Women's Role in Ensuring Seasonal Food Security in Rainfed India

by

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Dedication

Empowered women, empower women.

To the many empowered women that I have taught me important lessons, shaped the way I think, and challenged how I see myself in the world. To the empowered women that I had the privilege to work with as we collected, cleaned, and translated this data into a meaningful narrative. And, to the women that participated and those this work may help to empower.

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List of Acronyms

HFIAS	Household Food Insecurity Access Scale
IFPRI	International Food Policy Research Institute
MGREGA	Mahatma Gandhi National Rural Employment Guarantee Act
OPHI	Oxford and Poverty and Human Development
WEIA	Women's Empowerment in Agriculture

Abstract

India shares a quarter of the global hunger burden, with nearly 195 million undernourished people. Given that women can influence food security through their influence over decision-making, the time they spend tending to their children, the money they earn, and the crops they grow, they have been characterized as the "key to food security." As women increasingly become the cornerstone of food and nutrition interventions, it is paramount to understand the multiple, and sometimes conflicting, roles that they play in securing food and nutrition for their families. This dissertation analyzes the many ways that women can influence their families' food security and highlights how "economic empowerment" that hinges on women working more is not the most efficient way to increase food security. Instead, interventions should focus on building the capacity of women to have more decision-making influence within their households. The first chapter gives a brief introduction to the problem and highlights important concepts from the literature and the fifth chapter provides conclusions, suggestions for future research, and policy implications

My second chapter evaluates how income diversity shapes household food security throughout the year. We collected 1,200 monthly household surveys across four sites in rain-fed agricultural regions of India to assess seasonal food security and income diversity. Food security is measured using the Household Food Insecurity Access Scale and income diversity is measured as the number of income sources a family has, their relative evenness as indicated by the Simpson's Index, and how much of their income comes from non-farm sources. We find that considering gender-specific impacts of income diversity offers more important insights than looking at household-level income diversity alone. This work contributes to literature and theory about adaptation and livelihood strategies by incorporating a more gendered perspective and

including additional variables like women's empowerment and natural resource dependence and by looking at the specific impacts to foods security when women diversify their incomes.

In the third chapter we address how women's incomes affect food expenditure, which is significantly associated with food security. I use two analyses, linear regression and mediation modeling, to measure influence of women's income on food expenditure. The regression model builds on past literature by including information on women's empowerment, which affects both her ability to earn money and her bargaining power in the household. The mediation model allows us to compare direct and indirect pathways through which women could impact food expenditure. A direct path would be that women purchase food themselves with their own salaries and an indirect path would be that as women earn more income, they have more influence over the allocation of resources decision-making. We find that women's incomes do not explain variation in food expenditures directly, and the indirect pathway provide important insights for policy. As expected, when women have control over income, there was a higher association with food security. However, higher incomes did not translate into more control over income, which is often assumed in economic empowerment policies that promote women joining the workforce in an effort to increase empowerment.

My fourth chapter quantifies the multiple ways that women influence food security. Women are vital to food security and can impact food directly through how they spend their time, how much money they earn, influence they have over income and production decisions. Women can also influence food security through their level of education and through serving in public office, which is associated with reduced drudgery and unpaid work for women. We quantify and compare the many pathways through which women can influence food security. To do this, we use structural equation modeling to simultaneously test regressions across a network

of variables. First, we determine the aspects of women's empowerment that are most important for explaining food security using a factor analysis on the Women's Empowerment in Agriculture Index. We found that empowerment was mainly composed by women's influence over decision-making, control over productive resources, and to a lesser extent group participation. We used the three most important aspects of empowerment in structural equation modeling to understand the direct and indirect effects of empowerment and food security. We find that a woman's influence over income, the amount she makes, and her education level positively impact food security at a similar level. We also find that unpaid labor is negatively associated with food security, and reserved seats for women on village councils can reduce women's drudgery and have an indirect, positive, marginal impact on food security.

CHAPTER 1

Introduction

Food and nutrition insecurity is a critical problem in the Global South, with nearly two billion people suffering from micronutrient deficiency (CDC 2015), despite the fact that food production doubled in the last three decades (Bashir and Schilizzi 2011). Food and nutrition security has been at the forefront of development efforts since the World Food Summit in 1996 where it was defined as "when all people, at all times, have physical and economic resources to access sufficient, safe, and nutritious food to meet their dietary needs and food preferences for an active and healthy life" (FAO 1996). Food insecurity in India is particularly widespread and home to a quarter of the world's undernourished people (FAO 2018).

Many policies seek to improve food security by targeting women as beneficiaries of programs aimed to increase their decision-making because, when given the freedom to choose, women will spend more on their families' food security, education, and health (Quisumbing et al. 1998, Kadiyala et al. 2014, Rao et al. 2017). Women influence their families' food security in a multitude of ways such as by investing their incomes into their children's health and food; by growing crops that increase dietary diversity; and by performing unpaid domestic chores such as collecting water and firewood, and cooking. Given the many links between women and food security, development agents have referred to women as the "key to food security" (World Bank 2012, Gates 2014) and have called for women and gender justice to be the center of all food and nutrition interventions (Rao et al. 2017). Additionally, development agencies have increasingly recognized the inherent link between gender equality and other development goals (World Bank 2001, World Bank 2011, Rao et al. 2017). In particular, women's empowerment—her ability to make strategic life choices (Kabeer 1999)— is often characterized as necessary, or even a

prerequisite, step to achieve other development goals like poverty alleviation and food security (World Bank 2001, World Bank 2011). Not only is women's empowerment important because of its potential to accelerate development, but also because equality between men and women is a desirable goal in and of itself (Duflo 2011). Jackimow and Kilby (2006) explain, "Rather than seeing it as a necessary precondition, self-empowerment should be regarded as a desirable outcome" (pg. 378, emphasis in original). Therefore, the aim of any effective policy on food and nutrition in India would need to (1) reduce the number of people suffering from food and nutrition security and (2) provide opportunities for women to influence their families' food security without necessarily burdening them with the onus of changing institutional norms and be respectful of their limited time, which is tied to food security.

This introduction aims to explain the trends and conditioning factors that have led development agencies to put women's economic empowerment programs on a pedestal and how this approach may undermine their goals of increasing food security and empowering women. It also provides more context for my field collection experience and how it has shaped the types of variables I have collected and how I have measured them. This dissertation seeks to challenge the dominant narrative common in "economic empowerment" programs by questioning the commonly accepted theory of change that emphasizes capacity development of individual women and emphasizes participation in market-based activities and income generation as the key to development. We suggest an alternative approach that puts women's groups, and not individual women, at the center of food security and empowerment programs. Also, we suggest that women's groups mobilize to lobby for community issues instead of emphasizing economistic goals like micro-financing and gaining access to micro-loans. Even though this new

theory of change is not well studied within the scope of this dissertation, we offer an alternative theory of change based on literature and suggest its investigation as a goal of future research.

Study Site in Rainfed Regions

Women and men living in rural, rainfed (no or limited irrigation) regions of India are particularly susceptible to chronic and short-term food insecurity. Rainfed regions are characterized by marginal soils and support some of the poorest, most underserved populations. Understanding rainfed systems is critical given their large population, the large amount of food that they produce, and their vulnerability to shocks like drought and flooding. Rainfed cultivation dominates global agriculture: it is practiced on 80% of the world's agricultural land area; generates about 70% of the world's staple foods (Rockstrom et al. 2010); and is the main source of income for the world's rural poor (World Bank 2012; Singh 2001). India has the highest amount of rainfed agriculture globally, both in terms of extent (86 million hectares) and value of production (Sharma et al. 2010).

Additionally, understanding the patterns of food insecurity in rainfed regions is necessary since these areas are at increasing risk of food insecurity due to the negative consequences of climate change (Mall 2006; Schlenker and Roberts 2006; Lobel et al. 2008). As temperatures increase and rainfall patterns become more irregular, climatic shocks will be more common, and natural resource-dependent people will be even more vulnerable to food insecurity. Given that many rainfed households are very poor and have had to contend with hardships and unexpected shocks, many have employed adaptive strategies to cope and smooth their incomes. Strategies are wide-ranging, but a popular one is income diversity. Development agencies and researchers studying poverty-reduction and resilience have lauded income diversity as a strategy that can smooth incomes and consumption. However, decades of empirical research provide conflicting

results; it is not clear if diversity, or which measure of diversity, is associated with higher food security (e.g., Babatunde and Qaim 2010, Block and Webb 2001, Robaa and Tolossa 2016) Moreover, since researchers use the household as the unit of analysis, they cannot explore the potential differences between how women's and men's incomes may differently impact food security. Empirical research that accounts for gendered differences is necessary, especially if women continue to be targeted for income diversity programs (Appendix A).

DESCRIBING TRENDS

Despite consistent economic growth at the national level, improvements in malnutrition have remained stagnant. In fact, India has experienced high rates of economic growth, making it the world's seventh-largest economy and the third largest by purchasing power parity (Heady et al. 2011), yet improvements in nutrition have remained stagnant. The Indian Enigma—as this phenomenon is known—has puzzled researchers since normally increased income leads to improvements in quality of life. As Sen (1999) explains, "The usefulness in wealth lies in the things that it allows us to do—the substantive freedoms it helps us to achieve" (pg. 14). This highlights that income alone will not necessarily improve food security. Instead, policies that aim to encourage women to join the workforce or get more employment may not be as effective since they do not recognize the cultural circumstances and tradeoffs when women are expected to earn incomes.

In an effort to improve their dire status, India passed the National Food Security Act in 2013, also known as the Right to Food Act. It provides heavily subsidized or free food to poor people through the Public Distribution System. In addition, other food-related programs gave specific entitlements to women, who for the first time were legally recognized as the head of the household. This recognition echoes other international development agencies and organizations

that acknowledge women as the key to food security (World Bank 2012, Gates 2014). Even though women are integral to food security and valorized at the international-level, their unpaid work is often underestimated and undervalued at the household-level in India (Dixon 1982, Lahoti and Swaminathan 2016).

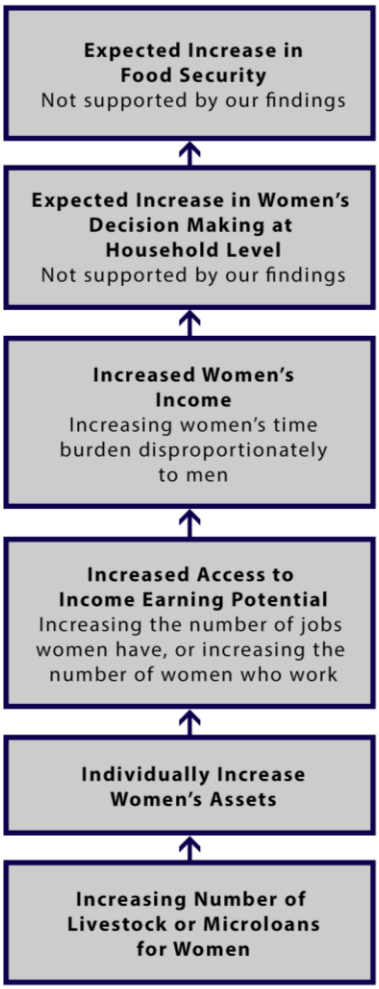
Many development agencies and organizations have targeted women as recipients of empowerment programs in order to promote development and to reduce gender inequalities (Duflo 2012). The United Nation's Sustainable Development Goals and the preceding Millennium Development Goals, for example, have set a clear global agenda for addressing gender inequalities and women's empowerment. Many multilateral institutions, nonprofits, and academics have acknowledged that gender equity is a prerequisite to other goals like poverty alleviation and food security (Quisumbing 1998, Duflo 2012, Rao et al. 2017). Empowerment refers to control over decisions and the resources that determine one's quality of life (Kabeer 1999, Narayan-Parker 2002). Even though empowerment is impossible to measure directly and is mediated by many cultural contexts (Atker et al. 2017), USAID, International Food Policy Research Institute (IFPRI), and Oxford and Poverty and Human Development (OPHI) developed an index to measure it: The Women's Empowerment in Agriculture Index (WEIA). WEIA combines various domains of empowerment, including the ability to influence decisions and the material and social resources needed to carry out those decisions (Alkire et al. 2013). Specifically, it combines information on five aspects of empowerment: influence on how to spend income and sell productive assets, access to and control over credit, asset ownership, group participation, and workload.

Literature from the end of the Twentieth Century studied the link between women's incomes and better food security, though the results have been mixed (Some find that women's

incomes have a positive effect on food expenditure (e.g., Hoddinott and Haddad 1996, Duflo and Udry 2004, Doss 2006, Thomas 1990, Quisumbing and Maluccio 2003). Even though the level of a woman's income does not always translate into higher spending on food and health for the family, the literature has consistently indicated that when women have control over how money is spent, their families' food security improves (e.g., Molyneux 2008, Skoufias 2005, Barrientos et al. 2016). Women's empowerment as measured by WEIA is associated with higher nutrition (Malapit and Quisumbing 2015) and food security (Sraboni et al. 2014), suggesting that empowering women may lead to higher food security. Even though it is clear that empowered women and their families have higher food security, it is not clear how to best empower women and increase their decision-making within the family.

Many development initiatives aim to reduce the inequalities between men and women by focusing on improving women's economic status by increasing her empowerment (Duflo 2011, World Bank 2012). "Women's economic empowerment" is a neoliberal approach that seeks to alleviate poverty through encouraging women to earn income so that can be reinvested in their families' wellbeing or human capital. Given that women often invest more in their families' wellbeing, they are often described as having a "multiplier effect." This effect is a common justification for promoting programs for women to earn money or gain access to microcredit (Appendix A). For example, the Trump Administration's Women's Global Development and Prosperity Initiative will provide US$50 million to encourage women to participate in the workforce and to encourage entrepreneurship with increasing access to microcredit. The theory of change or logic behind many of these programs is that women need access to more opportunities to earn more income and join the formal workforce since they will spend more on their children's nutrition, health, and education (Figure 1.1).

Figure 1.1. Commonly accepted theory of change used in development initiatives that emphasize women's economic empowerment.



However, many programs that use an economistic approach, equate empowerment with the ability to earn and spend an income (Appendix A). Programs that focus on "women's economic empowerment" seek to improve the status of women by assuming that when women earn money, they will have control over it, and gain influence over decisions within the family. Literature on intra-household decision-making, often referred to as intra-household bargaining, suggests that women who have more assets, have more education, and/or earn higher incomes will have more influence over household decisions, especially about income allocation and productive resources (Blood and Wolfe 1960, Doss 2013). However, feminist scholars have

argued that intra-household bargaining is not simply based on the endowments of an individual woman. Instead, it is also influenced by external factors related to the market, community, and the State. Community norms and practices not only influence a woman's ability to bargain, but they also shape what she can bargain about (Agarwal 1997). In other words, local institutions or community norms, which are often deeply entrenched and shape relations, define values and shape the choices women make (Kabeer 1999). In India, important social constructs like the caste system and patriarchal family dynamic limit women's decision-making, time allocation, and freedom of movement. Often, a woman's time is undervalued and considered a free household commodity (Singh and Pattanaik 2018). Therefore, programs that seek to empower her by requiring her to work more do not have the same consequences for empowerment and increased influence over household decisions as it may in other cultural contexts. Within our study site we found women's level of income did not positively impact her decision-making over household expenditures and, in fact, reduced it.

Therefore, efforts to encourage women to work may not lead to increased decision-making and, therefore may not actually lead to increased food security. And, many off the tradeoffs associated with women working more, like the time she spends away from her family, which may disrupt child feeding practices or limiting her leisure time, which is associated with empowerment, are often not considered. This framework undervalues women's time and treats it as though it is a free household resource, which puts women in a difficult position where she is often over extended (Dixon 1982, Lahoti and Swaminathan 2016).

Women can influence their families' food security in many more ways besides earning an income. The time women spend with their children as well as her education level are strongly associated with higher food security (Choudhary and Parthasarathy 2007, Alaofè et al. 2017,

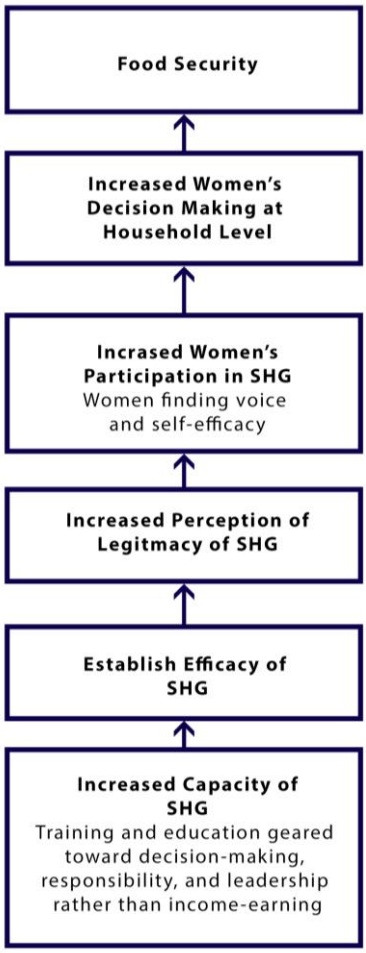
Ukwuani and Suchindran 2019). Since women have limited time, energy, and resources, they must make choices about how to best or most efficiently influence food security, especially when balancing multiple obligations. Researchers have studied the how women influence food security, but they are often examined in isolation. For example, some studies consider how time working in agriculture could affect child feeding practices (Wandel and Holmboe-Ottensen 1992. Jones et al. 2012) or how women's education can impact nutrition (Olumakaiye and Ajayi 2006), or how empowered farmers can contribute to higher dietary diversity (Choudhary and Parthasarathy 2007, Alaofè et al. 2017). Yet, no literature, to our knowledge, has analyzed the multiple ways women influence food security to understand potential tradeoffs and feedbacks between pathways. Given that women continue to be placed at the center of food policies, it is imperative to understand how women can most effectively influence their families' food security.

NEW THEORY OF CHANGE

One significant strategy to improve food security for the family is to increase the decision-making authority of women within their households. However, this theory of change diverges from the dominant narrative because it suggests the agents of change should be women's Self-Help Groups and not individual women, and that initiatives should focus on lobbying for community improvement goals and not be entirely economistic. Theories of change that focus on endowing the oppressed with individual assets and skills place the burden of change on the most vulnerable, least powerful and often the least equipped to change the system that has been mistreating them (Kapoor 2002, Kothari 2001). Jackimow and Kilby (2006) argue that "women's empowerment" should be reconceptualized as "empowering women," which they define as the reduction or removal of constraints that reduce the ability of women to pursue their

interests. Therefore, a new theory of change needs to focus on how to increase women's decision-making in a way effectively removes constraints and does not add to her time burden (Figure 2.2). Our proposed theory of change is primarily based on literature and interviews with women and has not been modeled using our own data. We hope that future research can be done to better test this proposed theory of change.

Figure 1.2. Newly proposed theory of change that leverages Self-Help Groups as sites of empowerment, so that women can be seen as effective decision-makers who contribute to community-driven (and not necessarily economic) initiatives.



An institution that has become an increasingly popular vehicle for organizing and empowering women in India is the formation of the Self Help Groups (SHGs) (Holvoet 2005,

Jackimow and Kilby 2006, Parthasarathy 2015). SHGs are groups of approximately 10-15 women from the same caste who come together mainly to save small sums of money to establish opportunities for borrowing money in times of need (Garikipati 2008). Often SHGs are created by local nonprofits or government representatives, but the quality and effectiveness of these SHGs varies widely, ranging from totally defunct, existing in name only, to powerful institutions of community change that have wide reach from banning alcohol and establishing grain banks. However, the goal of most SHGs related to savings and credit. Several studies note the benefits associated with the financial or economic activities of SHGs (Sharma and Varma 2008, Swain and Wallentin 2009).

However, Jackimow and Kilby (2006) argue that this preoccupation with economic activities are restrictive and reduce women to positions as economic producers. Even though their position as economic producers has enabled women to pursue their interests in the material world, it has inadvertently led some to equate self-worth with financial contribution and, more harmful, reinforced norms that suggest that women's domestic and reproductive work has less value. With this norm strengthened, women's marginal position in society becomes less about the unequal social structures and more about women's inability to succeed within the social system. Further, for systemic reasons many Indian women lack control or ownership over income. Thus, any economic gains may be diverted from women and they do not necessarily enjoy increased empowerment (Garikipati 2008). So, even though women are able to improve their economic status through earning incomes, they do not necessarily change the system that marginalizes them. Agarwal (2005) explains that women are rewarded for operating within expected cultural norms and women who do not conform are often punished. Therefore, individual women may not be best situated to change cultural norms. However, women, working

together in groups may be able to change norms more easily than individually outspoken women because women working in coordination can have a bigger impact than individuals working independently, and women can learn skills of self-efficacy, communication skills within the SHGs that can then be translated to other realms of her life.

Participating in an SHG can potentially offer more benefits for women than financial advantages. For example, when women are able to commune and hear about one another's struggles, they learn that they are not alone in their suffering, and that the suffering is not due to her own deficiencies but due to structural inequalities (Green 1998, Jackimow and Kilby 2006). When women have time together they exercise personal choice and self-determination, which can translate to influence in other domains. And when women share in humor they can acknowledge and resist gender stereotypes. "Leisure spaces should not be underestimated, especially in terms of their potential for resistance and renewal for women enmeshed in patriarchal cultures that continue to define [women] as wives and mothers" (Green 1998, pg. 172). Moreover, when women participate in SHGs they practice the same decision-making and executive functioning skills that can be translated into other spheres. For example, Jackimow (2014) argues that when people participate in institutions like SHGs they can transform their understanding of themselves, society, and their relationship with the state. As women start to see themselves as citizens with rights and a voice, they may be more inclined to act on their rights as citizens in other contexts.

Even though SHGs have the potential to empower women through self-efficacy, women are only going to participate within them if they see them as legitimate and offer more benefits than the time it requires to participate. Too often SHGs become defunct and are in name only. This happens most often in SHGs that are formed by top-down, external entities like government

officials, who often sign members up and then leave without providing appropriate training. Another way that SHGs become non-functioning is when members take out loans that are never repaid. Interviews with participants revealed that many SHGs ended when women took out loans (often under pressure from husbands) and did not pay them back. The breakdown of the SHG may have started before people started to not pay back loans because they did not view the SHG as a legitimate institution. Once members stop paying back loans trust is eroded within the SHG and it breaks down even further.

This demonstrates that in order for people to participate in SHGs, the group needs to be seen as legitimate not only by the women who participate, but also by men in the community. In order to be seen as legitimate the SHG will have to participate in activities beyond simply saving such as mobilizing to undertake lobbying efforts to improve community benefits. It may be difficult to demonstrate legitimacy through efficacy, since effective engagement requires being viewed as legitimate to begin with. One way to ensure improved legitimacy is for NGOs to provide training and capacity building for the group and its members without focusing exclusively on financial outcomes. Though, this may prove a challenge, as Jackimow and Kilby (2006) describe, many NGOs are motivated to focus on financial outcomes because they are easy to measure and describe to donors who are seeking tangible results. Focusing on skills like decision-making are essential to improving women's empowerment, building efficacy, and creating real change within the community. Some SHGs are able to practice decision-making by organizing Midday Meal Schemes, which involves organizing meals for children that are in school. During interviews, some women suggested that SHGs could also be put in charge of proposing projects and assigning work duties under the National Rural Employment Guarantee Act (NREGA). It is worth noting that any transfer of responsibilities to SHGs could result in

additional work burden for women that they will have to see the work as useful to them personally and policy makers would need to ensure that other people or entities do not coopt decision-making authority from SHGs, especially as they transition into new roles.

Another means of improving the legitimacy of women as decision-makers has been through requiring reserved seats for women on village councils. Our data demonstrate that as more women serve on village councils, women's unpaid drudgery is reduced. Research from (Chattopadhyay and Duflo 2004) indicates that when women are elected, they vote and advocate for infrastructure projects that are important to women. Not only does reserving seats for women have the advantages of advancing issues of interest to women, it can also validate that women can be capable and legitimate decision-makers. However, this means of improving the status of women as decision-makers may be complementary to improving SHGs since only a few women can serve on village councils at any particular time.

Methodological Approaches and Field Experience

In order to better understand how to improve seasonal food insecurity in India, I conducted fieldwork and lived in India for 15 months—three months in my field site in Bankura shadowing employees of the local NGO, and another year mainly living in Hyderabad at the Indian School of Business. During my year-long stay I spent approximately 14 weeks in my field sites training enumerators as well as collecting qualitative data. I interviewed approximately 125 participants (over 10% of my sample size from household surveys). Additionally, I interviewed NGO staff and conducted focus groups with all of my 40 enumerators. These lived experiences allowed me the opportunity to refine my research questions, think deeply about how to measure variables and how to train enumerators in order to collect data in a sensitive and thorough manner.

When I first went into the field I was eager to research when and how income diversity was able to limit vulnerability. I anticipated that income diversity could alleviate susceptibility through income smoothing and providing opportunities to increase wealth, especially since researches and development agents have lauded it as an effective adaptation strategy. I, too, had assumed that the key to improving rural livelihoods was related to providing more sources of income, especially for women. Yet, as I spoke to more people in the field, it became clear that even though income smoothing was important, respondents were less interested in adding different income sources to their household's income portfolio, and more interested in limiting the risks already present in the activities they were doing. Moreover, many women expressed both excitement and pressure to complete multiple unpaid domestic chores alongside income earning activities. These initial observations suggested that increasing the number of jobs people work alone may not lead to such obvious benefits without some drawbacks, including time burdens. When interviewing a woman who had recently started working as a tailor for our partner NGO in Dewas, she explained how she was excited to buy a bed with her first paycheck. She also said that she would only be able to work there until she had her first baby and then she would no longer have time to do both. This drew my attention to the multiple responsibilities that women juggle, and sparked an interest in measuring women's empowerment, and better understanding how empowered women may be better able to provide for her family.

