INTERNATIONAL FOOD POLICY RESEARCH INSTITUTE
IFPRI

IFPRI Discussion Paper 01653

June 2017

Does Providing Agricultural and Nutrition Information to Both Men and Women Improve Household Food Security?

Evidence from Malawi

Catherine Ragasa

Noora-Lisa Aberman

Cristina Alvarez Mingote

Development Strategy and Governance Division

INTERNATIONAL FOOD POLICY RESEARCH INSTITUTE

The International Food Policy Research Institute (IFPRI), established in 1975, provides evidence-based policy solutions to sustainably end hunger and malnutrition and reduce poverty. The Institute conducts research, communicates results, optimizes partnerships, and builds capacity to ensure sustainable food production, promote healthy food systems, improve markets and trade, transform agriculture, build resilience, and strengthen institutions and governance. Gender is considered in all of the Institute's work. IFPRI collaborates with partners around the world, including development implementers, public institutions, the private sector, and farmers' organizations, to ensure that local, national, regional, and global food policies are based on evidence.

AUTHORS

Catherine Ragasa (c.ragasa@cgiar.org) is a senior research fellow in the Development Strategy and Governance Division of the International Food Policy Research Institute (IFPRI), Washington, DC.

Noora-Lisa Aberman is a country program manager in the Development Strategy and Governance Division of IFPRI, Lilongwe, Malawi.

Cristina Alvarez Mingote is a research specialist in the Department of Agricultural and Consumer Economic at the University of Illinois at Urbana-Champaign, US.

Notices

Contents

Tables

Figures

ABSTRACT

The International Food Policy Research Institute is leading a three-year research program to assess the state of agricultural extension and advisory services provision in Malawi in order to inform the national extension policy review and reformation of government and donor processes and programming. This research program includes a series of studies undertaken in response to a request by the Ministry of Agriculture, Irrigation and Water Development to look closely at the state of extension services provision with the intent to further strengthen the contribution of these services to food security, economic growth, and the achievement of sustainable development goals.

In this paper, we examine the role of gender in various pathways to food security in Malawi, emphasizing improved access to agriculture and nutrition information along these pathways and considering the implications of gender targeting for agriculture and nutrition extension services. We propose a gendered typology of households: those with both male and female adults, those with only adult males, and those with only adult females. We take a mixed-methods approach of sequential quantitative-qualitative data collection, consisting of focus group discussions in eight districts and nationally representative household and community surveys. The results show that food insecurity is highest in male-only households. In dual-adult households, in which women are frequently tasked with attending training and meetings but have little power to implement lessons, joint access to information is a more powerful driver of food security than women's access.

Keywords: gender, food security, agriculture, extension services, information, mixed methods, sub-Saharan Africa

ACKNOWLEDGMENTS

We would like to thank numerous people for making this project and study possible:
We are thankful for the funding support for the overall project from the Government of Flanders and from the Gesellschaft für Internationale Zusammenarbeit (GIZ), the development agency of the German government. Specifically, we thank Nikolas Bosscher of the Government of Flanders and Florian Bernhardt and Elena Zanardi of GIZ for their guidance.

Significant complementary funding for the survey was received from the Strengthening Agricultural and Nutrition Extension (SANE) project, funded by the United States Agency for International Development (USAID) mission in Malawi as an activity of Feed the Future. This funding enabled us to increase our sample size for the household survey. We especially acknowledge SANE staff members Marie Cadrin, Clodina Chowa, Paul McNamara, Austen Moore, Stacia Nordin, and Lonester Sibande for their support in various forms, including input on and review of the questionnaires, questionnaire pretesting, provision of contacts and links, and assistance in completing the list of sections used in the sampling.

We acknowledge the support provided by the Malawi Country Strategy Support Program (MaSSP) of the International Food Policy Research Institute (IFPRI). MaSSP receives support from USAID/Malawi and is undertaken as part of the CGIAR Research Program on Policies, Institutions, and Markets (PIM), which is led by IFPRI and funded by CGIAR Fund Donors. In addition, PIM graciously provided funds to write a precedent paper and a policy note that paved the way to securing funds for the larger project under which this paper was written.

Wadonda Consult, headed by Ephraim Chirwa and Peter Mvula, managed and implemented the household and community surveys. We are thankful to Dr. Chirwa and Dr. Mvula and to all the supervisors, translators, and enumerators for their hard work and efforts to collect quality data despite numerous challenges. We acknowledge with thanks the work of Tyler Moorhead and Amrik Cooper in programming the survey questionnaires onto computer tablets so that the surveys could be completed using computer-assisted personal interviewing techniques.

We thank Kenan Kalagho, Diston Mzungu, Eric Kaima, Judith Chilowera, and Hawa Munganya for conducting the census of service providers and focus group discussions.

Within IFPRI, we are grateful for the support of Todd Benson, who has been instrumental since we first began writing the project proposal and who continues to guide us in the project. We are thankful to Bob Baulch and Chance Mwabutwa for providing support in management, logistics, and technical matters as well as for connecting us to policy makers and key stakeholders in Malawi. We are very grateful for the excellent research assistance provided by Cynthia Kazembe.

We are grateful to Stacia Nordin and an anonymous reviewer for their useful comments and suggestions on this paper.

Finally, and most importantly, we are indebted to the farmers and key informants we interviewed who shared their valuable time with us and enabled us to gain a glimpse into the complexities of their work and life. This project and study would not have been possible without their willingness to engage with us.

This paper has not gone through IFPRI's standard peer-review procedure. The opinions expressed here belong to the authors and do not necessarily reflect those of PIM, IFPRI, CGIAR, or any other organization listed here.

1. INTRODUCTION

Food security is a major development problem confronting many countries, including the overwhelming majority in Africa south of the Sahara. In this part of the world, millions of smallholder famers rely on agriculture to ensure their families' livelihoods, yet low land productivity, inadequate agricultural inputs, labor limitations, and erratic rains translate into widespread food shortages, hunger, and poverty. Malawi is one of these countries. In Malawi, poverty, food insecurity, and undernutrition remain significant problems despite recent improvements in national food security and economic growth (Malawi, MoAIWD 2016; Harris, Meerman, and Aberman 2015; Pauw, Verduzco-Gallo, and Ecker 2015).

In this paper, we explore the role gender plays in making households more food secure in Malawi. Our research departs from previous studies in a number of ways. First, we avoid the simple female-headed households (FHHs) versus male-headed households (MHHs) comparison and instead propose a typology of gendered households (households with both male and female adults, households with only male adults, and households with only female adults). While several studies have shown that FHHs have substantially higher food insecurity than MHHs (Tibesiga and Visser 2016; Kassie, Ndiritu, and Stage 2013; Kassie, Stage, et al. 2015), our typology allows us to estimate the contribution of males and females (jointly or separately) to household food security. Second, we examine how access to advice on crucial topics—nutrition, agricultural production, market access, and postharvest handling—affects food security. By focusing on this information and training pathway, we analyze whether the topic and the gender of the person receiving such information matter for our outcomes of interest. This contributes to the literature on gender-focused strategies and their connection with food security in Malawi and Africa south of the Sahara more broadly. Third, we analyze the different pathways leading to food security, with a focus on access to information and advisory services, and explore whether significantly different effects exist across these household types. Lastly, we also use a mixed-methods approach that relies on quantitative and qualitative empirical evidence to understand gender and intrahousehold dynamics relating to access to information as well as its effect on food security. Combining these approaches enables us to triangulate the results and enriches the discussion with insights on pathways and mechanisms.

The paper is structured as follows. Section 2 summarizes the salient points on gender and food security in the literature, both globally and focusing on Malawi. Section 3 describes our methods and data sources. Section 4 discusses the main results, using both quantitative and qualitative methods. Section 5 concludes and highlights the major implications of our findings.

2. GENDER AND FOOD SECURITY

Gender Gaps and Food Security

In general, evidence shows that households headed by females are less food secure than those headed by males, across different countries and contexts (Tibesiga and Visser 2016; Kassie, Ndiritu, and Stage 2013; Kassie, Stage, et al. 2015). Babatunde et al. (2008) also find FHHs more likely to skip meals in the presence of food shortages in Nigeria, while Sraboni et al. (2014) conclude that increasing women's empowerment in agriculture is positively associated with better diets in Bangladeshi households.

Importantly, however, some research in this area offers a more complex picture connecting gender and food security. Mallick and Rafi (2010), for example, focus on indigenous groups in Bangladesh and show that FHHs are not less food secure than MHHs, thanks to informal redistributive mechanisms as well as fewer restrictions on women's access to the labor market within these groups. In Kenya and Malawi, Kennedy and Peters (1992) find that the interaction between income and gender matters most, as the proportion of income controlled by women is positively associated with a higher caloric intake. Relatedly, Levin et al. (1999) and Schmeer et al. (2015) emphasize the link between women's access to resources and better household food security in Ghana and Nicaragua, respectively.

These findings suggest that the relationship between gender, including household headship, and food security is complex and multifaceted. Thus, understanding the pathways leading to food security is essential to improving nutritional outcomes.

Gendered Pathways from Agriculture to Food Security

Productive capacity is determined to a large extent by ownership, use, and accumulated physical and human capital. Productive capacity, in turn, affects food security directly when households consume what they grow, and indirectly due to its effect on food markets, prices, and income from crop sales (FAO 2001). When agricultural production is diverse, it can contribute to the diversity of foods available in markets and accessed (or directly consumed) by households. Furthermore, crops that are produced can be sold to provide the resources to buy different food items and thus enhance nutritional outcomes (Hawkes and Ruel 2007; Herforth and Harris 2014).

Although women account for a significant share of the agricultural labor force, they are typically disadvantaged in agriculture. In particular, women have less access to land, labor, agricultural inputs, and extension services (see, for example, Staudt 1978; Doss 2001; Ragasa et al. 2013). These circumstances reduce productivity levels and the adoption of new technologies, which then negatively influence food security (Udry et al. 1995; Ibnouf 2011; Doss 2001).

Addressing these gender differences has proved instrumental to improving food security. For instance, multiple studies link women's power over farmland, income, and resource allocation with higher spending on food, which positively affects child health and nutrition (Agarwal 1994; Hoddinott and Haddad 1995; Quisumbing 2003; Duflo and Udry 2004; Doss, 2006). Moreover, other works show that by adapting extension services to reach more women, through, for example, hiring more female extension workers, these services raise production levels and can be equally useful to men and women (Alene et al. 2008). Lastly, most works reviewing agricultural interventions (for example, homestead gardening, livestock distribution, and land rights) conclude that, despite methodological limitations, programs that include gender considerations, empower women, make nutrition a key element, and target behavior change are better at accomplishing nutritional outcomes (for example, Leroy and Frongillo 2007; Arimond et al. 2011; Girard et al. 2012; Pandey, Mahendra Dev, and Jayachandran 2016).

In this paper, we contribute to the understanding of the role of gender in household food security by differentiating household types beyond the common FHHs versus MHHs dichotomy. We introduce a new typology of households: (1) sole male adult households (SMHHs), (2) sole female adult households (SFHHs), and (3) households with both male and female adults, or dual-adult households with either male or female heads (DMHHs and DFHHs). This typology recognizes that these different household types face different constraints and might rely on different pathways to food security. Moreover, moving away from the simple FHH/MHH distinction allows us to determine, for example, the role of women in food security and how closing the remaining gender gaps within dual-adult households (DMHHs and DFHHs) can contribute to improving food security. Second, we analyze the pathways leading to food security, with a focus on access to information and advisory services, and explore whether significantly different effects exist across these household types. Third, we explore gender gaps in access to different extension messages (nutrition, agriculture, market access, and postharvest handling). Exploiting variation in the content of advice is crucial to understanding how extension services can deliver better food security outcomes. This is also a substantial improvement over current research on MHHs and FHHs and food security, which in most cases captures access to extension services with a simple dummy variable (for example, Babatunde et al. 2008) or by considering the distance to the nearest extension office (for example, Kassie, Ndiritu, and Stage 2013; Kassie, Stage, et al. 2015). Table A.1 in the appendix identifies the literature reviewed that examines primarily MHHs and FHHs and their food security levels.

