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Determinants of food security in Tanzania: gendered dimensions of household headship and control of resources

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Abstract This paper examines heterogeneous impacts of gendered household headship and control of resources on food security in rural Tanzania (as measured by a World Food Programme score based on quantity and quality of food consumed in the household over a 7 day period). Analysis with minimal attention to heterogeneity in gender considerations indicates no differences in household food security between male and female-headed households. But with a more differentiated household headship variable (reflecting heterogeneity in household composition) and accounting for gendered differences in resource ownership, the results differ markedly. Using more gender-disaggregated variables, our results show significant differences between female-headed and male-headed households. In these results we find support for the claim that gender norms in the study villages often restrict women's access to resources, resulting in more vulnerable female-headed households. Female-headed households with no male adults present are particularly vulnerable. The study also points to specific opportunities for enhanced food security with attention to female and joint ownership of livestock. These results represent a hopeful sign that efforts to enhance female livestock ownership could be a useful strategy to address lower levels of food consumption in these Tanzanian villages.

Keywords Household headship · Food security · Livelihoods · Socioeconomic status · Household survey · Gender · Ownership

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Introduction

Following the 2007 global food crisis, the agricultural research community has stepped up efforts to understand gendered aspects of food security and to promote gender equity in the global food system (World Bank et al. 2009). In particular, scholars are calling for more attention to the role of household headship structure (Seebens 2010) and the role of female and joint ownership of resources (Meinzen-Dick et al. 2011) in addressing food insecurity. As contributors to this research, we investigate the relationship between gender roles (i.e., gender-specific household headship and resource ownership) and household food consumption within the context of small-scale farming in rural Tanzania. Our objective is to provide methodological and empirical refinements to the literature on gender and food security by examining how household food consumption is influenced by: (1) household headship structures and (2) gender-specific differences in the ownership of household resources. In pursuing a clearer picture regarding determinants of food consumption, we explore heterogeneous impacts of household composition by going beyond the use of simple dichotomous headship variables, and instead explore how the presence (or absence) of other adult males in the household influences household food consumption. Reflecting the extent of "maleness" in the household, our heterogeneous household headship variable

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offers important insights over more conventional approaches to research on this topic. We also introduce variables related to gendered resource ownership, including joint ownership, offering important insights into our understanding of food security in this setting. Guiding the research in this paper, we focus on the question: How does gendered household headship and gendered resource ownership affect household food security? To set the context for this study, the next section reviews published literature on gendered household headship, gendered resource ownership and how these topics are linked to food security.

Literature review

Gendered headship structure and food security

Dominant threads within the international agriculture literature involve complex and sometimes contradictory evidence about the relationship between female headship and food security. "Women comprise an average of 43 % of the agricultural labor force in developing countries," with almost 50 % in sub-Saharan Africa (FAO 2011, p. 7). Though such numbers may be controversial, we agree with Doss (2011, p.1) that "women are important to agriculture and agriculture is important to women" and then seek to understand the unique experiences of women and men within different agricultural systems. Toward this end, we are interested in the differential experience of women and men in meeting food security challenges.

In exploring the issue of household food security, Case and Deaton (1998), find that income controlled by women tends to favor food expenditures. From this literature, one might expect that female household headship is linked to enhanced food production and food security at the household level. Yet challenges exist for these women as they take on household headship responsibilities. Therefore, authors are calling for more attention to the complexity of gender roles in theory and practice (Chant 2006), claiming that women's household headship may be linked to both household impoverishment and gender empowerment.

With respect to household impoverishment, a United Nations report on gender and agriculture found that "women and girls, for a number of socioeconomic reasons, often have limited access to productive resources, technology, and information, resulting in lower agricultural productivity" (World Bank et al. 2009, p. 307). Women also have worse "access to and control over land and other productive resources" (World Bank et al. 2009, p. 185), making it difficult to realize food security gains by enhancing female participation in the agriculture sector. Other studies also report that women frequently face restrictions to: off-farm work opportunities, property rights, and credit facilities (e.g., Horrell and Krishnan 2007; Seebens 2010; Boon et al. 2009; Deininger and Jin 2006). Along these lines, numerous studies find that female-headed households are more vulnerable and are often poorer than male-headed households (e.g., Buvinic and Gupta 1997). O'Laughlin (1995, p. 76), speaking about female headship in Africa, goes as far as to suggest that "a high proportion of those who are de jure or de facto heads of households are in fact desperately poor."