Women seemed to also be empowered when they talked about working within their Self-Help Groups (SHGs). But the women who spoke so highly of SHGs were those who were part of high-functioning SHGs that had lobbied for community initiatives, like banning alcohol, advocating for reduced domestic violence, or establishing grain banks. It became abundantly clear that not all SHGs were effective, especially those that were formed by a government

representative which provided no additional training or logistical support. One woman in Bankura explained that a couple of years ago she would have been too shy to speak to us and do an interview, but after participating in an SHG and becoming a leader within her Panchayat's federation of SHGs, she now had the confidence to talk to anyone because she believes in herself. This type of self-efficacy and empowerment was encouraging and suggested to me that SHGs had the potential to transform individuals and communities. Group participation is recognized as a contributor to women's empowerment and is one of five domains within the Women's Empowerment in Agriculture Index (Alkire et al. 2012). Within this Index, any participation in any group is grounds to be empowered within this domain. However, I collected additional data about varying levels of group participation, as suggested by Arnstein (1969). One limitation of the data that I collected within my household surveys is that I did not ask respondents about the quality of their SHG, including benefits from participating and how it is perceived within the community. I did collect baseline data for women's self-efficacy and confidence before joining and SHG, but I have not yet been able to get post-joining data.

After living in Bankura for a summer and reading Sen's (1999) Development as Freedom, I knew that I did not want my outcome variable to be income related. As Sen explains, the value of income comes from what one can purchase and is not valuable in and of itself. Instead, I wanted a different, more meaningful variable to represent well-being. Given the high prevalence of food insecurity in the region, food security seemed like something that represented well-being and also could be quantified. I collected a variety of variables related to food security including dietary diversity, but I chose to highlight the Household Food Access Insecurity Scale (HFAIS) within this dissertation. This method requires enumerators to ask the woman of the house questions about their actually scarcity of food and concern about not having enough,

which captures both the lack of food and, perhaps more importantly, the lived experience of what it is like to be hungry. The internal validity of this scale has been tested across a number of cultural contexts, including rural India (e.g., Sethi et al. 2017, Pasricha et al. 2010) and it requires tailoring to local contexts. As such, our group spent a lot of time talking about the sensitivity required when asking these questions and role-played with NGO staff in order to ensure that our enumerators knew what to expect and were appropriately trained. Asking people about their food insecurity is an incredibly intimate question because respondents have to be vulnerable. When you ask a mother—who often identifies her main purpose in life as providing for her children—if her children went to bed hungry, you are basically asking her to question her own legitimacy and value. Naturally, many women would get upset. Asking so much of participants has made me all the more committed to share results with partner NGOs and has made me seriously question the common notion in academia that more data is always better. During one of my interviews, I was waiting for a woman to tend to her chores, when she abruptly walks in and says, "You have come a long way to see how I suffer." I was shocked and a little embarrassed that my data collection strategy had been taking advantage of the people I was trying to help.

The level of suffering for women who are mildly and severely food insecure is distinctly different and should not be combined. For this reason, I chose to treat the HFAIS as a continuous variable instead of a dichotomous variable. Even though I originally chose to do so for the sake of getting the model to converge, I have become more confident that this approach is more appropriate to the context of the study site. We should not undervalue incremental change and should provide information on what kinds of variables are associated with incremental improvements towards food security. After running the logistic regressions, the story is nearly

the same in that income from nonfarm sources is significantly associated with food security, but the gendered dimension of the story became more muted. In the model where HFAIS is treated as continuous, women's non-farm was distinctly significant, but both were in the logistic regression. Additionally, the number of jobs that a man works is positively associated with food security in the logistic regression and the number of jobs was negatively associated with food security when modeled as a continuous variable. Given that women are often targeted as recipients of income diversity programs, the potential tradeoffs and drawbacks for women, including time burdens, are best unpacked in the continuous model.

Outline of Dissertation

This goal of this dissertation is to better understand how income diversity and women influence food security outcome for their families. One of the main findings is that interventions that rely on women joining the workforce or increasing their income diversity are not necessarily associated with higher food expenditures or food security. Programs that emphasize income earning as the key to "economic empowerment" may undermine both food security and empowerment goals since they do not consider the potential tradeoffs associated with women working more and they incorrectly assume that higher income generation will translate into more decision-making influence over how income is spent.

Chapter 2 models how income diversity both at the household level and the individual level shape food security as measured by the Household Food Insecurity Access Scale. We find that women and their level of income diversity has a higher association with food security than men's income diversity. This emphasizes the need to better understand the gendered dynamics of income diversity. We find that percent of income earned by women from nonfarm sources is highly associated with food security and women with more jobs are associated with less food

security, highlighting that the type of job women have is important and that income diversity is not always better.

Chapter 3 aims to unpack the relationship between men and women's incomes on food expenditure, which is highly associated with food security. We find that women's income does not have an association with food expenditure after controlling for men's income and other household-level characteristics. We also ran a mediation analysis to determine if higher incomes indirectly lead to higher food expenditure through increasing women's decision-making over income. Our findings challenge the dominant narrative that women with higher incomes are associated with higher household food security. In our study site, women's control over income, and not their level of income, was most associated with food security, while higher incomes are actually associated with decreased decision-making power about household expenditures. These findings suggest that initiatives that seek to increase women's decision-making by encouraging them to join the workforce are not sufficient to increase food expenditures.

The aim of Chapter 4 is to quantify the multiple ways through which women can impact food security, including the tradeoffs and feedbacks. We find that women's incomes are positively associated with food security, but they are not the largest pathway through which women can increase their families' food security. Instead, we find that women's empowerment and education are mutually reinforcing and have more potential to increase food security than encouraging women to earn more income.

As climatic shocks become more common and the need to feed more people with fewer dependable resources intensifies, India, and the Global South more broadly, will need to evaluate which adaptation strategies best improve household wellbeing and food security. It is also critical to understand how these strategies provide for the most vulnerable through their support or

challenge of traditional power relations that keep marginalized in vulnerable positions. This dissertation provides better evidence that income diversity and increasing women's income activities come with tradeoffs for food security and empowerment, which must be part of the decision calculus of development agents. We do not suggest that women are no longer targeted beneficiaries for programs, but instead challenge that these programs are sufficient to increase empowerment. Instead, we provide an alternative theory of change that seeks to change community norms by improving the Self Help Group model and encouraging women to lobby for community initiatives that improve their condition and wellbeing instead of focusing on small financial gains and microcredit.

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CHAPTER 2

Household-level and gender-specific income diversity and consequences of seasonal food insecurity

Abstract: Seasonal food insecurity remains a critical problem in the Global South and is particularly widespread in rainfed (no or limited access to irrigation) regions of India. Income diversity is an adaptation strategy that is often lauded as a solution for alleviating poverty and even mitigating risk for people who face climatic shocks. However, researchers have exclusively focused on the household as the basic unit of analysis and have not sufficiently studied the gendered impacts of income diversity and food security. This study follows 1,200 households in rainfed India throughout the year in order to capture seasonal variations in food security and job diversity. We find that household-level diversity was positively associated with the proportion of non-farm income and negatively associated with the number of income sources that a household has. However, further gender-specific analysis indicates that these relationships are similar, but have a much larger magnitude for women. When women are employed in nonfarm sources, household food security benefits more than if men were in nonfarm employment. Similarly, when women have multiple jobs, their family's food security suffers, but there is no effect for men. These findings have implications for development programs that specifically target women to diversify their incomes and suggests that offering women more income earning opportunities is not sufficient to improve food security.

Key Words: Income diversity, women's income, seasonal food security, women's empowerment

INTRODUCTION

In 2017, almost 124 million people across 51 countries and territories faced "crisis" levels of food insecurity (FAO 2018). Food security is a common measure of welfare and eliminating hunger is an international priority as designated by the United Nations' second Sustainable Development Goal. Households are considered food secure when they are able to acquire sufficient food to meet energy and nutrition requirements (Pinstrup-Andersen 2009). Researchers often distinguish between transient and chronic food insecurity, with the former referring to periodic limitations in food and the latter referring to long-term lack of sufficient food. Though related, transient and chronic food insecurity are rooted in different causes affecting different populations, thus demanding distinct solutions. Transient food insecurity is often related to seasonal cycles of income and agricultural harvest. In addition, it can also be related to shocks, or unexpected events such as droughts, floods, market fluctuations, and illness (Pinstrup-Andersen 2009). The mechanisms through which people prepare for and respond to transient food insecurity are less studied and are particularly important for building adaptive capacity in the developing world.

Climate change is predicted to increase environmental variability and frequency of extreme weather events such as flooding and drought, also known as climate shocks (Wheeler and Braun 2013). These short-term, unexpected events are a leading cause of increases in transient food insecurity. In fact, in the FAO (2018) survey mentioned above, most people experiencing "crisis" levels of food insecurity were negatively affected by climate shocks. In order to build adaptive capacity so that households do not suffer from transient food insecurity, it is important to first understand how people mitigate risks and the outcomes of their adaptation strategies.

To address transient food insecurity, development agencies and researchers have lauded income diversity, or having multiple revenue streams, as an adaptive strategy that households use to smooth, or stabilize, their income (Ellis 1998, Barrett et al. 2001) and mitigate risks (Agrawal and Perrin 2009; Wood et al. 2014, Wan et al. 2016). Women in particular are targeted recipients of income diversity programs, which are often characterized as "win-win" since they both promote poverty alleviation and attempt to reduce gender inequality by encouraging women to earn incomes (Duflo 2012). Popular literature refers to income diversity as a key to poverty alleviation (Kristof 2011) or to empowering women (Zakaria 2017). Nonprofits like the Bill and Melinda Gates Foundation claim that poultry farming allows women to "express their dignity and seize control" (Gates 2016). Multinational organizations like the Food and Agricultural Organization have explained: "Diversification can assist households to insulate themselves from environmental and economic shocks, trends and seasonality— in effect to be less vulnerable" (FAO 2004).

Even though income diversity has been lauded as a panacea that can smooth incomes, limit risk and vulnerability, and empower individuals, empirical findings remain mixed. For example, studies that compare income diversity and food security sometimes find that there is a positive association (Babatunde and Qaim 2010, Block and Webb 2001), but others find no effect (Robaa and Tolossa 2016). Conclusions about income diversity remain mixed for several reasons—studies vary in their definitions of income diversity, their analytical approach, and how outcomes were measured.

How women's income diversity influences food security is even less understood, yet this knowledge is critical if women continue to be targeted under income diversity programs (Akter et al. 2017, Appendix A). The literature has not provided a sufficient gendered analysis because

most research about rural income diversity uses households as the scale of analysis. Even though research has qualitatively discussed how women face different obstacles to diversifying incomes (e.g., Ellis 1998, Oluwatayo 2019, Adeniyi et al. 2016, Senadaza 2011, Brons 2005), our quantitative understanding is limited to analysis that compares female- and male-headed households (e.g., Eshetu et al. 2016, Kassie 2018, Lepper and Goebel 2010, Olale and Henson 2012). More research is needed to explicitly test how women's income diversity in male-headed households is associated with food security, especially because the vast majority of women live in male-headed households.

As climatic shocks become more common and the need to feed more people with fewer dependable resources intensifies, we have a responsibility to evaluate the efficacy of our interventions. Researchers and policy makers need to develop a more comprehensive understanding of if and how income diversity is associated with higher food security. Additionally, if agencies intend to target women, then empirical evidence should evaluate how women's income diversity, in particular, is associated with food security. To address this research gap we collected approximately 15,000 household surveys across four states and 80 villages in rural India. The first aim of this paper is to describe how different measurements of household income diversity are associated with seasonal food security in India. We hypothesize that all measures of diversity would be positively associated with food security because it mitigates the risk of total income failure and may lead to income smoothing. The second aim of this paper is to evaluate if men and women's income diversity impacts food security differently. We hypothesize that women's income diversity will be more positively associated with food security than men's because women often invest more in their families' food security than men (e.g., Hoddinott and Haddad 1996, Quisumbing et al. 1998, Duflo and Udry 2004, Doss 2006).

Research that specifically seeks to understand the unique role of women's income diversity in achieving food security is critical if policies and development programs are going to promote women's income diversity and economic empowerment.

LITERATURE REVIEW

Qualitative literature about income diversity highlights how it can be associated with poor households that are "pushed" to take on additional jobs in order to make ends meet or "pulled" to diversify because they have a surplus of cash to reinvest in other productive activities (Ellis 1998; Nghiem 2010; Eshetu et al. 2016). As Ellis (1998) explains, diversity was found to be both a deliberate choice (Stark 1991) and an involuntary response to crisis (Davies 1996); it was a means to both decrease rural inequality (Adams 1994) and to increase rural inequality (Evans and Ngau 1991); it was both a safety net for the rural poor (Zoomers and Kleinpenning 1996) and a way for the rich to increase wealth (Hart 1994). These discrepancies highlight the lack of standardized definitions of income diversity (Barrett et al. 2001) and how the causes and consequences of diversification depend on the context (Ellis 1998). Even though Ellis qualitatively discussed the determinants and outcomes of income diversity, he did not focus on the different ways that income diversity was measured. This paper seeks to describe the different measurements of diversity and compare their relative contribution to food security as well as highlighting the gendered consequences for income diversity on food security.

Measuring Income Diversity

Household diversity can be measured as a dichotomous variable wherein households are either diversified or not, usually based on whether they have one source of income or more than one source of income (Ellis 1998). Even though this is an obvious typology, few researchers define diversity so simply in empirical analyses. Instead, most household-based measures of

diversity are continuous. Specifically, income diversity is measured either as the proportion of income that comes from non-farm resources (e.g., Saith 1992, Reardon 1997, Agbola et al. 2008, Amurtiya 2015, Eshetu et al. 2016) or with evenness scores like from the Simpson (e.g., Minot 2006, Patil and Taillie 1982, Blarel et al. 1992, White 1986, Hayes and Zepeda 1997, Joshi et al. 2004), Shannon (e.g., Schwarze and Zeller 2005, Asfaw et al. 2018, Liao et al. 2015), or Herfindahl indices (e.g., Joshi et al. 2004, Mentamo and Geda 2016, Rhoades 1993, Barrett et al. 2001, Watson 2009, Hartmann et al. 2017).

Both proportion of nonfarm income and evenness indices have been used in literature. Development literature in the 1980s and 1990s often used proportion of nonfarm income to represent income diversity because the rhetoric around globalization, popular at the time, emphasized how transitioning economies needed to transform from primarily agricultural to industrial economies (Reardon 1997). Household income diversity was also encouraged as a means of escaping poverty traps, which is based on the association between non-farm income and higher incomes (Dzanku 2019).

The use of indices to measure income diversity has grown in popularity in the last decade or so. The Simpson's diversity index or Shannon index, for example, are measures of evenness borrowed from the field of ecology (Buckland et al. 2005), and information theory before that. Often used as a measure of biodiversity, these measures take into account both the number of species present and also the relative abundance of each species. Another index that is mathematically similar to the Simpson's index, but borrowed from the field of economics, is the Herfindahl index. The index measures the size of firms relative to others in an industry and characterizes the diversity of an industry on a scale of 0 to 1, where one is a monopoly and 0 has many small firms. When applied to income diversity, the goal of both of these approaches is to

measure the relative financial contribution of each job toward the total income. Evenness of income could potentially be beneficial for food security because it may represent income smoothing and evenly distributing risk amongst income streams.

Yet another approach to define income diversity is to group households by different attributes and compare how a certain type of household fares compared to others (e.g., Amuritya 2015, Agbola et al. 2008). For example, households are often sorted by the sector in which they earn the most income. A common, but not consistent, labeling scheme includes on-farm, off-farm, and non-farm (Ellis 1998, Barrett et al. 2001). On-farm refers to agricultural activities done on a household's own land. Off-farm refers to agricultural work that is done on someone else's farm and can either be local wage labor or migratory labor. Non-farm, however, refers to activities that are not related to agriculture or other natural resources and often related to service, construction, or trade sectors. Non-farm activities can include skilled and unskilled work as well as daily and salaried work, which makes it an all-encompassing category that may include more and less desirable jobs. Instead of researcher-curated categories, more recent literature uses cluster analysis to create groups of households based on their assets and activities (e.g., Jansen et al. 2006; Soltani et al. 2012; Liao et al. 2015). This bottom-up approach allows for categories to emerge based on similarities between household assets and activities.

The goal of this paper is to explore how different aspects of income diversity relate to food security outcomes. No existing literature in the field, to our knowledge, models multiple dimensions of diversity in a given study, which may be necessary because these definitions capture different dimensions of income diversity and may not be correlated with one another.

Gap to consider: differences in men and women's income diversity

Studies of income diversity typically consider the household to be the unit of analysis and do not collect data from both men and women within the same household. Without gender-specific information, we cannot compare differences between men and women in the same households. Many papers that discuss income diversity conceptually recognize the barriers women face to entering the formal workforce and the seasonality of their work (e.g., Ellis 1998, Oluwatayo 2019, Adeniyi et al. 2016, Senadaza 2011, Brons 2005). Some qualitative papers have included female respondents in household interviews or convened female focus groups (e.g., Robaa and Tolossa 2016, Bouahom et al. 2004, Eneyew 2012). In addition, quantitative research has only incorporated a gendered perspective by comparing male-headed and female-headed households (e.g., Appleton 1996, Kennedy et al. 1994, Smajic et al, 2007, Uraguchi et al. 2010). Understanding the differences between these two types of households is valuable because female-headed households are amongst the poorest, have fewer opportunities for social mobility, and are most prone to food insecurity. However, most women in India live and work in male-headed households. In order to get a clear and comprehensive understanding of how women's income diversity may be associated with food security, we need to compare it with men's income diversity. We would expect that men's and women's income diversity would have different associations with food security because of how they allocate their time, income, and energy. Men and women experience the world of work differently: cultural expectations that shape whether or not they work, the types of jobs that are available to them, how much they can earn, and how much control they have over their earnings all differ. Because men and women have different relationships with food security and income diversity, it is important to understand not just household effects but also individual ones.

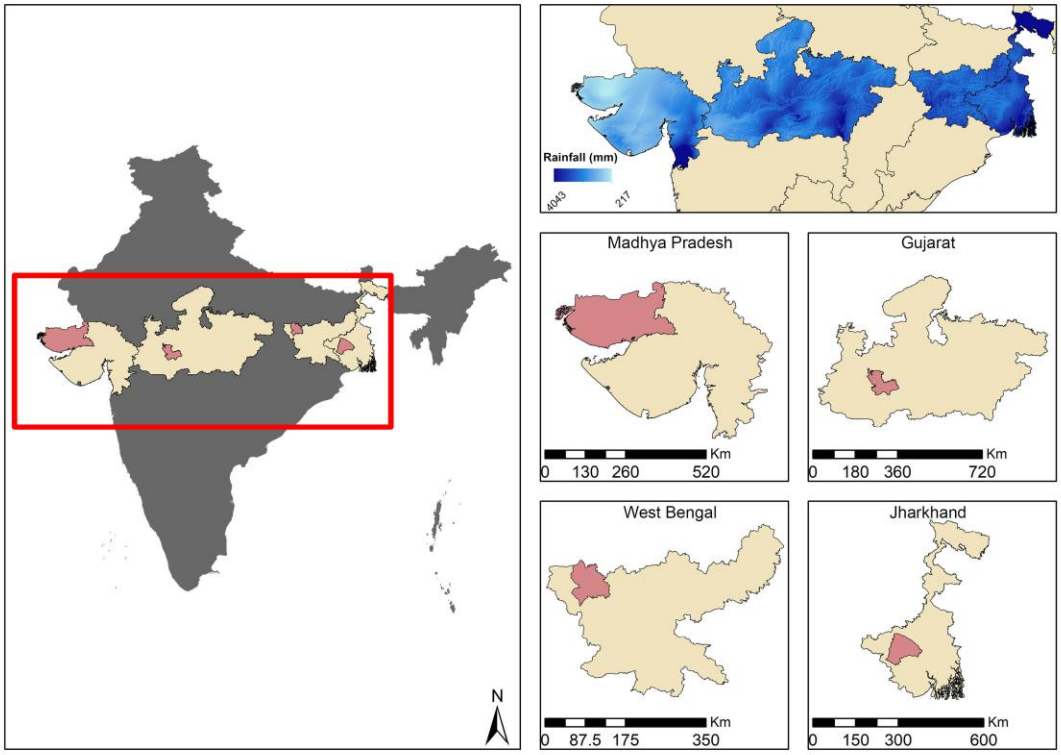
METHODS

Study Site

The study site covers four Indian states that span 2,000 kilometers of India: Kutch district, Gujarat; Dewas district, Madhya Pradesh; Palamu district, Jharkhand; and Bankura district, West Bengal (Figure 2.1). These sites were selected because of their dependence on rainfed agriculture and gradient of annual rainfall, as well as existing relationships between the study team and local NGOs. Even though the NGOs did work in some of our sample villages, we selected villages at random and our results are scalable to the district level. Working with NGOs within the Revitalizing Rainfed Agriculture Network allowed us to easily find local enumerators, pilot interviews, and orient our research questions to be more useful in advancing our partners' missions. The sites also vary in the proportion of households that experience food insecurity (Figure 2.2). Understanding the dynamics of food security in rainfed regions, where there is little to no irrigation, is important because these regions are home to large number of farmers, who grow most of the world's staple crops yet remain food insecure (Rockstrom et al. 2009). These study sites are well suited to understand dynamics of income diversity because approximately half the households in our sample population have one job, which is usually related to caste-based work or agriculture, and half have more than one job. Additionally, since we are surveying rural areas with high populations of scheduled castes and tribes, many women participate in the workforce, if only seasonally, which captures variation of how much women work and also how much control they have over income. Last, given the seasonal nature of agricultural work, this is an ideal place to study how income diversity and food security change within the year. Many of the women who do not work come from higher castes, which are also associated with higher food security, more wealth, and higher female education. Analysis of high-temporal, intra-annual

data is critical to understanding the seasonal nature of these relationships and appropriately tailoring and timing interventions.

Figure 2.1. Map of study sites, including Kutch district, Gujarat; Dewas district, Madhya Pradesh; Palamu district, Jharkhand; and Bankura district, West Bengal in India. The annual amount of precipitation is highest in West Bengal and lowest in Gujarat.



Data Collection

We randomly selected a total of 1,200 households across four study sites; within each site we randomly selected 20 villages and 15 households within each village, so our sample can be scaled to the district level. We collected data from each household from November 2016 to November of 2017, which created a dataset of approximately 15,000 household surveys. Collaborators within the Revitalizing Rainfed Agriculture Network compiled the complete list of residents for each selected village by first acquiring government census registries and then

meeting with village headmen and elders to adjust and confirm their completeness. In the handful of cases when a household did not want to participate in the study, we replaced it with another randomly selected house from within the village. On one occasion a village headman in the Kutch district did not want us to conduct surveys unless financially compensated. To avoid potential conflict, we replaced the village with another randomly selected one.

Given that many people within our sample population live in joint households, a household was determined by who shared a communal kitchen. . Thus, standard data collection procedures which target the household head were unclear and, given the diverse array of household structures, would have generated a less representative sample. Since the household head and his wife were not always obvious in extended-family households, we randomly selected one man and one woman between the ages of 18 and 70 from the same household. We excluded individuals that we were over 70 since our pilot studies indicated that the elderly were less interested in participating and often suggested a younger replacement within the family who was more familiar with financial decisions.

Many households in our study are natural resource dependent and, given the cyclical nature of agriculture work in these areas, we expected to see large seasonal differences in income generation and food security and women's paid labor. In order to capture this variation throughout the year, we collected household surveys each month from November 2016 to November 2017. Approximately 30 local enumerators were assigned to 1-3 neighboring villages and visited the same households 13 times during our sampling period. Each interview took 1-2 hours in the first couple months of data collection and later took 30 minutes to an hour to complete since enumerators became more efficient and knew background information on each household. The enumerators' familiarity with each household provided additional quality control

for respondent answers. Our surveys included data on cash expenditure, access to credit, income sources, assets (household, agricultural, livestock, and fish), natural resource dependence, collection of non-timber forest products, Household Food Insecurity Access Scale, 24-hour food recall, 7-day food frequency, time allocation, and harvest details like yield and whether the harvest was eaten, stored, or sold (Appendix B).

We hired four research coordinators in each of the field sites who were responsible for training enumerators and performing quality control of data. We hired local enumerators who lived near our selected villages for efficiency and to allow enumerators to develop relationships and trust with participants. To ensure accuracy and efficiency across sites, we hosted ten, 4-day trainings from October 2016 to December 2018 for research coordinators. When asking women about household food access, we found that these were delicate questions to ask since they could make women feel ashamed. We took extra time to train enumerators on how to sensitively ask these questions, so as to not harm participants. Additionally, forms were checked at site-based, monthly meetings where enumerators traded forms and were marginally rewarded for finding and correcting one another's mistakes and for completing mistake-free forms. Surveys were collected in local and native languages of participants and then translated when written into Hindi, Gujarati, or Bengali. Paper forms were entered into English-language Qualtrics platforms. Further quality control measures included writing code in R (version 3.5.3) to flag forms that were missing sections or had irregular answers that needed to be verified. From January to December 2018, research coordinators made corrections to online forms and made every effort to account for missing data.

Measurement of Variables

We represent food security with the Household Food Insecurity Access Scale because it considers multiple dimensions of the experience of being food insecure. This scale is superior to other measures of food security like caloric intake or food expenditure that only capture one dimension of food security. The HFIAS includes information about uncertainty and worry about food, inadequate quality of food, insufficient quantity of food, and social unacceptability (Coates et al. 2007). Questions are posed to a woman in the house and refer to the last 30-day period. Based on if and how frequently they face these challenges, households are sorted into four categories: food secure, mildly food insecure, moderately food insecure, and severely food insecure. The accuracy and reliability of this metric are robust across different cultures (Leroy et al. 2015), including India specifically (Sethi et al. 2017). However, this measure of food security does not include any information about the dietary and nutritional diversity, which are important to health outcomes (Pinstrup-Andersen 2009). Additionally, this variable considers food security at the household level only when there may be large discrepancies between people living in the same household, especially for women (Haddad et al. 1997).