Gender Gaps and Food Security in Malawi

Malawi is one of the poorest countries in the world, and the majority of the population relies on agriculture for its livelihood (FAO 2011). The agricultural sector, mostly based on smallholder farmers producing rainfed maize from December to March, is also highly vulnerable to the adverse effects of climate change, and erratic harvests, food shortages, and hunger are widespread (FAO 2011; Kassie, Stage, et al. 2015; Kassie, Teklewold, et al. 2015). Furthermore, despite a significant investment in the Farm Input Subsidy Program and record economic growth between 2005 and 2011, poverty and undernutrition are still significant challenges for many Malawians (Verduzco-Gallo, Ecker, and Pauw 2014; Harris, Meerman, and Aberman 2015; Pauw, Verduzco-Gallo, and Ecker 2015). Undernutrition and food insecurity are still widespread, with 37 percent of children under age five being stunted, according to the 2015/2016 Demographic and Health Survey, and 6.7 million people estimated to be in need of food assistance in the 2016/2017 crop year (Malawi, MoAIWD 2016).

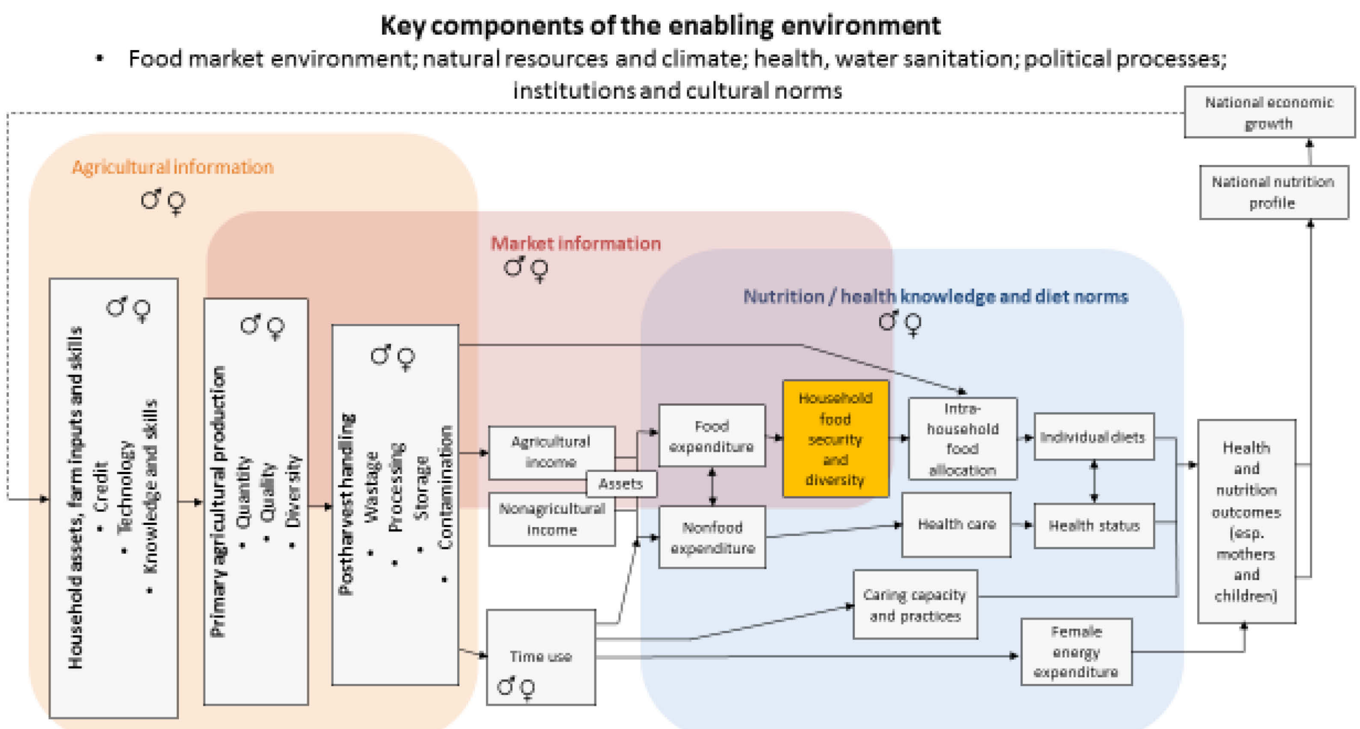
Various factors contribute to the persistence of food insecurity in Malawi. General explanations include overuse of land due to high population growth, limited access to improved inputs, and dependence on rainfed agriculture (Babu and Sanyal 2007; Benson 2015). Additionally, some research in Malawi indicates that gender differences in access to resources and services lead to gender gaps in technology adoption and agricultural productivity (Fisher and Kandiwa 2014) and contribute to food insecurity in the country (Riley 1995; Takane 2009; Kilic, Palacios-Lopez, and Goldstein 2013; Snapp and Fisher 2015). Moreover, few studies show that extension services are mostly provided to male heads, who often do not work with female household members, and also tend to overlook the fact that women have “different roles, resources, constraints and responsibilities” (Riley 1995, 31). Also, recent studies show that gender and cultural norms limit women’s ability to attend training sessions (for example, perceptions that women cannot understand and do not have time) as well as their decision-making power over adoption and use of harvests (Mudege et al. 2016). These differences negatively affect agricultural productivity, the adoption of agricultural innovations, and food security (Chipande 1987; Kilic, Palacios-Lopez, and Goldstein 2013). However, most of these studies have focused on household headship, that is, the difference between female- and male-headed households, and have ignored what is happening with female members in male-headed households, who are the majority of women farmers, and the gender relations in these households. Several experts have already highlighted the need for separate analysis and separate policies for female-headed households and females/wives in male-headed households:

> *Beyond ensuring that female farmers have access to improved technologies, separate policies that are specifically aimed at female household heads vs. wives in MHHs might be needed to completely eliminate the gender gap in adoption of modern maize in Malawi.* (Fisher and Kandiwa 2014, 111)

3. METHODS AND DATA SOURCES

To examine the pathways to household food security (HFS) and the association between gender gaps in these pathways and HFS, we use the conceptual framework presented in Figure 3.1. Pathways to HFS begin with gendered access to household assets, farm inputs, and skills, which determine (among other factors) production, and are influenced by exogenous external factors such as various shocks, weather risks, political processes, institutions, and social norms. Production can be used for own consumption or to yield agricultural income. Mediated by women's time use and empowerment, crops and income (from crop sales or nonfarm sources) determine the quantity and quality of food available to the household. Of particular interest is the role of specific types of information along these pathways: agricultural, market, and nutrition information.

Figure 3.1 Gendered pathways from agriculture to food security and nutrition



Source: Modified from Harris, Meerman, and Aberman (2015) and Herforth and Harris (2014).

Note: To illustrate gender gaps: ♂ = male; ♀ = female.

Q-squared Approach

The data sources used for this study include household and community surveys and focus group discussions. We followed a Q-squared research approach in which qualitative and quantitative rounds are undertaken separately but timed to create a process of "sequential mixing" (Grbich 2012; Kanbur and Ravi 2003). This allows for the qualitative and quantitative research approaches to address the requirements of their respective traditions, while still learning and adapting from each other. Specifically, the open questions that arose from the quantitative analysis were more deeply explored through the qualitative analysis process.

The quantitative data consisted of household and community surveys conducted by the International Food Policy Research Institute (IFPRI) between August and October 2016, with the assistance of Wadonda Consult. The community survey covers 299 randomly selected communities in each district, excluding Likoma (see Ragasa and Niu [2017] for details). Within these 299 sample communities, a total of 3,001 households were randomly selected. This sample size enables analysis and statistical inference concerning Malawi's farming population with a margin of error of less than 3 percent at a 95 percent confidence level. This sample size is nationally representative and far above the minimum sample size estimated using power calculations based on per capita expenditure and receipt of agricultural advice as the outcome variables.

The sample households were asked to list all their plots; therefore, the same household dataset also contains detailed information on 6,282 plots, of which 43 percent are jointly managed by females and males, 22 percent are managed solely by females, and 34 percent are managed solely by males. Maize is the dominant crop, planted in 67 percent of plots, either alone or intercropped. Maize occupies 61 percent of total crop acreage, followed by beans (12 percent), groundnuts (9 percent), and tobacco (5 percent).

In addition, 22 gender-disaggregated focus group discussion were undertaken, with a total of 113 male and 141 female respondents, sampled from 11 communities in eight districts from the same geographic areas as the household and community surveys. The locations of these focus group discussions are illustrated in Figure 3.2. Our sampling approach purposively chose a mix of very remote and more central communities to compare their experiences. These discussions were completed in January–February 2017. Focus group discussions were led by local enumerators fluent in the local Chichewa, Chibandya, and Chinyika languages. Discussions were recorded, transcribed, and translated, and then thematically coded according to a set of predetermined and empirically driven themes using NVivo 11. The focus group discussions included modules on gendered access to extension and training on agriculture, markets, and nutrition; information sharing among household members; and gendered barriers to the application of extension information.

Figure 3.2 Map of Malawi and the locations of the focus group discussions and districts covered in the household and community surveys used in this paper

Source: IFPRI surveys (2016).
Note: Surveys covered all districts (except Likoma), and 22 focus group discussions conducted by IFPRI in January–February 2017 in 11 communities in eight districts, as marked above. The areas shaded blue are bodies of water.

Indicators

Tables A.2 and A.3 in the appendix show the food security indicators used, measures of the different pathways, various household and community characteristics, and various controls used in the quantitative analysis.

Food Security

We use several food security indicators. First, the household dietary diversity score (HDDS) is applied, which is a count of food groups that household members have consumed over a 24-hour or seven-day reference period, following the approach documented by Swindale and Bilinsky (2006). Past studies show that a higher HDDS is associated with higher per capita consumption of calories in staples and nonstaples (Hoddinott and Yohannes 2002).

Second, the food consumption score (FCS) calculates the frequency of consumption of different food groups by a household during a seven-day reference period, using weights assigned to each food group by nutritional value, adapted from the World Food Programme (WFP 2008). The FCS monitors changes in food-security status across large geographic areas and is positively associated with per capita calorie consumption (Jones et al. 2013; Lovon and Mathiassen 2014).

Third, the household food insecurity access score (HFIAS) captures the experience of food insecurity, calculated following the questions adopted by Coates et al. (2007) reflecting the food insecurity of members of the household.

Value of Production and Productivity

We measure (1) the value of production of all croplands[1] as a proxy for food access from own production and agricultural income of the household and (2) the value of yield per hectare of various crops to measure land productivity. We used farmgate or market price for the produce at the household or village level (whichever is available in the datasets). For productivity, the value of production is used instead of

[1] For the value of production, we focus on quantifying crop production, and we use units of livestock owned separately in the food security models.

quantity of harvest because the majority of the plots were intercropped, making area estimates for each crop difficult to calculate.

Access to Extension and Advisory Services

Access to agricultural extension and advisory services is measured here as a dummy variable corresponding to the question, "Did you or anyone in your household receive any advice on agricultural production or marketing?" The question is asked pertaining to both the last 12 months and the last two years. The sources and the types of topics addressed by the extension services received (agricultural production, marketing, postharvest handling, and nutrition) are included in the datasets, and we use them for disaggregated analysis and measuring heterogeneous effects.

Gender Gaps

The dataset collected by IFPRI (2016) included basic characteristics of all adults in the household (female and male), all plots cultivated with field crops by households and the corresponding plot managers or decision makers, and data on access to knowledge, participation in community process, and technology adoption by the main female and male adult with the household. The household dataset covers 5,065 individual respondents (54 percent female, 46 percent male) from interviews with the main female and main male adults in the 3,001 sample households (if applicable and available). Following the different pathways in Figure 3.1, we computed for the difference between female and male adults within the household in terms of access to extension service, knowledge, technology adoption, and participation in community processes. Our indicators are categorical variables representing no gap (both female and male receives, adopts, or participates), and the presence of a gender gap in either direction (solely male or solely female).

