Green Growth Knowledge Platform (GGKP)
Fourth Annual Conference on
Transforming Development Through Inclusive Green Growth
6-7 September 2016
Jeju International Convention Center, Republic of Korea

SMALL-HOLDER FARMING, FOOD SECURITY AND CLIMATE CHANGE IN SOUTH AFRICA: MALE-FEMALE AND URBAN-RURAL DIFFERENCES

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ABSTRACT
With ongoing climate change, food insecurity is likely to become more widespread in most small-holder and subsistence farm households in sub-Saharan Africa. However, the existence and extent of gendered food (in)security remains unclear. This study extends existing knowledge by assessing gender inequality in food (in)security amongst small-holder farm households in urban and rural areas of South Africa. To do so, we use the gender of the head of household in a treatment effects framework. Overall, our analysis yields interesting results. First, we find that male-headed households are more food secure than female-headed households. This finding is consistent under objective and subjective measures. Second, we observe that, although male-headed households are more food secure in both rural and urban areas, the gender gap in food security is wider in rural than in urban areas. Third, we observe that the contribution of agriculture to food security is higher in female-headed households, especially those in rural areas. Fourth, we find that male- and female-headed households in rural areas are more likely to report chronic food insecurity than those in urban areas, where chronic food insecurity refers to having less than adequate food, i.e., the experience of hunger. This is in contrast to urban households, who are more likely to report either breaking even (i.e., household food was just adequate) or surplus food (i.e., household food was more than adequate, and the household was therefore food secure. Fifth, the climate and soil characteristics, especially precipitation, are more significant in predicting food security in rural than in urban areas. Also, winter climate appears to have a uniform impact on food security for both male- and female-headed households, while summer climate is more significant in predicting the food security of female-headed households. Our results suggest that the current policy interest in promoting both rural and urban agriculture is likely to increase food security in both male- and female-headed households, and to reduce the gender gap.

Keyword: *food security; male-headed households; female-headed households; urban; rural*

1. INTRODUCTION

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: men and women, boys and girls (WB, 2009: p.12). At present, although South Africa has the second largest economy in Africa, with an adequate food supply at the national level, this has not translated into food security at the household level (Shisana et al. 2014). The recent statistics show that 45.6% of South Africans are food secure, while 28.3% are at risk of hunger and 26% are actually food insecure, i.e., experience hunger (Shisana et al. 2014). Vulnerability to food insecurity may be more pronounced in female-headed and rural South African households, in comparison to male-headed and urban households (DOA 2002). For example, one-third of South African households are headed by women, and, in 1996, 52% of them spent a mere R1000 per month on food, compared to only 35% of male-headed households who spent so little. Further, while 25% of male-headed households spent R3500 per month, only 8% of female-headed households could afford to pay this amount for food (DOA 2002). Regarding urban and rural patterns, Shisana et al. (2014) show that 32.4% of urban residents of informal settlements and 32.8% of rural villagers are food insecure, compared to South Africans in urban formal areas (19.0%).

In an endeavour to increase household food security and meet the Millennium Development Goals (MDGs), South Africa's programmes and interventions are strongly grounded in agriculture (RSA 2014), as elsewhere around the globe (FAO 2014). In South Africa, an estimated 20.7% of households engage in agriculture, and 65% of these households use agriculture purely as a subsistence strategy to meet household food demand (RSA 2014). With the arrival of climate change, however, the strategy of using small-scale subsistence farming to promote food security continues to look bleak. Food security, or the lack thereof, is by nature multifaceted; although it remains a significant concern in the policymaking arena, it is increasingly being recognised that more information is needed to guide decision makers (Nelson et al. 2011). The same has been noted in South Africa (RSA 2014). Added to this, female-headed households continue to increase in sub-Saharan Africa (Bongaarts 2001; Horrell and Krishnan 2007), bringing an increase in household gender inequalities. South Africa appears to have the highest number of female-headed households, currently estimated to be 41.9%. This is relatively high, considering that the range of female-headed households' in West Africa is between 9.5% and 22.9%, while in East Africa it is between 24.4% and 29.5% (WB 2016). With increasing concerns about the increase of female headship, poor levels of household food security, the dependence on agriculture to improve these poor levels and the detrimental effects of climate change on agricultural productivity, areas that were somewhat dormant have found their way back into the literature with growing interest. The prime examples include male-female and urban-rural small-holder agriculture. However, limited evidence exists on household gender inequalities in food security and the participation of households in agricultural activities to increase food security in South Africa and the greater part of sub-Saharan Africa. This has been documented by the Food and Agriculture Organisation of the United Nations (FAO), which notes that: "In all developing regions, female-headed rural households are among the poorest of the poor….There is still limited understanding and few research results concerning the intersection of climate change, gender and agricultural development" (Nelson et al. 2011, p.1).