Belonging to female-headed households, however, may also be liberating for women. In a Latin American study, Chant (2006) illustrates how female-headed households may be empowered as a result of breaking the constraints of intra-household patriarchy. Similarly, Handa (1996) demonstrates that a large portion of women in Jamaica choose to maintain female-headed households based on their belief that their personal consumption will increase along with their child's welfare. Pant (2000) also explains that women face intra-household constraints as a result of distribution of division of labor roles. In female-headed households, such constraints may be alleviated, thereby better facilitating the pursuit of food security or general well-being. The tension between impoverishing and liberating aspects of female-headed households are also characterized by Dassanayake (2012) as being driven by external and internal gendered constraints that affect household poverty levels. Both internal and external constraints vary by culture, but external constraints are often related to women's access to resources, while internal gender constraints are associated with allowed roles within the household. Given that female-headed households may be disadvantaged with respect to access to resources, yet more free to allocate labor resources to pursue food security, the relationship between household headship and food security remains unclear.

Gendered resource ownership and food security

To date there is limited attention to gender-disaggregated data on the ownership structure of household resources. Some research shows that improving women's access to productive resources significantly increases their agricultural output. For example, a study in Ethiopia found that women who were provided with the same level of productive resources as male farmers increased their yields by 22 % (Boon et al. 2009). Similarly, Doss (2011, p. 1) notes that "women farm as productively as men do, when they have access to the same resources." The impact of livestock is also observed to be significant in promoting well-being. For instance, based on several studies in East Africa and Latin America, the presence of small ruminants (e.g., sheep and goats) are found to be closely associated with

improved food consumption, especially when these resources are in the hands of women (Valdivia and Gilles 2001).

Other empirical studies further this connection between women, access to productive resources and household food supply. Along these lines, Duflo (2003) finds that women tend to allocate more resources towards improving child nutrition than males do. Similarly, a United Nations study found that "resources controlled by women are more likely to be used to improve household food consumption and welfare, reduce child malnutrition, and increase the overall well-being of the family" in comparison to men (World Bank et al. 2009, p. 185). The idea of joint control and ownership as an aspect of asset accumulation is also emphasized in the conceptual work of Meinzen-Dick et al. (2011). Although the notion of joint ownership deserves further analysis in terms of how it functions in our study setting, these empirical categories extend from conceptual ideas, with this study being one of the first of its kind to explore more disaggregated resource ownership structures.

Human capital is another key variable in our analysis. The importance of human capital held by women and its influence on food security is also noted. A study in Nigeria about women's access to educational resources identified a positive relationship between the highest level of education attained and supply and diversity of food in the household (Olumakaiye and Ajayi 2006). Similarly, in an article outlining the importance of women in adapting to climate change in Tanzania, Nelson and Stathers (2009, p. 84) illustrate that "African women's indigenous agricultural knowledge supports household food security."

Measuring gender

In addition to these theoretical and pragmatic aspects of gender and food security, analysis of gender dynamics is also constrained by research methods and measurement approaches. Although the dynamics of families and household headship are recognized to be inherently complex (Handa 1996; Fafchamps and Quisumbing 2008), because of data limitations, studies often treat household structures as somewhat straightforward analytical categories. Studies on gender and food security often maintain two general categories to identify important distinctions in household headship structure, namely female versus male-headed. Although useful in delineating the effects of fatherless families on children as well as raising "important questions about the process and outcomes of class differentiation and the production of poverty" (Peters 1995, p. 96), these dichotomous categories may be insufficient in representing the diverse types of households in question, including the heterogeneity that exists within these categories. Several studies break down this binary headship variable by emphasizing the difference between de facto female-headed households, those that are temporarily the household head as a result of their spouse being absent, and de jure female-headed households, those households led by women as a result of being widowed, single or separated (FAO 2011). In research from rural Bangladesh, Joshi (2004) notes two types of female-headed households to be important, widowed and married women. These distinctions relate to differential access to dowries, linkages to other family members, and socio-economic status that result in starkly different livelihood outcomes. While these headship categories capture more nuance than the binary sex disaggregated headship structures, they are designed to capture vulnerabilities or opportunities based on life events (divorce, marriage, widowed, migration etc.) instead of the gendered structures that exist more fluidly within a household. In order to better measure the gender impacts of household composition, following Dassanayake (2012) we employ a gender variable with four types of headship, reflecting the extent of "maleness" in the household as an indicator of differential external and internal constrains on women. This variable is described in more detail within the method section of this paper.

