0308)	(0.194)	(0.0322)	(0.179)
Head of household age			0.00623	-0.0286	0.00847	-0.0391**
			(0.00407)	(0.0177)	(0.00560)	(0.0190)
Head of household age2			-4.58e-05	0.000246	-6.65e-05	0.000333**
			(3.34e-05)	(0.000153)	(4.47e-05)	(0.000159)
Head of household has education			0.00514	-0.109***	0.00215	-0.125***
			(0.0105)	(0.0402)	(0.0115)	(0.0420)
Number of household members			-0.0110***	-0.00416	-0.0117***	-0.00833
			(0.00271)	(0.0103)	(0.00317)	(0.0106)
Income source: non-labour			-0.000272	0.0422	0.00244	0.0609
			(0.0104)	(0.0518)	(0.0111)	(0.0526)
Income source: labour			0.0793***	0.0451	0.0780***	0.0549*
			(0.00759)	(0.0287)	(0.00718)	(0.0291)
Fertilisers					-0.0255	0.0889
					(0.0428)	(0.239)
Ploughing					0.378*	-0.0382
					(0.225)	(0.207)
Implement					0.111	-0.552**
					(0.0914)	(0.234)
Seeds					-0.0346	0.168
					(0.0499)	(0.197)
Labour					-0.0184	-0.0291
					(0.0132)	(0.0388)
Head of household farm labour					0.0196**	-0.0428
					(0.00927)	(0.0496)
2011			0.0107	-0.103***	0.00745	-0.103***
			(0.00684)	(0.0261)	(0.00641)	(0.0275)
2012			-0.0207***	-0.161***	-0.0218***	-0.161***
			(0.00540)	(0.0291)	(0.00575)	(0.0301)
Constant	0.141***	0.325***	-0.0238	1.184**	-0.101	1.520***
	(0.0102)	(0.0410)	(0.114)	(0.497)	(0.161)	(0.552)
Observations	1,686	1,686	1,686	1,686	1,636	1,686
R-squared	0.026	0.014	0.184	0.062	0.230	0.075
Number of households	592	592	592	592	592	592

- Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

Appendix A

Table A.1: Household Consumption Sources (%) by Gender of Head of Household

	Male-headed household	De jure Female-headed household	De facto Female-headed household
Labour/wages	15.9	7.4	8.4
Remittance	31.8	29.9	36.9
Government grants	19.3	22.4	25.5
Agriculture and natural resources	32.7	40.3	29.1

Appendix B

Table B.1: Impact of Shocks on Per Capita Consumption: Male-headed and Female-headed Households: Using a Categorical Weather Related Crop Failure