In an attempt to provide the needed evidence to increase our understanding, this study explores the following: first, the role of agriculture in the food security of male- and female-headed households in urban and rural areas; second, the differences in the determinants of food security between male- and female-headed farm households; and third, the impact of gender of the head of household and geographical location on food security. Our study builds on the existing literature (see, e.g., Levin et al. 1999; Horrell and Krishnan 2007; Mallick and Rafi 2010; Owusu et al. 2011; Crush et al. 2011; Mkwambisi et al. 2011; Ibnouf 2011; Modirwa and Oladele 2012) and extends the more recent studies by Kassie et al. (2014) and Tibesigwa et al. (2015). The recent two studies investigated the role of gender in food security in rural areas of Kenya and South Africa. In our study, we consolidate past studies and compare male-female and urban-rural small-holder subsistence farm households, who by definition engage in agriculture to boost household income and/or food levels. The role of urban agriculture in food security has received less attention, as indicated by FAO. Hence, our study will provide new insights by addressing urban agriculture, in addition to rural agriculture, in relation to food security. Documenting the current male-female and urban-rural evidence is important from a policy perspective because gender inequalities, rural development and urban planning are at the heart of policy concerns of most countries in developing regions. In our investigation, we use the 2008 nationwide National Income Dynamics Study (NIDS) and a treatment-effects regression framework to tease out the gender differences in food security of rural and urban small-holder farmers in South Africa. To capture food security, we use both a subjective and an objective measure. The former is a self-reported perception of household food, where household food security takes a value of one and food insecurity takes a value of zero, while the objective measure is per capita household monthly food consumption. The conceptualisation of these measures follows FAO (2002) and previous studies. The rest of the paper is structured as follows. Section 2 summarizes the literature on food security and agriculture among male and female farmers in urban and rural areas. Section 3 describes the estimation strategy. Section 4 provides the empirical results and Section 5 discusses our conclusion.

2. EMPIRICAL STRATEGY

2.1. Estimation Model and Data

In exploring the male-female and urban-rural differences in food security, we adopt the treatment-effects regression framework from Kassie et al. (2014). The analysis is based on the 2008 National Income Dynamics Study (NIDS). As our outcome, we use two measures of *household food security* so as to compare the robustness of our results to a different definition of food security. The first outcome is subjective and is derived from self-reported perceptions. The subjective household food security measure is binary and takes the value of one if the household's food was either adequate or more than adequate and zero otherwise. We augment the subjective measure with a second outcome; this is an objective measure defined as per capita household consumption. This includes household consumption of food purchased, produced by farming, given as a gift and given as a payment. This is then divided by the number of household members. A set of regressors are used as determinants of food security, following earlier studies.

3. EMPIRICAL RESULTS

3.1. The Contribution of Agriculture to Households' Food Security

In this section, we compare the contribution of agriculture to household food security in male- and female-headed households in urban and rural areas. We begin by showing (1) the amount of the agriculture output that is consumed by the household, (2) output that is given away as gifts and (3) the output that is sold by the household. This extends on Tibesigwa et al. (2014). Table 1 shows the distribution of agricultural output, Panel A depicts the pooled sample, Panel B displays rural households and Panel C shows urban households. We find that in the pooled sample (Column 1), most of the crops that were harvested were kept for household consumption (57.8%), while the remaining output was either sold (30.1%) or given away as gifts (12.0%). This is in sharp contrast to livestock output, which is displayed in the lower part of Column 1, and where we observe that the majority of the livestock was sold (48.9%), while a little was either consumed (26.7%) or given away as gifts (24.3%). This confirms the subsistence nature of crop agriculture amongst these households, in that most of the agriculture output is kept for consumption (Tibesigwa et al. 2014). Columns 2 and 3 compare male- and female-headed households, and show that, while male-headed households kept only 44.7% of crop output for consumption, female-headed households kept 71.7% of the crop output. This is consistent with the current literature. We further observe in Columns 2 and 3 that the livestock products are mainly sold (56.6%) or consumed (28.0%) by male-headed households, whereas in female-headed households the majority of the livestock products are either given away as gifts (40.8%) or sold (34.8%).