Estimation Methods

In theory, the contribution of a program, project, or service should be evaluated by estimating the average treatment effect on the treated (ATT):

$$E(y_i|I = 1) = E(Y_{i1}|I = 1) - E(Y_{i0}|I = 1), \tag{1}$$

where y_i denotes the unbiased food security effect for households i that have access to knowledge or of any of the HFS pathways described in Figure 3.1. And, for each pathway, we test whether there is an effect of the presence of a gender gap on HFS. Because we do not observe changes in the same households over time, we must compare households that are not identical. If households differ substantially in terms of observed or unobserved characteristics, this will lead to significant bias in the estimated effects. This is a crucial issue in cross-sectional datasets such as ours; however, there are several techniques to minimize this bias when estimating the magnitude of effects of different pathways and to determine whether a gender gap or greater equality matters. Among them are the use of various controls that would minimize the observed heterogeneity across the households through multivariate regression or matching techniques (Chiputwa, Spielman, and Qaim 2015); use of community or district fixed effects to control for heterogeneity coming from these levels (Slavchevska 2015); and use of instrumental variables that are significant in explaining the pathway but not directly affecting the food security outcome indicators in order to control for unobserved heterogeneity (Adams, Almeida, and Ferreira 2009; Sraboni et al. 2014).

We employed these various techniques and compared the results to establish the robustness of our findings. In particular, we used multivariate regression, with many possible controls to address for possible heterogeneity; community or district effects to account for heterogeneity at those levels; and the instrumental variable approach using the predicted probabilities in the first-stage regression models as the instruments in the second stage (following the approach proposed by Adams, Almeida, and Ferreira [2009]). The variable we instrumented for is the receipt of advice, given the focus on information access in this paper. The instruments tried are various variables related to different sources or methods of accessing information or provision of extension services in the community or households, such as the presence of an extension agent in the community, or the frequency of using a radio or phone (see Table A.2 in the appendix). The *F*-statistic is highly significant (*F*-stat = 23.03). We also tried a composite index of these variables using principal component analysis, which is again highly significant in the first-stage model (*F*-stat = 19.34) but not significant in the second-stage model explaining HFS. There is no guarantee that we have addressed all the sources of heterogeneity inherent in cross-sectional data, but our main results are robust and consistent across multiple estimations, implying at least a strong association and an indication of the effect of the gender gaps on the various pathways to HFS.

4. DISCUSSION OF RESULTS

This section describes the results of the mixed-methods analysis. The quantitative model examines the significant pathways to greater HFS in Malawi, focusing on the role of information and advisory services and identifying the effects of gender gaps in agriculture and knowledge using multivariate ordinary least squares (OLS) regression and fixed effects. Table 4.1 shows the results of the estimation models, using HDDS and HFIAS as outcome indicators to examine differences in food security scores across household types. Table 4.2 shows disaggregated food security models restricted to each household type to determine differentiated pathways across them.

Table 4.1 Estimation results on determinants of household food insecurity

Indicators	(1) HDDS /a	(2) HFIAS
Gendered household types		
Households with sole male adults (SMHHs), compared to DMHHs /b	-0.482** (0.214)	0.591 (0.765)
Households with sole female adults (de jure FHHs), compared to DMHHs	0.025 (0.110)	1.170*** (0.376)
Dual-adult households with female head (DFHHs) (de facto FHHs), compared to DMHHs	-0.028 (0.141)	0.553 (0.484)
Own production and agricultural income		
Value of annual crop production (MWK 000) (rainy season) /c	0.000*** (0.000)	-0.004*** (0.001)
Cultivates during dry (second) season (=1)	0.280*** (0.082)	-0.389 (0.280)
Simpson index of diversification /d	-0.081 (0.146)	0.590 (0.500)
% of fruits harvested and consumed by household	0.005*** (0.001)	0.004 (0.004)
% of fruits harvested sold	0.006* (0.003)	-0.024** (0.011)
% of cassava harvested and consumed by household	0.005*** (0.002)	0.003 (0.006)
% of cassava harvested sold	0.009*** (0.003)	-0.017 (0.011)
% of harvests sold (weighted by crop acre)	0.005 (0.003)	-0.030*** (0.010)
% of loss or wastage during postharvest	-0.014*** (0.028)	0.014 (0.094)
Received postharvest advice (=1) /e	0.036 (0.093)	0.191 (0.320)

Table 4.1 Continued

Indicators	(1) HDDS /a	(2) HFIAS
Received market access advice (=1) /e	0.461***	0.433
	(0.105)	(0.362)
Nonfarm income and assets		
Number of goats, sheep, and pigs owned	0.010	-0.216***
	(0.012)	(0.040)
Number of cattle and oxen owned	-0.005	-0.057
	(0.026)	(0.091)
Number of poultry owned	0.019***	-0.073***
	(0.005)	(0.016)
Off-farm is the main source of income (=1)	0.409***	-0.308
	(0.084)	(0.289)
Value of 11 asset types owned by household in 2015 /f	0.614***	-2.142***
	(0.171)	(0.584)
Nutrition knowledge		
Received nutrition advice (=1) /e	0.396***	-0.944***
	(0.091)	(0.311)
Household characteristics		
Highest grade level of education attained by head	0.086***	-0.342***
	(0.011)	(0.039)
Household size	-0.028	0.310***
	(0.018)	(0.063)
Age of head	-0.004	0.002
	(0.003)	(0.009)
Participates in agricultural committees (=1)	0.059	0.265
	(0.086)	(0.296)
Community characteristics		
Community has health facility (=1) /g	0.252***	-0.744***
	(0.096)	(0.211)
District fixed effects /h	YES	YES
Constant	3.737***	11.733***
	(0.189)	(0.650)
Observations	2,699	2,649
R^2	0.150	0.161
Adjusted R^2	0.134	0.144

Source: IFPRI survey (2016).

Note: Standard errors in parentheses; (=1) represents dummy variables and coefficients represent discrete change of dummy variable from 0 to 1; * p < 0.10, ** p < 0.05, *** p < 0.01. /a HDDS (household dietary diversity score), adopted from Swindale and Bilinsky (2006), is a count of food groups, out of 10, that household members have consumed over a 24-hour and seven-day reference period. Results are similar when we used FCS (food consumption score), which is calculated using the frequency of consumption of different food groups by a household during the seven days before the survey, adopted from WFP (2008). Results are also similar when Poisson models are used, which are commonly used for count variables. HFIAS (household food insecurity access score) is calculated following the questions adopted by Coates et al. (2007) reflecting the food insecurity of members of the household. /b DMHH = dual-adult household with male head. /c USD 1 = MWK 720 (average in 2016). We also used landholdings or cropland area in place of production, which yielded similar results. We could not use both simultaneously in the estimation models due to their high correlation. /d SID = Simpson index of diversification = $1 - \sum_{i=1}^{k} p_i^2$, where p = share of land allocated to crop i. /e We also used instruments for advice to account for unobserved heterogeneity, following Adams, Almeida, and Ferreira (2009). Results are similar. /f We also used the 2010 figures to address possible simultaneity, but results are similar. /g We used other community controls such as the presence of grain mills, storage, and irrigation; distance to road and market; and number of projects, associations, and farmer clusters but all are insignificant. /h We also used community fixed effects and the results are similar, although the adjusted R-squared becomes low.

Table 4.2 Estimation results on determinants of household food insecurity, disaggregated by gendered household types

Indicators	(1) HDDS [/a] (dual-adult household)	(3) HDDS (household with female only)	(4) HDDS (household with male only)
Gender gaps			
Both female and male receive nutrition advice, compared to no advice	0.544*** (0.130)		
Only male receives nutrition advice, compared to no advice	0.398*** (0.135)		
Only female receives nutrition advice, compared to no advice	0.062 (0.145)		
Both female and male receive market access advice, compared to no advice	0.877*** (0.233)		
Only male receives market access advice, compared to no advice	0.310** (0.135)		
Only female receives market access advice, compared to no advice	0.543*** (0.207)		
% of acreage jointly managed by female and male	0.004*** (0.001)		
% of acreage managed solely by female	-0.001 (0.003)		
Gender gap in education (male – female)	-0.085*** (0.015)		
Own production and agriculture income			
Value of annual crop production (MWK 000) during rainy season [/b]	0.000 (0.000)	0.003*** (0.001)	0.002 (0.001)
Cultivated during dry season (=1)	0.328*** (0.096)	0.315* (0.186)	-0.338 (0.579)
Simpson index of diversification [/c]	0.088 (0.178)	-0.565* (0.296)	
% of fruits harvested and consumed by household	0.004** (0.002)	0.006** (0.003)	
% of fruits harvested sold	0.003 (0.004)	0.004 (0.008)	
% of cassava harvested and consumed by household	0.003 (0.002)	0.003 (0.005)	
% of cassava harvested sold	0.008** (0.003)	0.033*** (0.011)	
% of harvests sold (weighted by crop acre)	0.005 (0.003)	0.013* (0.007)	-0.009 (0.019)
% of loss or wastage during postharvest	-0.012*** (0.003)	-0.013** (0.006)	
Nonfarm income and assets			
Number of goats, sheep, and pigs owned	0.014 (0.013)	0.010 (0.048)	
Number of cattle and oxen owned	-0.008 (0.029)	0.005 (0.174)	

Table 4.2 Continued

Indicators	(1) HDDS /a (dual-adult household)	(3) HDDS (household with female only)	(4) HDDS (household with male only)
Number of poultry owned	0.014***	0.037**	
	(0.005)	(0.015)	
Off-farm is main income of household	0.426***	0.373**	0.163
	(0.100)	(0.184)	(0.582)
Value of 11 asset types owned by HH in 2015 /d	0.544***	0.794	0.256
	(0.177)	(3.175)	(2.300)
Nutrition knowledge			
Received nutrition advice (=1) /e		0.334*	1.366**
		(0.187)	(0.576)
Household characteristics			
Household size	-0.017	-0.010	-0.256
	(0.022)	(0.045)	(0.176)
Age of head	-0.000	-0.004	-0.003
	(0.004)	(0.006)	(0.015)
Highest grade level of education attained by head	0.129***	0.109	0.095***
	(0.017)	(0.075)	(0.029)
District fixed effects /f	YES	YES	YES
Constant	3.249***	3.578***	3.508***
	(0.234)	(0.449)	(1.053)
Observations	1,938	444	120
R^2	0.158	0.261	0.173
Adjusted R^2	0.133	0.173	0.085

Source: IFPRI surveys (2016).

Note: Standard errors in parentheses; (=1) represents dummy variables and coefficients represent discrete change of dummy variable from 0 to 1; * p < 0.10, ** p < 0.05, *** p < 0.01. /a HDDS (household dietary diversity score). Results are similar when we used FCS (food consumption score) and HFIAS (household food insecurity access score). /b USD 1 = MWK 720 (average in 2016). We also used landholdings or cropland area in place of production, which yielded similar results. We could not use both simultaneously in the estimation models due to their high correlation. /c SID = Simpson index of diversification = $1 - \sum_{i=1}^{k} p_i^2$, where p = share of land allocated to crop i. /d We also used the 2010 figures to address possible simultaneity, but results are similar. /e We also used instruments for advice to account for unobserved heterogeneity, following Adams, Almeida, and Ferreira (2009). Results are similar. /f We also used community fixed effects and the results are similar, although the adjusted R-squared becomes low.

The qualitative data examine behaviors and preferences related to accessing extension and advisory services for agriculture, marketing, and nutrition. Specifically, women and men were asked to discuss who usually attends training and meetings or receives information on these topics (women, men, or both). In addition, the sharing of information was discussed, as well as differences in the application of the information depending on who attended the training.