We measured income diversity in three ways because each measure captures a different aspect of income diversity: the number of jobs done each month, the percent of income earned from non -farm sources, and the Simpson's index. The number of jobs one has may be related to whether they are able to substitute one job with another and how efficient each job is in terms of effort and pay. The percent of non-farm sources is related to consistency of employment that is not driven by seasonal availability of work. And the Simpson's index, which is an evenness score, indicates the relative proportion of income from each source, so it can measure the relative

level of dependence on one vs. many sources of income. When combined these measures provide a more comprehensive understanding of how income diversity can impact food security.

To create these variables, we asked people about their work activities that provide income, who in the household did the job, how much they earned, how frequently they were paid, if they had a gap or delay in pay, and also if women had input over how the job was completed and how income was spent. Since some people, particularly agricultural wage laborers, are paid in grain or other in-kind payments, we converted any in-kind payments to the cash equivalent. We used Google Refine to clean approximately 3,000 open-ended answers into 450 recognizable jobs. Next, two independent coders sorted income sources into four categories: income from their own farms, from their own livestock, other natural resource jobs (including farm wage labor), as well as non-farm income.

From this, we calculated the number of jobs completed by men and women in the household. In order to keep income proportional amongst male and female earnings within the same household, we also included family size and proportion of women in the model. We also calculated the percent of income from non-agricultural production. Proportion of income that comes from non-farm sources is associated with higher food security (Hesselberg and Yaro 2006; Babatunde and Qaim 2010; Esheta and Mekonnen 2016; Robaa and Tolossa 2016; Silvestri et al. 2016). Additionally, we calculated the Simpson's diversity index by combining the relative proportion of income across different job category types (Magurran 1998). Simpson's index is the probability that any dollar earned drawn at random will be for any income activity (Magurran 1988). The Simpson's index is also bounded between 0 and 1; a value of zero indicates that a household only does one activity to generate income and a value of one indicates that the household does all of the activities in equal proportion. We chose to use this measure of

income diversity evenness because it characterized the entire income portfolio as a diverse community of income sources instead of focusing on one particular type of job and because it is commonly used in the literature.

We included the following household characteristics because they are significantly associated with food security and we wanted to control for them in order to draw conclusions about associations between income diversity and household food security. Household characteristics that were consistently and significantly associated with food security according to a systematic literature review (Bashir and Schilizzi 2012) were included in the regression.

We incorporated the relative wealth of each household by including monthly income (Gyawali and Ekasingh 2008, Bashir et al. 2010) and how much land the household owned (Ahmad et al. 2002). Wealth influences food expenditure, which is positively associated with food security (Amaza et al. 2006, Omotesho et al. 2007). We also included information about caste because women from lower castes are more likely to participate in agricultural wage labor and many women from higher castes have the option not to work and may prefer not to (Rao 2014, Eswaran et al. 2013). Moreover, the structural inequalities faced by lower caste households, such as lack of land, literacy, and social mobility, may affect the ways that households are able to secure sufficient food (Rao 2014).

We included family size because the number of the people in the family may influence both how much food is required and how many people may be able to earn income within the family (Bashir et al. 2010, Sindhu et al. 2008). We measured family size as the number of adults and children that share a communal kitchen since many households in our sample population are part of joint households where extended families live together. We also included the proportion of adult women in the household because women can influence food security in a variety of ways

and a household with many women may be able to split up chores or spend more time with their children, which is highly correlated with food security (Wandel and Holmboe-Ottesen 1992, Quisumbing 1995, Jones et al. 2012). Similarly, we included the gender of the household head because female-headed households are often the most poor and, therefore, most susceptible to food insecurity (Appleton 1996, Kabbani and Wehelie 2005). Last, we also included women's educational attainment because women can influence their families' food security through how much income they make, how much time they have to tend to their children and prepare nutritious food, and also in how much they know about proper nutrition and hygienic practices (Olumakaiye and Ajayi 2006, Quisumbing et al. 1996). We included women's education in the gender-specific model and included highest education of anyone in the family in the household model because education, especially with men, is associated with non-agricultural work, which is not dependent on season and may offer additional benefits beyond a salary alone (Gyawali et al. 2008, Bashir et al. 2010).

Since our study population includes many farmers, we included information about their harvest, which can influence both their food security directly and may also influence whether or not they take on additional work during the rest of the year. To capture information about farms and harvests, we included crop diversity (Remans et al. 2011, Oyarzun et al. 2013, Jones et al. 2014) measured with the Simpson's index and total amount harvested in kilograms. We also included a dichotomous variable representing whether they farmed because we wanted to interpret our results with respect to farmers.

Women's empowerment was calculated according to a modified Abbreviated Women in Agriculture Empowerment Index (Alkire et al. 2012, Malapit et al. 2015). The validity and accuracy of this measure has been tested and elicits valid responses from participants (Johnson

and Diego-Rosell 2015). The abbreviated score included five domains: input over productive decisions, ownership of productive assets, control over use of income, leadership in the community, and time allocation. Each of these domains were reduced to dichotomous options: being empowered according to the domain or not. Input about productive decisions refers to whether the individual had any input on decisions about income-generating activities like food crop farming, cash crop farming, livestock raising, fish culture, or any other non-agricultural activities. A woman was considered empowered if she had influence over at least some decisions on two sources of agricultural income, this would not have included people that had no input or very little input. We modified the index slightly because we included all income sources and did not limit it to only agricultural jobs.

Access to productive assets refers both to asset ownership and access and control over credit. Individuals were asset-empowered if they owned at least one household, livestock, fish, or agricultural asset. Individuals were considered credit-empowered if they made either the decision to take a loan or a decision about the use of the money from a loan. Individuals were considered empowered with respect to their income if they made at least some consequential decisions about how income was spent. Leadership refers to active participation in community groups. A person was adequate if they made at least some decisions within any group. Time allocation refers to how an individual spends their time, including paid and unpaid work as well as leisure and rest. Individuals who worked 10.5 hours or less each day for six days a week were considered time-empowered.

We also included number of reserved seats for women on local village councils since it may affect the time women spend on unpaid labor or potentially influence empowerment by legitimizing female voices in decision-making process. Chattopadhyay and Duflo (2004) found

that villages with more female representatives invested more in the expressed development priorities of women, including infrastructure that reduced their domestic drudgery.

We also included natural resource dependence since we predicted that those that had access to the commons, or resources that belong to everyone (Ostrom 1990), would have more access to food or other products that they could sell to purchase food. Natural resource dependence also influences how much time a woman spends collecting goods and time away from her children, which is negatively associated with food security (Wandel and Holmboe-Ottesen 1992, Jones et al. 2012, Tsiboe et al. 2018). To create a variable for natural resource dependence, we measured the proportion of fodder, firewood, non-timber forest products, and timber that were collected from the commons.

Finally, to evaluate seasonal effects, we grouped months into three harvest-related seasons: Kharif, Rabi, and summer. Given that our sites span over 2,000 kilometers and experience monsoons at slightly different times, we included an interaction effect between site and season (Figure 3.5). Kharif is the reference group and refers to the first and most popular harvest season from August through November. Some households, especially those with access to irrigation, will grow and harvest a second crop during the Rabi season, which is from December through March. No one harvests during the summer, from April to July, because they are preparing their fields and waiting for monsoons that usually start in June (Jain et al. 2015).

Data Analysis

We used two mixed-model linear regressions to quantify how much both household income diversity and gender-specific income diversity impact seasonal food security. The covariates were nearly the same for both models. However, we added women's level of education and number female-owned assets to the gender-specific model because they are

positively associated with a woman's bargaining power, which influence empowerment (Doss 2013). We analyzed the data using the lem4 package within R software version 3.5.3 (Bates et al. 2015).

Because data were collected from the same households in multiple months, we included random slopes for month and also for households within villages. In order to explain variation that was due to differences across sites, we included site-level effects as fixed effects within the model. Both models had the same random effects structure that was developed a priori, and were tested for multicollinearity. In order to compare how each independent variable relates to food security within its own units we ran models with unscaled variables in the models. To compare the relative effects across independent variables on food security, we also ran the same models with scaled data (standardized and centered). We present unscaled models within the paper and scaled models in Appendix C.

Checking Robustness

Even though we tried to include all variables that could influence food security and income diversity, it could be that our analysis suffers from endogeneity problems from excluding unobservable variables. In order to test the robustness of our results we used two approaches by Altonji et al. (2005) and Oster (2017). Under the former approach we tested how much greater unobservable factors, relative to observable factors, would need to be in order to completely explain away the relationship between women's empowerment and food expenditure (Nunn and Wantchekon 2011). Oster (2014, 2017) builds on Altonji's approach, but also incorporates the amount of variation explained by the model (R^2). According to Oster, one can reject the hypothesis that the value of the coefficient is driven exclusively by unobservable

variables, if zero is not in the interval between the model coefficient and the B* statistic (Galor and Ozak 2014).

RESULTS

Robustness of Results

We found that both the scaled and unscaled data were sufficiently robust according to Altonji et al. (2005) and Oster (2017). Using unscaled data, we find that the influence of unobservable factors would need to be 3 and 5 times greater to explain away the relationship between nonfarm employment and number of jobs on food security within the household model. Unobservable variables would need to be 1.6 and 11.7 times larger to explain away the impact of female non-farm employment and number of jobs a woman has on food security, within the gender-specific model. All measures of income diversity in the household or the gender-specific model meet this threshold, indicating that our results' significance, direction, and magnitude are not affected by unobservable variables (Appendix D).

Descriptive results

We found that the level of food insecurity was significantly different between sites (Figure 2.2). Palamu and Dewas had significantly higher levels of food security as compared to Kutch, which was the most food secure. Households within Bankura also suffered from food insecurity but to a less dramatic extent. In Bankura, January was the only month that there was a significant spike in food security, which corresponds with their harvest season. Even in peak harvest season, when incomes are highest across all sites, men earn significantly more than women (Figure 2.3). Additionally, tables provide additional descriptive information across all variables in the model for the entire sample population (Table 2.1) as well as across the three

definitions of income diversity: number of jobs (Table 2.2), proportion of nonfarm income (Table 2.3), and Simpson's index (Tables 2.4). (See Appendix G for more graphs).

Figure 2.2: Number of households food secure or food insecure according to the Household Food Insecurity Access Score across 1,200 households in rainfed regions of India from November 2016- November 2017.

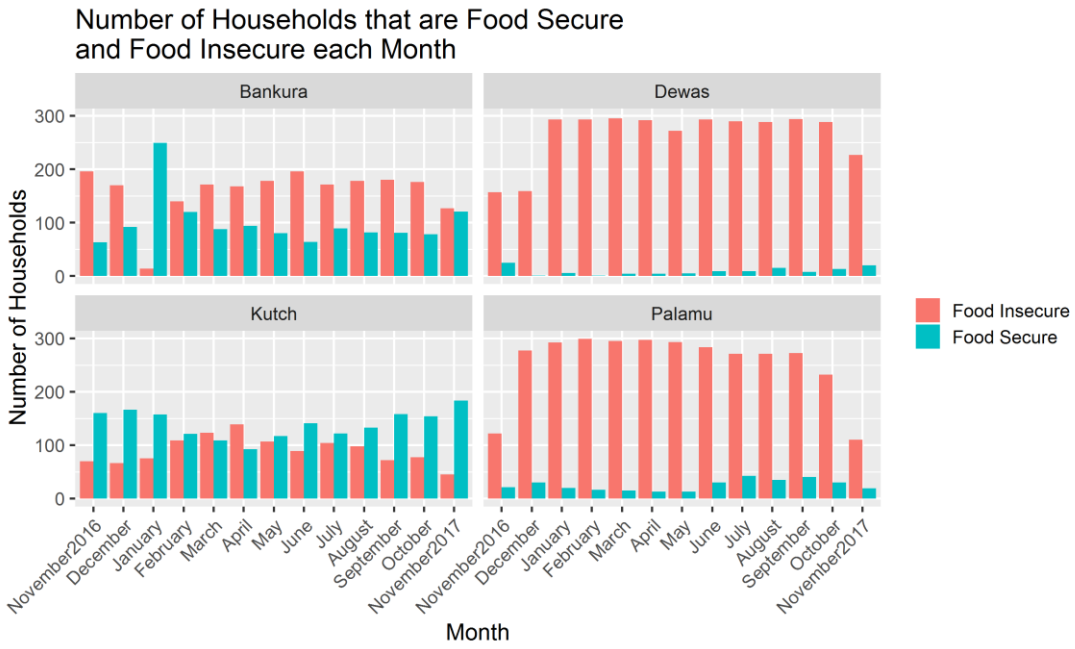


Figure 2.3: The average amount of rupees earned by men and women each month in 1,200 households in rainfed regions of India from November 2016- November 2017.

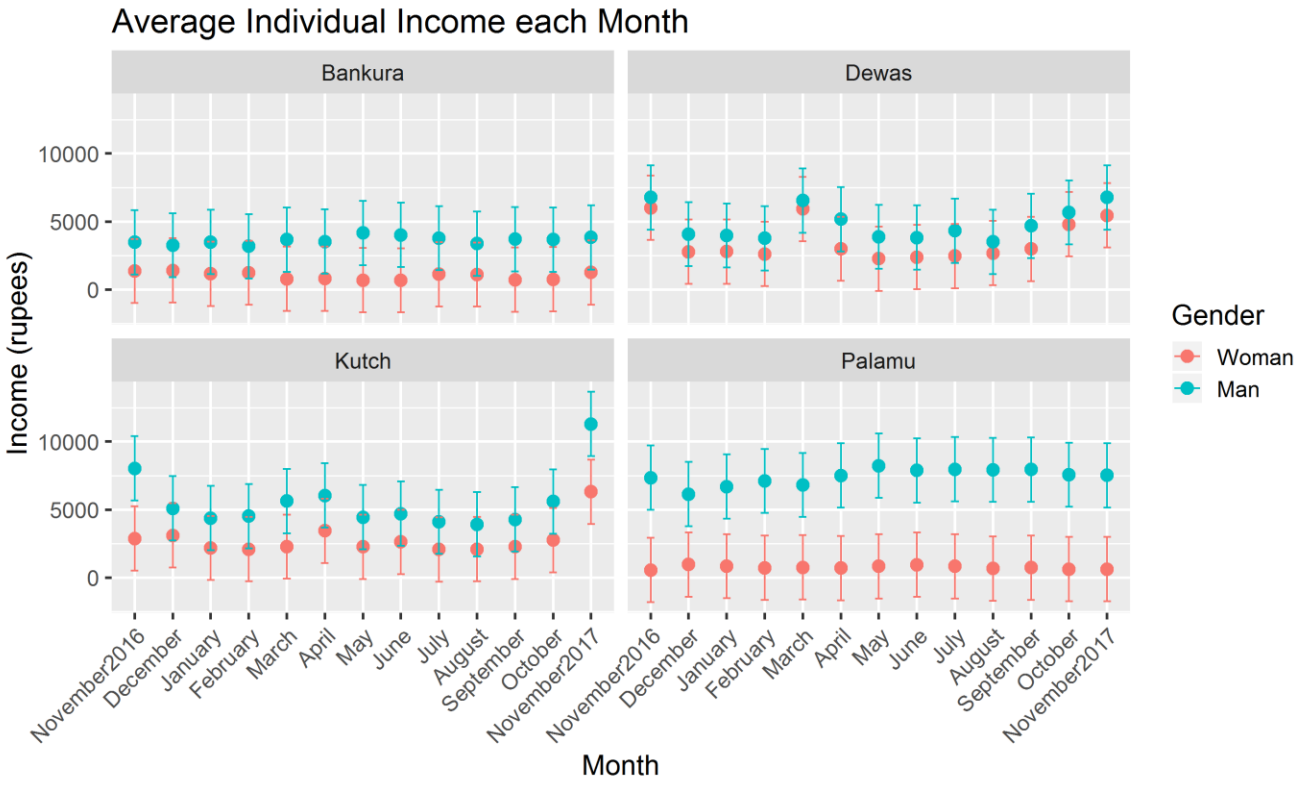


Table 2.1. Summary statistics of variables in models presented in chapter 2 for 1,200 households across four rainfed regions of India from 2016-2017.

Variable	Mean (sd)
Income Evenness Woman	0.071 (0.157)
Income Evenness Man	0.129 (0.202)
Percent Nonfarm Income Woman	0.103 (0.289)
Percent Nonfarm Income Man	0.295 (0.425)
Number of Jobs Woman	0.946 (0.908)
Number of Jobs Man	1.515 (0.831)
Yield (kg)	334.107 (2736.050)
Reliance on the Commons	14.279 (18.993)
Seats Reserved for Women	1.784 (1.255)
Woman's Empowerment	0.322 (0.198)
Food Expenditure	2561.586 (1240.232)
Monthly Household Income	111.478 (145.395)
Does Not Farm	0.825 (0.380)
Crop Diversity	0.838 (0.360)
Family Size	5.021 (1.958)
Access to Irrigation	0.194 (0.395)
Proportion of Women in HH	0.469 (0.167)
Gender of HH Head	0.019 (0.135)
Education	7.435 (4.088)
Land (ha)	1.455 (1.842)

Table 2.2. Summary statistics for households that have one job and more than one job across 1,200 households in rainfed regions of India from 2016-2017.

Variable	Single Job Mean (sd)	Multiple Jobs Mean (sd)
Number of Households in Category	4205	9390
Income Evenness Woman	0.013 (0.072)	0.088 (0.172)
Income Evenness Man	0.006 (0.050)	0.183 (0.219)
Percent Nonfarm Income Woman	0.032 (0.175)	0.136 (0.323)
Percent Nonfarm Income Man	0.286 (0.451)	0.301 (0.414)
Number of Jobs Woman	0.231 (0.422)	1.274 (0.881)
Number of Jobs Man	0.927 (0.261)	1.790 (0.852)
Yield (kg)	245.898 (1092.029)	372.384 (3203.523)
Reliance on the Commons	12.542 (17.808)	15.096 (19.464)
Seats Reserved for Women	2.062 (1.248)	1.661 (1.241)
Woman's Empowerment	0.224 (0.162)	0.367 (0.196)
Food Expenditure	2595.085 (1356.072)	2547.769 (1182.484)
Monthly Household Income	78.827 (90.888)	126.642 (161.994)
Does Not Farm	1.848 (0.359)	1.814 (0.389)
Crop Diversity	0.856 (0.344)	0.829 (0.366)
Access to Irrigation	1.174 (0.379)	1.203 (0.402)
Family Size	4.920 (2.089)	5.077 (1.892)
Proportion of Women in HH	0.463 (0.182)	0.472 (0.159)
Gender of HH Head	0.027 (0.163)	0.015 (0.122)
Education	7.806 (4.229)	7.277 (4.009)
Land (ha)	1.328836 (1.909015)	1.504 (1.803)

Table 2.3. Summary statistics for 1,200 households across rainfed regions of India from 2016-2017. Households are grouped into those that get 95% percent or more of their income from agriculture, 95% or more from non-farm sources, and those that have mixed incomes.

Variable	>95% Nonfarm Mean (sd)	<5% Nonfarm Mean (sd)	Between <95% and >5% Nonfarm Mean (sd)
Number of Housholds in Category	2174	7928	3566
Income Evenness Woman	0.013 (0.074)	0.065 (0.152)	0.105 (0.183)
Income Evenness Man	0.003 (0.028)	0.111 (0.191)	0.243 (0.223)
Percent Nonfarm Income Woman	0.293 (0.455)	0 (0)	0.217 (0.367)
Percent Nonfarm Income Man	0.903 (0.291)	0 (0)	0.578 (0.378)
Number of Jobs Woman	0.362 (0.603)	0.941 (0.867)	1.315 (0.961)
Number of Jobs Man	1.157 (0.628)	1.405 (0.738)	1.978 (0.935)
Yield (kg)	176.082 (798.363)	335.013 (1417.922)	428.430 (4880.117)
Reliance on the Commons	11.962 (17.557)	14.258 (18.939)	15.737 (19.803)
Seats Reserved for Women	2.070 (1.179)	1.727 (1.230)	1.734 (1.330)
Woman's Empowerment	0.305 (0.193)	0.302 (0.193)	0.380 (0.200)
Food Expenditure	2612.851 (1328.425)	2541.964 (1244.871)	2573.956 (1171.659)
Monthly Household Income	105.062 (132.744)	98.458 (141.561)	144.334 (155.760)
Does Not Farm	1.882 (0.323)	1.814 (0.389)	1.817 (0.387)
Crop Diversity	0.889 (0.309)	0.827 (0.369)	0.831 (0.364)
Family Size	4.859 (2.125)	5.045 (1.937)	5.068 (1.891)
Access to Irrigation	1.159 (0.365)	1.184 (0.387)	1.238 (0.426)
Proportion of Women in HH	0.479 (0.190)	0.467 (0.166)	0.468 (0.153)
Gender of HH Head	0.012 (0.109)	0.023 (0.149)	0.014 (0.118)
Education	8.402 (4.359)	7.112 (4.012)	7.565 (3.987)
Land (ha)	0.984 (1.552)	1.604 (1.949)	1.409 (1.703)

Table 2.4. Summary statistics for 1,200 households across rainfed regions of India from 2016-2017. Households were grouped into high and low income diversity according to the Simpson's Index where higher scores represent more diverse income portfolios.

Variable	Not Diverse: Simpson's <0.1 Mean (sd)	Diverse: Simpson's >= 0.1 Mean (sd)
Number of Housholds in Category	7065	6600
Income Evenness Woman	0.014 (0.071)	0.120 (0.191)
Income Evenness Man	0.009 (0.058)	0.254 (0.221)
Percent Nonfarm Income Woman	0.096 (0.294)	0.111 (0.283)
Percent Nonfarm Income Man	0.288 (0.452)	0.302 (0.395)
Number of Jobs Woman	0.558 (0.688)	1.362 (0.930)
Number of Jobs Man	1.129 (0.571)	1.928 (0.866)
Yield (kg)	278.030 (1303.876)	394.017 (3698.213)
Reliance on the Commons	13.054 (18.406)	15.585 (19.519)
Seats Reserved for Women	1.968 (1.221)	1.585 (1.262)
Woman's Empowerment	0.279 (0.189)	0.369 (0.196)
Food Expenditure	2545.935 (1304.983)	2578.145 (1167.053)
Monthly Household Income	96.247 (151.61)	127.832 (136.583)
Does Not Farm	1.840 (0.366)	1.809 (0.393)
Crop Diversity	0.850 (0.349)	0.824 (0.369)
Family Size	4.948 (2.005)	5.101 (1.903)
Access to Irrigation	1.169 (0.375)	1.220 (0.415)
Proportion of Women in HH	0.472 (0.177)	0.466 (0.155)
Gender of HH Head	0.021 (0.144)	0.016 (0.125)
Education	7.633 (4.162)	7.225 (3.998)
Land (ha)	1.305 (1.854)	1.615 (1.815)

Model Fits

The model for household-level income diversity had practically the same AIC (19,646) compared to the model where income was calculated by gender (19,673). Given that the delta AIC is only 27, the two models explain a similar amount of variation. Therefore, the gender-specific model provides a similar fit and has the added advantage of explaining more relationships between gendered income diversity and food security.

The random effect that explained the most variation was village, indicating that households within the same village are more similar to one another than households in other villages. Future researchers may be able to capture more variation by surveying more villages and fewer households within each village. The small variation explained in our random effect of month indicates that food security is more associated household characteristics than by month-to-month differences. In other words, once season was included as a fixed effect, the monthly data does not explain additional variation

Income diversity in the household-level model

Within the unscaled household-level model (Table 2.5), proportion of income from non-farm sources is positively significant (p=0.00); every additional percentage point increase in nonfarm income is associated with a food security increases by 0.07 points on a four-point scale. The number of jobs completed by the family, holding constant the number of people within the household, is significant (p=0.00) and negatively associated with food security. For every additional job that the household gains, there is an associated decrease of 0.03 points on a four-point scale of food security. The Simpson's index is also positively associated with food security (p=0.03). The effect of having an equal proportion of income across all sources as compared to only having one source is associated with a 0.07 increase in the food security scale. However,

incremental changes within the diversity score have a lot less impact; every 0.1 increase on a 1-point Simpson's scale is associated with a 0.007 increase in the four-point scale of food security.

Table 2.5: Output table with effect sizes, standard errors and p values from unscaled data to measure associations between household-level income diversity and food security, measured with the Household Food Insecurity Access Scale. Data was obtained from 1,200 households in Kutch district, Gujarat; Dewas district, Madhya Pradesh; Palamu district, Jharkhand; and Bankura district, West Bengal from 2016-2017.

Variables	Estimate	Std. Error	Pr(>|t|)	Sig.
(Intercept)	2.98E+00	1.88E-01	< 2e-16	***
Household Income Evenness	7.39E-02	3.37E-02	0.028389	*
Percent of Income from Non-Farm Sources	6.80E-02	1.76E-02	0.000112	***
Total number of Jobs within Household	-3.25E-02	8.46E-03	0.000125	***
Total Yield (kg)	1.11E-06	1.94E-06	0.567486	
Farming Household (Y/N)	-3.52E-01	6.75E-02	1.93E-07	***
Crop Diversity	3.33E-01	7.05E-02	2.30E-06	***
Family Size	1.15E-02	5.98E-03	0.055704	.
Proportion of Women in Household	-4.00E-02	6.85E-02	0.559109	
Gender of Household Head (M/ F)	1.83E-01	8.65E-02	0.034902	*
Highest level of education in household	1.42E-02	2.91E-03	1.28E-06	***
Total land (ha)	5.35E-03	7.19E-03	0.45754	
Other Backward Castes	-2.28E-01	4.76E-02	2.00E-06	***
Scheduled Caste	-2.76E-01	5.30E-02	2.31E-07	***
Scheduled Tribe	-3.48E-01	5.19E-02	3.44E-11	***
Monthly Food Expenditure	1.77E-05	6.37E-06	0.005539	**
Monthly Income	1.49E-04	4.28E-05	0.000524	***
Reliance on Commons	-2.09E-03	5.57E-04	0.000187	***
Reserved Seats for Women on Village Councils	1.00E-01	5.45E-02	0.069975	.
Women's Empowerment in Ag. Score	5.92E-02	4.52E-02	0.19022	
Number of Distinct Livestock Assets	3.97E-04	2.50E-03	0.873664	
Dewas	-5.21E-01	1.74E-01	0.003863	**
Kutch	4.15E-01	1.98E-01	0.040039	*
Palamu	-9.36E-01	1.74E-01	9.24E-07	***
Rabi	-3.64E-02	8.05E-02	0.660653	
Summer	-1.57E-01	8.08E-02	0.079616	.