Study setting and data collection

Approximately 74 % of the Tanzanian population lives in rural areas, with a comparable number of people employed in agriculture (CIA 2012). While there are hundreds of ethnic communities in Tanzania operating with different gender norms, the resettlement of 95 % of the population through the "villagization" process of the early 1970s (Coulson 1982; Jennings 2008) helped to shape a more standardized form of subsistence agriculture throughout the nation. This is not to say that we can assume gender norms are the same across all the tribes, just that patterns of agricultural labor may have more similarities than in other places.

We collected data for this study from a food security project funded by the International Development Research Centre in partnership with Sokoine University of Agriculture (Tanzania), the University of Alberta (Canada), and the International Livestock Research Institute (Kenya). The study was based in the Kongwa and Mvomero Districts of Tanzania. Project activities involved the introduction of dairy goats and root crops as a sustainable feeding system and these project interventions were distributed to a total of 120 "project households" in early 2012. The root crops were intended to enhance nutrition in humans and serve as feed stock for goats, thus enhancing milk production and overall animal health with associate livelihood and nutritional benefits for farmers and their families.

These districts are located in semi-arid climatic regions of Tanzania, which are especially susceptible to impacts of climate change (Safriel and Adeel 2005). Nelson and Strathers (2009) suggest that women in these semi-arid areas, especially Dodoma (area surrounding Kongwa), are disproportionally affected by the increased desertification and shortened growing season brought on by climate change. This potential for disproportionate impacts is crucial in emphasizing the importance of gathering gender-disaggregated data in these areas. The Kongwa District, and to a lesser degree the Mvomero District, is also documented historically as a reserve labor pool for more productive areas of the country (Coulson 1982; Hyden 1980; Maddox 1991). This perpetual migration of people (mainly men) away from their homes for temporary work would suggest higher variability in household headship structure as well as resource allocation and ownership.

We conducted a household survey from December 2011 to January 2012 with households directly involved in the food security project and with other households in the village and in neighboring villages. An interdisciplinary approach was adopted to create the questionnaire, with questions related to the socio-economic and nutritional situation of the households. A team of researchers (noted in the acknowledgements) created the questionnaire in English and Tanzanian enumerators were then trained to translate the questions into Swahili for the interview. In each district, the research team, in conversation with government agricultural extension officers, selected four villages to conduct a baseline survey. Table 1 shows details of the sampling plan with a goal of 560 randomly selected households. Based on this sampling plan, a total of 552 households completed the questionnaire with complete information on a total of 520 households.

Empirical specification and data for a food consumption model

To explore the relationship between gendered household headship, resource ownership, and food consumption we explore empirical relationships based on the following general form:

$$FCS = \beta_Z Z + \beta_{GH} GH + \beta_{GA} GA + \beta_{GL} GL + \beta_V V + \varepsilon \quad (1)$$

The food consumption score (*FCS*) of each household is assumed to be dependent on a number of vectors of variables: household characteristics *Z*; gender-specific differences in household headship structure *GH*; gendered ownership variables for land and livestock, respectively *GA*, and *GL*; and dummy variables controlling for village fixed effects *V*. Each of these vectors of explanatory variables is associated with a vector of coefficients. For example, β_{GH} represents the coefficients for *GH*. The error term is denoted with ε. In the following sections we describe the variables in each vector and then provide descriptive statistics in Table 2.

Food consumption score (FCS)

The *FCS* is based on the responses given by an adult member of the household. In most instances, the food consumption information collected from the adult was also the head of the household. Calculation of the *FCS* is based on a standard method designed by the World Food Programme (World Food Programme 2008). The method takes into account the quantity (frequency of consumption) and quality (type of food) of food consumed by a household in 1 week, and assigns weights, based on the type of food consumed. Table 2 shows that the mean value of this score for our sample (i.e., 50) is well within the range deemed "acceptable" (i.e., 35 and above).