Food Security by Gendered Household Types

We find more muted results for the difference in HFS between FHHs and MHHs, which is heavily emphasized in the literature. We find that sole female adult households (SFHHs) (commonly known in the literature as de jure FHHs) have lower food security as measured by HFIAS than other household types. However, they do not have statistically different HDDS and FCS than other household types. Surprisingly, we find lower HDDS and FCS for sole male adult households (SMHHs) compared to other household types, after controlling for various observed characteristics. From Table 4.3, these gender differences depend on the food groups. SMHHs are less likely to consume roots and tubers, legumes and nuts, and vegetables than other households. However, SFHHs are less likely to consume roots and tubers, meat, milk products, fats and oil, and sugar than other households. These results highlight the need to include men, especially those in SMHHs, in nutrition education programs and not to limit these programs to women, which reflects stereotypical gendered responsibilities.

Table 4.3 Difference in consumption of food groups by gendered household types

Food groups	Total	Dual-adult households	Households with sole female adults	Households with sole male adults
Whether household members consumed the food group in the last 24 hours (figures are the proportion of those households consuming)				
Grains and cereals	0.96	0.96	0.97	0.90
Root, tubers	0.37	0.39	0.29	0.30
Legumes and nuts	0.43	0.45	0.39	0.31
Vegetables	0.85	0.85	0.85	0.72
Meat, fish, egg	0.49	0.51	0.37	0.45
Fruits	0.21	0.22	0.17	0.20
Milk and milk products	0.11	0.11	0.07	0.19
Fats and oil	0.43	0.45	0.34	0.45
Sugar	0.34	0.35	0.29	0.37
Spices	0.63	0.63	0.65	0.61
Count of days in a week when household members consumed the particular food group (figures are the average number of days per week, 0–7)				
Grains and cereals	6.33	6.36	6.31	5.88
Root, tubers	1.38	1.48	0.99	1.04
Legumes and nuts	1.28	1.34	1.10	0.85
Vegetables	4.68	4.71	4.72	3.79
Meat, fish, egg	1.51	1.59	1.06	1.82
Fruits	0.84	0.89	0.67	0.66
Milk and milk products	0.48	0.48	0.34	0.96
Fats and oil	2.21	2.33	1.58	2.43
Sugar	1.78	1.83	1.46	2.05
Spices	4.35	4.34	4.40	4.16

Source: IFPRI survey (2016).

Based on further analysis of the data, 38 percent of men in SMHHs have never been married, 40 percent are separated or divorced, and 22 percent are widowers. They have the lowest access to nutrition advice and therefore are least likely to be aware of messages such as the need to consume six food groups daily and other nutrition messages. Given the strong social imperative that women be responsible for food preparation, men are not usually trained in these activities, and therefore we find that they are lagging behind in terms of consumption of diverse foods.

From the own production pathway, we find that households with both genders or dual-adult households with female head (DFHHs) (commonly known in the literature as de facto FHHs) have lower crop production and productivity per hectare than other household types, while SMHHs are less likely to adopt management practices than other household types (Table A.4 in the appendix). The latter may be due to their smaller household size and its implications for farm labor.

Our results highlight the need for more nuanced analysis rather than simply comparing food security levels between male- and female-headed households. It is clear from our results that differences across household types are not straightforward and depend on the differentiated pathways to food security. We further discuss these differences below.

Gendered Access to Information

Access to nutrition education is found to be a significant driver for HFS, as measured by HDDS. There is heavy emphasis on maize *nsima*, a dish made mostly of maize flour, in the diets of most households in Malawi (Table 4.3, in which the grains and cereals category is mostly maize *nsima*). Regardless of the household type, there is very low consumption of milk products and fruits. Only 11 percent of households consume milk or milk products daily, and the average frequency of consumption is about once every two or three weeks. Even for nonmaize staple crops such as roots, tubers, legumes, and nuts, only 37–43 percent of households are consuming these on a daily basis, or only once every week or two on average. While these results are impacted by socially based food preferences and limited access to diverse foods, the positive association with nutrition extension and education indicates that nutrition education is one important strategy for improving food security and diet diversity in the Malawian context.

Access to agricultural extension is a predictor of own production, which in turn influences HFS. Access to market information, in addition to production advice, is associated with higher production and HFS. Based on these results, combining agriculture, market, and nutrition information provision among rural producers proves to be a significant driver for HFS. This is the main idea of the farmer business schools, which are being promoted by several government and nongovernment programs and are showing promising results (based on a survey of key informants conducted November 7–10, 2016).

The strongest association with HFS is the nutrition education provided to SMHHs, which is consistently shown in Tables 4.1 and 4.2. Within dual-adult households (DMHHs and DFHHs), those in which both female and male heads receive nutrition education have the highest HFS. These results align with studies that emphasize the importance of nutrition education (Arimond et al. 2011; Girard et al. 2012; Kerr et al. 2016). Moreover, higher HFS is also associated with both female and male heads receiving agricultural and market information. This is consistent with studies highlighting the joint participation of women and men in training and access to extension services (Lambrecht et al. 2016 on adoption of mineral fertilizer in eastern Democratic Republic of Congo).

We further examine these pathways, and explanations for their significance, through insights from the focus group discussions. The qualitative results yield a typology of gendered approaches to extension services and other human capacity strengthening in the household and the community. The first approach divides capacity-strengthening activities in line with stereotypical gender roles, in which only women attend nutrition-focused training and meetings and only men attend agriculture and marketing training and meetings. This approach was commonly found in remote communities. The second approach emphasizes attendance for men and women across all categories of training and meetings. In the third approach, women more frequently attend agricultural or nutrition training and meetings than men, even in the case of dual-adult households (DMHHs and DFHHs). This third approach was most commonly described across respondents, especially by women. However, rather than being viewed as an empowering opportunity to participate in more training than their husbands or other men in the community, it was described as a burden placed on them by busy or disinterested husbands.

In communities that divided training according to stereotypical gender roles, women were seen as caring for the home and the kitchen while men were described as “directors of agriculture” in the home. In communities where women participated most, women and men explained that men were apparently disinterested or prideful. Sometimes men explained that they were busy doing piecework or fishing, which made it impossible for them to participate in training. Men often explained that they were busier than women, so they sent their wives to participate. The presence of groups, projects, or cooperatives was frequently described as a reason why men and women would both attend a training session. The quotes below illustrate the common view that women were tasked with participation in training, either because men were earning off-farm income or because they were negligent:

> Female respondent: *“Men are not always around home; they are even somewhere playing Bawo [board game], or having a drink. Whilst women we are mostly at the house, so any message that wants a family representation, women find themselves there, and men just hear the end results.”*
>
> Male respondent: *“In most meetings it is the women that dominate because for us men we go to look for money to buy food for the house.”*

Even though most communities placed responsibility on women to attend training, there were often exceptions; in these cases, men were still described as having higher access to market information. And even when respondents described joint participation, nutrition training sessions were a common exception, as they were still primarily attended by women.

We also explored the patterns of information sharing within the household when only one household member attended. While it was common to share information, a number of constraints were mentioned, both to sharing and to applying the information learned. Women reported having to approach information sharing cautiously so as not to hurt the pride of their husbands, or to avoid times when they had been drinking. Men sometimes questioned the ability of their wives to comprehend training messages and noted that their wives at times resisted new approaches the men learned without them. The following quotes illustrate challenges to sharing information in the household:

> Female respondent: *“We just need to find a good time to tell the husband, and see his mood at the time before telling them what we want to say. Otherwise they will beat you.”*

> Male respondent: *"When the males learn separate, the female will oppose because they have not heard, and also when the female learn in absence of a male, the males will also argue because they were not taught together."*

Another quote illustrates the barriers to accepting the shared messages when men question women's understanding of the messages they learn:

> Male respondent: *"I might think she is lying [incorrect] and the extension agent can explain better, and because she did not ask the extension worker did not explain."*

Finally, a number of respondents described the potential benefits of learning together. In addition to ensuring that the family retained the information, frequently they described a need for the household to learn together in order to support a unified vision for the development of the household moving forward. This idea is illustrated in the quote below:

> Female respondent: *"[If we learn together] there won't be any tricks towards each other. If you have agreed on what to grow, let's say peas, then come the time of selling, everyone will have the sense of ownership and with equal contribution we can all make sure that the money is [going] towards improving the household, because the woman's money is mostly used on the household. But such things can only happen if we would have more of these kinds of meeting that would see both men and women together and learn as a family."*

Other Gendered Pathways to Household Food Security

Our results confirm earlier findings that own crop production is a strong predictor of HFS. Gendered plot management seems to matter both directly, through consumption of own production, and indirectly, as an asset useful for food purchase and risk management (Table 4.1 and Table A.5). Greater acreage jointly managed by women and men within households is associated with greater HFS. Our data show that regardless of the crop, roughly 43–49 percent of plots are jointly managed, and 22–33 percent are managed by women or men only. The proportion of plots managed solely by women is not very different from that of plots managed solely by men, with a slightly greater proportion of female-only managers for vegetables and a greater proportion of male-only managers for tobacco. This debunks the notion of gendered crops (Doss 2001; Aberman and Roopnaraine 2015), as decision making and management are largely shared by females and males regardless, and depend more on household dynamics and strategic alliances than commonly described in the literature (for example, Randolph and Sanders 1988).

Our results also confirm the critical importance of assets (especially livestock units) and other sources of food or income (dry-season farming, harvesting tree crops and cassava, and nonfarm income), both to directly purchase food and to increase own production (Table 4.1 and Table A.4). In particular, off-farm income and landholdings are strong predictors of technology adoption. This is consistent across household types.

There is some evidence that commercialization of production is a significant predictor of HFS, as found in previous studies (Kennedy 1994; Mazunda, Kankwamba, and Pauw 2015). It is especially important for SFHHs. There are indications of postharvest losses affecting HFS, but they are significant in only a few models. This contrasts with earlier studies (see FAO 2013; Gustavsson et al. 2011; HLPE 2014) but is in line with the complexities of measuring food wastage and loss highlighted by Chaboud and Daviron (2017). We did not find evidence of a positive association between crop diversification and household dietary diversity, in contrast to other studies (see Jones, Shrinivas, and Bezner-Kerr 2014; Mazunda, Kankwamba, and Pauw 2015). However, we find strong evidence of planting cassava and fruit trees and harvesting fruits and cassava, either for own consumption or for sale, to be strong predictors of HFS.

We also find a positive association between participation in agricultural and development committees and production, although not directly on HFS (in contrast to Sraboni et al. 2014). Similar to the training and meetings discussed above, participation by both women and men in agricultural and development committees is associated with higher HFS.

Lastly, the education level of the household head is very important for all household types. Moreover, within dual-adult households (DFHHs and DMHHs), closing the gender gap in education is also a predictor of HFS. Female adults having an education level that is closer to that of their husbands or male adults in the household is associated with greater HFS. This may be important because the ability to understand extension messages may be dependent on the level of education and literacy of the rural population.

5. CONCLUSIONS

Our results confirm earlier findings that education, assets (most importantly, livestock units), and other sources of food or income (dry-season farming, planting trees and harvesting fruits, and nonfarm income), access to information, and agricultural productivity-enhancing technologies are significant factors affecting HFS. We also demonstrate that the content or topic of extension services and information provided matters. Education on nutrition and market access is consistently and positively associated with better food security. Additionally, advice on agricultural production and market access is also consistently and positively associated with better agricultural production, which is a critical pathway to HFS. Combined provision of agriculture, market, and nutrition information for rural producers proves to be a significant driver for HFS. Closing the gender gaps in these various pathways also clearly accelerates improvements in HFS, which in turn fuel greater food security at the community and national levels.

This joint participation in nutrition education can also empower women by making men key partners in ensuring good household nutritional outcomes along with women. That is, given women's increasing participation in activities outside the household (for example, political, training attendance, and economic activities), sharing this responsibility with their husbands can be tremendously useful for the division of household chores and for making joint decisions about resource allocation.

While we would expect women's access to information and training to lead to improved food security (via empowerment and productive capacity), the quantitative results also show that joint access is a much more powerful driver of food security, especially for nutrition and marketing information. The qualitative evidence adds to this powerfully in that women in dual-adult households are frequently given the responsibility of attending training and meetings. This tendency, counter to common conceptualizations of gendered responsibilities, reflects the discourse on women's time poverty, in which many gendered development interventions unintentionally increase the time burden faced by women (Herforth and Harris 2014). Thus, while we would expect information and training to be empowering for women, it can also be an added burden.