Table 1. % Distribution of Agriculture Revenue
Male-headed households (MMH); female-headed households (FHH)

	Panel A: All			Panel B: Rural			Panel C: Urban		
	Pool (1)	MHH (2)	FHH (3)	Pool (4)	MHH (5)	FHH (6)	Pool (7)	MHH (8)	FHH (9)
Crops (%)									
• Sold	30.1	42.9	16.7	32.0	43.4	18.8	19.0	38.3	6.9
• Given away as gift	12.0	12.5	11.6	12.7	13.1	12.3	7.7	7.4	7.9
• Retained for consumption	57.8	44.7	71.7	55.3	43.5	68.8	73.3	54.3	85.3
Livestock (%)									
• Sold	48.9	56.6	34.8	52.5	65.4	29.0	42.5	41.1	45.2
• Given away as gift	24.3	15.4	40.8	19.5	6.9	42.5	32.9	30.3	37.7
• Retained for consumption	26.7	28.0	24.5	28.0	27.6	28.6	24.6	28.6	17.1

When we move to Panel B in Table 1, which compares male- and female-headed households in rural areas, we observe that female-headed households mainly consumed their crop output (68.8%), while, in the male-headed households, the output is equally distributed between sales (43.4%) and own consumption (43.5%). This finding echoes the current literature. In addition, while male-headed households in rural areas sell 65.4% of their livestock products, female-headed households either sell the livestock (29.0%), or consume it (28.6%), but the majority of it is given away as gifts (42.5%). Amongst the urban sample in Panel C, we find that, as in rural areas, female-headed households consume the majority of their crops (85.3%), and very little is either sold (6.9%) or given away as gifts (7.9%). Amongst the male-headed households in urban areas, 54.3% of the crops are kept for consumption, which is almost half of the amount that female-headed households keep for consumption, and the remaining 38.3% is sold, while 7.4% is given away as gifts. Again, this is consistent with the literature. As before, we find that most livestock products are sold, in both male-headed (41.1%) and female-headed (45.2%) households.

When we compare between rural (Panel B) and urban (Panel C) households, we find that female-headed households in urban areas keep a higher proportion of their crop output for consumption (85.3%), in comparison to female-headed households in rural areas, who only keep 68.8%. We also observe that male-headed households in urban areas keep slightly higher crop output for consumption (54.3%) in comparison to those in rural areas (43.5%). Speculatively, one may argue that, because of underdeveloped markets in rural areas, rural households are likely to use agriculture as a source of income, in addition to consumption, so as to meet other household requirements, e.g., school fees. In Table 2, we show the contribution of agriculture to per capita household consumption. Recall that our objective measure is per capita household consumption (using monetary values) and includes household consumption of (1) purchased food, (2) food produced from farming, (3) food received as gifts and (4) food received as payment. In comparing these different sources of household food, we find that, overall, most of the food that is consumed by the households is purchased, followed by produced food, and little is from gifts and payments.

Table 2. % Distribution of Food Sources

	Panel A: All			**Panel B: Rural**			**Panel C: Urban**		
	Pool (1)	MHH (2)	FHH (3)	Pool (4)	MHH (5)	FHH (6)	Pool (7)	MHH (8)	FHH (9)
Food given as payment	2.2	0.0	4.1	0.0	0.0	0.0	7.5	0.1	16.1
Food given as gift	0.4	0.4	0.3	0.4	0.3	0.5	0.3	0.6	0.0
Produced food	19.7	18.4	20.7	21.2	18.2	23.3	16.1	18.7	13.1
Purchased food	77.7	81.2	74.9	78.4	81.4	76.2	76.0	80.6	70.7

Male-headed households (MMH); female-headed households (FHH)

In comparing male- and female-headed households in rural areas (Panel B), we observe that agriculture contributes more to household food amongst female-headed households (23.3%) than in male-headed households (18.2%). In urban households (Panel C), however, we find that agriculture contributes slightly more in male-headed households (18.7%) than in female-headed households (13.1%). In comparing between rural and urban areas, we find that agriculture contributes more to household food in female-headed households in rural areas (23.3%) than in urban areas (13.1%). Amongst the male-headed households, however, the contribution of agriculture to household food is equal between rural (18.2%) and urban areas (18.7%).