Household characteristics (Z)

We investigate the potential effects of a number of household characteristics on our *FCS*. As our focus is on the gendered aspects of household headship structure and resource ownership, we interpret the *Z* vector as a set of control variables. The variables we include are household

Table 1 Study sampling plan

District	Villages	Target sample	Actual sample	Villages	Target sample	Actual sample
Kongwa	Ihanda	120	120	Malima	20	19
	Masinyethi	120	117	Mlumbilo	20	20
Mvomero	Kunke	120	119	Mautya	20	20
	Wami Luhindo	120	115	Musingisa	20	22
Total		480	471		80	81

The second column of villages has smaller sample sizes because they were part of a different study that was investigating them as control villages. The treatment for that study happened after our data was collected, so did not impact our data

Table 2 Description of variables used in the regression analysis (N = 520)

Variable	Description	Metric	Mean	SD
Dependent variable				
Food consumption score (*FCS*)	Index of quantity and quality of food consumed by household members	Continuous	50.07	19.71
Household characteristics (*Z*)				
Household size	Total number of people living in household	Continuous	5.67	2.55
Age of household head	Age in years	Continuous	44.92	16.39
Age of household head squared	Squared term that captures the potential decrease in the marginal effect of age	Continuous	2,285.80	1,729.71
Education of head	Whether the household head completed their primary level of education	1 = primary, 0 = no	0.52	0.50
Household physical assets	Index constructed using PCA	Continuous	0.01	1.02
Gender variables for household headship (*GH*)				
Male head (Model 1 only)	Whether a household is male-headed; base case is female-headed	1 = yes, 0 = no	0.80	0.40
Female head with no male adult	Headship structure capturing the least presence of male adults	Base case	0.10	0.30
Female head with male adult(s)	Headship structure capturing increasing presence of male adults	1 = yes, 0 = no	0.10	0.30
Male head no other male adult	Headship structure capturing increasing presence of male adults	1 = yes, 0 = no	0.53	0.50
Male head with other male adult(s)	Headship structure capturing strongest presence of male adults	1 = yes, 0 = no	0.27	0.44
Gender variables for land ownership (*GA*)				
Total land	Measured in acres	Continuous	8.30	17.81
Land owned by men	Subset of total land	Continuous	3.51	6.61
Land owned by women	Subset of total land	Continuous	0.93	2.58
Land jointly owned	Subset of total land	Continuous	3.85	17.42
Gender variables for livestock ownership (*GL*)				
Total household livestock units	Livestock units (Tropical Livestock Units)	Continuous	3.84	15.75
Male owned livestock units	Subset of total livestock units	Continuous	1.15	10.28
Female owned livestock units	Subset of total livestock units	Continuous	0.30	3.93
Jointly owned livestock units	Subset of total livestock units	Continuous	2.35	11.55
Village control variables (*V*)	Subset of total livestock units			
Village 1	Kunke	1 = yes, 0 = no	0.21	0.41
Village 2	Wami Luhindo	1 = yes, 0 = no	0.21	0.41
Village 3	Mlumbilo	1 = yes, 0 = no	0.04	0.19
Village 4	Malima	1 = yes, 0 = no	0.04	0.19
Village 5	Ihanda	1 = yes, 0 = no	0.22	0.41
Village 6	Masinyeti	1 = yes, 0 = no	0.21	0.41
Village 7	Mautya; village with lowest average income per household	Base case	0.04	0.19
Village 8	Musingisa	1 = yes, 0 = no	0.04	0.20

size, age of household head (linear and non-linear relationships), education of household head, and physical assets.

Variables for physical assets are based on a physical asset index, generated using principal component analysis (PCA). The physical assets index is based on an aggregation of 30 physical asset characteristics into ten broad groups. These broad groups are: "furniture," which includes beds, chairs, sofas and tables owned; "stoves" which includes electric or gas stoves owned; "other appliances," which includes generators, refrigerators, and sewing machines; "small implements" which includes axes, spades, shovels, hoes, and bush knives; "large implements," which was mainly comprised of agricultural equipment such as ploughs, seeders, weeders, and wheelbarrows. The other categories are "cell phones," "radio and tv," "bicycles," "carts," and "agricultural pump

sprays." The PCA generates factor scores for each of the ten asset categories and reflects a general indicator of wealth at the household level. A regression method that assumes uncorrelated rotated factors is used to calculate the factor scores. In the PCA analysis, the ten asset categories correspond to ten factors, which are standardized to zero mean and unit variance. After several alternative factor scores are generated, the factor that explains most of the variation in the asset categories is selected as the PCA index variable. Our physical asset data is also gender-differentiated (as per the resource variables discussed below) but co-linearity with household headship variables prevented us from including this data in our models.