Income diversity in the gender-specific model

The unscaled gender-specific model (Table 2.6) indicates that a lot of the patterns we observed at the household-level may be driven by women's income diversity. For example, women's nonfarm income was positively and significantly associated with food security (p= 0.01); for every additional percentage point of nonfarm income earned by women, food security increased by 0.06 on a four-point scale. Non-farm income earned by men was only marginally significant (p=0.10). Yet, non-farm income earned by men had half of the impact on food security compared to women's non-farm income.

When women in the household have many jobs, there is a significantly negative association with food security (p=0.00). For every additional job a woman works, the household's food security is associated with a 0.04 decrease on a four-point scale. The number of jobs a man has does not have any significant association with food security. Neither the Simpson's index for men or women had a significant impact on food security (p=0.78, p=0.54).

Table 2.6: Effect sizes, standard errors and p values from unscaled data to measure associations between gender-level income diversity and food security, measured with the Household Food Insecurity Access Scale. Data was obtained from 1,200 households in Kutch district, Gujarat; Dewas district, Madhya Pradesh; Palamu district, Jharkhand; and Bankura district, West Bengal from 2016-2017.

Variables	Estimate	Std. Error	Pr(>|t|)	Sig.
(Intercept)	2.98E+00	1.87E-01	< 2e-16	***
Woman's Household Evenness	1.28E-02	4.68E-02	0.783779	
Man's Household Evenness	2.48E-02	4.04E-02	0.540165	
Woman's Percent of Income from Nonfarm Sources	6.14E-02	2.34E-02	0.00882	**
Man's Percent of Income from Nonfarm Sources	3.01E-02	1.81E-02	0.096017	.
Woman's Total Number of Jobs	-4.26E-02	1.03E-02	3.66E-05	***
Man's Total Number of Jobs	3.64E-03	1.11E-02	0.741917	
Total Yield (kg)	1.10E-06	1.95E-06	5.73E-01	
Farming Household (Y/N)	-3.08E-01	7.49E-02	3.93E-05	***
Crop Diversity	2.83E-01	7.81E-02	0.000292	***
Family Size	2.52E-03	6.58E-03	7.02E-01	
Proportion of Women in Household	-5.53E-03	7.58E-02	0.941843	
Gender of Household Head	2.51E-01	9.29E-02	0.006965	**
Highest level of education in household	1.48E-02	3.10E-03	2.09E-06	***
Total Land (ha)	3.33E-03	7.37E-03	0.651352	
Other Backward Castes	-1.87E-01	5.57E-02	8.39E-04	***
Scheduled Caste	-2.80E-01	6.30E-02	1.00E-05	***
Scheduled Tribe	-3.09E-01	5.91E-02	2.20E-07	***
Monthly Food Expenditure	1.57E-05	7.08E-06	2.69E-02	*
Monthly Income	1.10E-04	4.87E-05	2.39E-02	*
Reliance on Commons	-2.30E-03	6.15E-04	0.000193	***
Reserved Seats for Women on Village Councils	8.86E-02	5.34E-02	0.101984	
Women’s Empowerment in Ag. Score	1.22E-01	5.01E-02	0.01507	*
Number of Distinct Livestock Assets	7.37E-03	7.00E-03	0.292292	
Dewas	-5.35E-01	1.67E-01	0.002128	**
Kutch	4.37E-01	1.91E-01	0.025555	*
Palamu	-9.95E-01	1.70E-01	1.49E-07	***
Rabi	-5.01E-02	8.43E-02	0.565878	
Summer	-1.55E-01	8.45E-02	9.63E-02	.

Figure 2.4: Effects of continuous variables within the unscaled gender-specific model on food security, as measured by the Household Food Insecurity Access Scale. Data were collected for 1,200 households in rainfed regions of India. These graphs were based on unscaled data, so we observe how each variable is associated with food security in its own units.

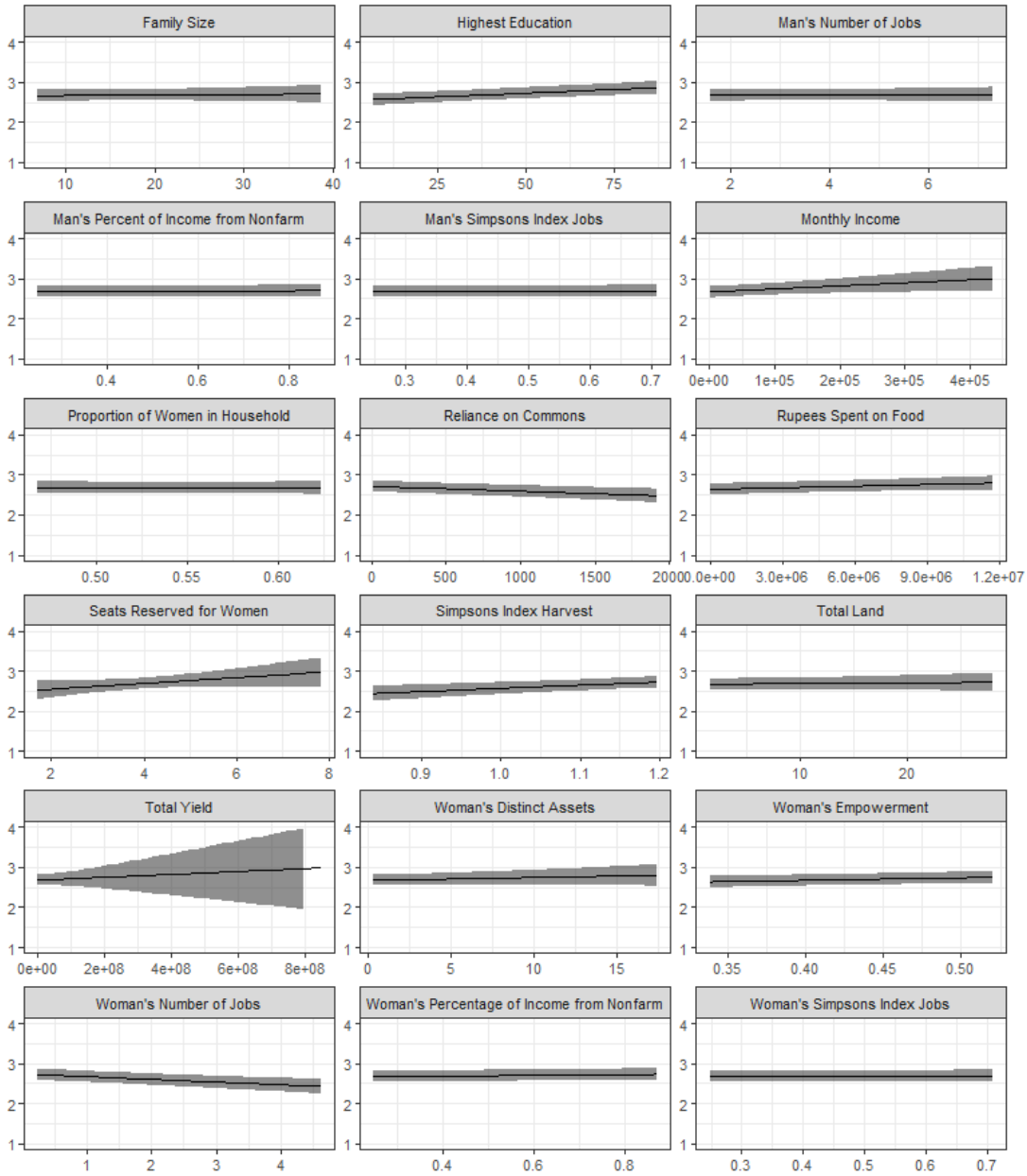
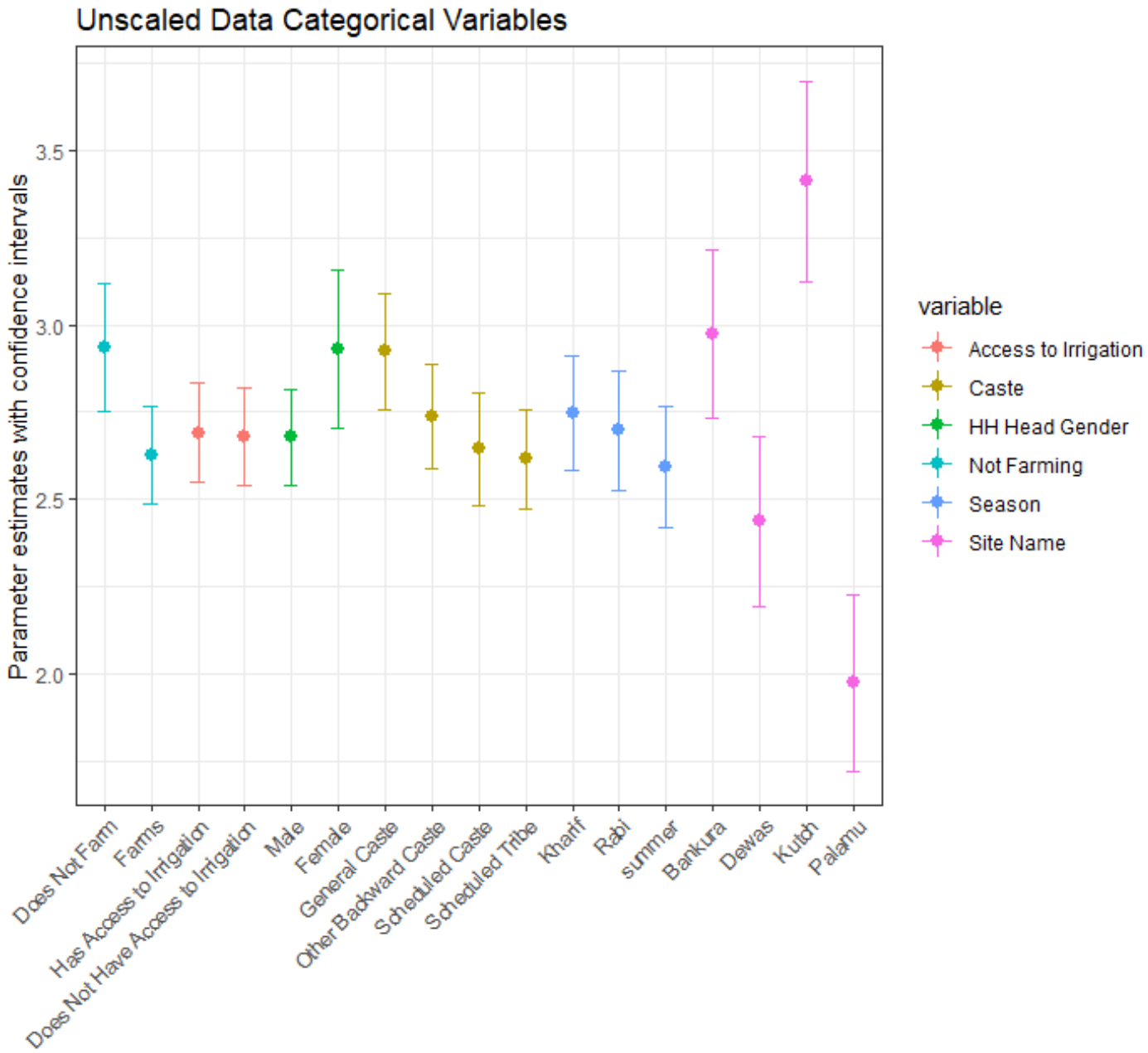


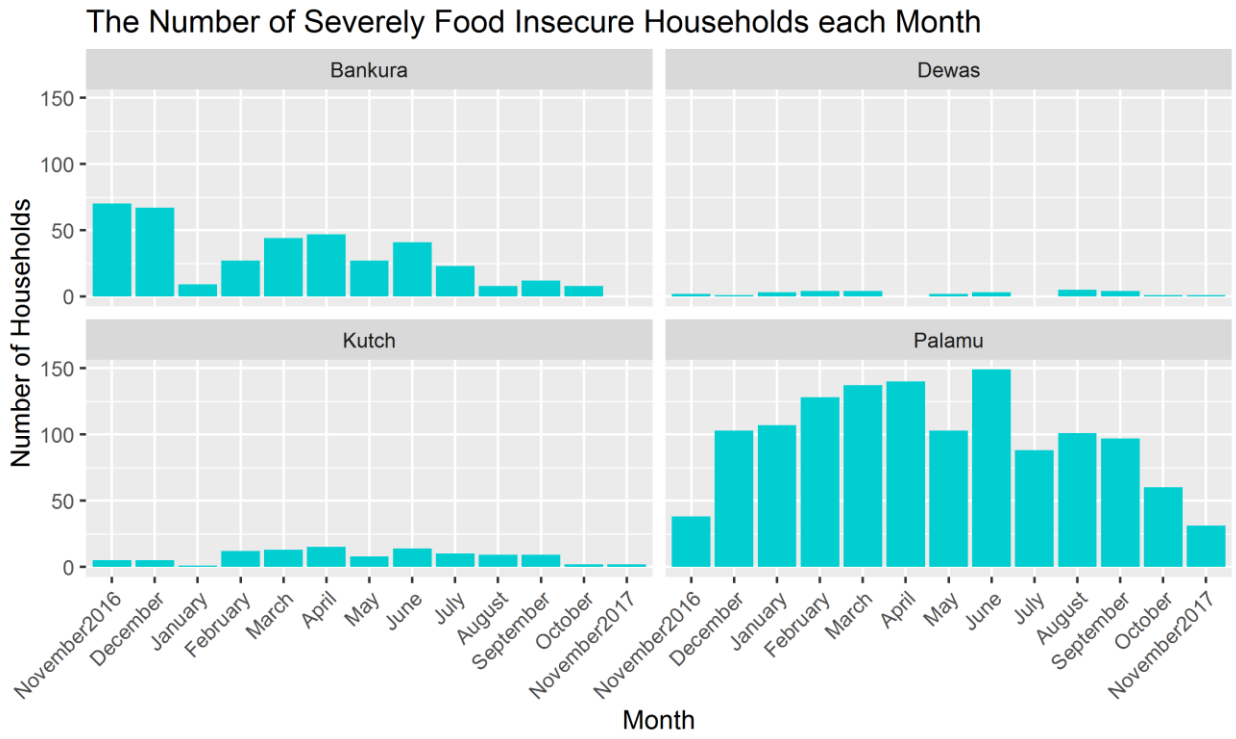
Figure 2.5: Effects of categorical variables within the unscaled gender-specific model on food security, measured by the Household Food Insecurity Access Scale. Data was collected for 1,200 households in rainfed regions of India. These graphs were based on unscaled data, so we observe the average level of Food Insecurity Access Scale across all categorical variables.



Seasonal Differences

Food security was different across seasons and lowest in the summer (p=0.093). In the summer season, households are 0.16 points lower on the four-point food security scale. The summer season is when farmers are waiting for their next harvest and may be running low on the previous year's harvest stock. Though this is generally true, seasonal differences were best understood in the context of site. There were significant differences across site and season interaction terms (Figure 2.6).

Figure 2.6: The number of households that were severely food insecure in each month for four sites: Bankura, Dewas, Kutch, and Palamu.



Women's empowerment, related variables and food security across models

Women's empowerment score was significantly associated with food security in all models except the unscaled household model. The gendered-model indicates that empowered

women are associated with a 0.12 increase in food security on a four-point scale, which is double the effect of any diversity measures (p=0.02). Similarly, the number of reserved seats for women was positively associated with food security in all models, except the unscaled-gender model. Within the household-model, for every additional seat that was reserved for women, food security increased 0.10 on a four-point scale (p=0.07). Women's education, which can also influence empowerment, was significant in the gendered-model. For every additional year of schooling that women receive, their families' food security is associated with an 0.06 increase (p=0.00). Lastly, female-headed households are associated with higher food security than male-headed households, holding all other variables constant. In the household model, female-headed households are associated with a 0.18 higher food security scores compared to male-headed households. This impact is higher in the gender-specific model that indicates female-headed households are associated with a 0.25-point increase in food security.

DISCUSSION

Non-farm income and food security

Nonfarm income was significantly and positively associated with food security in the household model. Upon further investigation, this relationship is actually driven by the effect of women earning income in the nonfarm sector. On average, households where women earn income from non-farm sources have higher food security than other households where women do not. Other research finds that nonfarm income is associated with food security because it is often more regular and is available year-round, unlike agricultural work that follows harvest cycles and is more susceptible to climatic shocks (Abgola et al. 2008, Babatunde et al. 2008). Despite controlling for income within our model, non-farm income is often associated with higher and more dependable incomes (Babatunde and Qaim 2010; Silvestri et al. 2016, Dzanku 2019).

Dependable incomes are not only important for income smoothing; those with salaried jobs often have more access to formal credit, which requires collateral, and informal credit, in which a person borrows against their next paycheck.

Women's non-farm income may be significantly related to food security because women who work in non-farm sectors may have more control over the money that they earn. Since we are controlling for level of empowerment and women's education in the model, other factors must explain why women in non-farm sectors are able to translate their access to income into spending decisions. Intra-household bargaining is driven not just by a woman's characteristics, like her education, assets, and income, (Doss 2013) but also by external factors like community norms, markets, and other social structures, like class, caste, and race (Agrawal 1997, Kabeer 2000). Female seclusion norms, for example, limit the range of income-earning choices women have. Such limitations include whether or not they work, what sector of work they can work in, and if they have control over their incomes.

Unlike parts of the Western world where higher incomes translate to more influence over the budget (Blood and Wolfe 1960), higher incomes are not necessarily associated with higher control over women's income in our study population in India. We find that poorer women have higher empowerment scores and have more control over their income as compared to women in wealthier households. In India, a woman's control over income may be influenced by the job sector she works in and if it is in a public or private sphere (Kabeer 1999, Kantor 2003). For example, Kantor (2003) finds that women in India had more control over their income when they were doing activities that were not traditionally attached to domestic labor, which is unpaid and often undervalued (Singh and Pattanaik 2018). Kantor (2003) also notes that women are more likely to have control over their income if they are making a small amount of money; when

women start to earn more money, they may no longer be able to control it. Therefore, emphasis on earning more money may not translate into more female control over income, an important way to improve food security.

The finding that higher incomes from non-farm sectors are associated with higher food security, suggests that policies that reduce barriers of participation and do more to ensure that women have control over the money they earn can improve food security. Barriers women face to doing more non-farm work include a lack of formal education and specialized training, unequal pay, social norms surrounding women's freedom of movement, and the lack of jobs in non-farm sectors in rural areas (Rao et al. 2017, Dzanku 2019). Moreover, policies that encourage women to take on non-farm work also need to incorporate measures to ensure that women have control over the money they earn. For example, direct deposit in private bank accounts controlled by women may be one strategy for keeping money in the hands of women. Though this strategy offers hopeful outcomes, low literacy rates and difficulty associated with getting to banks make it difficult for women to access cash and make purchases in a cash economy. More research should include randomized control trials to determine how to best keep money in the hands of women.

Number of Jobs and Food Security

The number of jobs a household participates in each month was negatively associated with food security in the household model. This was driven by the negative consequences of women having multiple jobs within the same month. In the gender-specific model, how many jobs a man had was not associated with food security.

Research that discusses diversity as a risk-management approach often characterizes the value of having more than one job as a safety net so that if one income source fails, another is

available (Ellis 1998, Agrawal 2008, Barrett et al. 2001, FAO 2004). However, each additional job that a person undertakes comes with its own set of potential risks of failure and successes, so it is not necessarily true that more jobs equates to less risk. Also, when people lose a job it is often replaced by a less desirable job that either pays less for the same amount of work or is more laborious and difficult. So, replacing one source with another is not as straightforward as some would anticipate. A negative association between the number of jobs a woman has and food security is likely due to time spent away from children and inefficiencies associated with having multiple jobs that are less than ideal, like time or money spent on transporting between jobs.

As women work more jobs they also have less time to spend taking care of their children, which is important for food security (Jones et al. 2012, Choudhary 2007). Worldwide, women are responsible for most domestic chores and spend significantly more time working in unpaid capacities than male counterparts (Sayer 2005, Budlender 2010, Miranda 2011, Singh and Pattanaik 2018). In India, more than 75 percent of women's work remains unpaid (Choudhary 2007, Singh and Pattanaik 2018), though this varies by caste and class (Eswaran et al. 2013). A time allocation study from Odisha found that women work, on average, 4 more hours a day than men (Kabeer 1992). Given the gendered norms associated with domestic chores being thought of as "women's work" (Palriwala 1993), any additional paid work that women do will come at the cost of their leisure time. Not only is leisure important for mental and physical health (Pencavel 2014, Schwarzenberg et al. 2019, Harpham et al. 2005), it is also associated with empowerment (Green 1998, Chapter 4). As women spend time together they exercise personal choice and self-determination, which can translate to influence in other domains. And when women share in humor they can acknowledge and resist gender stereotypes. "Leisure spaces should not be

underestimated, especially in terms of their potential for resistance and renewal for women enmeshed in patriarchal cultures that continue to define [women] as wives and mothers" (Green 1998, pg. 172).

An alternative to women working more jobs would be for women to get paid more, or at least equitably, in the jobs that they are already working. Women working in the agricultural sector in India make at least 20 to 30 percent less than men doing the same activity (Ramachandran 2003, Varkkey and Korde 2013). Moreover, this wage gap is highest for the poorest women, indicating that poor women face higher burdens and have to work much more to earn the same amount of money (ILO 2018). National legislation that requires equal pay would be necessary for cultural norms to change, but it is unlikely to be supported in a male-dominated parliament. If women were guaranteed equal pay, they could spend less time working, imparting positive consequences for food security. It is not clear, however, that if women were paid more the extra time would be reinvested in childcare activities; without proper incentives, women (or their families) may choose to work more and earn more income (Jones et al. 2012).

Future research should analyze the potential tradeoffs for food security when women have to choose between working more or spending more time with their children. Many acknowledge that women's time is already limited (e.g., Kabeer 1992, Choudhary 2007, Quisumbing 1995) and other policy recommendations have suggested technological solutions to make domestic chores more efficient or to provide free childcare to women who work (Quisumbing 1998, Rao et al. 2017, Akter et al. 2017). Even though these options may give women more time, they do not change the cultural context that makes them time-constrained. Future research should test how different interventions that could motivate men to take responsibility for more domestic housework. Given the deep cultural norms associated with

women and housework (Agrawal 1997, Rao et al. 2017), it may not even be possible for women to negotiate these changes.

Income Evenness and Food Security

Evenness, or having an equal proportion of income from each job, is only associated with food security in the unscaled household model, indicating that it is not always associated with food security. Given the small effect size of income diversity, we can conclude that there is a positive association with food security when households have more than one job, but there is little advantage in incremental changes within the 0-1 index. Also, the Simpson's index was not significant in the gender-specific models, perhaps because we were splitting up its effect by dividing across two genders, which may not be that diverse independently, and are only diverse when pooled. We would not necessarily expect that individuals with an equal proportion of income from each job to be better off than an individual who gets the majority of their income from one source and a minority from two side jobs, for example. In the latter case, the person is probably "pulled" into diversifying because they have more time and resources to invest in additional money making opportunities. We postulate that someone who gets money equally from two sources is perhaps "pushed" into taking on more jobs since one job was not enough to make ends meet. The Simpson's index may be a useful measure in describing community-level diversity, especially in ecological contexts that favor evenness, and may still be appropriate at the household-level, but it should not be used to describe individual income sources.

Our results may have been different if we had we not calculated income diversity each month and instead constructed it annually, which is most common in the literature. Because we specifically designed this analysis to look at monthly variation, high Simpson's index scores are given to families that work many jobs within one month. The monthly approach more closely

reflects the logic that if one job fails, they can spend more time on another job they were already doing. However, more households would have been considered diversified had we calculated it at the annual-level. Perhaps the people that have higher evenness throughout the year would be better off than those that had the same level of evenness in a particular month. This could be because they would not necessarily have to work so many jobs at a time, a behavior that is negatively associated with food security.

CONCLUSION

The three measures of income diversity have different relationships with food security and the significance and magnitude of these associations was larger for women than men. Women's income diversity has a different relationship with food security than men's. Specifically, the proportion female earnings from non-farm is positively associated with food security and the number of jobs women have within one month is negatively associated with it. The Simpson's index, which is a measure of evenness, was only significant in the unscaled household model, suggesting that household-level income diversity is sometimes associated with food security.

These results may suggest that when women are employed in non-farm sectors there is higher return for food security, but this does not mean that food security is always served when women work more. As women work more in the formal labor force, they have less time to spend with their children, which influences food security, and they also have less time for leisure, which is associated with empowerment and food security. Instead of encouraging women to join the workforce under the auspices of "economic empowerment," more resources should be spent on changing the structural barriers that make it difficult for women to join the workforce and operate equally within it.

Many economic empowerment initiatives suggest that there should be simultaneous efforts to expand women's role in the workforce while reducing structural inequalities that they face within it (Appendix A). However, asking women to engage in an unfair system to increase empowerment of women may undermine both the goal of increased food security and higher empowerment. Assuming that women are empowered through earning incomes may inadvertently put the burden of poverty alleviation on women, the most disenfranchised and time-burdened demographic. Finally, without proper social and cultural acknowledgment of the unpaid labor that women already do, encouraging women to work more may only translate to higher work expectations without additional rewards for women (Singh and Pattanaik 2018).