3.2. Food Security in Male- and Female-Headed Farm Households

Table 3 shows the gender-specific differences in the determinants of food security between male- and female-headed households. The F-tests under the subjective and objective measures are $F(43, 1041) = 2.85$ and $F(43, 1041) = 15.66$ respectively, suggesting that there is a 1% statistically significant interaction between gender and the variables. The results, in Table 3, appear to be qualitatively similar between the subjective and objective measure, i.e., Panels A and B. Recall that the subjective measure is self-reported and takes the value of 1 if the household is food secure and 0 otherwise, while the objective measure is real household consumption per capita. Some of the most notable differences between Panels A and B are that household size and education of the head of household are significant in the latter but not in the former.

Overall, the results are in line with our expectations and consistent with the current literature. To give an example, relatively similar observations can be found in Kassie et al. (2014). As we observe, the factors that predict food security in male-headed households are mostly significant in predicting food security in female-headed households. In particular, age, household size, household income, number of household assets, marital status, climate variables, and crop and livestock extensions are significant in predicting food security in both male- and female-headed households. The main difference is the magnitude, i.e., the size of the coefficient and level of significance. More specifically, household size and education appear to have a greater effect on the food security of female-headed households, while household off-farm income, household assets and marital status are more significant in predicting food security in male-headed households. This is in agreement with Owusu et al. (2011), who found that off-farm income significantly predicts food security in general, while Levin et al. (1999) and Owusu et al. (2011) found this to be more significant in male-headed households. Similar to Levin et al. (1999), household size is negative and significant in predicting food security. Under the subjective measure, male-headed households located in either urban or formal rural areas are more likely to report food insecurity than those in traditional rural areas, while location does not appear to predict food security under the objective measure. Also, being married increases the likelihood of reporting food security, and this is more significant in male-headed households. Households' expenditure on crop farm extensions (i.e., fertilisers, manure, ploughing and seeds) is significant amongst female-headed households, while expenditure on livestock farm extensions (i.e., livestock feed, dips and veterinary services) is significant in male-headed households. Expenditure on these extensions appears to have a non-linear relationship with food security, which is consistent with Di Falco et al. (2011). The different types of soils have different impacts on male- and female-headed households, but their effects are more significant in female-headed households. This suggests that female-headed households are more likely to cultivate fertile land compared to male-headed households. Winter precipitation and temperature predict food security in both male- and female-headed households, while summer precipitation and temperature predict food security only in female-headed households.