Table 2 shows that the average household size is 5.7 with the average age of head being 45. Approximately half of the household heads have completed the primary level of education.

Household headship variables (GH)

We present results for two types of household headship variables. First, we divide our sample into female and male-headed households. Table 2 shows that 80 % of the households in our sample are male-headed. But in order to move beyond the limits of these categories, as discussed above, this study relies on emerging analytical approaches to reflect more of the complexity of these headship structures. We adopt an approach proposed by Dassanayake (2012) that seeks to reflect the dual effects of internal and external gender constraints. Dassanayake (2012) suggests that both forms of constraints can be reflected with an index based on the increasing presence of males. As male presence in a household increases, external constraints are hypothesized to decrease, while internal constraints are hypothesized to increase. Increasing male presence is measured with two factors: (1) how often male adults are present (i.e., present, temporarily present, or not present); and (2) the type of male present (i.e., male spouse vs. other male adults).

Based on these criteria, we create four headship variables that capture the increasing presence of males: (1) female head living with no other male adult(s); (2) female head living with male adult(s); (3) male head with no other male adult(s) present; and (4) male head with other male adult(s) present in household. Adult males are defined as men above the age of 16. These headship variables represent a more nuanced understanding of headship realities with potentially important implications to delineate gender constraints and opportunities within the rural Tanzanian context. Table 2 shows that of these four categories, the majority of our sampled households (i.e., 53 %) fall under the third category containing a male head with no other male adults. Within the sample, female-headed households without other males present (Category 4, Table 2) generally is populated by widowed women, divorcees, and women choosing to be single mothers. The remainder of the female-headed households (Category 3, Table 2) include a mixture of self-appointed female heads, some de facto female heads resulting from migratory work and female heads created by polygyny. However, not all women in polygamous marriages are female heads.

Resource ownership variables (GA, GL)

For both resource variables, we specify a total measure of resources and three sub-measures that indicate amounts owned by males, females, and jointly. Variables for land are based on the total amount of agricultural land owned in acres. Variables for livestock are also based on a standard tropical livestock units (TLUs) index developed by the International Livestock Research Institute (e.g., Njuki et al. 2011). TLUs assign weights for different types of animals based on bio-physical criteria such as body weight, and nutritional requirements of animals. Table 2 shows that for our sampled households, for all types of resources, average amounts are greatest for jointly owned and smallest for female-owned.

Village control variables (V)

With our sample being drawn across eight villages, we recognize that there may be a number of other differences reflected in different geographic locations. We control for these differences with a number of village dummy variables and we use the poorest village measured by average household income as our omitted base case.

Results: linking food consumption, household headship, and resource ownership

Before presenting our regression results, we present several descriptive tables to illustrate the relationship between key gender variables and household patterns such as ownership structure and food consumption. In Table 3, *FCS*s are reported for different types of household. The categorization of food consumption is based on the World Food Programme (2008) threshold, which delineates a *FCS* of 0–21as poor, 21.5–35 as borderline and a score >35 as acceptable.

Most of the sampled households lie within the "acceptable" category, but the two female-headed household types (with and without male adults) have the lowest percentages of 56 and 49 %, respectively. Moreover, relatively more female-headed households are on the margins in terms of food consumption. Within the sample of

Table 3 Mean food consumption scores for categories based on World Food Program conventions, and corresponding percentage of households (N = 520) (95 % confidence interval for the means are in parenthesis)