Given that women can influence food security in a number of ways that may be in tension with one another, future research should analytically evaluate the tradeoffs between the pathways that women can influence food security. Even if a woman does earn more income, there may not be benefits for food security if she does not have influence over the money she makes. Future research should first clarify if higher female wages translate into higher resource allocation to food and food security. It would also be valuable to better understand and quantify the different ways that a woman influences food security whether it is through the income she earns, how she allocates her time, or potential enhancements to empowerment through working.

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CHAPTER 3

Gender Justice and Food Security: Getting money into the hands of women when they already have their hands full

Abstract: Women's economic empowerment, or endowing women with the capacity and creating a more equitable distribution of growth, is a prerequisite for achieving development goals. Development policies have increasingly promoted the idea that the key to women's empowerment is to increase her participation in the workforce, arguing that women have a "multiplier effect" by disproportionately spending their incomes on their families' wellbeing. However, this paper contributes to this discussion by pointing to an often ignored assumption: women do not always control the income that they earn. To evaluate this assumption we conducted 15,000 household surveys across 80 villages in rainfed regions of India. Our study sites were ideal to study how women's income impacts food security and also impacts their influence over the budget because our study population included both tribal and lower caste women who work, at least seasonally, and women from higher castes who often do not to work. We used both regression analyses to find associations between women's income and empowerment on food expenditure and also a mediation analysis to quantify the direct and indirect pathways that women's income can affect food expenditure. We find that women's incomes do not necessarily translate to higher food expenditure. And, higher incomes are not associated with more influence on how income is spent. Though, when women have control over their income, there are positive associations with food expenditure. Therefore, development programs that encourage women to work without also ensuring that they have control over their income may undermine goals of higher food expenditure and food security.

Key words: women's economic empowerment, women's empowerment, female incomes, intra-household resource allocation, and food expenditure

INTRODUCTION

Women's economic empowerment has become a popular development strategy that aims to reduce gender gaps, alleviate poverty, and increase food security. Multilateral institutions like the UN Women, The World Bank's National Rural Livelihood Mission as well as national aid programs and nonprofit investments through the Gates Foundation, amongst many others, have identified women as priority clients who, if empowered, can transform societies (Appendix A). Many of these organizations seek to empower women through training and financial services so that women can work in the formal sector and earn incomes. Investment in women and her entrepreneurship in particular are often characterized as "win-win" solutions that reduce gender inequalities and alleviate poverty. Women can provide a "multiplier effect" since they often reinvest in their families' development more than their male counterparts (e.g., Hoddinott and Haddad 1996, Quisumbing et al. 1998, Duflo and Udry 2004, Doss 2006).

Women are indeed important to food security and can affect it in many ways, including the direct purchase of food and by influencing decisions about how income is spent. Given that women will invest more in their families when given the opportunity, many programs are becoming increasingly oriented to encouraging women to participate in the formal workforce and to earn incomes. However, these programs assume that women will have control over the income they earn, which may not always be the case. Additional research is needed to better understand how women can directly and indirectly impact food expenditure for their families, which is positively associated with food security.

Researchers have been studying how women's incomes could potentially influence higher food expenditures for decades. First, attempts at understanding how women's incomes could translate into food security compared spending patterns across households that have

different levels of female income. The literature on how women's incomes affect food expenditures is still mixed (e.g., Hoddinott and Haddad 1995, Quisumbing and Maluccio 2003, Thomas 1990, Thomas 1997). These results are likely mixed because researchers assumed that women will control their earned incomes and they did not include any information on women's empowerment or their level of decision-making. The next phase of literature focused on how women shape expenditures when given external cash from conditional cash transfers. Randomized control trials confirm that when women have more decision-making authority, they will invest more in food expenditure (e.g., Schady et al. 2008, Molyneux 2008, Skoufias 2005, Barrientos et al. 2016).

Women's economic empowerment may have the potential to transform societies to be more wealthy, equitable, and sustainable. However, women's economic empowerment encompasses both the ability to earn income and having control over how to spend it. These two distinct ideas are often conflated in economic empowerment initiatives. The assumption is that when women join the workforce they will become more empowered or have more influence over decisions within the household. This relationship may be obvious in Western contexts (Blood and Wolfe 1960, England and Kilbourne 1990), but it has not always been the case in the Global South, especially in strongly patriarchal societies (Palriwala 1993, Kantor 2003).

The goal of this paper is to describe if and how women's income influences household food expenditure in rainfed regions of India. First, we used a regression analysis to test if incomes earned by women are associated with higher food expenditures. We improve on past analysis by incorporating women's empowerment scores, along with other variables that may impact a women's influence over decision-making and food expenditures. Second, we used mediation analysis to simultaneously quantify the direct and indirect ways that women's income

can influence food expenditures. Mediation analysis seeks to identify the process or mechanism that underlies an observed relationship between an independent and dependent variable by including a third variable, known as a mediator variable. In this paper, our mediation analysis determines if higher female incomes cause higher household food expenditures; if higher female incomes lead to more control over the income; and if more control over income leads to higher household expenditures on food.

LITERATURE REVIEW

Women's Income and Food Expenditure

In the 1990s and early 2000s, studies focused on evaluating if women's incomes were associated with higher food, health, or education expenditures. Some find that women's incomes have a positive effect on food expenditure (e.g., Hoddinott and Haddad 1996, Quisumbing et al. 1998, Duflo and Udry 2004, Doss 2006), although others find that they do not (Thomas 1990, Quisumbing and Maluccio 2003) or that the effect depends on the season (Hopkins et al. 1994). For example, in Côte d'Ivoire, women's share of the cash income significantly increases the share of the budget that is spent on food and significantly decreases share of income on alcohol and cigarettes (Hoddinott and Haddad 1995, Duflo and Udry 2004). In addition, Doss (2006) found that when women in Ghana owned a higher proportion of the household assets, particularly farmland, their household also spent a significantly higher proportion of their budget on food.

Other studies found a less distinct relationship between female-earned income and higher food expenditures. Hopkins et al. (1994) finds that income from a woman only affects food expenditures when season is also taken into consideration. This finding highlights the importance of intra-annual variation, which was not otherwise captured in previous studies. Our research

fills this gap because it uses frequent data collection strategies and incorporates seasonal variation within the models. Yet, other research finds that women's earned incomes are not associated with higher food expenditure (Thomas 1990, Quisumbing and Maluccio 2003). A study from Bangladesh found that women's assets at marriage had no effect on food expenditure, but did have a positive and statistically significant effect on education expenditures and their husbands' assets at marriage were positively associated with higher food expenditures (Quisumbing and Maluccio 2003).

Results may be mixed because researchers only measure the effect of the level of female income on food expenditure and they do not include variables describing if and how women have control over the incomes they earn. Our regression analysis, includes a variable on women's empowerment, which is an index based on variables that may influence her bargaining power, like her assets and group participation as well as her influence over decisions about income, productive resources, and credit.

Women's Influence on Decisions and Food Expenditure

Even though higher female incomes might not necessarily translate to higher investments in food expenditure, when women have control over income, they spend more on food expenditure as well as other human capital for their families. Researchers have studied the relationships between women's empowerment and spending on food within the contexts of female headed-households and female-targeted cash transfer programs. Additional research that uses the Women's Empowerment in Agriculture (WEIA) Index provides important insights as to how women's empowerment could influence food and nutrition security for the family, but it has not explicitly evaluated food expenditure.

Literature that compares spending in male- and female-households sheds light on different spending preferences for men and women. For example, Kennedy and Peters (1992) found that despite female headed-households having the lowest incomes, their preschoolers' nutritional status was significantly better than higher-income, male-headed households in Kenya and Malawi. However, other studies show that a female head-of-household does not necessarily guarantee higher nutritional outcomes for children, even accounting for income levels (Kennedy and Haddad 1994, Felker-Kantor and Wood 2012). Even though food expenditure dynamics are important to understand within female-headed households given their vulnerability to food insecurity, additional research is needed to understand how women earn and control income in male-headed households. This gap is critical to study because most women in India live in male-headed households. Therefore, it is important to understand the mechanisms that could translate women's incomes into higher food expenditure in these contexts.

Randomized control trials on female-targeted, cash transfer programs provide analytically rigorous evidence that when women have more control over household income, they will spend more on food (Thomas 1990, Schady et al. 2008). This body of work also finds that households with women in control of resources are associated with improved food security and better child and household nutrition and health outcomes (e.g., Molyneux 2008, Skoufias 2005, Barrientos et al. 2016). One of the first studies on the subject found that cash transfers in the hands of mothers increased family nutrition 4-7 times more than income of fathers; additionally, women's income increases child survival 20 times more than man's income (Thomas 1990). In another randomized control trial in Ecuador, women that received unconditional cash transfers spent more on food than women that did not receive the transfer (Schady et al. 2008). A better research

design would have analyzed spending before and after the intervention because there may be unobserved variables that could influence why households were selected for the program.

Other research on conditional cash transfers shows that short-term benefits do not always continue into the long-term. A pilot project in Northern India that gave families additional money after giving birth to girls found a higher ratio of female births in targeted areas and more investment in post-natal health of girls. However, long-term impacts, like enrolling in school or older age at marriage, showed no significant benefit from the program (Sinha and Yoong 2009). This program did not specifically give money to mothers, so women did not necessarily choose how the money was spent, which may explain the lack of long-term benefits.

Randomized control trials that test the impact of female-targeted cash transfer programs have demonstrated that these programs are associated with higher food expenditures as well as health and nutrition outcomes. National programs like Bolsa Família in Brazil (Barrientos et al. 2016), PROGRESSA in Mexico (Skoufias 2005), and Bono Solidario in Ecuador (Schady et al. 2008) have demonstrated success in terms of higher investments and returns to human capital like improved education and health outcomes. Even though human capital investments have increased, these programs have not necessarily empowered women. De Brauw et al. (2014) explicitly looked at the potential increase in decision-making within the Bolsa Família program and found heterogeneous impacts on decision-making. Urban women had more decision-making power over contraception, but there was no marked difference in rural women's decision-making power before and after the cash transfer. This demonstrates that access to resources does not always translate to greater influence within the household and community. This is likely because the level of decision making depends on a variety of household dynamics and community norms, markets, and government initiatives (Agrawal 1997).

Research about the role of women's empowerment as measured by the WEIA Index focuses on nutrition and food security outcomes, but there is little known about how WEIA influences food expenditure. WEIA is a comprehensive measure of empowerment that includes variables on women's input to decisions about income, productive assets, and credit. It also includes variables that could potentially increase women's level of influence like the assets she owns and group participation, a measure of social capital. The majority of the literature finds that women with higher empowerment scores have more diverse diets themselves (Srabroni et al. 2014, Malapit et al. 2015, Alaofè et al. 2017); their households have higher food security (Srabroni et al. 2014, Tsiboe et al. 2018); and their children have higher nutrition as measured by weight-for-age ratios (Shroff et al. 2009).

Within the same body of work, researchers test which domain(s) of empowerment are most associated with higher food security. Results differ across study sites. For example, researchers found that control over income has positive associations with women's nutrition in Nepal and Ghana (Malapit et al. 2015) and higher weight-for-age scores in Andhra Pradesh, India (Shroff et al. 2009). But, Begum and Sen (2009) find that increased decision-making does not influence child health outcomes in Bangladesh. The conflicting results across studies highlights the importance of the specific cultural context as well as potential problems with modeling decision-making as a dichotomous variable. Additionally, in a multi-country study De Silva and Harpham (2007) find that individual social capital did not affect food security, but cognitive social capital, or trust and harmony, within the village was positively associated with child nutritional status. Yet, Moestue et al. (2007) found that maternal participation in groups was associated with positive length-for-age measurements in children in Andhra Pradesh, India.

Incomes and Influence over Decision-Making

A range of empirical research focuses on intra-household bargaining, resource allocation, and decision-making. Doss (2013) suggests that research could be divided into four categories: tests of a unitary model of household bargaining; tests of efficiency of household allocations; estimates of the determinants of household resource allocation; and experiments designed to better understand the process of intra-household decision making. Bargaining power has been well-studied because it is associated with health, education, and well-being for the whole family and for women in particular (Agrawal 1997, Kantor 2003, Doss 2013). Bargaining power is difficult to model because it is fundamentally unobservable; many researchers instead use proxies for it like education, assets, and incomes. The problem with this approach is that researchers are not able to explain causal relationships (Doss 2013). The mediation analysis in this paper provides the opportunity to quantify causal pathways through which female incomes and decision-making influence one another and food expenditures simultaneously.

Both sociology and economics have frameworks for evaluating intra-household bargaining and understanding how individuals translate their assets into influence (Kantor 2003). Resource Theory was first described by Blood and Wolfe (1960) who found that education and employment were good predictors of women's decision-making power in Michigan households. However, this theory has been criticized since it does not hold in cross-cultural contexts. In economics, bargaining models seek to understand dynamics within a household while recognizing that outside factors like social norms and legal structures shape options outside of the marriage (Agrawal 1997, McElroy 1990, Sen 1990). A woman with little recourse to survive on her own outside of the marriage will be a lot more likely to compromise. Agrawal (1997) adds to this theory in explaining that bargaining power is not only about a person's ability to get her desired outcomes, but it also shapes the subjects that women are willing to negotiate. For

example, women in rural India working outside of the household may not even discuss their husbands' helping with domestic chores because it is not socially common for men to take on domestic responsibilities (Agrawal 1997, Kantor 2003).

Researchers have debunked the unitary model of bargaining power, wherein households act as coordinated units by establishing that individuals have different spending preferences (e.g., Alderman et al. 1995, Haddad et al. 1997, Agrawal 2002, Quisumbing and Maluccio 2003). However, we still need to understand how women influence decision-making since many households in our study site pool their resources. Given the strong patriarchal traditions in India, many women, especially young women, give at least some of their earnings to their father or husbands (Palriwala 1993). Moreover, 12 percent of households in our sample population do not have women earning an income and can only influence their budget indirectly. We need to evaluate the potential mechanisms through which women's income could translate into higher food expenditure, especially if development projects are going to continue to promote well-being through women's economic empowerment and encouraging women to earn incomes (Quisumbing et al. 1995, Atker et al. 2017, Appendix A).

METHODS

Please see Methods in Chapter 2 for general details on the study site and data collection.

Study Site

Our study sites are appropriate contexts in which to understand the impacts of women's income generation and food expenditures because of the high levels of food insecurity and high variety of income strategies present. Households in these sites include both rain-dependent farmers and landless agricultural workers, and most households include women who work at least seasonally. Each site has varying levels of wealth, precipitation, and proportion of women

working (Figure 3.3). Twelve percent of the sample population had households where no woman worked, 38 percent of households had women that worked seasonally (1 to 9 months), and 50 percent of the population worked regularly (10 months or more) (Figure 3.2). Moreover, these regions are susceptible to weather and market-related shocks and are home to some of India's most vulnerable populations, which means they could potentially benefit from income diversity and food security interventions. Many local and international nonprofits have targeted women in these regions for income diversity programs because of their dependence on natural resources, their limited access to seasonal jobs, and their role in improving food security.

Measurement of Variables

In order to best understand how women's incomes affect food expenditure, we included variables about income and held constant other variables that could influence income or food expenditure. The outcome variable was food expenditure, which was measured as the amount of rupees spent on food each month. Household food expenditures, along with eleven other spending categories, were recorded each month. We chose to use the amount spent on food, instead of proportions of spending, because households that spend a higher proportion of their income on food are often poorer (Kennedy et al. 1994). Given that we also included the number of people in the family as well as the proportion of women, the total amount spent on food was actually calculated as per capita amount spent on food. Since a basic level of food is required with all families, a higher proportion of income spent on food may only be due to earning little. Additionally, we chose to consider food expenditure as an outcome because it was relatively consistent from month to month as compared to education and health expenditures, which are often covered by loans and not income. Also, food expenditure is a spending category that is

often discussed in the literature because of its positive association with food security, so it allows for direct comparisons with other literature.

In order to compare income earned by men and women within the household, we collected information about every source of income earned by anyone in the family, who did the job, how much they were paid, and how often they were paid. Since some people, particularly agricultural wage laborers, are paid in grain or other in-kind payments, we converted in-kind payments to the cash equivalent. To get the total amount of income earned, we added together cash and in-kind equivalents for each job. From this data, we calculated income that was earned by men and women in the family, the number of jobs each had, and how frequently each job paid.

Frequency of payment was calculated in terms of the proportion of earnings that came from daily, weekly, and monthly installments. We included this variable because Haddad et al. (1996) suggested that women spending on food may be higher because they get paid in small increments, which are more easily spent on relatively cheap items like food. They further suggest that, since men are often paid in lump sums, they would be more responsible for larger purchases like bricks, home building supplies, and agricultural inputs.

We also included a variable about level of education measured by the highest number of years any woman in the household attended school. We chose to include this because education could be associated with influence over decision-making and more educated women may purchase more nutritious food for their families (Thomas et al. 1991, Nayga 1996, Quisumbing et al. 1998, Doss 2006).

Additionally, we included a number of household-level covariates in our model because they have been significantly associated with food expenditure in other literature. We included

family size because larger households have more mouths to feed and will likely spend more on food than small households (Kabbani and Wehelie 2005, Sindu et al. 2008). We measured family size by the total number of children and adults that share a communal kitchen since many in our sample population are part of joint or extended families. We also included the proportion of women in each household because sometimes households will buy less food for women because they eat less or are perceived to need fewer calories (Haddad et al. 1996, Bashir et al. 2010, Harris-Fry et al. 2017). We also included gender of the household head because female-headed households are often poorer, which may indicate that they would spend less on food, but also, since women are in control of their incomes, they may choose to invest more in food (Kennedy and Peters 1992, Appelton 1996, Kabbani and Wehelie 2005). Households were also sorted into caste groups, including General Caste, Other Backward Castes, Scheduled Caste, and Scheduled Tribe. We included caste because it can influence whether a woman works or if she has control over income. Also, lower castes are generally poorer and less food secure, so they may spend less on food than higher ones (Chapter 2, Eswaran et al. 2003, Rao 2015).

We also included variables about the household's harvest since it may impact how much money they need to spend on purchasing food (Bhagowalia et al. 2012). Our sample population includes many farmers who have varying levels of subsistence. We included a dichotomous variable for farming where households either had or had not farmed that month. Additionally, we include the total harvest amount (kilograms) and the crop diversity score, measured with the Simpson's Index. The Index provides an estimate of evenness and the relative proportion of each crop compared to the total amount harvested (Meng et al. 1998). Farms with a high diversity of crop types generally provide higher dietary diversity (an important measure of food security)

and, therefore, do not need to spend as much on food (Remans 2011, Jones et al. 2014, Jones et al. 2018).

We also wanted to control for other variables that may indicate how much a household would need to spend on food. This is critical to our analysis because some households were able to eat from their own supplies and some received food through India's Public Distribution Program (PDS), a federal program that provides free or highly subsidized staple grains in fair price shops (Ahluwalia 1993, Ramaswami and Balakrishnan 2002, Kichar 2005). To calculate these variables, we used data from a 24-hour food recall: we asked a randomly selected man and woman in the household what items they ate and where they were sourced. We included a variable about household-level subsistence that measured the proportion of the food that they ate came from the market as compared to their own sources, like their own harvest, storage supply, and family garden. We also included a dichotomous variable on whether or not they received additional food from the PDS.

We used two measures of empowerment within our analysis. We used an Abbreviated Women in Agriculture Empowerment Index or A-WEIA (Alkire et al. 2012, Malapit et al. 2015) in the regression and a dichotomous variable for women's influence over income decisions. We used the A-WEIA score in the regression analysis because it includes many domains of empowerment that we would want to hold constant to better isolate the relationship between women's income and food expenditures. We used a slightly modified version of this score because we included information about all income sources, not just agricultural.

In the mediation analysis we used the narrower definition of empowerment: whether a woman made at least some decisions about income (as compared to none or just a few

decisions). We chose not to use the A-WAEI Index for the mediation analysis to isolate the role of women's influence over the budget. We also included covariates within the model that could affect a woman's influence over the budget like her level of education, caste, as well as the number of assets she owns, including household, agricultural, and livestock assets.

Last, in order to capture seasonal differences, we categorized months into three harvest-related seasons: Kharif, Rabi, and summer. Kharif season, which was used as the reference group, is the most popular harvest season and is between August and November. Rabi is from December through March and is the second growing season for households that have access to irrigation or plant a crop that does not require much water like pulses. The summer season is from April to July when farmers are preparing their fields and growing crops. Because our sites span 2,000 kilometers and experience the monsoon at slightly different times, we included an interaction between site and season in the model.

Data Analysis

Regression Analysis

First, to test how women's income influences food expenditures, we used a hierarchical linear model in the lme4 package within R (Bates 2015). Households were nested within villages and repeated each month, so we included random effects for village and month. We included district-level effects as fixed effects within the model and controlled for variables that may influence either food expenditure or women's income. We tested the model for multicollinearity and used a variance inflation factor (VIF) cut-off of 2. The only exception to this was a correlation between whether or not a household farmed in that month and their level of crop diversity, as measured by the Simpson's Index, which had a VIF score of 18. We kept both in the

model because we wanted to interpret our results for farmers as our reference group. We also wanted to measure how much crop diversity changed food expenditure.

We ran the same regression model twice using both the original data and standardized variables. The former allows us to interpret the effect of an independent variable on food expenditure in its own units. The standardized model, which is centered and normalized by the standard deviation, allows us to compare which variables most influence food expenditure. We report the effect sizes, their standard errors, and p-values for the same model with both original and standardized data.

Mediation Modeling

The mediation modeling approach allows us to simultaneously quantify the direct and indirect ways that women's income can influence food expenditures: whether higher female earnings lead to more decision-making power over spending; and whether more female influence over income allocation led to higher food expenditures. An advantage of this approach is that it does not suffer from the same concerns of endogeneity common in regression models that describe correlations between household characteristics and food security (Doss 2013). When measuring the direct path we included covariates that were significantly related to food expenditures in the regression model. When measuring the impact of income on decision-making, we held constant variables that have also been found to influence bargaining power, like education, number of assets, and caste (Doss 2013).

To analyze the data, we used the lavaan package in R (Rosseel 2012), where we used scaled data, robust standard errors, and clustered by individual households to take into account the repeated measures each month. We report unstandardized effects, their standard errors, and standardized effects (Kline 2015). The model fit was evaluated with the Chi-square, comparative

fit index (CFI), root-mean-square error of approximation (RMSEA), and standardized root-mean-square residuals (SRMR). We used the following scores to indicate that the model had a good fit: chi-square $p < 0.05$, CFI > 0.90, RMSEA<0.08, and SRMR< 0.08 (Beaujean 2014, Kline 2015).

RESULTS

Descriptive results

The amount of income spent on food varied by site with people in Kutch spending the most on food. In Kutch and Bankura, households where women worked spent more on food, but the opposite trend was the case in Palamu where women who did not work spent more on food (Figure 3.1). Twelve percent of the sample population had households where no woman worked, 38 percent of household had women that worked seasonally (1 to 9 months), and 50 percent of the population worked 10 months or more in a year (Figure 3.3). The number of women who work is highest in Dewas and Kutch and women do more seasonal work in Bankura and Palamu (Figure 3.3). How much control a woman has over her income varies by site (Figure 3.4). In Dewas women have little control over income decisions, regardless of how much they work. Similarly, in Bankura, how much women work does not change based on participating in seasonal work. Conversely, women in Palamu have more influence over income decisions during the months that they work and in general have more influence over how income is spent. In Kutch women in general work more and have more say over their families' budget. These results highlight the stark differences between site and the importance of geographic and cultural context across sites. (See Appendix F for additional graphs)

Table 3.1. Descriptive statistics of sample population delineated by women who do not work, women who work regularly (more than 10 months out of the year), and women who work seasonally (women who work more than one month and less than 10). Data from a sample population of 1,200 households from rainfed regions of India, including Kutch district, Gujarat; Dewas district, Madhya Pradesh; Palamu district, Jharkhand; and Bankura district, West Bengal from 2016-2017.

Descriptive Table by Number of Months Woman Works

Variable	All Mean	Woman Works 0 Months Mean	Woman Works 1 - 9 Months Mean	Woman Works 10+ Months Mean
Number of Housholds in Category	13668	1607	5185	6876
Food Expenditure	2561.586	2848.41	2493.014	2546.252
Woman's Monthly Income	30.031	0	15.158	48.267
Man's Monthly Income	81.043	102.157	83.164	74.51
Woman's Empowerment	0.323	0.181	0.29	0.379
Woman's Education	6.637	8.778	6.808	6.008
Income Paid Daily	0.109	0.179	0.156	0.057
Income Paid Weekly	0.077	0.06	0.058	0.095
Income Paid Monthly	0.503	0.322	0.489	0.555
Family Size	5.021	5.094	5.021	5.005
Does Not Farm	0.825	0.834	0.818	0.829
Crop Diversity	0.838	0.846	0.828	0.843
PDS	2.409	2.366	2.584	2.286
Proportion of Women in HH	0.469	0.427	0.45	0.494
Gender of HH Head	0.019	0.031	0.03	0.007
Land (ha)	1.455	0.906	1.127	1.829

Figure 3.1. The amount of money that is spent on food expenditure each month across households where women work or do not work across each site in each month.