Table 3. Food security – Male vs. Female

	Panel A: Subjective measure Food security (1/0)		**Panel B: Objective measure Per capita household consumption**	
Variables	(1) Male-headed households	(2) Female-headed household	(3) Male-headed households	(4) Female-headed household
Age of the head of household	0.0138**	0.0196***	0.000443***	8.13e-05
	(0.00669)	(0.00568)	(0.000133)	(8.94e-05)
Household size	0.260	0.172	-0.0228***	-0.0333***
	(0.166)	(0.151)	(0.00330)	(0.00239)
Per capita household off-farm income	0.248***	0.166**	0.00825***	0.00655***
	(0.0844)	(0.0804)	(0.00177)	(0.00124)
Number of household assets	0.283***	0.323***	0.00697***	0.00685***
	(0.103)	(0.0949)	(0.00221)	(0.00149)
Education level of head of household	-0.0636	-0.0881	0.00356*	0.00494***
	(0.0874)	(0.0897)	(0.00185)	(0.00141)
Head of household is married	0.356**	0.344**	0.0130***	0.00131
	(0.175)	(0.152)	(0.00364)	(0.00238)
Urban areas	-1.139***	-1.224***	-0.0121	0.00549
	(0.419)	(0.393)	(0.00811)	(0.00625)
Formal rural areas	-0.877***	-0.157	-0.00828	0.00468
	(0.258)	(0.228)	(0.00516)	(0.00358)
Expenditure on crop extensions	-0.000151	-0.00106	1.81e-05	2.30e-05*
	(0.00115)	(0.000908)	(2.17e-05)	(1.38e-05)
Expenditure on crop extensions^2	8.57e-07	2.10e-07	-9.90e-09	-1.56e-08**
	(1.14e-06)	(5.12e-07)	(1.80e-08)	(7.31e-09)
Expenditure on livestock extensions	0.00180**	-0.000299	7.45e-06	-7.46e-07
	(0.000831)	(0.000604)	(8.25e-06)	(9.14e-06)
Expenditure on livestock extensions^2	-1.02e-06**	2.38e-07	-2.00e-09	3.87e-09
	(4.99e-07)	(3.21e-07)	(1.90e-09)	(4.30e-09)
A4-lixisols, cambisols, luvisols	-0.0184	-0.453	0.00298	-0.00872*
	(0.340)	(0.315)	(0.00723)	(0.00505)
AR-arenosols	-0.904	-0.194	0.0275**	0.0240***
	(0.567)	(0.501)	(0.0120)	(0.00757)
B1-ferralsols, acrisols, lixisols	-1.082	-0.628	-0.00933	-0.0117
	(0.905)	(0.690)	(0.0184)	(0.0106)
C1-luvisols, planosols & solonetz	-0.185	0.592**	0.00344	0.0107**
	(0.280)	(0.266)	(0.00592)	(0.00423)
E1-leptosols, regosols, calcisols	-0.397	-0.189	-0.00311	0.00273
	(0.251)	(0.250)	(0.00522)	(0.00392)
Temperature, winter	1.090	2.046	0.163***	0.0510**

	Panel A: Subjective measure Food security (1/0)		**Panel B: Objective measure Per capita household consumption**	
Variables	(1) Male-headed households	(2) Female-headed household	(3) Male-headed households	(4) Female-headed household
	(1.823)	(1.583)	(0.0365)	(0.0255)
Temperature, winter^2	-0.0670	-0.0689	-0.00632***	-0.00209*
	(0.0769)	(0.0682)	(0.00156)	(0.00110)
Temperature, summer	-12.33*	-1.098	-0.301**	0.105
	(6.941)	(5.913)	(0.142)	(0.0948)
Temperature, summer^2	0.299*	0.0438	0.00707**	-0.00177
	(0.158)	(0.135)	(0.00326)	(0.00215)
Precipitation, winter	-0.0313	0.196	-0.00108	-0.00145
	(0.179)	(0.206)	(0.00366)	(0.00331)
Precipitation, winter^2	-0.00178	-0.000854	-5.91e-05*	-5.37e-05**
	(0.00159)	(0.00164)	(3.36e-05)	(2.60e-05)
Precipitation, summer	-0.0770	0.0765	-0.00550	0.00740**
	(0.257)	(0.228)	(0.00494)	(0.00366)
Precipitation, summer^2	-4.63e-05	0.000293	9.23e-06	2.09e-06
	(0.000315)	(0.000260)	(6.25e-06)	(4.11e-06)
Temperature, summer* Precipitation, summer	0.00516	-0.00543	0.000188	-0.000377**
	(0.0112)	(0.0103)	(0.000220)	(0.000165)
Temperature, winter * Precipitation, winter	0.0124	-0.00970	0.000417	0.000308
	(0.0167)	(0.0192)	(0.000343)	(0.000308)
Constant	115.3*	-15.43	2.086	-1.724*
	(69.72)	(59.82)	(1.414)	(0.963)
Observations	539	618	539	618
R-squared			0.481	0.526

Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1
Reference: traditional rural areas, A2-ferralsols, acrisols & lixisols