Whether or not these training sessions or meetings are viewed as extra work may depend on their quality and their ability to strengthen capacity (see Ragasa, Mazunda, and Kadzamira 2016). Moreover, exploiting other cost-effective delivery methods, such as radio and phone messaging, can be a useful way to minimize the time burden of participation in human capacity-strengthening programs. These mass media can be especially useful for awareness campaigns, which can then be followed up with more intensive training and farm demonstrations based on the demand and needs of the communities. The location and timing of more intensive training and meetings should be chosen in such a way as to increase the likelihood of participation by both men and women without taxing other productive activities, household chores, and child care.

Women and men both report barriers to sharing and applying information learned from training sessions and meetings attended alone. In particular, joint attendance was viewed as important both to reinforce the messages learned in order to facilitate adoption and to promote a unified whole-family approach to household development, as suggested by Cornwall (2000). Furthermore, barriers to the sharing and adoption of the information and messages learned by women likely diminish the importance of receiving those messages, as women in dual-adult households are tasked with hearing the messages but have limited ability to apply them, which is similar to the findings of Mutenje et al. (2016).

With respect to the gendered household types, this paper finds that, contrary to widespread belief, FHHs are not always the most food insecure. We highlight here a more nuanced analysis and interpretation due to the complexities of the pathways to HFS. SFHHs (or those commonly called de jure FHHs in the literature) have lower food security in some aspects and SMHHs are disadvantaged in other aspects. Both have indications of lower levels of HFS. While narrowing the gaps between FHHs and MHHs can contribute to food security, this focus would be incomplete and insufficient for addressing food insecurity holistically. What our study highlights is a differentiated strategy for dual-adult households (most of these are those called MHHs in the literature) to ensure that both female and male decision makers have access to information and to close the gender gaps in terms of education, participation in community committees and processes, and plot management. For SMHHs, formal education and literacy levels and nutrition education seem to be the most significant pathway to improved food security. For SFHHs, landholdings, harvesting tree crops, assets, and health-related information seem to be the most relevant characteristics driving HFS.

Our results also have implications for national nutritional policy. Recent efforts toward "gender-sensitive" nutrition policies still consider nutrition a women's responsibility (Mkandawire, Hendricks, and Mkandawire 2016). However, our results indicate that food and nutrition security should be a shared and joint responsibility of women and men. Household food and nutrition security can be improved by delivering nutritional advice to men and women jointly at the household and the community level and by making both men and women responsible for HFS and nutritional outcomes.

APPENDIX: SUPPLEMENTARY TABLES

Table A.1 Selected literature on gender dimensions of food security

Author(s) (Year)	Country	Some key results	Sample	Dependent variable(s)	Key independent variable(s)
Tibesiga and Visser (2016)	South Africa (urban and rural areas)	MHHs are more food secure than FHHs; there is a wider food security gap in rural areas.	1,100 households engaged in smallholder subsistence farming	A subjective and an objective measure of household food security	Male- vs. female-headed households
Schmeer et al. (2015)	Nicaragua	Maternal access to social and economic resources reduces household food insecurity.	Sample of 443 households in Leon, Nicaragua	Perceived household food insecurity, adult and child food insecurity	Maternal economic and social resources
Kassie, Stage et al. (2015)	Malawi	FHHs have lower food security than MHHs due to lower levels of productive assets and returns to these resources.	Nationally representative sample of 1,920 farm households and 6,052 plot-level observations	Self-reported subjective household food security status	Male- vs. female-headed households, de jure and de facto
Kassie, Ndiritu, and Stage (2013)	Kenya	The food security gap between MHHs and FHHs is explained by differences in their observable and unobservable characteristics.	Household and plot data from 605 farm households and 2,831 plots in 88 villages in five districts	Households' self-reported subjective food security status	Male- vs. female-headed households, de jure and de facto
Sraboni et al. (2014)	Bangladesh	Increases in women's empowerment are positively associated with calorie availability and dietary diversity at the household level.	Nationally representative sample of rural Bangladesh; final sample of 3,273 farm households	Per capita calorie availability, household dietary diversity (7-day recall), and adult BMI	Women's Empowerment in Agriculture Index
Mallick and Rafi (2010)	Bangladesh	There are no significant differences in the food security between FHHs and MHHs of indigenous ethnic groups. The result does not hold if Bengalis (outside the indigenous groups) are included in the sample.	510 households from each of the five ethnic groups, totaling 2,550 households	Households' self-reported subjective food security status	Male- vs. female-headed households (dichotomous measure, self-reported) based on (1) income earner and (2) ultimate decision maker in family
Owusu et al. (2011)	Ghana	Nonfarm work improves household income and food security status. Males contributed to higher incomes and better food security than their female counterparts.	300 households in 10 rural communities	Household income and food security indicators: (1) household does not mortgage its standing field crops for current consumption and (2) household's harvested food stock declines during critical periods of food shortages	Household participated in cash-oriented nonfarm work or not, disaggregated male- vs. female-headed households

Table A.1 Continued

Author(s) (Year)	Country	Some key results	Sample	Dependent variable(s)	Key independent variable(s)
Babatunde et al. (2008)	Nigeria	FHHs used more of the severe coping strategy of skipping meals. Education and off-farm income helps FHHs improve food security, while farm size and crop output will be more beneficial for MHHs.	Representative sample of 60 farm households in Kwara state in north-central Nigeria	Level of vulnerability to food insecurity: index based on how the households adapt to the presence or threat of food shortages—use, frequency, and severity of using coping strategies such as consuming less food	Female- vs. male-headed households
Levin et al. (1999)	Ghana	Women are less likely to be employed as wage earners, and more likely to work as street food vendors or petty traders, but tend to allocate more of their budget to basic goods. Women earn lower incomes, but tend to allocate more of their budget to basic goods for themselves and their children, while men spend more on entertainment for themselves only. Despite lower incomes and additional demands on their time as housewives and mothers, FHHs, petty traders, and street food vendors have the largest percentage of food-secure households.	559 urban households in 16 enumeration areas	Household food budget share, calories per adult equivalent unit per day, and price per 1,000 calories	Female- vs. male-headed households
Kennedy and Peters (1992)	Kenya and Malawi	Food security and preschooler nutritional status are influenced by the interaction of income and the gender of the head of household. The proportion of income controlled by women has a positive influence on caloric intake.	Not specified	Household caloric intake and child caloric intake	Female- vs. male-headed households, de jure and de facto and migrant

Source: Various studies specified in the table.
Note: BMI = body mass index; FHH = female-headed household; MHH = male-headed household.

Table A.2 Descriptive statistics of variables used in the estimations (N = 3,001 households; 299 communities)

Variable	Mean	SD	Min.	Max.
Outcome variables				
Household dietary diversity score (HDDS)	4.82	2.15	0.00	10.00
Food consumption score (FCS)	34.60	18.52	0.00	126.00
Household food insecurity access score (HFIAS)	9.91	7.61	0.00	27.00
Value of production (MWK 000) during 2016 rainy season *	201.64	297.38	1.96	4,043.25
Value of production (MWK 000 / hectare) during 2016 rainy season *	81.99	74.69	1.28	704.15
Agricultural diversification, commercialization, and postharvest loss				
% of fruits harvested that are consumed by household	17.02	31.46	0.00	100.00
% of fruits harvested that are sold	2.74	11.56	0.00	100.00
% of cassava roots harvested that are consumed by household	6.49	22.79	0.00	100.00
% of cassava roots harvested that are sold	1.97	11.92	0.00	100.00
Simpson crop diversification index *	0.60	0.30	0.00	1.00
Planted more than 1 crop (0/1) *	0.54	0.50	0.00	1.00
Number of different crops planted *	2.84	1.31	1.00	9.00
% of harvest sold (weighted by crop acreage)	7.70	14.09	0.00	100.00
Cultivated during dry (second) cropping season (0/1) *	0.38	0.49	0.00	1.00
Number of maize bags wasted or lost during postharvest of 10 bags	0.40	1.42	0.00	10.00
Indicators of income and assets				
Main source of income is off-farm (0/1)	0.34	0.47	0.00	1.00
Landholding (acre)	2.78	3.22	0.00	79.47
Land area cultivated with crops (acre) *	2.41	2.04	0.00	21.27
Livestock units owned				
Number of goats, sheep, and pigs owned	1.78	3.55	0.00	71.00
Number of cattle and oxen owned	0.34	1.62	0.00	26.00
Number of poultry owned	5.01	8.88	0.00	120.00
Nonfood per capita expenditure (MWK 000,000)	0.18	0.04	0.00	11.00
Value of assets (MWK 000,000)	0.05	0.27	0.00	8.89
Access to extension and advisory services *				
Received some nutrition- or health-related advice in past 2 years (0/1)	0.58	0.49	0.00	1.00
Received some agriculture-related advice in past 2 years (0/1)	0.52	0.50	0.00	2.00
Received some market-access-related advice in past 2 years (0/1)	0.21	0.41	0.00	1.00
Received some processing- or postharvest-related advice in past 2 years (0/1)	0.31	0.46	0.00	1.00
Awareness of improved practices *				
Number of improved agricultural technologies members have knowledge of	4.67	3.08	0.00	11.00
Members have knowledge of dietary diversity practices (0/1)	0.73	0.45	0.00	1.00
Members have knowledge of iron-rich foods (0/1)	0.31	0.46	0.00	1.00
Members have knowledge of the benefits of iodized salt (0/1)	0.54	0.50	0.00	1.00
Indicators of connectivity				
Number of associations that head is a member of	0.35	0.66	0.00	7.00
Members participate in village agricultural committees (0/1)*	0.37	0.48	0.00	1.00
Frequency of going to markets (1 = most frequent, 5 = least frequent)	3.25	1.03	1.00	5.00
Frequency of going to town (1 = most frequent, 5 = least frequent)	1.92	0.92	1.00	5.00

Table A.2 Continued

Variable	Mean	SD	Min.	Max.
Adoption of technologies *				
Quantity of inorganic fertilizer applied (kg)	105.63	162.07	0.00	2,725.00
Applied organic fertilizer (0/1)	0.45	0.50	0.00	1.00
% of crop area planted with modern varieties	0.80	0.34	0.00	1.00
Number of improved practices adopted	2.06	1.24	0.00	9.00
Household characteristics				
Age of head	40.72	15.81	15.00	90.00
Highest education grade level attained by head	5.82	3.80	0.00	15.00
Male head (0/1)	0.75	0.43	0.00	1.00
Member is a lead farmer (0/1)	0.16	0.36	0.00	1.00
Household size	5.07	2.39	1.00	32.00
Community characteristics (N = 299)				
Distance to nearest market (km)	3.67	4.96	0.00	30.00
Distance to nearest paved road (km)	15.42	18.36	0.00	132.00
Number of development projects in community	3.01	1.61	0.00	9.00
Community has adopted Model Village concept (0/1)	0.20	0.40	0.00	1.00
Community has elementary school (0/1)	0.81	0.40	0.00	1.00
Community has mills (0/1)	0.70	0.46	0.00	1.00
Community has storage facility (0/1)	0.20	0.40	0.00	1.00
Community has irrigation infrastructure (0/1)	0.26	0.44	0.00	1.00
Number of farmer clusters in the community	3.44	25.98	0.00	400.00
Instruments for advice tried				
Number of extension workers working in the community	1.19	0.73	0.00	8.00
Extension worker lives in the community (0/1)	0.24	0.43	0.00	1.00
Frequency of using radio (1 = most frequent, 5 = least frequent)	2.42	1.50	1.00	5.00
Frequency of viewing television (1 = most frequent, 5 = least frequent)	4.40	1.06	1.00	5.00
Frequency of using cell phone (1 = most frequent, 5 = least frequent)	2.30	1.53	1.00	5.00
Community has health facility (0/1)	0.25	0.43	0.00	1.00
Number of lead farmers in the community	2.60	2.97	0.00	40.00
Resident of the community was a member of Parliament (0/1)	0.08	0.28	0.00	1.00
Current resident of the community is a member of Parliament (0/1)	0.10	0.30	0.00	1.00
Member of Parliament visited in the last 6 months (0/1)	0.25	0.43	0.00	1.00

Source: IFPRI survey (2016).
Note: *Variables with gender gap within households in the datasets. HDDS, adopted from Swindale and Bilinsky (2006), is a count of food groups, out of 10, that household members have consumed over a seven-day reference period. FCS is calculated using the frequency of consumption of different food groups by a household during the seven days before the survey, adopted from WFP (2008). HFIAS is calculated following the questions adopted by Coates et al. (2007) reflecting the food insecurity of members of the household. SID = Simpson index of diversification = $1 - \sum_{i=1}^{k} p_i^2$, where p = share of land allocated to crop i. USD 1 = MWK 720 (average in 2016).