Household type	Food consumption score (*FCS*)								
	Poor (0–21)			Borderline (22–35)			Acceptable (35 and above)		
	Mean	N	%	Mean	N	%	Mean	N	%
Female head without male adult(s) (N = 57)	–	0	0.0	30.1 (±1.8)	19	33.3	49.2 (±4.1)	38	66.7
Female head with male adult(s) (N = 66)	17.5 (±44.5)	2	3.0	29.8 (±1.7)	21	31.8	55.9 (±5.5)	43	65.2
Male head without male adult(s) (N = 251)	18.7 (±3.1)	9	3.6	29.8 (±1)	47	18.7	58.5 (±2.3)	195	77.7
Male head with other male adult(s) (N = 146)	13.1 (±5.3)	7	4.8	29.5 (±1.4)	30	20.5	60.1 (±3.5)	109	74.7
Total (N = 520)	16.4 (±2.7)	18	3.5	29.8 (±0.7)	117	22.5	57.8 (±1.7)	385	74

Table 4 Demographic and asset levels for different household headship structures (95 % confidence intervals)

Variable	Female head without male adult(s) (N = 57)	Female head with male adult(s) (N = 66)	Male head without male adult(s) (N = 251)	Male head with other male adult (N = 146)
Dependant variable				
Food consumption score (*FCS*)	42.8 (±3.6)	46.4 (±4.7)	51.7(±2.4)	51.6 (±3.6)
Household characteristics (*Z*)				
Household size	4.4 (±0.5)	6.7 (±0.7)	4.9 (±0.2)	7.0 (±0.4)
Age of household head	46.3 (±5.1)	50.1 (±4.0)	40.2 (±1.9)	50.1 (±2.3)
Education of head	0.4 (±0.1)	0.3 (±0.1)	0.6 (±0.1)	0.5 (±0.1)
Household physical assets	−0.6 (±0.2)	0.0 (±0.2)	0.0 (±0.1)	0.3 (±0.2)
Gender variables for land ownership (*GA* in acres)				
Total land	4.4 (±1.3)	6.7 (±3.2)	8.1 (±1.9)	11.2 (±4.3)
Male owned		0.9 (±0.6)	4.0 (±0.9)	5.0 (±1.1)
Female owned	3.6 (±0.9)	3.3 (±1.1)	0.2 (±0.1)	0.2 (±0.2)
Jointly owned	0.1 (±0.1)	2.4 (±3.0)	3.9 (±2.2)	6.0 (±4.2)
Gender variables for livestock ownership (*GL*)				
Total livestock units	1.0 (±1.1)	5.0 (±4.4)	4.0 (±2.4)	4.4 (±1.8)
Male owned		1.7 (±3.2)	1.3 (±−0.2)	1.1 (±1.3)
Female owned	0.2 (±0.1)	1.9 (±2.7)	0.03 (±0.02)	0.1 (±0.1)
Jointly owned	0.8 (±1.1)	1.2 (±1.2)	2.5 (±0.7)	3.1 (±1.2)

female-headed households (with and without male adults) just over 30 % of these households are in the "borderline" category, as compared to approximately 20 % of male-headed households (with and without male adults) that are in this category. Curiously, there are no female-headed households with no adults in the "poor" category.

Summary statistics for demographic and resource levels for different household headship structures are presented in Table 4. Following from Table 3, female-headed households (with and without males) are shown to have the lowest mean *FCS*s. Moreover, total land owned is shown to increase across headship types with increasing male presence. Differences with respect to livestock units are most evident in lower values for female-headed households with no male adults. There are also notable differences across headship categories in amounts owned by males, females and jointly. As expected, women own more land and livestock resources in female-headed households and men own more resources in men-headed households. But whereas an adult male can hold substantial shares of the land and livestock assets in a female-headed household (respectively 13 and 24 % of totals), women hold much smaller shares in male-headed households (<3 % for both types of resources in households with and without other

Table 5 OLS regressions (with robust standard errors) for household food consumption scores (with robust standard errors)