Thus far, we have compared the determinants of food security between male- and female-headed households. Recall that the second objective of this study is to measure the impact of gender on food security. Here, we address this objective. Table 4 compares the expected food security between actual and counterfactual scenarios for male- and female-headed households. In deriving these scenarios, we use the estimates in Table 3, and, as before, Panel A shows the subjective measure, while Panel B depicts the objective measure. In Panel A, (i) and (ii) show the observed or actual food security for male- and female-headed household respectively. We observe that the probability of food security is statistically significantly higher by 14.6% in male-headed households in comparison to female-headed households. However, according to (iii), if female-headed households had similar response coefficients as male-headed households, the food security gap between male- and female-headed households would have been 6.2%. This is 8.4% lower than the actual or observed food security gap. On the other hand, when we look at the counterfactual in (iv), we see that, if male-headed households had similar response coefficients as female-headed households, the probability of food security would have been higher by only 5.1%.

Similarly, (i) and (ii) in Panel B present observed food consumption per capita for male- and female-headed households respectively. According to the observed values, male-headed households have 13.2% statistically significantly higher food consumption per capita in comparison to female-headed households. In the counterfactual case in (iii), the food consumption gap between male- and female-headed households would have been much lower at 2.5% (0.159). Further, in (iv), male-headed households would have consumed only 0.9% (0.064) more than female-headed households if they had the same characteristics as female-headed households. The statistical significance of the heterogeneity effects in Panels A and B indicates that there are unobserved factors that make male-headed households more food secure than female-headed households. Overall, this suggests that male gender of the head of household significantly increases household food security. This is influenced by both observed and unobserved characteristics. These findings are qualitatively similar to the studies by Kassie et al. (2014) and Tibesigwa et al. (2015).

Table 4. Food Security – Male vs. Female Treatment and Heterogeneity Effects

	Panel A: Subjective measure			**Panel B: Objective measure**		
	MHH	FHH	Treatment effects	MHH	FHH	Treatment effects
MHH	*(i)*0.5459	*(iii)* 0.4839	0.0619***	*(i)*6.4947	*(iii)* 6.3349	0.1598***
	(0.0094)	(0.0073)	(0.0118)	(0.0198)	(0.0162)	(0.0254)
FHH	*(iv)*0.5095	*(ii)* 0.459	0.0505***	*(iv)*6.5481	*(ii)* 6.4839	0.0642***
	(0.0100)	(0.0083)	(0.0129)	(0.0163)	(0.0148.)	(0.0219)
Heterogeneity effects	0.0363***	0.0249***		-0.0534***	-0.1489***	
	(0.0110)	(0.0079)		(0.0102)	(0.0084)	

Robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1; male-headed households (MMH); female-headed households (FHH)

Table 5 shows the distribution of male- and female-headed households under chronic, break-even and surplus household food. Chronic food insecurity refers to households who reported having less than adequate food and hence experience hunger. Break-evens are those who reported that their household food was just adequate and are therefore at risk of hunger. Surplus food refers to those that mentioned that their household food was more than adequate, i.e., food secure (see Kassie et al. 2014). According to Table 5, the majority of female-headed households (53.1%) reported being chronically food insecure, while male-headed households are evenly split between chronic food insecurity (44.12%) and break-even food security (44.9%).

Table 5. % Distribution of Food Security under Subjective Measure

	Chronic Food Insecurity	**Break-even Food**	**Surplus Food**
MHH	44.2	44.9	11.0
FHH	53.1	38.2	8.7

Male-headed households (MMH); female-headed households (FHH)

We explore the distribution of food security further using the subjective (i.e., chronic food insecurity, break-even and surplus food) and objective (i.e., Q25, Q5 and Q75) categories. Upon disaggregating the food security measures, we make two observations: first, we find that the average per capita consumption under subjective categories (i.e., chronic food insecurity, break-even/at-risk and surplus food) is strikingly close to that of the objective categories (i.e., Q25, Q5 and Q75). More specifically, in both cases, we observe an increase in the average per capita consumption gap between male- and female-headed households as we move chronic food insecurity, break-even/at-risk and surplus food in subjective categories and Q25, Q5 and Q75 in objective categories. That is, the gender gap increases with increases in the availability of household food, and this observation is consistent under the subjective and objective measures. Second, the average per capita consumption in Column 3 under the subjective measure is slightly less than the average per capita consumption. However, the average per capita consumption is slightly more in the subjective than under the objective measure when we compare between chronic food insecurity and Q55 and break-even/at-risk and Q5.