Table A.3 Descriptive statistics of gender gap variables used in the estimations (N = 3,001 households)

Variable	Mean	SD	Min.	Max.
Gender gap in access to nutrition extension				
No member received nutrition advice (0/1)	0.42	0.49	0.00	1.00
Both female and male received nutrition advice (0/1)	0.20	0.40	0.00	1.00
Only male received nutrition advice (0/1)	0.16	0.37	0.00	1.00
Only female received nutrition advice (0/1)	0.21	0.41	0.00	1.00
Gender gap in access to production extension				
No member received production advice (0/1)	0.48	0.50	0.00	1.00
Both female and male received production advice (0/1)	0.16	0.37	0.00	1.00
Only male received production advice (0/1)	0.20	0.40	0.00	1.00
Only female received production advice (0/1)	0.16	0.37	0.00	1.00
Gender gap in access to market access extension				
No member received market access advice (0/1)	0.79	0.41	0.00	1.00
Both female and male received market access advice (0/1)	0.03	0.17	0.00	1.00
Only male received market access advice (0/1)	0.12	0.33	0.00	1.00
Only female received market access advice (0/1)	0.06	0.24	0.00	1.00
Gender gap in access to postharvest extension				
No member received postharvest advice (0/1)	0.69	0.46	0.00	1.00
Both female and male received postharvest advice (0/1)	0.07	0.26	0.00	1.00
Only male received postharvest advice (0/1)	0.14	0.35	0.00	1.00
Only female received postharvest advice (0/1)	0.10	0.30	0.00	1.00
Gender gap in awareness of nutrition practices				
No member is aware of dietary diversity practice (0/1)	0.27	0.42	0.00	1.00
Both female and male are aware of dietary diversity practice (0/1)	0.32	0.46	0.00	1.00
Only male is aware of dietary diversity practice (0/1)	0.15	0.36	0.00	1.00
Only female is aware of dietary diversity practice (0/1)	0.26	0.44	0.00	1.00
Gender gap in participation in community committees and meetings				
No member participates (0/1)	0.63	0.48	0.00	1.00
Both female and male participate (0/1)	0.08	0.27	0.00	1.00
Only male participates (0/1)	0.17	0.38	0.00	1.00
Only female participates (0/1)	0.12	0.32	0.00	1.00
Gender gap in land access				
% of plot acreage managed by female solely	25.16	42.63	0.00	100.00
% of plot acreage managed by male solely	34.78	46.15	0.00	100.00
% of plot acreage managed by both female and male jointly	40.07	47.87	0.00	100.00
Gender gap in education				
Highest education grade level of male minus education grade level of female	1.28	4.17	-15.00	15.00

Source: IFPRI survey (2016).

Table A.4 Estimation results on determinants of value of crop production, productivity, and technology adoption

Indicators	(1) Value (MWK 000) /a	(2) Productivity (MWK 000/ha) /a	(3) Number of improved ag. practices adopted /b
Gendered household types			
Households with sole male adults (SMHHs), compared to dual-adult households with male head (DMHHs) /c	8.944	1.891	-0.211***
	(22.626)	(7.389)	(0.079)
Households with sold female adults (de jure FHHs), compared to DMHHs	1.201	-5.652	-0.007
	(11.687)	(3.818)	(0.039)
Dual-adult households with female head (DFHHs) (de facto FHHs), compared to DMHHs	-35.113**	-16.359***	-0.009
	(14.950)	(4.883)	(0.048)
Input use and technology adoption			
Quantity of inorganic fertilizer used (kg)	0.482***		
	(0.030)		
Quantity of inorganic fertilizer used (kg/acre)		0.001***	
		(0.000)	
Applied organic fertilizer (=1)	5.796	4.870*	
	(8.376)	(2.736)	
% of cropland acres with modern variety	22.688*	7.271*	
	(12.302)	(4.015)	
Number of improved management practices adopted	7.323**	3.289***	
	(3.631)	(1.186)	
Nonfarm income and assets			
Off-farm is main source of income	-3.132	-0.058	-0.067**
	(8.789)	(2.870)	(0.029)
Crop area (acre)	52.632***	-5.984***	0.035***
	(2.506)	(0.768)	(0.007)
Value of 11 asset types owned by household in 2015 /d	28.493	15.197**	0.016
	(18.603)	(5.976)	(0.044)
Number of goats, sheep, and pigs owned	6.533***	1.969***	0.002
	(1.231)	(0.400)	(0.003)
Number of cattle and oxen owned	8.658***	1.468	-0.009
	(2.767)	(0.901)	(0.008)
Number of poultry owned	2.646***	0.944***	0.002
	(0.490)	(0.160)	(0.001)
Access to extension services			
Received production advice (=1) /e	8.129	7.077**	0.157***
	(9.116)	(2.974)	(0.030)
Received market access advice (=1) /e	27.166**	0.950	0.140***
	(10.789)	(3.524)	(0.033)

Table A.4 Continued

Indicators	(1) Value (MWK 000) /a	(2) Productivity (MWK 000/ha) /a	(3) Number of improved ag. practices adopted /b
Household characteristics			
Highest grade level of education attained by head	2.595**	2.096***	0.007*
	(1.219)	(0.398)	(0.004)
Household size	-1.034	-0.051	0.010*
	(1.943)	(0.634)	(0.006)
Age of head	-0.700**	-0.123	0.001
	(0.286)	(0.093)	(0.001)
Member participates in agricultural committees	15.688*	2.167	0.169***
	(9.236)	(3.017)	(0.029)
Agroecological conditions			
10-year average temperature (Celsius)	-14.951**	-11.047***	-0.040*
	(6.819)	(2.215)	(0.022)
Number of abnormal months in 2016	3.263	-8.610**	-0.019
	(12.592)	(4.093)	(0.041)
District fixed effects /f	YES	YES	YES
Constant	-43.208**	62.118***	
	(20.729)	(6.769)	
Observations	2,750	2,750	3,000
R^2	0.466	0.092	
Adjusted R^2	0.457	0.076	
Log lik.			-4,539.262
Chi-squared			333.099

Source: IFPRI survey (2016).

Note: Standard errors in parentheses; (=1) represents dummy variables and coefficients represent discrete change of dummy variable from 0 to 1; * p < 0.10, ** p < 0.05, *** p < 0.01. /a Log forms were also used but the signs of the variables of interest are the same. /b Estimated using Poisson models, which are commonly used for count data. /c USD 1 = MWK 720 (average in 2016). We also used landholdings or cropland area in place of production, which yielded similar results. We could not use both simultaneously in the estimation models due to their high correlation. /d We also used the 2010 figures to address possible simultaneity, but results are similar. /e We also used instruments for advice to account for unobserved heterogeneity, following Adams, Almeida, and Ferreira (2009). Results are similar. /f We also used community fixed effects and the results are similar, although the adjusted *R*-squared becomes low.

Table A.5 Estimation results on determinants of value of crop production, productivity, and technology adoption, disaggregated by household type

Indicators	(1) Value of prod. (DMHH)	(2) Value of prod. (DFHH)	(3) Value of prod. (SFHH)	(4) Value of prod. (SMHH)	(5) Value of prod. per ha (DMHH)	(6) Value of prod. per ha (DFHH)	(7) Value of prod. per ha (SFHH)	(8) Value of prod. per ha (SMHH)
<u>Gender gaps</u>								
Both female and male receive production advice, compared to no advice	33.741**	-21.099			8.175*	-16.434		
	(16.310)	(66.738)			(4.947)	(25.732)		
Only male receives production advice, compared to no advice	4.891	-15.487			10.099**	26.779		
	(14.473)	(50.207)			(4.396)	(19.428)		
Only female receives production advice, compared to no advice	-17.989	3.894			-4.524	9.787		
	(19.732)	(23.661)			(5.992)	(9.110)		
% of acreage jointly managed by female and male	0.278**	1.784**			0.036	0.258		
	(0.118)	(0.867)			(0.036)	(0.336)		
% of acreage managed solely by female	0.429	1.604*			-0.011	0.272		
	(0.405)	(0.853)			(0.123)	(0.330)		
Gender gap in education (male – female)	0.412	0.334			-0.224	-0.232		
	(1.816)	(2.876)			(0.551)	(1.113)		
Both female and male participate in committees, compared to no participation	33.524*	-98.462			4.229	-21.654		
	(19.564)	(88.195)			(5.943)	(33.927)		
Only male participates in committees, compared to no participation	21.536	5.557			1.685	20.549		
	(14.310)	(52.767)			(4.346)	(20.400)		
Only female participates in committees, compared to no participation	-6.047	-8.966			-3.462	-3.760		
	(20.921)	(25.824)			(6.354)	(9.901)		

Table A.5 Continued

Indicators	(1) Value of prod. (DMHH)	(2) Value of prod. (DFHH)	(3) Value of prod. (SFHH)	(4) Value of prod. (SMHH)	(5) Value of prod. per ha (DMHH)	(6) Value of prod. per ha (DFHH)	(7) Value of prod. per ha (SFHH)	(8) Value of prod. per ha (SMHH)
Input use and technology adoption								
Quantity of inorganic fertilizer used (kg)	0.462*** (0.035)	0.513*** (0.128)	0.411*** (0.089)	0.420* (0.211)				
Quantity of inorganic fertilizer used (kg/acre)					0.001*** (0.000)	-0.000 (0.004)	0.042** (0.016)	0.028 (0.021)
Applied organic fertilizer (=1)	1.384 (11.243)	34.146 (20.652)	0.065 (10.613)	12.500 (24.836)	4.363 (3.415)	15.101* (8.010)	6.284 (6.263)	2.810 (15.297)
% of cropland acres with modern variety	28.728* (17.159)	-13.661 (33.361)	12.198 (13.189)	32.443 (30.313)	5.305 (5.203)	3.207 (12.847)	5.362 (7.817)	37.023* (18.818)
Number of improved management practices adopted	6.493 (4.684)	20.775** (10.433)	-4.370 (5.109)	10.512 (13.290)	3.496** (1.423)	4.262 (4.029)	0.733 (3.022)	-0.444 (8.270)
Nonfarm income and assets								
Off-farm is main source of income (=1)	-3.175 (11.801)	6.570 (25.513)	-9.284 (10.788)	-20.255 (23.800)	0.656 (3.584)	3.853 (9.894)	-0.187 (6.400)	-21.520 (14.823)
Crop acre (acre)	54.429*** (3.202)	44.993*** (7.620)	24.535*** (5.261)	61.194*** (4.773)	-5.446*** (0.905)	-4.100 (2.857)	-16.171*** (2.928)	-5.691* (2.935)
Value of 11 asset types owned by household in 2015	17.703 (21.465)	44.527 (89.021)	378.517* (193.790)	251.295*** (91.984)	11.272* (6.423)	60.841* (34.093)	206.822* (114.789)	76.886 (51.332)
Number of goats, sheep, and pigs owned	6.519*** (1.505)	2.907 (3.315)	12.753*** (2.748)	7.665 (8.365)	1.770*** (0.455)	2.135* (1.262)	3.292** (1.621)	-1.061 (5.227)
Number of cattle and oxen owned	11.026*** (3.369)	-5.744 (7.306)	16.091 (10.783)	4.784 (12.050)	1.759* (1.020)	-0.849 (2.758)	-0.781 (6.397)	5.630 (7.083)
Number of poultry owned	2.626*** (0.606)	3.137** (1.543)	1.975** (0.917)	-1.462 (2.110)	0.915*** (0.184)	0.934 (0.598)	1.502*** (0.545)	-0.684 (1.314)