Dependent variable Food consumption score (*FCS*)	Model 1		Model 2		Model 3	
	Coef.	SE	Coef.	SE	Coef.	SE
Household characteristics (*Z*)						
Household size	0.031	0.339	−0.121	0.348	−0.191	0.352
Age of household head	0.020	0.249	−0.003	0.251	−0.004	0.224
Age of household head squared	−0.001	0.002	−0.001	0.002	−0.001	0.002
Education of head (1 = primary, 0 = no)	4.117**	1.786	4.205**	1.788	3.987**	1.801
Household physical assets	5.867***	1.273	5.828***	1.267	6.110***	1.288
Gender effects in household headship (*GH*)						
Male head	1.976	1.887				
Female head with male adult(s)			4.312	3.001	4.689	3.027
Male head no other male adult(s)			3.718*	2.059	4.569*	2.633
Male head with other male adult(s)			5.015**	2.436	5.801*	3.017
Gender effects in land ownership (*GA*)						
Agricultural land in acres	−0.041	0.046	−0.038	0.050		
Agricultural land owned by men					−0.018	0.160
Agricultural land owned by women					0.225	0.445
Agricultural land jointly owned					0.053	0.042
Gender effects in livestock ownership (*GL*)						
Total household livestock units	0.182**	0.048	0.180**	0.050		
Male owned livestock units					0.039	0.070
Female owned livestock units					0.155***	0.061
Jointly owned livestock units					0.288***	0.075
Village effects						
Village 1	15.320***	3.442	15.090***	3.393	15.114***	3.266
Village 2	15.090***	3.521	15.060***	3.510	15.238***	3.367
Village 3	7.085	5.600	6.987	5.556	7.131	5.484
Village 4	12.03***	4.298	12.020***	4.203	12.292**	4.106
Village 5	8.190***	2.832	8.310***	2.771	8.515***	2.612
Village 6	7.719***	3.036	7.831***	2.963	7.800**	2.840
Village 8	4.371	3.775	4.652	3.762	4.584	3.540
Constant	36.290***	6.736	35.700***	6.742	35.458***	6.800
N	520		520		520	
R squared	0.263		0.266		0.275	

Asterisks indicate statistical significance levels: * for 10 %, ** for 5 %, and *** for 1 %. Robust standard errors are used to correct for non-constant variance of estimators

male adults). But joint ownership of land and livestock resources is substantial across all headship types that have both adult females and males, with shares increasing as male presence increases. For land, joint ownership increases from 35 to 54 % of total holdings as male presence increases, while for livestock units, the corresponding increase is from 24 to 78 %. In aggregate, these numbers indicate quite different socio-economic conditions for female versus male-headed households within these study villages, particularly with respect to the control of resources.

Results from three regression models are presented in Table 5. Model 1 provides the most basic version that includes a dichotomous representation of household headship (male or female), and no breakdown between male or female ownership of resources. This model shows that food consumption is significantly and positively impacted by education, physical assets, livestock resources, and a number of village effects. Notably, household headship is not a significant factor in this model.

Model 2 elaborates on Model 1 with a more differentiated household headship variable. All of the same variables

remain significant in Model 2, but with the addition of significant gendered effects of household headship. All headship categories are shown to be greater than female-headed households with no male adults (i.e., the excluded category) influencing the *FCS*. But the two male headship categories are shown to be significantly different in Model 2. For example, relative to a female-headed household with no male adult(s) present, a male-headed household with male adult(s) present corresponds with an increase of 5.0 on the *FCS*.

In Model 3, we add to Model 2 gendered effects of land and livestock ownership. Similar to the previous models, education remains a significant and positive force in contributing to *FCS* and the effect of physical asset ownership remains consistent in all three models. Also, the gendered effects of household headship (found in Model 2) are even stronger in Model 3. For example, relative to a female-headed household with no male adult(s) present, a male-headed household with male adult(s) present results in an increase of 5.8 on the *FCS*. These numbers are given further relevance in relation to the categories used by the World Food Programme *FCS* (Table 3). A six-point *FCS* value is a sizable change that can move a number of households from poor to borderline, or borderline to acceptable food consumption. Model 3 also explores the gendered sub-categories of resource ownership. As per the previous two models, land holdings do not influence the *FCS*, but ownership of physical assets and livestock resources does. For livestock, female and jointly owned livestock resources have a positive effect, reflecting a clear distinction between male versus female owned livestock as a contribution to food consumption.

Discussion

In this paper, we seek to understand how household *FCS*s are influenced by: (1) household headship structures and (2) gender-specific differences in the ownership of household resources. We suggest that the literature on gender and household livelihood outcomes such as food security remains ambiguous and contradictory, and we seek to show that accounting for more nuanced measures of gender could help provide clarity. In broader terms, we find support for the claim that gender norms in these villages often restrict women's access to resources, resulting in more vulnerable female-headed households. This claim is supported by evidence of limited access to land and lower *FCS*s in female-headed households. These findings are consistent with the work of the World Bank et al. (2009), Horrell and Krishnan (2007) and others researchers discussed earlier in the paper. But looking closer at household headship structures and gender-specific differences in ownership of resources provides further insights.