	Panel A: Without Covariates		Panel B: With HH Characteristics		Panel C: With Farm Inputs	
	(1) Objective measure : HH per capita consumption	(2) Subjective measure: Food shortage	(3) Objective measure : HH per capita consumption	(4) Subjective measure: Food shortage	(5) Objective measure : HH per capita consumption	(6) Subjective measure: Food shortage
Lost a little crop	-0.0346***	0.0435	-0.0227**	0.0795	-0.0231**	0.0883*
	(0.0119)	(0.0542)	(0.0107)	(0.0537)	(0.0116)	(0.0536)
Lost some crops	-0.0420***	0.0675	-0.0292**	0.0884*	-0.0270*	0.0944*
	(0.0161)	(0.0534)	(0.0144)	(0.0535)	(0.0143)	(0.0561)
Lost most of the crops	-0.0542***	0.109**	-0.0302***	0.157***	-0.0331***	0.168***
	(0.0107)	(0.0448)	(0.00953)	(0.0453)	(0.0107)	(0.0454)
Lost all of the crops	-0.0709	0.0963	-0.0328	0.145	-0.0332	0.145
	(0.0447)	(0.119)	(0.0372)	(0.114)	(0.0360)	(0.114)
De jure head	-0.0419*	-0.0515	-0.0380**	-0.00594	-0.0359*	0.00436
	(0.0219)	(0.0892)	(0.0191)	(0.0846)	(0.0185)	(0.103)
De facto head	-0.102***	0.350*	-0.0928**	0.423**	-0.0940**	0.400**
	(0.0330)	(0.187)	(0.0371)	(0.183)	(0.0375)	(0.201)
Lost a little crop* De jure head	0.0263	0.0297	0.0231	0.0128	0.0216	0.00607
	(0.0220)	(0.0869)	(0.0202)	(0.0864)	(0.0180)	(0.0906)
Lost a little crop* De facto head	0.118***	-0.273	0.109**	-0.306	0.110**	-0.278
	(0.0352)	(0.274)	(0.0437)	(0.253)	(0.0454)	(0.256)
Lost some crops* De jure head	0.0174	0.0684	0.0162	0.0733	0.0113	0.0651
	(0.0238)	(0.0804)	(0.0220)	(0.0790)	(0.0215)	(0.0808)
Lost some crops* De facto head	0.0711**	-0.405*	0.0839**	-0.399*	0.0710*	-0.298
	(0.0360)	(0.235)	(0.0403)	(0.242)	(0.0428)	(0.244)
Lost most of the crops* De jure head	-0.00131	0.00655	-0.000283	0.00608	-0.000225	0.00391
	(0.0159)	(0.0692)	(0.0148)	(0.0679)	(0.0152)	(0.0691)
Lost most of the crops* De facto head	0.0614*	-0.514***	0.0705*	-0.493***	0.0599	-0.466**
	(0.0330)	(0.191)	(0.0361)	(0.189)	(0.0368)	(0.195)
Lost all of the crops* De jure head	0.0114	-0.262*	0.0130	-0.212	0.00549	-0.201
	(0.0493)	(0.150)	(0.0419)	(0.144)	(0.0411)	(0.149)
Lost all of the crops* De facto head	0.0724	-0.424*	0.0313	-0.365	0.0692	-0.282
	(0.0611)	(0.217)	(0.0509)	(0.223)	(0.0524)	(0.242)
Constant	0.148***	0.317***	-0.0297	1.243***	-0.110	1.579***
	(0.0109)	(0.0414)	(0.114)	(0.464)	(0.163)	(0.538)
Observations	1,686	1,686	1,686	1,686	1,686	1,686
R-squared	0.044	0.021	0.188	0.070	0.237	0.081
Number of observations	592	592	592	592	592	592

● Robust standard errors in parentheses ●*** p<0.01, ** p<0.05, * p<0.1

Appendix C

Table C.1: Impact of Shocks on Per Capita Consumption: Male-headed and Female-headed Households: Alternative Model Specification

	(1)	(2)	(3)
Outcome variable: ΔHH per capita consumption	FE	FE	2SLS
HH per capita consumption(*t-1*)		-1.830***	-0.000125***
		(0.120)	(3.10e-05)
Crop failure	-0.0640*	-0.0352***	-0.0176
	(0.0388)	(0.0113)	(0.0181)
De jure head	-0.130**	-0.0361	-0.0283*
	(0.0534)	(0.0364)	(0.0169)
De facto head	-0.229***	-0.101**	0.00696
	(0.0686)	(0.0444)	(0.0301)
Crop failure* De jure head	0.0558	0.00392	0.00213
	(0.0478)	(0.0174)	(0.0235)
Crop failure* De facto head	0.130*	0.0647*	0.0126
	(0.0682)	(0.0336)	(0.0365)
Constant	0.0636**	0.224***	0.0370*
	(0.0315)	(0.0213)	(0.0217)
Observations	1,073	1,073	555
R-squared	0.014	0.846	0.311
Number of observations	555	555	
Anderson canon. corr. LM statistic			0.0000

- Robust standard errors in parentheses ●*** p<0.01, ** p<0.05, * p<0.1
- Instrumented for HH per capita consumption (*t-1*) in Column (3)
- Excluded instruments: HH per capita consumption (*t-2*)