Table A.5 Continued

Indicators	(1) Value of prod. (DMHH)	(2) Value of prod. (DFHH)	(3) Value of prod. (SFHH)	(4) Value of prod. (SMHH)	(5) Value of prod. per ha (DMHH)	(6) Value of prod. per ha (DFHH)	(7) Value of prod. per ha (SFHH)	(8) Value of prod. per ha (SMHH)
Access to extension services								
Received production advice (=1)			-6.403	-28.406			-0.584	-9.649
			(11.652)	(24.312)			(6.922)	(15.130)
Received market access advice (=1)			13.898	53.247			-3.206	-0.422
			(17.010)	(33.305)			(10.086)	(20.703)
Agroecological conditions								
10-year average temperature (Celsius)	-17.762**	-9.153	-8.517*	-10.538	-12.995***	-8.814	-9.509***	-7.163
	(8.987)	(16.100)	(4.929)	(11.211)	(2.726)	(6.228)	(2.902)	(6.974)
Number of abnormal months in 2015	5.751	-17.383	18.858***	18.663	-6.520	-13.783	6.974*	16.551
	(16.850)	(28.670)	(7.180)	(16.902)	(5.117)	(11.098)	(4.179)	(10.308)
Household characteristics								
Highest grade level of education attained by head	2.475	-0.117	3.444*	5.150	2.158***	-0.687	3.455***	3.220
	(2.036)	(4.105)	(1.823)	(3.223)	(0.617)	(1.593)	(1.062)	(1.956)
Household size	0.681	-3.138	1.827	-15.184*	0.410	-0.384	0.847	-2.135
	(2.641)	(4.505)	(2.709)	(8.376)	(0.800)	(1.725)	(1.597)	(5.334)
Age of head	-1.180***	-1.459*	0.084	-1.016	-0.206	-0.209	0.218	-0.627
	(0.430)	(0.761)	(0.336)	(0.622)	(0.131)	(0.294)	(0.198)	(0.386)
Member participates in committees (=1)			4.049	0.009			-1.351	6.061
			(12.723)	(26.893)			(7.560)	(16.876)
District fixed effects	YES	YES	YES	YES	YES	YES	YES	YES
Constant	336.664	106.257	138.404	176.435	380.059***	271.728*	249.561***	200.331
	(228.223)	(420.615)	(130.276)	(288.145)	(69.261)	(162.696)	(76.658)	(179.316)
Observations	1,961	223	447	120	1,961	223	447	120
R^2	0.451	0.481	0.432	0.825	0.094	0.160	0.194	0.311
Adjusted R^2	0.435	0.326	0.408	0.783	0.068	-0.091	0.161	0.147

Source: IFPRI survey (2016).
Note: Standard errors in parentheses; (=1) represents dummy variables and coefficients represent discrete change of dummy variable from 0 to 1; * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

REFERENCES

Aberman, N.-L., and T. Roopnaraine. 2015. "Understanding the Pathways to Improved Diets from the Production of Nutritious and Marketable Commodities." In *Mapping the Linkages between Agriculture, Food Security and Nutrition in Malawi*, edited by N.-L. Aberman, J. Meerman, and T. Benson. Malawi Strategy Support Program. Washington, DC: International Food Policy Research Institute.

Adams, R., H. Almeida, and D. Ferreira. 2009. "Understanding the Relationship between Founder-CEOs and Firm Performance." *Journal of Empirical Finance* 16: 136–150.

Agarwal, B. 1994. *A Field of One's Own: Gender and Land Rights in South Asia*. New York: Cambridge University Press.

Alene, A. D., V. M. Manyong, G. O. Omanya, H. D. Mignouna, and M. Bokanga. 2008. "Economic Efficiency and Supply Response of Women as Farm Managers: Comparative Evidence from Western Kenya." *World Development* 36 (7): 1247–1260.

Arimond, M., C. Hawkes, M. T. Ruel, Z. Sifri, P. R. Berti, J. L. Leroy, et al. 2011. "Agricultural Interventions and Nutrition: Lessons from the Past and New Evidence." In *Combating Micronutrient Deficiencies: Food-Based Approaches*, 41–75. Rome: Food and Agriculture Organization of the United Nations and CAB International.

Babatunde, R. O., O. A. Omotesho, E. O. Olorunsanya, and G. M. Owotoki. 2008. "Determinants of Vulnerability to Food Insecurity: A Gender-Based Analysis of Farming Households in Nigeria." *Indian Journal of Agricultural Economics* 63 (1): 116–125.

Babu, S., S. Haggblade, E. Mkandwarie, F. Nankhuni, and S. Hendriks. 2016. *Micronutrient Policy Process in Malawi*. Research Paper 38. East Lansing, MI, US: University of Michigan, Feed the Future Innovation Lab for Food Security Policy.

Babu, S., and P. Sanyal. 2007. *Persistent Food Insecurity from Policy Failures in Malawi*. Case Study 7-2 of the Program Food Policy for Developing Countries: The Role of Government in the Global Food System. Ithaca, New York, US: Cornell University.

Benson, T. 2015. "Irrigated Farming and Improved Nutrition in Malawian Farm Households." In *Mapping the Linkages between Agriculture, Food Security and Nutrition in Malawi*, edited by N.-L. Aberman, J. Meerman, and T. Benson. Malawi Strategy Support Program. Washington, DC: International Food Policy Research Institute.

Boudet, A. M. M., P. Petesch, and C. Turk. 2013. *On Norms and Agency: Conversations about Gender Equality with Women and Men in 20 Countries*. Washington, DC: World Bank.

Chaboud, G., and G. Daviron. 2017. "Food Losses and Waste: Navigating the Inconsistencies." *Global Food Security* 12: 1–7.

Chipande, G. H. R. 1987. "Innovation Adoption among Female-Headed Households: The Case of Malawi." *Development and Change* 18: 315–327.

Chiputwa, B., D. Spielman, and M. Qaim. 2015. "Food Standards, Certification, and Poverty among Coffee Farmers in Uganda." *World Development* 66: 400–412.

Coates, J., A. Swindale and P. Bilinsky. 2007. Household Food Insecurity Access Scale (HFIAS) for Measurement of Household Food Access: Indicator Guide (v. 3). Washington, DC: FHI 360/FANTA.

Cornwall, A. 2000. "Missing Men? Reflections on Men, Masculinities and Gender in GAD." *IDS Bulletin* 31 (2): 18–27.

Doss, C. R. 2001. "Designing Agricultural Technology for African Women Farmers: Lessons from 25 Years of Experience." *World Development* 29 (12): 2075–2092.

———. 2006. "The Effects of Intrahousehold Property Ownership on Expenditures in Ghana." *Journal of African Economies* 15 (1): 149–180.

Duflo, E., and C. Udry. 2004. *Intrahousehold Resource Allocation in Côte d'Ivoire: Social Norms, Separate Accounts, and Consumption Choices*. Working Paper 10498. Cambridge, MA, US: National Bureau of Economic Research.

FAO (Food and Agriculture Organization of the United Nations). 2001. *Agricultural Investment and Productivity in Developing Countries*. Rome.

———. 2011. *Gender Inequalities in Rural Employment in Malawi: An Overview*. Rome.

———. 2013. *Food Wastage Footprint Impacts on Natural Resources: Summary Report*. Rome.

———. 2016. FAOSTAT database. Accessed May 2017. http://faostat3.fao.org/download/Q/QC/E.

Fisher, M., and V. Kandiwa. 2014. "Can Agricultural Input Subsidies Reduce the Gender Gap in Modern Maize Adoption? Evidence from Malawi." *Food Policy* 45: 101–111.

Girard, A. W., J. L. Self, C. McAuliffe, and O. Olude. 2012. "The Effects of Household Food Production Strategies on the Health and Nutrition Outcomes of Women and Young Children: A Systematic Review." *Paediatric and Perinatal Epidemiology* 26 (1): 205–222.

Grbich, C. 2012. *Qualitative Data Analysis: An Introduction*, 2nd ed. London: SAGE.

Gustavsson, J., C. Cederberg, U. Sonesson, R. van Otterdijk, and A. Meybeck. 2011. *Global Food Losses and Food Waste: Extent, Causes and Prevention*. Rome: Food and Agriculture Organization of the United Nations.

Harris, J., J. Meerman, and N.-L. Aberman. 2015. "Introduction to Conceptual Issues Related to Agriculture, Food Security and Nutrition." In *Mapping the Linkages between Agriculture, Food Security and Nutrition in Malawi*, edited by N.-L. Aberman, J. Meerman, and T. Benson. Malawi Strategy Support Program. Washington, DC: International Food Policy Research Institute.

Hawkes, C., and M. Ruel. 2007. *From Agriculture to Nutrition: Pathways, Synergies and Outcomes*. Washington, DC: World Bank.

Herforth, A., and J. Harris. 2014. *Understanding and Applying Primary Pathways and Principles*. Technical Brief Series. Arlington, VA, US: Strengthening Partnerships, Results, and Innovations in Nutrition Globally (SPRING) Project.

HLPE (High Level Panel of Experts on Food Security and Nutrition). 2014. *Food Losses and Waste in the Context of Sustainable Food Systems*. HLPE Report 8. Rome.

Hoddinott, J., and L. Haddad. 1995. "Does Female Income Share Influence Household Expenditures? Evidence from Côte d'Ivoire." *Oxford Bulletin of Economics and Statistics* 57 (1): 77–96.

Hoddinott, J., and Y. Yohannes. 2002. Dietary Diversity as a Household Food Security Indicator. Washington, DC: Food and Nutrition Technical Assistance Project, Academy for Educational Development.

Ibnouf, F. O. 2011. "Challenges and Possibilities for Achieving Household Food Security in the Western Sudan Region: The Role of Female Farmers." *Food Security* 3: 215–231.

IFPRI (International Food Policy Research Institute). 2016. Household Survey Dataset. Joint activity of the Enhancing the Impact of Agricultural Extension in Malawi project and the Strengthening Agriculture and Nutrition Extension Services Activity (SANESA) Washington, DC.

Jones, A. D., F. M. Ngure, G. Pelto, and S. L. Young. 2013. "What Are We Assessing When We Measure Food Security? A Compendium and Review of Current Metrics." *Advances in Nutrition* 4: 481–505.

Jones, A. D., A. Shrinivas, and R. Bezner-Kerr. 2014. "Farm Production Diversity Is Associated with Greater Household Dietary Diversity in Malawi: Findings from Nationally Representative Data." *Food Policy* 46: 1–12.

Kanbur, S. M. R. 2003. *Q-squared: Combining Qualitative and Quantitative Methods in Poverty Appraisal*. Delhi: Permanent Black.

Kassie, M., S. M. Ndiritu, and J. Stage. 2013. "What Determines Gender Inequality in Household Food Security in Kenya? Application of Exogenous Switching Treatment Regression." *World Development* 56: 153–171.

Kassie, M., J. Stage, H. Teklewold, and O. Erenstein. 2015. "Gendered Food Security in Rural Malawi: Why Is Women's Food Security Status Lower?" *Food Security* 7: 1299–1320.

Kassie, M., H. Teklewold, P. Marenya, M. Jaleta, and O. Erenstein. 2015. "Production Risks and Food Security under Alternative Technology Choices in Malawi: Application of a Multinomial Endogenous Switching Regression." *Journal of Agricultural Economics* 66 (3): 640–659.

Kennedy, E. 1994. "Health and Nutrition Effects of Commercialization of Agriculture." In *Agricultural Commercialization, Economic Development, and Nutrition*, 79–99. Baltimore, MD, US: Johns Hopkins University Press.

Kennedy, E., and P. Peters. 1992. "Household Food Security and Child Nutrition: The Interaction of Income and Gender Household Head." *World Development* 20: 1077–1085.