Looking at general household characteristics (*Z*), the educational achievement of the household head is a significant and positive contributor to household food consumption. This finding is consistent in all three models, and remaining significant in Model 3 with the full suite of gender variables. With this result we add to established findings from (Olumakaiye and Ajayi 2006) and others who show a link between education attainment and the supply and diversity of food in the household. When examining the relationship between gender and food consumption, results indicate that the inclusion of gendered variables can be both insightful and challenging. One major insight comes from differences in results that occur from the disaggregation of conventional binary gendered household headship structures (i.e., male vs. female-headed) into more detailed categories. As indicated earlier, this approach to disaggregation draws on the work of Dassanayake (2012) who suggests that internal and external forms of constraints can be reflected with an index based on the increasing presence of males. The differences between the gendered effects of household headship (*GH*) in Model 1, where the binary variable is not significant, compared to Models 2 and 3 where two of three disaggregated variables are significant, show the importance of accounting for different gendered structures. In our results, we find the presence of a male adult in the household has a strong effect on household food consumption, illustrating the point made by Seebens (2010) that de jure female-headed households are poorer and more socially constrained than other household structures. Relative to female-headed households with no male adults present, Model 3 indicates that, on average, a male-headed household with the presence of a male adult corresponds to an increase in the *FCS* of 5.8, an amount equal to approximately 42 % of the range in the "borderline" category of *FCS*s (Table 3). As a policy outcome, for development projects that aim to work with the most marginalized households within this region, these results indicate that the least secure households are not simply female-headed households, but female-headed households with no adult males present. In other words, in reaching the most marginalized, pro-poor development interventions can be even more precisely directed at households where male adults are not present. Moreover, results from Table 5 illustrate the inadequacy of account for gender through binary analysis of male versus female-headed households.

Another insight that emerges with the inclusion of gender variables involves how livestock resources (*GL*) influence *FCS*s. Model 1 demonstrates a significant and positive relationship between total livestock units and food consumption at the household level. But when livestock

units are disaggregated by gender in Model 3, the presence of female and jointly owned livestock units has an even stronger effect on food consumption with larger and more significant coefficients. In this same model, the effect of male owned livestock units also becomes insignificant, suggesting that male owned livestock units have no effect on household *FCS*s. These results are consistent with the general claims by Valdivia and Gilles (2001) and the World Bank et al. (2009) that resources available to women tend to have a positive effect on food production and the availability of food in the household. These results also represent a hopeful sign, in that female livestock ownership could be used to address the results discussed above that show lower *FCS*s for female-headed households.

Conclusion

With the predominance of women in the African agriculture sector, gender-based research on issues of food security has taken on renewed urgency. This study uses a new approach to gender sensitive analysis of household food consumption with a focus on gendered household headship structures and the gendered ownership of resources as explanatory variables. A primary conclusion for this study is that female-headed households (especially those without a male adult present) are disadvantaged relative to male-headed households in terms of ownership of resources and in terms of livelihood outcomes such as food consumption. These insights are realized, however, only when a more differentiated variable is introduced that moves beyond conventional dichotomous analysis of male versus female household headship. In spite of these disadvantages for female-headed households, however, female ownership of livestock resources offers an important pathway to improved food consumption and confirms the need for ongoing development interventions that involve the ownership of livestock by women.

Moving forward, we see a number of fruitful avenues to extend this research on gender and food security. First, the models presented here are limited in terms of gender disaggregated data. Further introduction of gendered independent variables such as education and income would continue to add insight into the differences between male and female resources as they relate to livelihood outcomes. Accurate measures of physical assets disaggregated by consumptive and productive assets would be particularly insightful. The introduction of other variables, such as social capital, is also an important yet underexplored aspect of food security in statistical models of this type. Second, our study explores heterogeneous household composition using variables designed to capture male presence. Future research using these variables would involve other regions of the world and would investigate the role of female presence in the household contributes to food security. Lastly, our analysis is limited to a single dependent variable, food consumption. It would be helpful to test similar models on other measures of food security such as self-administered weekly food diaries or self-perception of food security.

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