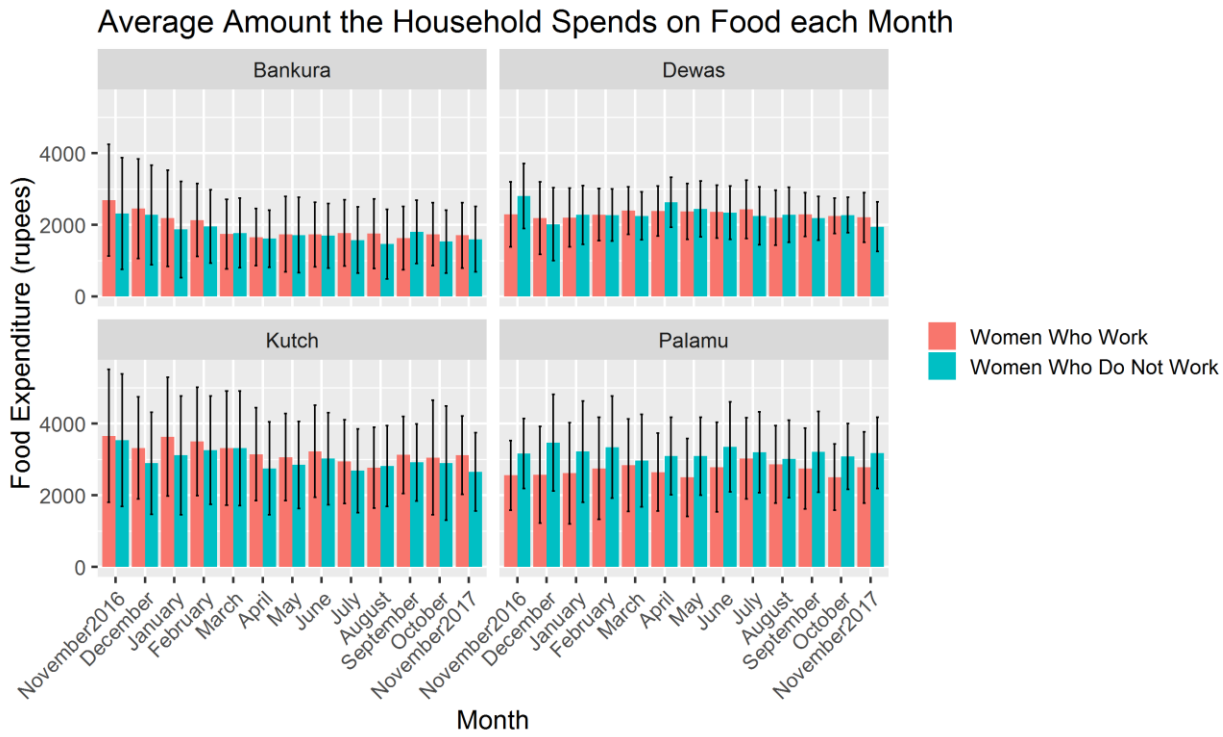


Figure 3.2. Frequency histogram of the number of households where women work each month.

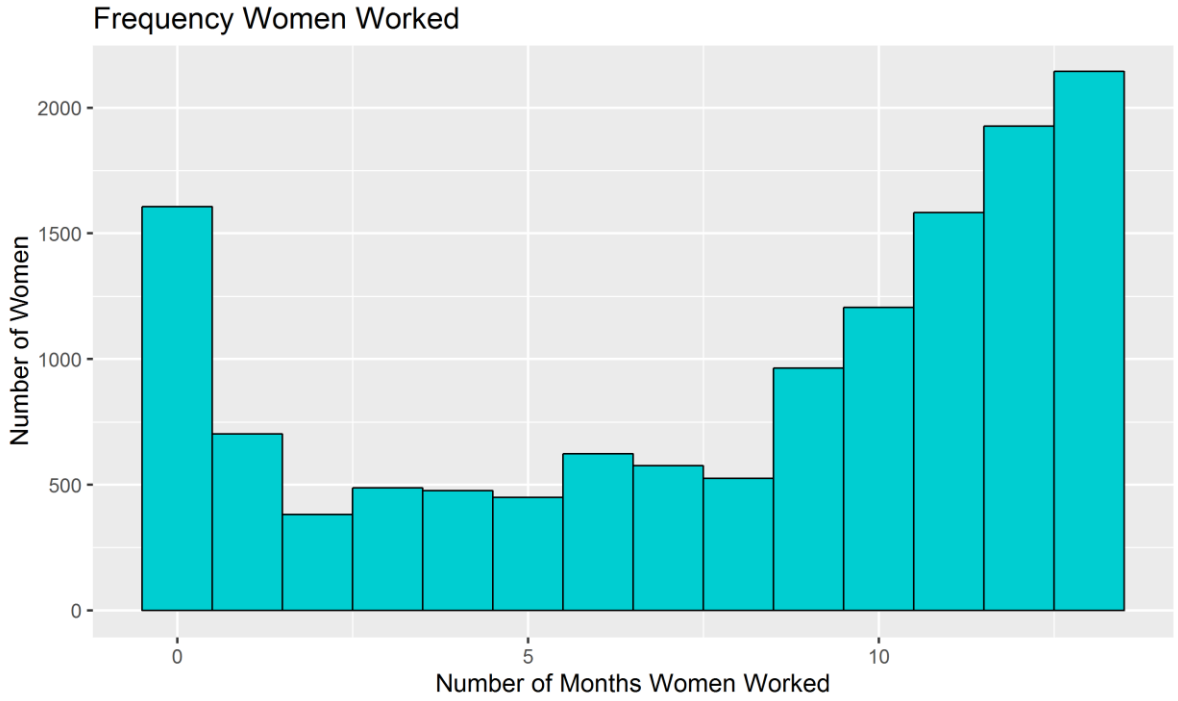


Figure 3.3: Number of households where women work and do not work each month across each site.

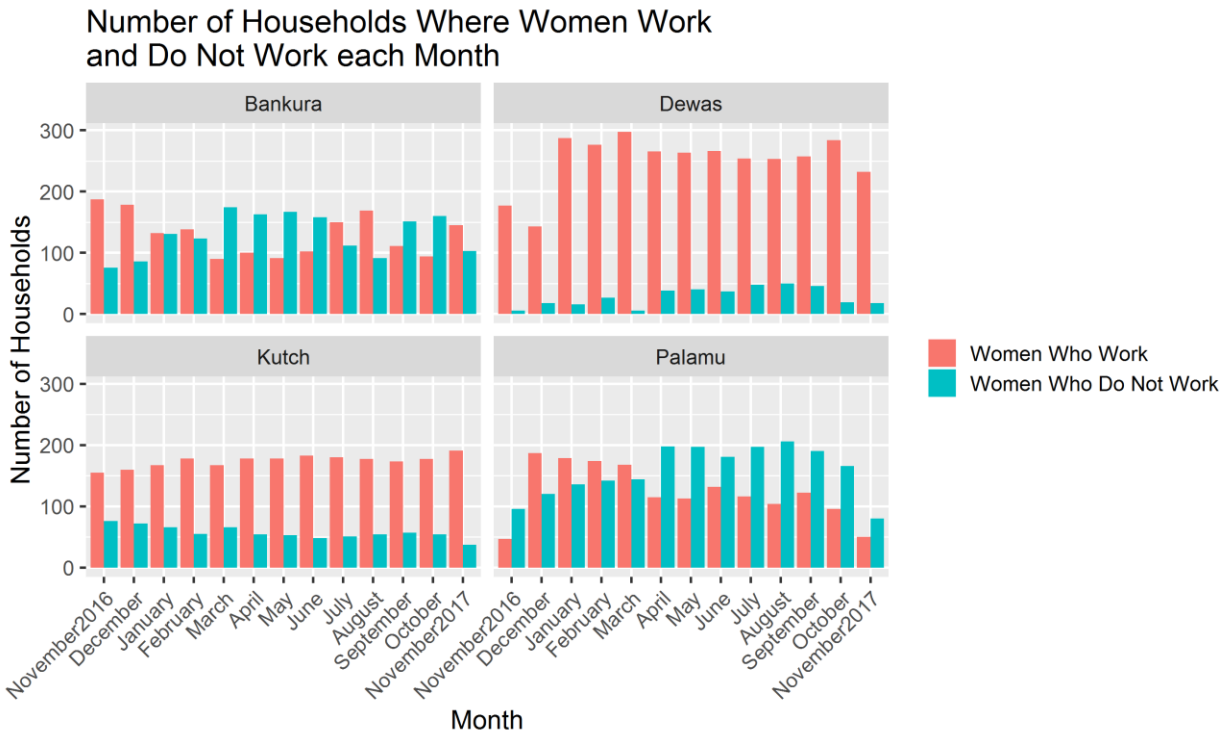
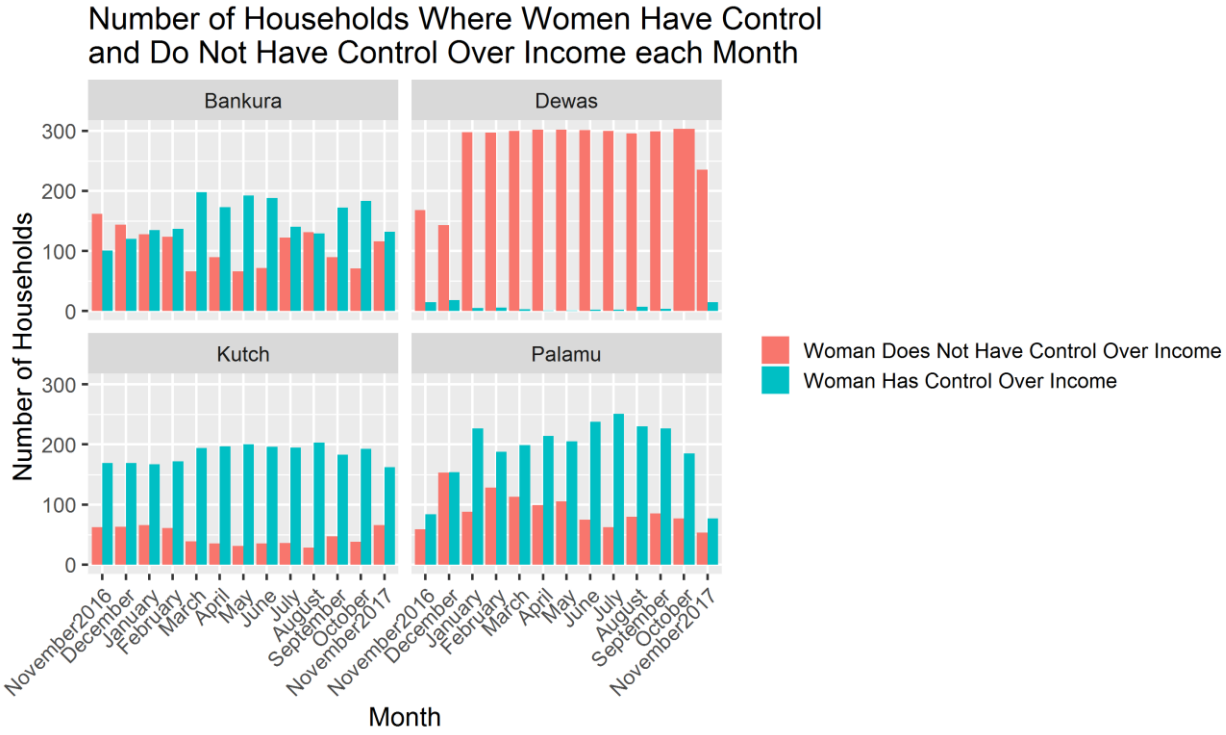


Figure 3.4: Number of households where women have and do not have control over any income earned by anyone in the household, including her own, each month across each site.



Regression Analysis: a closer look at incomes

Female income does not seem to have any significant effect on food expenditures once controlling for male income ($p=0.76$) (Table 3.2). Male income, on the other hand, was statistically significant ($p << 0.01$) but effectively meaningless. For every additional 100 rupees that a man earns, food expenditure increases by about 1 rupee. The only income frequency variable that is statistically significant is monthly earnings. As the proportion of women's income coming from monthly payments increase by 1 percent, food expenditure increases by 123 rupees. We found that the significance and direction of all variables were the same across the unscaled (Table 3.2) and scaled models (Table 3.3).

Table 3.2. Regression coefficients, standard errors, and p-values, and significance from unscaled model that measure associations between women and men's income and food expenditure. Data was obtained from 1,200 households in Kutch district, Gujarat; Dewas district, Madhya Pradesh; Palamu district, Jharkhand; and Bankura district, West Bengal from 2016-2017.

Variables	Estimate	Std. Error	Pr(>|t|)	Sig.
(Intercept)	1.69E+03	1.98E+02	7.43E-15	***
Women's Monthly Income	-8.52E-03	1.57E-01	0.95664	
Man's Monthly Income	9.24E-01	1.02E-01	< 2e-16	***
Women's Empowerment in Ag. Score	1.68E+02	6.56E+01	0.01058	*
Women's Education	1.59E+01	3.89E+00	4.58E-05	***
Proportion of income from daily sources	4.92E-01	4.48E+01	0.99124	
Proportion of income from weekly sources	-3.84E+01	4.66E+01	0.40975	
Proportion of income from monthly sources	1.22E+02	2.89E+01	2.49E-05	***
Family Size	4.26E+01	8.54E+00	7.50E-07	***
Farming Household (Y/N)	2.61E+02	1.02E+02	0.01036	*
Crop Diversity	-3.88E+02	1.06E+02	0.00026	***
Access to Public Distribution System	-2.72E+00	2.08E+00	0.19164	
Proportion of Women in Household	-3.08E+02	1.02E+02	0.00268	**
Gender of Household Head	5.47E+01	1.22E+02	0.65351	
Percent of foods from market	8.59E-01	7.06E-01	0.22345	
Total yield (kg)	1.25E-03	2.62E-03	0.63268	
Caste (General/ Other)	-1.17E+02	6.74E+01	0.08349	.
Rabi	2.30E+02	1.15E+02	0.0705	.
Summer	-1.43E+02	1.15E+02	0.23777	
Dewas	3.80E+02	2.02E+02	0.06408	.
Kutch	1.09E+03	2.15E+02	2.96E-06	***
Palamu	1.05E+03	2.07E+02	2.88E-06	***
Rabi * Dewas	-2.66E+02	5.04E+01	1.37E-07	***
Summer * Dewas	2.85E+02	4.87E+01	4.88E-09	***
Rabi * Kutch	1.27E+02	5.43E+01	0.01933	*
Summer * Kutch	1.65E+02	5.22E+01	0.00155	**
Rabi * Palamu	-2.91E+02	5.47E+01	1.09E-07	***
Summer * Palamu	2.78E+02	5.33E+01	1.91E-07	***

Table 3.3. Regression coefficients, standard errors, and p-values, and significance from scaled model that measure associations between women and men's income and food expenditure. Data was obtained from 1,200 households in Kutch district, Gujarat; Dewas district, Madhya Pradesh; Palamu district, Jharkhand; and Bankura district, West Bengal from 2016-2017.

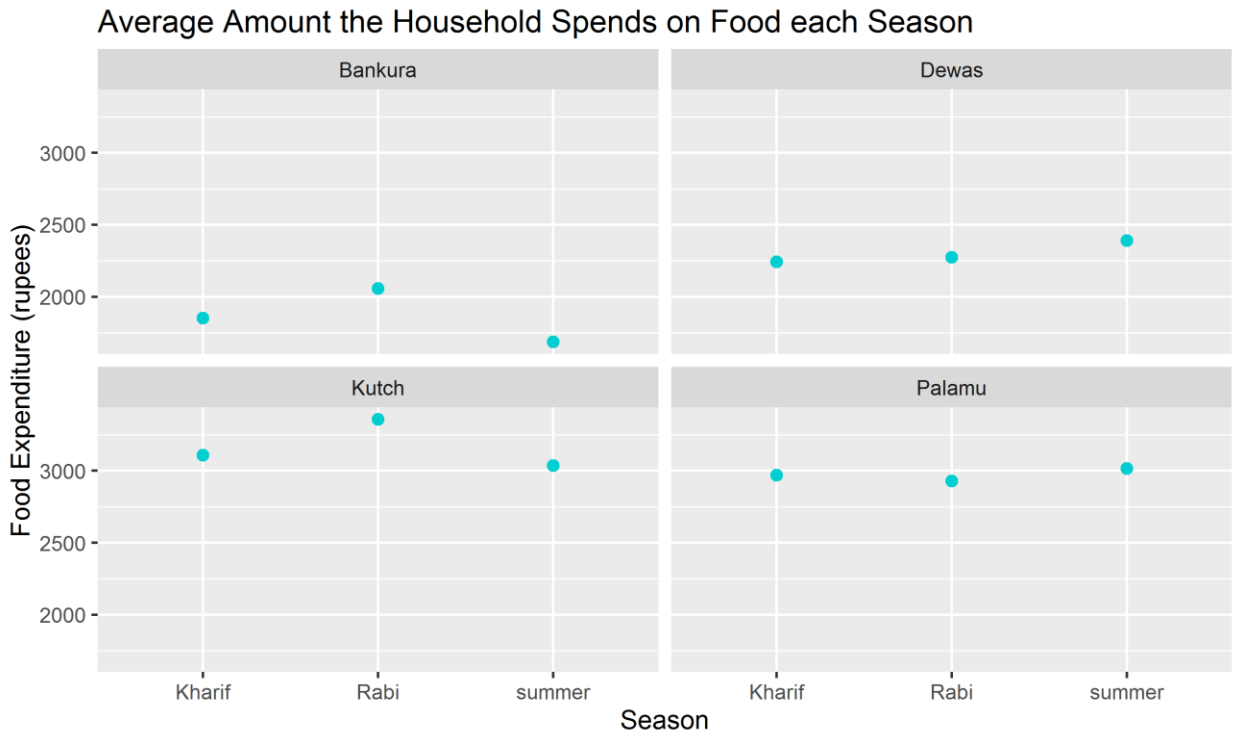
Variables	Estimate	Std. Error	Pr(>|t|)	Sig.
(Intercept)	-6.28E-01	1.63E-01	0.000165	***
Women's Monthly Income	-4.71E-04	8.66E-03	0.956643	
Man's Monthly Income	7.93E-02	8.75E-03	< 2e-16	***
Women's Empowerment in Ag. Score	2.79E-02	1.09E-02	0.01058	*
Women's Education	5.73E-02	1.40E-02	4.58E-05	***
Proportion of income from daily sources	1.16E-04	1.06E-02	0.991243	
Proportion of income from weekly sources	-7.86E-03	9.53E-03	0.40975	
Proportion of income from monthly sources	4.68E-02	1.11E-02	2.49E-05	***
Family Size	6.76E-02	1.36E-02	7.50E-07	***
Farming Household (Y/N)	2.22E-01	8.68E-02	0.010359	*
Crop Diversity	-1.18E-01	3.23E-02	0.00026	***
Access to Public Distribution System	-9.97E-03	7.63E-03	0.191636	
Proportion of Women in Household	-4.07E-02	1.35E-02	0.002682	**
Gender of Household Head	4.66E-02	1.04E-01	0.653507	
Percent of foods eaten from market	1.24E-02	1.02E-02	0.22345	
Total yield (kg)	3.24E-03	6.77E-03	0.632678	
Caste (General/ Other)	-9.96E-02	5.75E-02	0.083494	.
Rabi	1.96E-01	9.81E-02	0.070498	.
Summer	-1.22E-01	9.78E-02	0.237769	
Dewas	3.24E-01	1.72E-01	0.064078	.
Kutch	9.31E-01	1.83E-01	2.96E-06	***
Palamu	8.93E-01	1.76E-01	2.88E-06	***
Rabi * Dewas	-2.27E-01	4.30E-02	1.37E-07	***
Summer * Dewas	2.43E-01	4.15E-02	4.88E-09	***
Rabi * Kutch	1.08E-01	4.63E-02	0.019329	*
Summer * Kutch	1.41E-01	4.45E-02	0.001548	**
Rabi * Palamu	-2.48E-01	4.66E-02	1.09E-07	***
Summer * Palamu	2.37E-01	4.54E-02	1.91E-07	***

Regression Analysis: Season and Site effects on Food Expenditure

Season-by-site effects were significant, indicating that food expenditure varied by site and season. Across all sites, spending was the highest in the Rabi or harvest season. People spent 225 more rupees during this time than Kharif, the first harvest season. There was no significant difference between how much is spent during the Kharif season and the summer when crops are

being planted (p= 0.23). Interactions between site and season indicate that households spend substantially different amounts of money on food across sites in different seasons (Figure 3.5). From our model with scaled data, we observe that site and then season have the biggest effects on food expenditure.

Figure 3.5: The average amount of rupees spent on food in 1,200 households in rainfed India by season and site.



Regression Analysis: other household characteristics

Empowerment and women's education were both significantly and positively related to food expenditure. As empowerment increases by 0.1 on a 1-point scale, the association with food expenditure increased by 167 rupees. Similarly, women's education had a significant and positive association on food expenditures; for every additional year they are in school, food expenditure was associated with a 16 rupees increase. The gender of the household head was not significantly associated with food expenditure (p=0.65).

Non-farming households were associated with 261 more rupees on food than those that farmed. More diversified farmers were associated with 389 rupees less on food than diversified farmers. Whether or not a household farmed was among the variables that was most associated with food security, after site and season according to the scaled model. How much a household harvested in terms of the total number of kilograms was not significantly associated with food expenditure ($p=0.63$). Similarly, subsistence, or how much of what they ate came from their own resources was not significantly associated with food expenditure ($p=0.22$). Public distribution, or the proportion of their food that was from PDS, was not significant either ($p=0.11$).

In terms of household characteristics, food expenditure was higher in families with more people and each additional person in the family was associated with 41 more rupees spent on food. However, families with higher proportion of women in the household were associated with less food expenditure. Families that did not farm spent 261 rupees more on food, on average and holding other covariates constant, than those that did farm. Holding all other variables constant, those in general caste were associated with 112 rupee higher food expenditure than other backward castes, scheduled caste, and scheduled tribes altogether.

Mediation Model

Women's income does not have a significant direct effect on food expenditure ($p=0.85$), but when women have more decision-making power over income there is a small, positive association with food expenditure ($p < 0.0001$) (Figure 3.6). However, women's income has a strong, negative and significant impact on decisions over income ($p<0.001$). The indirect pathway between women's income and food expenditure is very low (Figure 3.6), indicating that there is not a strong relationship between women's incomes and food expenditure. We ran the mediation model with both the control-over-income variable and with the entire WEIA score and

the results had the same direction and magnitude. We found that the model had a good fit: The p-value of the Chi-square is 0.00, CFI is 0.996, RMSEA is 0.048, and SRMR is 0.013. These tests indicate that this is a good model fit, except for Chi-square, which is a harder threshold to meet with high sample size.

When evaluating if higher incomes are associated with more decision-making, we also included variables that could influence women's decision-making. We found that income, caste, and women's livestock ownership were negatively associated with decision-making. However, women's education as well as women's agricultural and household assets were positively associated with decision-making. Since we used scaled data in our mediation analysis, the standardized coefficients indicate their relative influence on decision-making (Table 3.4). Women's livestock ownership was the most influential variable, followed by women's income. Caste, household assets, and agricultural assets have similar impact, but less than the women's livestock ownership. The variables that had the most impact on food expenditure were man's income and proportion of money from monthly installments. Family size and women's influence over the budget had the next largest influence on food expenditures.

Figure 3.6: Mediation model measuring the direct and indirect impact of women's income on food expenditure, holding constant statistically significant variables from the regression for households in rainfed regions of India.

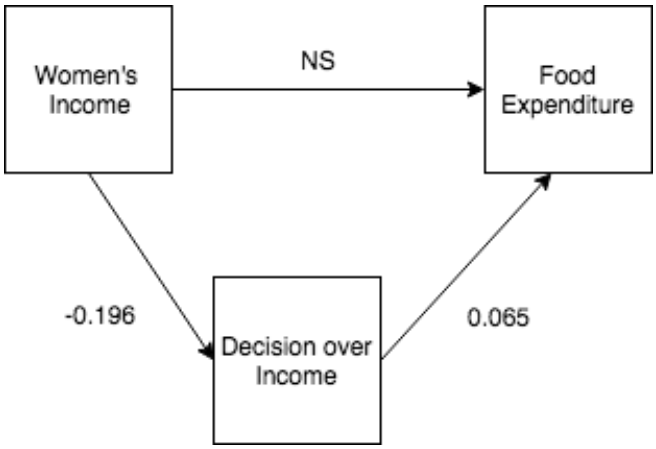


Table 3.4: Output of a mediation model measuring the direct and indirect pathways that women's income could potentially influence food expenditure with data collected from 1,200 households in rainfed regions of India collected each month from November 2016- November 2017.

	Estimate	Std.Err	z-value	p-value	Std.lv	Std.all
Food Expenditure ~						
Women's influence over income	76.554	10.766	7.111	0	76.554	0.065
Women's income	-2.291	16.95	-0.135	0.892	-2.291	-0.002
Man's income	247.97	22.705	10.921	0	247.97	0.212
Proportion of income from monthly allotments	225.084	10.916	20.62	0	225.08	0.192
Family Size	134.768	12.207	11.04	0	134.77	0.115
Proportion of women in hh	-97.672	11.261	-8.674	0	-97.672	-0.083
Women's education	-55.225	11.242	-4.913	0	-55.225	-0.047
Caste	-302.3	40.452	-7.473	0	-302.3	-0.076
Crop diversity	-4.608	11.695	-0.394	0.694	-4.608	-0.004
Women's asset empowerment	108.68	28.532	3.809	0	108.67	0.034
Women's influence over income~						
Women's income	-0.196	0.014	-13.97	0	-0.196	-0.20
Caste	-0.424	0.028	-14.95	0	-0.424	-0.12
Women's education	0.067	0.009	7.432	0	0.067	0.067
Women's agricultural assets	0.122	0.013	9.091	0	0.122	0.122
Women's household assets	0.123	0.015	8.137	0	0.123	0.123
Women's livestock assets	-0.262	0.016	-16.59	0	-0.262	-0.26

DISCUSSION

Women's Incomes and Food Expenditure

Both our regression and our mediation models indicate that women's income does not affect household food expenditures, once we had controlled for men's incomes and other variables. This is consistent with previous studies (Thomas 1990, Quisumbing and Maluccio 1993); but some studies have found significant relationships between women's income and food expenditures (Hoddinott and Haddad 1996, Duflo and Udry 2004, Doss 2006). Varying results among studies could be, in part, due to cultural norms that guide which women work and how much control they have over their own incomes.