In addition, we use the disaggregation of subjective and objective measures to derive the actual and counterfactual food security scenarios under the treatment-effects framework. Similar to Kassie et al., (2014), we observe that female-headed households have a higher probability of experiencing chronic food insecurity while the male-headed households have a higher probability of reporting food surplus. To gain a further understanding of gender dynamics, here, we compare between rural and urban areas. In essence, this section extends the most recent work by Kassie et al. (2014) and Tibesigwa et al. (2015). We further compared food security between rural and urban areas. We found that the main differences between the rural and urban area is the magnitude, i.e., the size of the coefficients and level of significance. Specifically, in rural areas, household size, education, and marital status are more significant in female-headed households, while household income and expenditure on livestock extension are significant in male-headed households. Also, the effects of soil characteristics on food security appear to be similar for male- and female-headed households in rural areas. This is in slight contrast to urban areas, where we observe significant effects of household size and household off-farm income, household assets and marital status in male-headed households. Further, the climate and soil variables, especially precipitation, are more significant in predicting food security in rural than in urban areas.

In Tables 6 and 7, we show the effects of gender on food security in rural and urban areas. When we compare food security using the subjective measure, i.e., Panel A in Tables 6 and 7, we see that the observed probability of food security is 9.1% in rural areas and 6.1% in urban areas. A similar pattern is observed under the objective measure, i.e., Panel B in Tables 6 and 13 depicts a statistically significant 1.7% per capita food consumption gap in rural areas, while in the urban areas this gap is -0.5%, although it is not statistically significant. Thus the observed or actual values under subjective and objective measures reveal that male-headed households are more food secure. Further, we observe a higher food security gap between male- and female-headed households in rural than in urban areas. However, if female-headed households had similar characteristics as male-headed households, the food security gap would have reduced to 7.0% and 1.6% in rural and urban areas respectively. This can be observed in (iii) in Panel A in Tables 6 and 7. Added to this, while this gap is significant at the 1% level in rural areas, it is, however, insignificant in urban areas.

Table 6. Food Security – Male vs. Female Treatment and Heterogeneity Effects Rural

	Panel A: Subjective Measure			**Panel B: Objective Measure**		
	MHH	FHH	Treatment effects	MHH	FHH	Treatment effects
MHH	*(i)*0.5372	*(iii)* 0.4672	0.0700***	*(i)*6.4715	*(iii)* 6.3187	0.1142***
	(0.0113)	(0.0087)	(0.0141)	(0.0203)	(0.0152)	(0.0287)
FHH	*(iv)*0.5300	*(ii)* 0.4466	0.0835***	*(iv)*6.5689	*(ii)* 6.4548	0.1528***
	(0.0149)	(0.0101)	(0.0141)	(0.0256)	(0.0154)	(0.0249)
Heterogeneity effects	0.0072	0.0207***		-0.0974***	-0.1361***	
	(0.0159)	(0.0102)		(0.0200)	(0.0085)	

Robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1; male-headed households (MMH); female-headed households (FHH)

Under the objective measure in Panel B in Tables 6 and 7, the counterfactual in (iii) shows that, if female-headed households had the same characteristics as male-headed households, the per capita consumption gap would have been 1.7% and 1.2% in rural and urban areas respectively. However this remains insignificant in urban areas, while in rural areas it is significant at the 1% level. Under the counterfactual in (iv), Panel A in Tables 6 and 7 shows a 8.4% food security gap in rural areas and 6.7% in urban areas if male-headed households had similar characteristics as female-headed households. A similar pattern emerges in Panel B, where we find a 2.4% and -1.4% gap in rural and urban areas, respectively. Hence, overall, there is a higher food security gap in rural than in urban areas, and this can be explained by both observed and unobserved characteristics, as evident in the significant heterogeneity effects.