Kerr, R. B., E. Chilanga, H. Nyantakya-Fimpong, I. Luginaah, and E. Lupafya. 2016. "Integrated Agriculture Programs to Address Malnutrition in Northern Malawi." *BMC Public Health* 16: 1–14.

Kilic, T., A. Palacios-Lopez, and M. Goldstein. 2013. *Caught in a Productivity Trap: A Distributional Perspective on Gender Differences in Malawian Agriculture*. Policy Research Working Paper 6381. Washington, DC: World Bank Group.

Lambrecht, I., B. Vanlauwe, R. Merckx, and M. Maertens. 2014. Understanding the process of agricultural technology adoption: mineral fertilizer in Easter DR Congo. *World Development* 59: 132-146.

Leroy, J. L., and E. A. Frongillo. 2007. "Can Interventions to Promote Animal Production Ameliorate Undernutrition?" *Journal of Nutrition* 137: 1017–1022.

Levin, C. E., M. T. Ruel, S. S. Morris, D. G. Maxwell, and M. Armar-Klemesu. 1999. "Working Women in an Urban Setting: Traders, Vendors and Food Security in Accra." *World Development* 27: 1977–1991.

Lovon, M., and A. Mathiassen. 2014. "Are the World Food Programme's Food Consumption Groups a Good Proxy for Energy Deficiency?" *Food Security* 6: 461–470.

Malawi, MoAIWD (Ministry of Agriculture, Irrigation and Water Development). 2016. *Agriculture Sector Performance Report 2015/2016 Fiscal Year*. Draft final report from the joint sector review. Lilongwe, Malawi.

Mallick, D., and M. Rafi. 2010. "Are Female-Headed Households More Food Insecure? Evidence from Bangladesh." *World Development* 38 (4): 593–605.

Mazunda, J., H. Kankwamba, and K. Pauw. 2015. "Food and Nutrition Security Implications of Crop Diversification in Malawi's Farm Households." In *Mapping the Linkages between Agriculture, Food Security and Nutrition in Malawi*, edited by N.-L. Aberman, J. Meerman, and T. Benson. Malawi Strategy Support Program. Washington, DC: International Food Policy Research Institute.

Mkandawire, E., S. Hendriks, and L. Mkandawire. 2016. *Gendering Malawi's National Nutrition Policy Using the Integrated Framework for Gender Analysis in Nutrition Policy*. Policy Research Brief 18. East Lansing, MI, US: University of Michigan, Feed the Future Innovation Lab for Food Security Policy.

Mudege, N. N., T. Chevo, T. Nyekanyeka, E. Kapalasa, and P. Demo. 2016. "Gender Norms and Access to Extension Services and Training among Potato Farmers in Dedza and Ntcheu in Malawi." *Journal of Agricultural Education and Extension* 22 (3): 291–305.

Mutenje, M., H. Kankwamba, J. Mangisonib, and M. Kassie. 2016. "Agricultural Innovations and Food Security in Malawi: Gender Dynamics, Institutions and Market Implications." *Technological Forecasting and Social Change* 103: 240–248.

NSO (National Statistics Office) and Macro. 2016. *Malawi Demographic and Health Survey*. Lilongwe, Malawi.

Owusu, V., A. Abdulai, and S. Abdul-Rahman. 2011. "Non-farm Work and Food Security among Farm Households in Northern Ghana." *Food Policy* 36: 108–118.

Pandey, V. L., S. Mahendra Dev, and U. Jayachandran. 2016. "Impact of Agricultural Interventions on the Nutritional Status in South Asia: A Review." *Food Policy* 62: 28–40.

Pauw, K., I. Verduzco-Gallo, and O. Ecker. 2015. "Poverty, Food Prices and Dietary Choices in Malawi." In *Mapping the Linkages between Agriculture, Food Security and Nutrition in Malawi*, edited by N.-L. Aberman, J. Meerman, and T. Benson. Malawi Strategy Support Program. Washington, DC: International Food Policy Research Institute.

Quisumbing, A. R. 2003. *Household Decisions, Gender, and Development: A Synthesis of Recent Research*. Washington, DC: International Food Policy Research Institute.

Ragasa, C., G. Berhane, F. Tadesse, and A. S. Taffesse. 2013. "Gender Differences in Access to Extension Services and Agricultural Productivity." *Journal of Agricultural Education and Extension* 19 (5): 437–468.

Ragasa, C., J. Mazunda, and M. Kadzamira. 2016. *The Impact of Extension Services in the Context of a Heavily Subsidized Input System: The Case of Malawi*. IFPRI Discussion Paper 1498. Washington, DC: International Food Policy Research Institute.

Ragasa, C., and C. Niu. 2017. *The State of Agricultural Extension Services Provision in Malawi*. MaSSP Technical Report. Washington, DC: International Food Policy Research Institute.

Randolph, S., and R. Sanders. 1988. "Constraints to Agricultural Production in Africa: A Survey of Female Farmers in the Ruhengeri Prefecture of Rwanda." *Studies in International Comparative Development* 23: 78–98.

Riley, P. J. 1995. "Gender Issues and the Training of Agricultural Extensionists in Malawi." *Agriculture and Human Values* 12 (1): 31–38.

Schmeer, K. K., B. A. Piperata, A. Herrera Rodriguez, V. M. Salazar Torres, and F. J. Centeno Cardenas. 2015. "Maternal Resources and Household Food Security: Evidence from Nicaragua." *Public Health Nutrition* 18 (16): 2915–2924.

Slavchevska, V. 2015. "Gender Differences in Agricultural Productivity: The Case of Tanzania." *Agricultural Economics* 46 (3): 335–355.

Snapp, S., and M. Fisher. 2015. "'Filling the Maize Basket' Supports Crop Diversity and Quality." *Food Security* 7: 83–96.

Sraboni, E., H. J. Malapit, A. Quisumbing, and A. U. Ahmed. 2014. "Women's Empowerment in Agriculture: What Role for Food Security in Bangladesh?" *World Development* 61: 11–52.

Staudt, K. 1978. "Agricultural Productivity Gaps: A Case Study of Male Preference in Government Policy Implementation." *Development and Change* 9: 439–457.

Swindale, A., Bilinsky, P., 2006. *Household Dietary Diversity Score (HDDS) for Measurement of Household Food Access: Indicator Guide*, version 2. Food and Nutrition Technical Assistance Project, Academy for Educational Development. Washington, DC.

Takane, T. 2009. "Disparities and Diversities among Female-Headed Households in Rural Malawi after 20 Years of Economic Liberalization." *Singapore Journal of Tropical Geography* 30: 358–372.

Tibesiga, B., and M. Visser. 2016. "Assessing Gender Inequality in Food Security among Small-holder Farm Households in Urban and Rural South Africa." *World Development* 88: 33–49.

Udry, C., J. Hoddinott, H. Alderman, and L. Haddad. 1995. "Gender Differentials in Farm Productivity: Implications for Household Efficiency and Agricultural Policy." *Food Policy* 20 (5): 407–423.

Verduzco-Gallo, I., O. Ecker, and K. Pauw. 2014. *Changes in Food and Nutrition Security in Malawi*. IFPRI Working Paper 04. Washington, DC: International Food Policy Research Institute.

WFP (World Food Programme), Vulnerability Analysis and Mapping Branch. 2008. *Food Consumption Analysis: Calculation and Use of the Food Consumption Score in Food Security Analysis*. Rome.

RECENT IFPRI DISCUSSION PAPERS

For earlier discussion papers, please go to www.ifpri.org/publications/discussion_papers.
All discussion papers can be downloaded free of charge.

1652. *Is the WTO dispute settlement procedure fair to developing countries?* Antoine Bouët and Jeanne Metivier, 2017.

1651. *Role of media in shaping the policy process: Comparative lessons from the food price crisis in Bangladesh, China, India, and Viet Nam.* Suresh Chandra Babu, Smita Aggarwal, and Junjie Chen, 2017.

1650. *Food and nutrition security in transforming Ghana: A descriptive analysis of national trends and regional patterns.* Olivier Ecker and Joanna van Asselt, 2017.

1649. *Pathways from agriculture to nutrition in India: Implications for sustainable development goals.* Mousumi Das, Ajay Sharma, and Suresh Chandra Babu, 2017.

1648. *Agribusiness competitiveness: Applying analytics, typology, and measurements to Africa.* Suresh Chandra Babu and Mahika Shishodia, 2017.

1647. *The Abbreviated Women's Empowerment in Agriculture Index (A-WEAI).* Hazel Malapit, Crossley Pinkstaff, Kathryn Sproule, Chiara Kovarik, Agnes Quisumbing, Ruth Meinzen-Dick, 2017.

1646. *Intertemporal choice and income regularity: Non-fungibility in a lab-in-the-field experiment.* Berber Kramer and David Kunst, 2017.

1645. *Climate change and variability: What are the risks for nutrition, diets, and food systems?* Jessica Fanzo, Rebecca McLaren, Claire Davis, and Jowel Choufani, 2017.

1644. *Building resilience for food systems in postwar communities: Case study and lessons from Northern Sri Lanka.* Hamsha Pathmanathan, Suresh Chandra Babu, and Chandrashri Pal, 2017.

1643. *Empowerment, adaptation, and agricultural production: Evidence from Niger.* Fleur Wouterse, 2017.

1642. *Insurance structure, risk sharing, and investment decisions: An empirical investigation of the implications of individual and group weather index insurance.* Laura Munro, 2017.

1641. *Economic accounts for agriculture and farm income in Senegal*. Ismaël Fofana, Mahamadou Tankari, and Fousseini Traore, 2017.

1640. *Food inflation and food price volatility in India: Trends and determinants.* C. S. C. Sekhar, Devesh Roy, and Yogesh Bhatt, 2017.

1639. *Revitalized agriculture for balanced growth and resilient livelihoods: Toward a rural development strategy for Mon State.* Mateusz Filipski, Ulrike Nischan, Joanna Van Asselt, Ben Belton, Adam Kennedy, Aung Hein, Duncan Boughton, and Paul Dorosh, 2017.

1638. *Rural livelihoods in Mon State: Evidence from a representative household survey.* Mateusz Filipski, Joanna Van Asselt, Ulrike Nischan, Ben Belton, Kyan Htoo, Myat Thida Win, Aung Hein, L. Seng Kham, Zaw Min Naing, Ellen Payongayong, and Duncan Boughton, 2017.

1637. *The great Chinese inequality turnaround.* Ravi Kanbur, Yue Wang, and Xiaobo Zhang, 2017.

1636. *Can agricultural aspirations influence preferences for new technologies?: Cropping systems and preferences for high-efficiency irrigation in Punjab, Pakistan.* Andrew R. Bell, Patrick S. Ward, Muhammad Ashfaq, and Stephen Davies, 2017.

1635. *Impact of India's national food security act on domestic and international rice markets.* Deepayan Debnath, Suresh Chandra Babu, Parijat Ghosh, and Michael Helmar, 2017.

1634. *Agricultural diversification in Nepal: Status, determinants, and its impact on rural poverty.* Ganesh Thapa, Anjani Kumar, and P. K. Joshi, 2017.

1633. *The "discouraged worker effect" in public works programs: Evidence from the MGNREGA in India.* Sudha Narayanan, Upasak Das, Yanyan Liu, and Christopher B. Barrett, 2017.

1632. *Measuring postharvest losses at the farm level in Malawi.* Kate Ambler, Alan de Brauw, and Susan Godlonton, 2017.

1631. *Nutrition transition and the structure of global food demand.* Christophe Gouel and Houssein Guimbard, 2017.

INTERNATIONAL FOOD POLICY RESEARCH INSTITUTE

www.ifpri.org

IFPRI HEADQUARTERS

1201 Eye Street, NW
Washington, DC 20005 USA
Tel.: +1-202-862-5600
Fax: +1-202-862-5606
Email: ifpri@cgiar.org

IFPRI LILONGWE OFFICE

PO Box 31666
Lilongwe 3
Malawi
Tel.: +265-1-789747
Email: IFPRI-Lilongwe@cgiar.org