The inconsistent effect of women's income on food security may be due to a number of unsupported assumptions in their analysis. First, they assume that women would prefer to spend more on food; so higher spending on food would reflect both her control over income and her preferences over spending. However, it may be that women do not prioritize food spending and prefer instead to spend on other aspects of human development like health and education (Quisumbing and Maluccio 2003). Second, they assume that women will have control over the money that they make. However, a woman's influence over income is based on characteristics related to her own endowments, features of her household, as well as external conditions like community norms, markets, and legal-systems as well as other social structures like class, caste, and race (Agrawal 1997, Eswaran et al. 2003, Rao 2015).

Linking women's incomes to more decision-making

Even though higher incomes do not translate to higher food expenditure, when women have influence over how income is spent, more is allocated to food expenditures. This finding is consistent with other literature that finds positive benefits for families' food, health and

education in female-targeted cash transfer programs (e.g., Shroff et al. 2009, Malapit et al. 2013, Moestue et al. 2007, Thomas 1990, Schady et al. 2008, Molyneux 2008, Skoufias 2005, Barrientos et al. 2016) and studies about Women's Empowerment in Agricultural Index (Shroff et al. 2009, Srabroni et al. 2014, Malapit et al. 2015, Alaofè et al. 2017, Tsiboe et al. 2018).

We found that higher incomes are not associated with more control over money, which may be surprising for the many organizations that promote women's economic empowerment. These organizations encourage women to join the formal workforce so that they can become empowered and influence spending to benefit the entire family (Atker et al. 2017, Appendix A). However, these programs will not be effective in circumstances when incomes do not translate to influence over income. And encouraging women to earn more may undermine both household wellbeing goals and empowerment because it limits her time caring for children and leisure time. Leisure time is important for empowerment because as women spend time together they exercise personal choice and self-determination they can also translate their voice and influence in other domains (Green 1998, Chapter 4).

Whether or not a woman has bargaining power, and influence over spending has been studied within the fields of sociology as resource theory (Blood and Wolfe 1960) and in economics as bargaining models (Kabeer 1994, McElroy 1990, Sen 1990). Resource theory suggests that women with higher education and income had more decision-making within the household and it shares the same logic as many women's economic empowerment initiatives. However, this theory has been criticized for not holding up in other cultural contexts, especially in patriarchal societies where men control incomes (Kantor 2003). The bargaining model approach, on the other hand, has provided more details on how bargaining power works in the family because it explicitly recognizes the individual woman and her endowments (Doss 2013),

but it can be much more influenced by community norms, markets, and legal-systems as well as other social structures like class, caste, and race (Agrawal 1997).

Our mediation analysis confirms that women's influence over the budget is driven both by a woman's endowments and also by caste. As expected, women's education, household and agricultural asset ownership are associated with more decision-making. Income and livestock ownership, however, had a negative consequence with control over income. The more money a woman earns either from income or owning livestock assets is often in control of men, especially in higher castes, which supports the bargaining model approach that recognized the importance of external institutions. Women from lower castes are more likely to work and have more freedom of movement than upper caste women (Eswaran et al. 2003, Rao 2015). Also, women from lower castes are likely to make less income because they are often employed in the agricultural sector, which is associated with low pay or no pay (Singh and Pattanaik 2018, Rao et al. 2017, Dzanku 2019). Kantor (2003) found that women were more in control of small sums of money than larger ones. However, we controlled for level of income, so different caste-based norms may explain why women from lower castes have more influence over the budget. Despite the abolition of the caste system in 1950, its influence is still wide reaching. Changing gendered-norms within the caste system is an uphill battle, but one that is worth pursuing since it is at the root of many inequalities. Given the vastness of this institution, it is not appropriate to assume that women alone can change it, even if they do become more empowered.

Frequency of payment and Food Expenditure

Analysis on income frequency revealed that proportion of female income from monthly installments was positively associated with food expenditure. This association is likely due to the fact that payment in monthly installments is often associated with salaried jobs, which are not

only higher paying but also consistent throughout the year. This result does not confirm the hypothesis presented in Haddad et al. (1996), who had predicted that women spent more on food because they get paid in smaller installments and could easily buy smaller purchases. They argued that men, on the other hand, were often paid in lump sum and would be more likely to be responsible for purchasing larger, more expensive goods (see also: Hamilton et al. 1984; Tripp 1982). It may still be true that women may spend their daily wages on food, but this pattern could not be identified within our data. This finding suggests that control over income may not have to do with how frequently women get paid, but how she was able to earn the money and what sector she was working in. Households with women earning monthly wages were associated with higher food expenditure not because of higher salaries, which we controlled for, but because of additional social capital or because women had more control over that income.

People with salaried jobs have more opportunities to formally borrow money since they have steady income and to informally borrow from the local grocer or neighbors who knew they would get repaid with the next paycheck, especially if payment was delayed. Another mechanism that could explain this relationship is that women who make salaried incomes have more control over the money that they earn. Women who work in salaried jobs may be more empowered or have higher levels of education than woman who do not. Since we controlled for these two mechanisms in our regression model, something else must explain why women that earn monthly incomes have higher food expenditure. A case study from India about women in the garment industry found that women were more likely to control their income if they were working in a sector that was not traditionally associated with women's unpaid, domestic work (Kantor 2003). It is likely that women receiving salaried work are employed in non-agricultural work, which is associated with daily and weekly wages. Future research should seek to better

understand what other external, job-related factors may increase women's control over income. Additionally, research should seek to better understand how to change cultural institutions so that women can have more influence over the money that they make. Randomized control trials where women receive different interventions that establish her own bank account or provide additional accounting skills are needed to determine if these strategies increase women's influence over the budget. In addition, more research is needed to determine if supporting female influence over decision-making could benefit men in male-centered interventions. Putting the onus of change on women, who are already time-limited and disenfranchised, may not yield the most effective or efficient results. More research is needed to understand how male-centered interventions can change social dynamics so women are more able to influence decision-making within the household.

CONCLUSION

The results from the regression analysis confirm that women's income is not associated with food expenditures, but women's empowerment is. The mediation analysis indicated that control over income was key to higher food expenditures, but that higher incomes do not translate into more influence over the budget. The negative relationship between women's income and food expenditures is critical to understand, especially as multilateral organizations, non-profits, and governments continue to push an agenda of "women's economic empowerment" and equate empowerment with joining the formal workforce.

Encouraging women to work more in a system where they do not get paid equally, have little control over income, and are already burdened with unpaid domestic chores will likely not change the system and, instead exhaust women. Many donor campaigns, including the 50 million dollar Women's Global Development Prosperity Initiative supported by the White House

acknowledge that women face structural barriers and that the need to be "simultaneously addressed." However, encouraging women to work within a broken system does little more than continue the status quo. Moreover, donor campaigns that center empowerment within the context of "economic empowerment" and earning incomes may inadvertently change norms so that women are expected to work more. Women may face the double burden of empowerment initiatives centered on employment, which they may not be interested in and losing out in other forms of empowerment like education and improving their legal status. In fact, many women in India have chosen to leave the workforce as their families have become less poor in recent years (Mehrotra and Parida 2017). Instead of putting the burden of change on the most disenfranchised group, more research and funding should be dedicated to training men and their families on the value of women's unpaid work and her potential contribution to household decisions. As we seek to empower women and reduce gender inequality we need more diverse approaches that not only target women and increase her endowments but also efforts that change the rules of the game, so that women can have more freedom of choice with how she spends her time and cares for her family.

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CHAPTER 4

Measuring Women's Effect on Food Security: Quantitative analysis of empowerment, income, and time allocation from rural India

Abstract: Women influence their families' food security in a number of ways, including through their empowerment or level of decision-making, level of education, how they spend their time, how they spend money, and by serving in public office. Given the multitude of ways that women can influence their families' food security, they are often characterized as the key to food security. In recognition of this, many development policies are putting women at the center of their interventions and academics and development agents have called for more a gendered-lens applied to nutrition interventions. This paper contributes to this by quantifying the many ways that women can influence their families' food security, including the tradeoffs and feedbacks between pathways. With a dataset of approximately 15,000 household surveys, we find that women's influence over income decisions, her education level, and her income level are positively associated with food security. Surprisingly, higher incomes did not translate to more decision-making over income allocation or reduce unpaid work burdens, indicating that policies that aim to expand women in the workforce may not be the most efficient way to support women's empowerment and food security.

Key words: food security, women's impact on food security, Indian Enigma, time allocation, women's incomes, women's empowerment

INTRODUCTION

With nearly 200 million people undernourished and 38 percent of children stunted, India has the world's largest population of undernourished people (FAO 2018). Despite consistent economic growth and output—it has the seventh largest nominal Gross Domestic Product globally—India ranks 100 out of 119 on the Global Hunger Index (von Grebmer 2018). The "Indian Enigma," as this phenomenon is known, has puzzled researchers and development agents because economic growth typically translates into prosperity and increased food security (Deaton and Drèze 2009). Efforts to better understand this phenomenon have been coupled with calls to evaluate the complexity of the food system more systematically (Pinstrup-Anderson 2011) and to place gender justice at the center of food and nutrition interventions (Rao et al. 2017). Calls for a more gender-sensitive approach stem from recognition that women are integral to food security and that solutions need to recognize, and potentially transform, the structures and norms that are associated with gender roles.

Women can impact food security by growing crops, tending to livestock, and purchasing and preparing food (Tisboe et al. 2017, Galie et al. 2015). Women can also indirectly influence food security by making decisions about resource allocation or how to spend incomes (Kadiyala 2014, Malapit et al. 2015, Begum and Sen 2009, Shroff et al. 2009). How women allocate their time affects food security as well. When women spend more time in paid labor, they have less time to dedicate to feeding and caring for children (Wandel and Holmboe-Ottesen 1992, Jones et al. 2012). Given that women affect food security in a variety of ways (Ramachandran 2006, Kadiyala 2014), they are often characterized as the "key to food security" (Quisumbing 1995). Even though women's influence over food and nutritional security has been discussed conceptually for decades (Bruce 1989, Bennett 1992, Quisumbing 1995, Kadiyala et al. 2014),

most of the empirical work describes a single pathway of influence rather than the interplay between multiple pathways. Since women have limited time and resources, they have to make strategic decisions about how to secure their families' nutrition and food security. Quantifying the ways that women influence food security and how they interact with one another is necessary to efficiently allocate resources and weigh potential tradeoffs.

A recent review of how women influence nutrition and food security identifies serious gaps in the literature, including the omission of women's time expenditure in food security models (Kadiyala et al. 2014). How women allocate their time is closely associated with food security—the more time she spends caring for her children and less time on drudgery, the better her families' food security (Quisumbing et al. 1996, Jones et al. 2012). Additionally, no other studies quantitatively compare the many pathways through which women influence food security or account for tradeoffs and feedback loops. In order to gain new insights about the Indian Enigma and better design gender-sensitive interventions, we need to empirically evaluate the different ways that women impact food security throughout the year and consider the potential positive feedback pathways and tradeoffs between them (Rao et al. 2017). This paper seeks to quantify the pathways through which women can influence food security: women's empowerment, income, time allocation, education, and representation on village councils. We aim to (1) quantify causal pathways by which women directly and indirectly affect food security, (2) describe potential tradeoffs and feedback loops between the pathways, and (3) quantify women's empowerment as a latent variable. Highlighting the tradeoffs between strategies to achieve food security is essential, especially as we continue to place women at the center of food and nutrition interventions. An additional methodological goal of this paper is to measure the relative importance of the dimensions of women's empowerment that are part of the Women's

Empowerment in Agriculture Index. This corresponds to our overarching goal to better understand how working women influence family food security.

LITERATURE REVIEW

Women's Income and Food Security

Higher earnings by women are not always associated with higher family food expenditures (e.g., Hoddinott and Haddad 1996, Duflo and Udry 2004, Doss 2006, Thomas 1990, Quisumbing and Maluccio 2003), but they are often associated with better child nutrition outcomes (e.g., Tripp 1982, Kennedy and Peters 1992, Ukwani and Suchindran 2003). This indicates that women's incomes are important, but they are not the only driver of food security. Women can influence their families' food security through earning income, making decisions over how income is spent, through the time they spend doing unpaid labor, by serving on village councils, and through their education.

Income from mothers can have a positive association with child nutrition outcomes (Tripp 1982, Kennedy and Peters 1992), but the results are mixed when it comes to improving women's own nutrition (Rathnayake and Weerahewa 2011, Rahman 2002, Aromolaran 2004). For example, Tripp (1982) found that children with the highest weight-for-age ratio were in families where the mother earned her own income from trading. Whether a mother trades has a larger impact on child nutrition than a father's trading activities, even though male trading activities are more profitable (Gans 1963 cited in Tripp 1982). Similarly, in Kenya and Malawi, Kennedy and Peters (1992) found that despite female headed-households having the lowest incomes, their preschoolers' nutritional status was significantly better than higher income male-headed households. Children of working mothers in Nigeria had reduced stunting, but other expected positive benefits to nutrition were not found (Ukwani and Suchindran 2003).

Evidence that higher income translates into higher food security for women is mixed (Rathnayake and Weerahewa 2011; Rahman 2002; Aromolaran 2004). A case study in Sri Lanka indicated that a mother's income had positive association with her calorie intake (Rathnayake and Weerahewa 2011). Similarly, Rahman (2002) found that with an additional 1,000 taka (US$57) in the dowry, brides ate 25 percent more animal, dairy, and fish in Bangladesh. However, Aromolaran (2004) found that increases in women's share of household income are likely to result in marginal declines in food calorie intake by individual household members in western Nigeria. Differences across studies highlight how cultural norms and intra-household eating practices, such as the order in which people eat, are highly location dependent (Haddad et al. 1996). Another reason these results may be mixed is because these studies do not explicitly include a variable about for who controls the income; many erroneously assume that women will control the incomes that they earn.

If women's income earnings are positively associated with food security, it is vital to consider the challenges and structural barriers to make it more fair and equitable for women to participate in the workforce. Women are often paid less than men, they have more difficulty entering non-farm sectors, and they face cultural, caste-based barriers that limit their movement (Eswaran et al. 2013, Rao 2014). South Asian women make substantially less than men; women's wages range from half to two-thirds of men's wages (Ramachandran 2006). In India, women in the agricultural sector make at least 20 to 30 percent less than men for doing the same activity (Ramachandran 2003, Varkkey and Korde 2013). A recent report from the International Labor Organization indicates the wage gap is highest for the poorest women, indicating that poor women face higher burdens and have to work much more to earn the same amount of money (ILO 2018). In fact, 68 percent of rural women involved in informal work make less than the

national minimum wage set by the government. There is some evidence that wage disparities have decreased recently (Varkkey and Korde 2013). As living conditions have improved for rural families, nearly 20 million women withdrew from the workforce between 2005 and 2012 (ILO 2018). This may partially explain the reduction in the wage gap; the lowest paid workers withdrew from the workforce (Kheterpal 2018).

Moreover, women have fewer opportunities to formally participate in the workforce. Women from poorer households work most often in agriculture or other wage-labor jobs and women from better-off homes tend to work on home-based activities, which are less likely to be included in workforce statistics (Kabeer 2003, Ramachandran 2006). In rural areas of India, working outside of the home is considered a low-status activity (Eswaran et al. 2013). As families become wealthier, women, especially those from higher castes, elect not to earn an income (Eswaran et al. 2013). Women who are interested in earning money are often relegated to working in the agricultural sector, which is often low-paying and seasonal. Seventy-eight percent of working women in India are employed in agriculture and 70 percent of farm work is done by women (Rao 2006). Women face additional barriers like lack of education and formal training required to participate in non-farm jobs (Ncube 2012), which are often higher-paying and positively associated with food security (Anderson 2002, Ch. 1).

Women's Empowerment and Food Security

When women have influence over decisions about income, their families have higher food security. Female-headed households, those that participate in female-targeted cash transfers, and households with women who are empowered according to the Women's Empowerment in Agriculture Index have higher food security. Even though female-headed households are often significantly poorer than male-headed households, their children are at either no greater risk of

malnutrition (Handa 1996) or may even have higher food security (Tinker 1979, Kennedy and Peters 1992). However, Kennedy and Haddad (1994) point out that female-headedness itself may not be the cause of higher nutritional status of pre-school children in Kenya. They suggest that the degree of authority mothers have over income and time allocation is most important to food security outcomes. Additionally, conditional cash transfer programs where mothers receive ATM cards with their own name have also demonstrated success in food security as well as other human capital (see Yoong et al. 2012, Skoufias 2005).

More recently, literature about women's empowerment and food security has used the Women's Empowerment in Agriculture Index to measure relative empowerment compared to male counterparts across five domains: input over productive decisions, ownership of productive assets, control over use of income, participation in community groups, and time allocation (Alkire et al. 2012). The goal of much of this work is to describe the characteristics of empowered women across geographical contexts. Another goal is to examine which domains of empowerment are more or less associated with food security outcomes (Alaofé et al. 2017). Many studies indicate that higher WEAI scores are associated with higher food security. For example, women with higher WEAI scores had higher dietary diversity and body mass index in Nepal but had only greater dietary diversity in Ghana (Malapit et al. 2015, Malapit and Quisumbing 2015). Much of the literature indicates that decision-making power over income and other productive resources is highly associated with food security (Moestue et al. 2007, Shroff et al. 2009, Begum and Sen 2009).

Women's Time Allocation and Food Security

Globally, women are disproportionately burdened with domestic and unpaid work as compared to male counterparts (Sayer 2005, Budlender 2010, and Miranda 2011). Rural women

are expected to do arduous and time-consuming activities in order to help the household function: they cook; clean; care for children, the elderly, and the sick; collect firewood, fresh water, and fodder for animals; and do light household construction. For those with family farms, they also participate in agricultural drudgery like weeding, harvesting, processing, and more (Choudhary and Parthasarathy 2007). The domestic work done by women is often unseen and undervalued (Miranda 2011).

The time women spend on household work exceeds that of men across contexts (Rao et al. 2017, Kumar and Hotchkiss 1988, Rajivan 1999). In India, more than 75 percent of women's work remains unpaid (Choudhary 2007), though this varies by caste and class. A time-allocation study in the Indian state of Odisha found that women from lower castes had on average 11 to 12 hours for leisure and rest per day while men had 15 to 16 hours, indicating women have, on average, four more hours of work each day (Rao et al. 2017). Women in female-headed households face the highest work burdens and have the least amount of leisure time (Kabeer 1992). Given that women, and particularly mothers, have a number of time-consuming responsibilities, they have to make choices about where they spend their time and energy. The more a woman works, in either paid or unpaid capacities, the less time she has for childcare or leisure.

The time women spend taking care of and feeding their children is positively associated with nutritional and healthcare outcomes (Choudhary et al. 2016). When women have time to prepare nutritious meals, fetch clean water, and implement safe and hygienic practices, their children benefit. In particular, the care that children receive in the first 1,000 days of life is critical to their immediate survival and long-term health outcomes, including obesity, diabetes, hypertension, neurodevelopment, and mental health (Schwarzenberg et al. 2019).

As women spend more time doing paid work, they may be able to buy more food or more nutritious food, but it comes at the cost of spending time with and caring for their children. Maternal employment can be a barrier to childcare and feeding practices because it takes time away from tending to children (Paolisso et al. 2001, Jones et al. 2012). And for those that do take their children with them to work, the conditions are not amenable to nurturing interactions between mother and child (Ukwani and Suchindran 2003, Jones et al. 2012). Moreover, arduous working conditions, including exposure to toxins and disease associated with agricultural work, can pose health threats to mothers and have negative consequences for lactation (Rasmussen 1992, Jones et al. 2012). A study in India shows that the risk of rural infant mortality is 50% higher when mothers work in agriculture as compared to mothers who do not work in agriculture or to fathers working in agricultural or non-farm sectors (Bhalotra 2010).

Not only does working more interrupt time tending to children, it can also come at the expense of leisure time, which is important for wellbeing, productivity, and empowerment. Leisure is essential for managing stress and promoting self-efficacy (Caldwell 2005). Lack of rest is related to health outcomes like obesity, diabetes, cardiovascular disease, immune function, and mental health issues (Division of Sleep Medicine at Harvard Medical School 2008). Additionally, when mothers suffer from mental health conditions, their children's health and nutrition can suffer (Harpham et al. 2005). Beyond physical health and wellbeing, proper rest is also associated with higher work productivity (Pencavel 2014).

More notably, leisure time is essential for self-determination and, ultimately, empowerment. Green (1998) explains how leisure time, especially when spent with other women, is important for women to review their lives with others in similar circumstances; exercise personal choice and self-determination that provides further opportunities for

individuals to exercise personal power; and share in humor, which can be a source of empowerment and resistance to gender stereotypes. “Leisure spaces should not be underestimated, especially in terms of their potential for resistance and renewal for women enmeshed in patriarchal cultures that continue to define [women] as wives and mothers” (Green 1998). Therefore, when a woman spends more time earning money, it may come at the expense of food security outcomes for her children and her own empowerment.

Women on Village Councils and Food Security

Women can also influence food security by serving on village councils, which administer local public goods. Communities where women serve on village councils are more likely to support initiatives that are important to women, including infrastructure that reduces their daily drudgery (Duflo 2012). In West Bengal, for example, women advocated for drinking water and roads, and villages with female representatives invested more in these infrastructure improvements than villages with only male representatives (Chattopadhyay and Duflo 2004). In order to address persistent gender inequality, India passed a constitutional amendment in 1993 that required that one-third of rural village seats and village presidencies be reserved for women (Constitution (Seventy-third Amendment) Act, 1992). This law was passed unanimously, but its goals were not debated or clarified, which make it difficult to judge its effectiveness (Nanivadekar 2006). The amendment created approximately 1 million new seats for women, but some were proxy seats that went to wives and relatives of male politicians and others remained unfilled (Nanivadekar 2006). Within our sample, for example, 10 of 80 villages did not have one woman on their village council. Despite the lack of enforcement, women who serve on village councils vote for policies that support other women (Chattopadhyay and Duflo 2004, Pande and Ford 2012).

Women's Education and Food Security

Women's education can influence food security through knowledge of good nutrition and hygienic practices (Quisumbing et al. 1996). Although, a case study from Nigeria found that level of educational status of women had no effect on child stunting or wasting, which are measures of malnutrition. This is likely because the vast majority of women in the study population had very low levels of education and had not attended secondary education or higher (Ukwani and Suchindran 2003). Education may also indirectly influence food security through increased earning potential (Thomas et al. 1991, Olumakaiye and Ajayi 2006, Duflo 2012) and increased bargaining power (Doss 2006). Women with higher educations may also have the needed skills to participate in the non-farm sector, which is associated with higher and steadier incomes (Dzanku 2019). Literature about bargaining power has acknowledged that women with higher education have more influence over decision-making and resource allocation (Doss 2006). Confounding these trends, however, are women from higher castes who typically have higher education but may not choose to work (Rao et al. 2014).

METHODS

Please see Methods in Chapter 2 for general details on the study site and data collection.

Measurement of Variables

We measure food security with the Household Food Insecurity Access Scale (HFIAS), which includes nine items about uncertainty and concern about food, inadequate quality of food, insufficient quantity of food, and social unacceptability (Coates et al. 2007). If and how frequently the household faces these challenges determines if a household is defined as one of four categories: food secure, mildly food insecure, moderately food insecure, and severely food insecure. This metric is reliable and valid across many cultures, including the rural Indian

households that were surveyed (Sethi et al. 2017, Leroy et al. 2015). The questions are asked about the last 30 days and posed to a woman. Given the sensitivity of these questions, enumerators were additionally trained to make women feel comfortable answering honestly. This scale is more comprehensive than other measures of food security than other scales that measure sufficiency of food because it includes details on the lived experience of being food insecure. Since this variable is focuses on scarcity of food, it does not sufficiently measure the nutritional quality of people's diets. Micronutrient sufficiency is an often understudied measurement of food security, though it is critical for good health (Pinstrup-Andersen 2009). Another limitation is that since this variable aggregates household, it does not account for potential food security differences between men and women, which may be different (Haddad et al. 1997).

We were mainly interested in understanding the pathways through which women impact food security, so we included variables related to women's income, the amount of time women spent on paid and unpaid work, women's empowerment and education, as well as how many women serve on local village councils.

Each month we collected information about every source of income earned by all members of the household, who did the job, how much they were paid, and how often they were paid. Since some people, particularly agricultural wage laborers, are paid in grain or other in kind payments, we converted in kind payments to their cash equivalent. In order to keep income proportional amongst male and female earnings within the same household, we also included family size and proportion of women in the household in the model.

Empowerment was calculated as a latent variable according to the domains within the Abbreviated Women in Agriculture Empowerment Index (A-WEIA, Alkire et al. 2012; Malapit et al. 2015). The A-WEIA score includes five domains: input over productive decisions,

ownership of productive assets, control over use of income, leadership in the community, and time allocation. Each of these domains were reduced to dichotomous options: being empowered according to the domain or not.

We separately asked a randomly selected man and woman about their time allocation. Specifically, we asked how many times in the 30 days they did 26 different activities and how long it took, on average, to do each activity. To calculate monthly time allocation, we multiplied these two together. We then sorted activities into paid labor, unpaid labor, or leisure activity. Other studies that collect time allocation ask only about the last 24 hours (Zereyesus et al. 2017; Diiro et al. 2018; Alaofé et al. 2017). However, this approach provides a more comprehensive understanding of how natural resource dependent people spend their time because it accounts for how they often change activities drastically from day to day.

Additionally, we included education and reserved seats for women on village councils because they may directly influence food security or indirectly it because they affect women's time allocation and empowerment. The number a years a woman goes to school can affect how much money she earns and her ability to influence decisions (Olumakaiye and Ajayi 2006, Thomas et al. 1991, Doss 2006). We included number of reserved seats for women on local village councils since female representatives invest more in infrastructure that reduces the unpaid work burdens (Chattopadhyay and Duflo 2004).