Table 7. Food Security – Male vs. Female Treatment and Heterogeneity Effects Urban

	Panel A: Subjective Measure			**Panel B: Objective Measure**		
	MHH	FHH	Treatment effects	MHH	FHH	Treatment effects
MHH	*(i)* 0.5693	*(iii)* 0.5537	0.0156	*(i)*6.5584	*(iii)* 6.4812	0.0771
	(0.0268)	(0.0273)	(0.0385)	(0.0539)	(0.0556)	(0.0777)
FHH	*(iv)*0.5755	*(ii)* 0.5089	0.0666*	*(iv)*6.5038	*(ii)* 6.5951	-0.0913
	(0.0218)	(0.0262)	(0.0338)	(0.0490)	(0.0446)	(0.0672)
Heterogeneity effects	-0.0062	0.0448***		0.0546***	-0.1139***	
	(0.0255)	(0.0235)		(0.0404)	(0.0423)	

Robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1; male-headed households (MMH); female-headed households (FHH)

Table 8 uses the subjective measure and compares the distribution of male- and female-headed households under chronic (i.e., experiencing hunger), break-even (i.e., at risk of experiencing hunger) and surplus household food (i.e., food secure) between rural and urban areas. We find that more female-headed households in rural areas reported chronic food insecurity (54.5%) than did female-headed households in urban areas (47%). Similarly, more male-headed households reported chronic food insecurity in rural areas (45.6%) than in urban areas (40.4%). Under the objective measure,

Table 8. % Distribution of Food Security under Subjective Measure – Rural vs. Urban

	Panel A: Rural			**Panel B: Urban**		
	Chronic Food Insecurity	**Break-even Food**	**Surplus Food**	**Chronic Food Insecurity**	**Break-even Food**	**Surplus Food**
MHH	45.6	44.1	10.3	40.4	47.0	12.6
FHH	54.5	36.8	8.7	47.6	43.7	8.7

Male-headed households (MMH); female-headed households (FHH)

We further compares the average per capita consumption between rural and urban areas, where we observe that households located in urban areas have higher per capita consumption than those located to rural areas.

4. CONCLUSION

This study set out to explore the effects of the gender of the head of household on food security of small-scale farm households in rural and urban areas. We employ the switching treatment-effects regression framework to tease out the gender and geographical effects, using a sample of 1100 farm households from the 2008 nationwide National Income Dynamics Study (NIDS). The following summarises our results: Off-farm household income and quantity of household assets are the main determinants of household food security. While the quantity of household assets appears to have an almost equal impact on food security of male- and female-headed households, off-farm income is more significant in predicting food security of male-headed households. The other factors that influence food security include marital status, purchase of farm inputs, i.e., farm extensions, and education. In addition, winter climate appears to have a uniform impact on food security in both male- and female-headed households, while summer climate is more significant in predicting food security of female-headed households. The effects of climatic characteristics on food security are more apparent in rural than in urban areas.

We observe that the contribution of agriculture to food security is higher in female- than in male-headed households, especially those in rural areas. We further find that the gender of the head of household determines the level of food security. More specifically, male-headed small-scale farm households are more food secure than female-headed households, and this finding is consistent under subjective and objective measures of food security. Because off-farm income is one of the main determinants of food security in male-headed households, promoting off-farm labour activities to female-headed households will likely boost their food security and narrow the gender gap. In addition, the food security gap between male- and female-headed households is higher in rural areas than in urban areas, where households in rural areas are more likely to report chronic food insecurity than are those in urban areas, where chronic food insecurity refers to having less than adequate food, i.e., the experience of hunger. In contrast, urban households are more likely to report break-even, i.e., household food was just adequate and hence they were at risk of experiencing hunger, and surplus food, i.e., household food was more than adequate and therefore they are food secure. Overall, our results support the growing interest of the South African government in promoting rural agriculture and development. This is because it appears that agriculture contributes more to food security in rural than in urban areas, and this is more pronounced amongst female-headed households. Also, while urban small-scale farm households have more opportunities, e.g., off-farm employment, rural areas are often resource-poor and characterised by under-developed markets, thus offering limited opportunities for small-scale farm households. However, because agriculture also contributes to household food security in urban areas, the current policies on urban agriculture should continue to be emphasised, in light of the effects of climate change on agriculture productivity and rural-urban migration.

ACKNOWLEDGEMENT
We acknowledge helpful comments from Peter Berck and the participants in the 9th Environment for Development (EfD) Initiative conference. We also thank EfD and ERSA for financial support.

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