We included the following variables to hold constant because they significantly impacted food security according to Bashir and Schilizzi (2013). We included gender of the household head because female-headed households are often poorer, which is negatively associated with food security, but women in female-headed households have control over their income, which is positively associated with food security (Kennedy and Peters 1992, Appelton 1996, Kabbani and

Wehelie 2005). We also included a categorical variable for caste: General Caste, Other Backward Castes, Scheduled Caste, and Scheduled Tribe. We included caste because it can influence whether a woman works or if she has control over income. Also, lower castes are generally poorer and less food secure, so they may spend less on food than higher castes (Chapter 2, Eswaran et al. 2003, and Rao 2015).

We included other variables about income, including man's income (Gyawali and Ekasingh 2008, Bashir et al. 2010) and the proportion of income from non-agricultural production (Hesselberg and Yaro 2006; Babatunde and Qaim 2010, Robaa and Tolossa 2016), because they are both associated with higher food security. How much money a man makes may explain how much food he is able to purchase and it may influence whether or not his wife needs to work. Income earned from nonagricultural sources is not dependent on the seasonal weather patterns, so it is more consistent. When households have a consistent stream of income, they are more food secure than those who work sporadically. Last, we included food expenditure (Amaza et al. 2006, Omotesho et al. 2007) because the more money that is allocated to food, the higher a household's food security.

Statistical Analysis

First, we ran a factor analysis to quantify how much each domain of empowerment, as outlined by the Abbreviated-Women in Agricultural Empowerment Index, contributed to women's empowerment. Instead of giving equal weight to each domain and adding them together, which is the typical A-WEIA procedure, we calculated women's empowerment as a latent variable. A latent variable is a variable that is not directly observed and is instead inferred by other quantifiable variables (Beaujean 2014). In the case of empowerment, we cannot ask women directly if they are or are not empowered since it is an abstract concept and may mean

something different to each respondent. Instead, we measure variables that directly measure the a women's level of decision-making as well as other assets that could increase her bargaining power such as how many assets a woman owns, whether or not she participates in groups, and if she has access to and control over credit. The latent variable approach allows us to quantify which domains of empowerment are most associated with women's empowerment.

Based on the results of our factor analysis, which are further discussed below, we chose to use a more specific variable about women's decision-making in our simultaneous equation model. We defined decision-making as having some input over decisions about how income was spent and how to sell productive resources. Both of these metrics are within the A-WEIA Index, but we chose to use the more specific measure of decision-making because it was what drove the empowerment as a latent variable and related to our questions about women's indirect influence over income allocation. Though, it is worth noting that the results did not change the significance or direction of the relationship between empowerment and food security when we used the A-WEIA score itself.

Second, we used structural equation modeling to quantitatively evaluate and compare the pathways through which women influence food security. This approach allowed us to hold a different combination of variables constant within each pathway (Beaujean 2014). We used the lavaan package in R (version 3.5.3) for both the factor analysis and the structural equation modeling (Rosseel 2012). We used robust standard errors and report unstandardized effects, their standard errors, and standardized effects (Kline 2015). We also clustered our data at the household-level in order to address potential autocorrelation concerns arising from monthly data collection. We calculated total effects of each pathway by adding together the statistically significant direct and indirect effects on food security. Indirect, or mediator, effects were

calculated by multiplying the coefficients along the statistically significant paths from the indirect variable to food security. The model fit was evaluated with the chi-square test, CFI, RMSEA, and SRMR (Beaujean 2014, Kline 2015). Cut-off scores indicating good model fit were as follows: chi-square $p < 0.05$, CFI > 0.90, RMSEA<0.08, and SRMR< 0.08 (Beaujean 2014, Kline 2015).

RESULTS

Descriptive results

We found differences between the sample population (Table 4.1) and when we divided women into four groups: women who worked and had control over her income, those who worked and had no control, women who did not work and had an influence over income, and women who did not work and had no control over income (Table 4.2). Household food security was highest in household where women worked and had control over their income. However, women's incomes were higher in households where women worked and did not have control over their own income, suggesting that control over income as compared to level of income is most important for food security.

Table 4.1. Descriptive table of all variables presented in models for the entire study population, which includes 1,200 households across Kutch district, Gujarat; Dewas district, Madhya Pradesh; Palamu district, Jharkhand; and Bankura district, West Bengal in India. Data was collected from November 2016- November 2017.

Descriptive Table All Variables

Variable	Mean (sd)
Income Evenness Woman	0.071 (0.157)
Income Evenness Man	0.129 (0.202)
Percent Nonfarm Income Woman	0.103 (0.289)
Percent Nonfarm Income Man	0.295 (0.425)
Number of Jobs Woman	0.946 (0.908)
Number of Jobs Man	1.515 (0.831)
Yield (kg)	334.107 (2736.050)
Reliance on the Commons	14.279 (18.993)
Seats Reserved for Women	1.784 (1.255)
Woman's Empowerment	0.322 (0.198)
Food Expenditure	2561.586 (1240.232)
Monthly Household Income	111.478 (145.395)
Does Not Farm	0.825 (0.380)
Crop Diversity	0.838 (0.360)
Family Size	5.021 (1.958)
Access to Irrigation	0.194 (0.395)
Proportion of Women in HH	0.469 (0.167)
Gender of HH Head	0.019 (0.135)
Education	7.435 (4.088)
Land (ha)	1.455 (1.842)

Table 4.2: Descriptive table of variables presented in models for the entire study population and grouped by women's work status and whether or not they have control over income. The study site includes 1,200 households across Kutch district, Gujarat; Dewas district, Madhya Pradesh; Palamu district, Jharkhand; and Bankura district, West Bengal in India.

Descriptive Table by Woman's Work Status and Control Over Income

Variable	Work and Control Mean (sd)	Work and No Control Mean (sd)	No Work and Control Mean (sd)	No Work and No Control Mean (sd)
n	2678	6130	4280	580
Food Security	3.072 (1.194)	2.595 (1.047)	2.739 (1.103)	2.666 (1.086)
Monthly Income Woman	43.039 (74.756)	48.159 (73.159)	0.000 (0.000)	0.000 (0.000)
Woman's Education	6.457 (3.938)	5.994 (4.308)	7.621 (4.456)	6.997 (4.477)
Seats Reserved for Women	1.150 (0.859)	1.800 (1.307)	2.139 (1.229)	1.914 (1.323)
Woman's Control Over Income	1.000 (0.000)	0.000 (0.000)	1.000 (0.000)	0.000 (0.000)
Woman's Unpaid Labor	175.689 (111.262)	141.703 (110.365)	142.264 (108.783)	170.809 (129.281)
Woman's Empowerment	0.191 (0.140)	0.455 (0.157)	0.206 (0.154)	0.385 (0.164)
Woman's Ownership of Assets	0.816 (0.387)	0.802 (0.399)	0.914 (0.280)	0.848 (0.359)
Monthly Household Income	128.037 (184.509)	117.384 (143.719)	92.834 (120.246)	110.170 (109.002)
Monthly Income Man	84.998 (132.025)	69.021 (85.620)	91.844 (101.315)	110.170 (109.002)
Caste	2.338 (0.967)	3.352 (1.002)	2.633 (1.134)	3.228 (1.077)
Crop Diversity	0.873 (0.322)	0.809 (0.382)	0.853 (0.348)	0.860 (0.344)
Food Expenditure	2954.078 (1460.051)	2369.621 (995.922)	2582.993 (1368.178)	2622.969 (1006.834)
Percent Nonfarm Income	0.207 (0.334)	0.237 (0.348)	0.379 (0.463)	0.368 (0.447)
Yield (kg)	380.846 (1987.645)	410.227 (3771.890)	212.028 (936.318)	214.638 (1076.998)
Does Not Farming	0.859 (0.348)	0.794 (0.404)	0.845 (0.362)	0.855 (0.352)
Family Size	4.923 (1.791)	5.031 (1.866)	5.004 (2.152)	5.500 (2.067)
Proportion of Women in HH	0.464 (0.161)	0.493 (0.167)	0.442 (0.168)	0.444 (0.142)
Gender of HH Head	0.012 (0.110)	0.013 (0.114)	0.031 (0.174)	0.014 (0.117)
Education	7.227 (3.582)	6.914 (4.113)	8.267 (4.193)	7.766 (4.236)
Land (ha)	2.218 (2.423)	1.432 (1.654)	0.993 (1.530)	1.569 (1.539)
Reliance on Commons	14.952 (18.671)	15.035 (19.649)	12.896 (18.068)	13.384 (19.516)

Table 4.3. Results from a factor analysis, which indicates which latent variable loadings were most associated with women's empowerment in rainfed regions of India and number of women who were empowered within each domain of women's empowerment as identified by the Women's Empowerment in Agriculture Index.

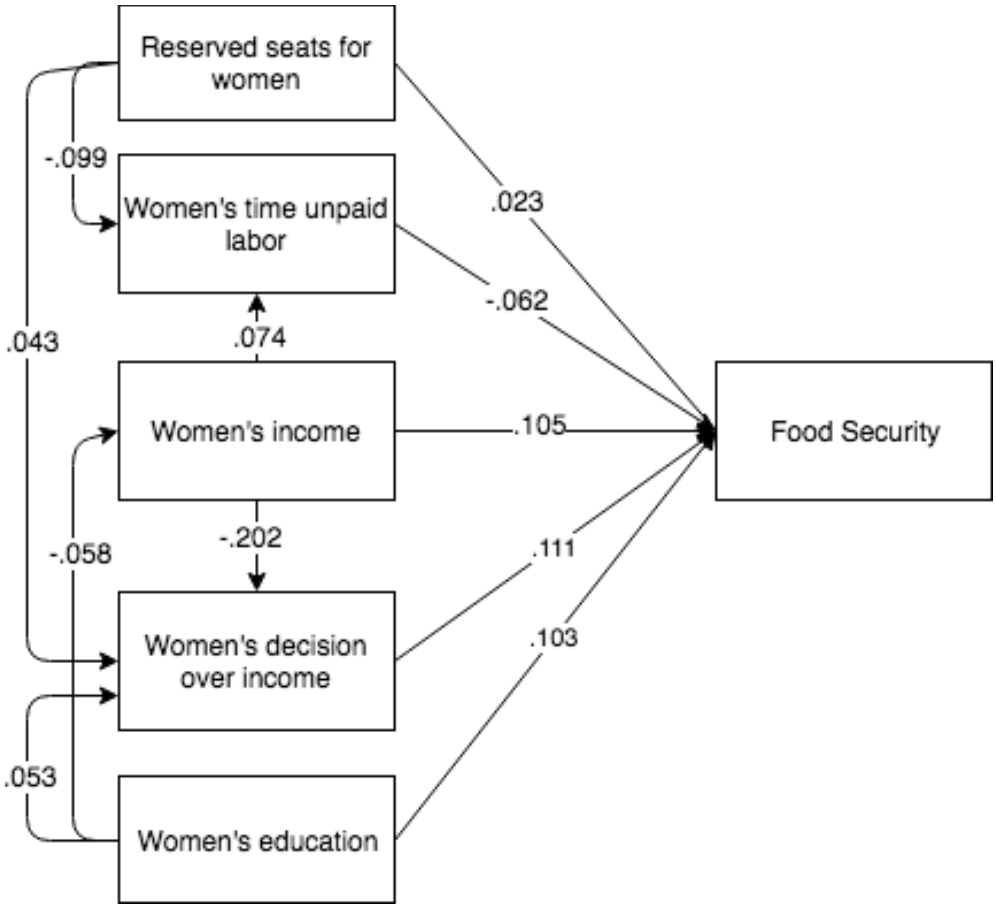
Factor Analysis

Statistic	Percent of Woman Empowered by Variable	Estimate	Std. Err	p-Value	Std. all	r^2
Asset ownership	15.82 %	1			0.132	0.02
Access to credit	1.43 %	0.096	0.029	0.001	−0.039	0.00
Workload	43.55 %	−0.924	0.135	0	−0.101	0.01
Group participation	29.37 %	−3.692	0.345	0	−0.41	0.17
Control over income	49.09 %	6.213	0.578	0	0.687	0.47
Input of productive decisions	27.46 %	6.648	0.614	0	0.695	0.48

Women's empowerment factor analysis

When measuring empowerment as a latent variable, we found that it was primarily constructed by the domains related to control over income (r^2= 0.47), input on productive decisions (r^2=0.48), and, to a lesser extent, group participation (r^2= 0.17) (Table 4.3). Decision over income (p=0.0) and productive decisions (p=0.0) were significantly and positively associated with food security. Group participation, on the other hand, was negatively associated with food security (p=0.0). Asset ownership (r^2=0.02), access to credit (r^2=0.0), and workload (r^2=0.01) were not correlated with our latent variable.

Figure 4.1: Structural equation model measuring associations of women's time, income, women's influence over income, and the number reserved seats for women on village councils and food security, as measured by the Household Food Insecurity Access Scale. The sample population included women from 1,200 households across rainfed regions of India.



Measurement Error Metrics: The Robust Comparative Fit Index (CFI) is 0.853, the root mean square error of approximation (RMSEA) score is 0.053 (90% CI = 0.051, 0.055), and the standardized root mean square residual (SRMR) is 0.031, and the Chi-square metric is (p = 0.000, df= 87). All of these metrics indicate good fit, except the Chi-square metric, which is not surprising since this metric penalizes fit for each additional variable added and this is a complex model with many variables.

Pathways food security

All reported pathways were significant at the 0.05 level (Figure 4.1). The most significant, direct pathways through which women influence food security is through their decision-making about income (r^2=0.099), their education (r^2=0.092), and their earned income (r^2=0.094) (Table 4.4). However, once we also include indirect effects between these pathways, women's education has the highest association with food security (r^2=0.100) and women's income becomes less associated with food security (r^2=0.075). Decisions over income were most influenced by caste and, to a much lesser extent, asset ownership and education (Table 4.5). Amount of time spent on unpaid labor is negatively associated with food security (r^2=-0.056). Reserved seats for women are significantly associated with food security, though the magnitude of the effect is minimal (r^2=0.033). However, the number of reserved seats is negatively associated with unpaid labor (r^2=-0.099); the more reserved seats for women, the less time women in that village spent on unpaid labor.

Table 4.4. Quantifying the pathways through which women influence food security for their family, including the direct, indirect, and total effects.

Statistic	Direct	Indirect	Total
Women's income	0.094	−0.024	0.070
Unpaid labor time	−0.056		−0.056
Women's decision over income	0.099	−0.024	0.099
Reserved seats for women	0.023	0.010	0.033
Education	0.092	0.008	0.100

Table 4.5. Output for the Structural Equation Model describing the different pathways through which women can influence food security: earning income, decision over income, time in unpaid labor, education and reserved seats for women on village councils. The sample population includes women who work and do not work in 1,200 households throughout rainfed regions of India.

Statistic	Estimate	Std. Err	z-Value	p-Value	Std. lv	Std. all
Household Food Security Access:						
Women's income	0.105	0.013	7.89	0	0.105	0.094
Unpaid labor time	−0.062	0.012	−5.103	0	−0.062	−0.056
Women's decision over income	0.111	0.023	4.736	0	0.111	0.099
Caste	−0.281	0.025	−11.343	0	−0.281	−0.273
Women's education	0.103	0.024	4.262	0	0.103	0.092
Crop diversity	0.016	0.009	1.666	0.096	0.016	0.014
Food expenditure	0.044	0.023	1.934	0.053	0.044	0.039
Percent nonfarm income	0.02	0.019	1.061	0.289	0.02	0.018
Number of reserved seats for women	0.025	0.025	1.022	0.307	0.025	0.023
Unpaid labor time:						
Number of reserved seats for women	−0.099	0.015	−6.687	0	−0.099	−0.099
Women's income	0.074	0.015	4.937	0	0.074	0.074
Paid labor Time	0.224	0.012	18.603	0	0.224	0.224
Women's income:						
Paid labor Time	0.173	0.01	17.049	0	0.173	0.173
Women's education	−0.058	0.017	−3.511	0	−0.058	−0.058
Caste	0.029	0.014	2.103	0.035	0.029	0.032
Mans income	0.492	0.054	9.15	0	0.492	0.492
Women's decision over income:						
Women's income	−0.2	0.019	−10.289	0	−0.2	−0.2
Caste	−0.344	0.025	−13.767	0	−0.344	−0.373
Women's education	0.053	0.025	2.139	0.032	0.053	0.053
Women's ownership of assets	0.202	0.051	3.953	0	0.202	0.074
Number of reserved seats for women	0.043	0.027	1.599	0.11	0.043	0.043

DISCUSSION

Measuring women's empowerment as a latent variable

When we measured empowerment with a latent variable approach, we found that it was constructed by mainly two domains: decision-making over income and productive decisions. Decision making over income and productive decisions were positively and strongly associated with empowerment. To a much lesser extent, group membership was negatively associated with empowerment. The three other domains did not impact it at all. Our findings are consistent with other literature that finds decision-making over income is highly associated with empowerment (e.g., Malapit et al. 2015, Shroff et al. 2009, Begum and Sen 2009). However, the negative

association with group membership is surprising, given that group membership may endow members with new skills, more access to microfinance, and wider social networks.

Research about group membership indicates that it is positively associated with empowerment and self-efficacy (Swain and Wallentin 2009). Research that uses the Women's Empowerment in Agriculture Index also finds that group membership can be positvely associated with empowerment (Malapit et al. 2015, Moestue et al. 2007) but not always (De Silva and Harpham 2007). Our study population did not have this expected relationship, perhaps because our threshold to be empowered through participation was very low—As long as people made at least one decision within the group, they were considered empowered. However, participation should not be thought of as dichotomous; the extent to which someone participates and the depth of her engagement is much more associated with empowerment (Arnstein 1969).

The most common group that women in our study site participate in was a Self-Help Group (SHG). SHGs are groups of 10-20 women of the same caste who save small amounts of money to be able to borrow it back when needed. Though the original goal was to equip women with micro-lending options, SHGs also have the potential to increase women's decision-making and bargaining power, increase women's social networks, and improve access to government support to meet local needs (Tesoriero 2005). However, not all SHGs are well-functioning and able to achieve these goals (Kabeer 2005). Well-functioning SHGs must have the trust of the members, display autonomy and earn respect within the community, take initiative on projects important to the community, and, often, have support (logistical or financial) from another institution such as an NGO that can lend legitimacy. Those SHGs that do not function well are often those that do not have a strong bond or trust between members and view the SHG strictly as a means to receive external benefits. The negative association we see in our data may be due

to differences between the qualities of the SHGs; only active SHGs are able to empower women. Future research on women's empowerment should include a measurement about the quality or effectiveness of the institution and participation should be measured as a continuous variable instead of a simple yes or no (Arnstein 1969).

Asset ownership, access to credit, and workload were not significantly associated with our latent variable of empowerment. We suspect that the threshold to be empowered in terms of asset ownership was very low. As long as a woman owned any good besides chickens, non-mechanized equipment, or small durable goods, she was considered empowered. Over 99 percent of our population was empowered by this standard, so there was not enough variation in our sample for it to pick up on the potential influence of owning assets. Similarly, about 99 percent of our population was not empowered via credit. Women were considered credit empowered if they had a choice to take out a loan or if they had any influence over what happened to the money that came from a loan. However, this measure only applies to people that have taken out a loan, which may signal that their household had faced a shock, which is negatively associated with food security. We found that of the women that took out a loan, 83 percent either did not a choice in the matter or say in what happened to the money, indicating that many women have lines of credit taken out in their names without having any control over it. This seems to suggest that increasing microcredit access may have negative consequences for women if supplemental policies do not also ensure that women can control the money from the loan.

Women's Income and Food Security

Women's income, her control over it, and her level of education have a similar and positive effect on food security. However, after including the interrelationships between pathways, income becomes less associated with food security, indicating that women's income

has negative tradeoffs. In particular, the more income a woman makes the less influence she has over decisions over income. Even though this commonly not the case in many western contexts (Blood and Wolfe 1960), it is in India where men control income, regardless of who earns it (Kantor 2003). Kantor (2003) found that women were allowed to keep small amounts of money, but as they started to earn more, their husbands controlled it. Kantor hypothesized that the sector in which a woman worked also influenced whether or not she was able to control her income; if a woman worked in a sector that was traditionally associated with women such as compared to sewing or agricultural sector work, men would control her income. Similarly, Chapter 3 established that women who earn monthly salaries had more control over their income than women who earned daily and weekly wages, which are commonly associated with agricultural work. Future research should focus on which types of jobs or sectors are most associated with control over income.

Additionally, we found that women who earn higher incomes also have higher unpaid labor responsibilities. We would have expected that as women work more in the paid labor sector that their unpaid labor responsibilities would decrease or at least stay the same. However, the more time a woman spends doing paid work, the more unpaid labor she also does. A similar study in the United States found that married mothers who work do about 32 extra minutes of housework a day compared to unmarried women (Pepin et al. 2018). They suggest that women's time becomes a "shared household resource" because "marriage remains a gendered institution that ratchets up the demand for housework and childcare through essentialist beliefs that women are naturally focused on home and hearth" (Pepin et al. 2018, pg. 110). Women in India face similar cultural and social norms where women are often identified as mother and wife. This finding indicates that women are not necessarily rewarded with less housework when they work.

Therefore, policies that focus on women's empowerment through cash-earnings activities may actually undermine the goal because women do not necessarily gain more control of their incomes and lighten their unpaid labor load.

Tradeoffs within women's time allocation

As women spend more time doing unpaid domestic chores and agricultural labor, there is a negative association with food security. This is the only pathway that has a negative consequence for food security, indicating that women's time on unpaid tasks is not contributing to food security. Domestic drudgery, beyond cooking and tending to children, is distracting her from her ability to provide higher food security for her family. Many have called for reducing the burden of domestic chores for women (e.g., Quisumbing 1995). One unexpected way to reduce women's unpaid work burden is to have more reserved seats for women on village councils. The more seats that were reserved for women, the less time women did unpaid work. Chattopadhyay and Duflo (2004) explain that this could be because women support projects that are important to women, including infrastructure to minimize the work burden of women. In 1993, India passed a law that required one-third of all village councils and Presidents be women. Despite benefits at the local level, a more recent bill to reserve seats in the Lower House of Parliament was introduced in 2008 and is still pending (Nanivadekar 2006). Perhaps more representation of women in the legislature would encourage more funding for initiatives that are important to women and laws that reduce their discrimination, it may also empower women.

Policy implications

As we look for ways of achieving the United Nation's Sustainable Development Goals of zero hunger and achieving gender equality, we will need to continue to have a gender-sensitive approach that recognizes the many ways women contribute to food security and acknowledges

how much women are overextended. However, many interventions aim at expanding women's participation in the formal workforce because of the "multiplier" effect, arguing that women will spend more on food and health than male counterparts (Akter et al. 2017, Appendix A).

Initiatives that promote women's economic empowerment have become an increasingly popular response to structural problems and gender inequity faced by women. Many multilateral organizations, nonprofits, and national governments have adopted programs encouraging women to join the workforce and called for reduction of barriers to participation (Akter et al. 2017, Appendix A). The logic behind many of these programs suggests that as women earn more money they will not only spend more on their families, but that they will also become more empowered. The implicit assumption within these policies is that as women earn more income, they will have more control over it. However, we find that this is not the case—the more women earn, the less influence they have over their income. Therefore, any policies that encourage women to work more for her own empowerment may undermine that goal as well as food security goals. Additionally, as women earn higher incomes, their unpaid work burdens do not decrease, they increase, suggesting that as women work more they face additional burdens that may additionally limit food security.

Many structural barriers in India impede a woman's ability to convert resources into empowerment outcomes like a difference in marriage age between men and women, social stigma of divorce, and women's dependence on men to carry out public activities (Kantor 2003). The assumption that participating in the workforce will lead to empowerment can have negative consequences for women. Women are already time constrained due to cultural norms associated with unpaid and often undervalued responsibilities like homemaking, tending to children, and agricultural tasks. Given that women often have fewer assets, skills, social networks, and time

compared to male counterparts, the burden of alleviating rural poverty through "economic empowerment" falls on the most disenfranchised. Many programs that encourage economic empowerment recognize the inequalities and obstacles women face and suggest that these issues should be addressed. However, unless these issues are first resolved, encouraging women to work within these unfair structures validates them and encourages the status quo.

CONCLUSION

We used structural equation modeling to quantify how women influence food security and the potential tradeoffs and feedbacks between activities. We found that women's influence over decisions, women's income, and level of education were all positively and similarly associated with food security. Reserved village council seats for women were positively associated with food security, but to a much lower extent. Time doing unpaid labor was the only pathway that was negatively associated with food security.

Women's influence over income was the strongest pathway through which women could influence food security. Unlike what is often suggested in "economic empowerment" initiatives, women's decision over income did not increase with higher incomes. Though, women's education was associated with both higher decision-making and food security. A woman's education and her decisions over income are mutually reinforcing and together have a much stronger association with food security than the amount of income she earns.

Even though women's income was positively associated with food security, its effect was dampened when incorporating feedbacks between decision over income and time spent on unpaid labor. Women's incomes were negatively associated with influence over decision-making, indicating that as women earn more money, they will not necessarily have more control over it. Also, as women earned more income they also spent more time doing unpaid labor,

which is negatively associated with food security. This means that women in India will not necessarily become more empowered through working more. Therefore, any program advocating for "women's economic empowerment" may undermine goals of empowerment if additional measures are not taken to ensure that women control the money that they earn. Future research should seek to understand what kind of support women need to control their incomes and use randomized control trials to test how different interventions affect women's level of influence over the budget and how resources are allocated. Additional efforts should be given to improving retention rates of young women in India, including financial incentives for girls who stay in school and making menstrual products more widely available (Oster and Thorton 2011). Documentaries like Period, which recently won an Academy Award, highlight the importance of menstruation products in changing school attendance of young girls.

Given that unpaid labor has negative consequences for food security, future policy initiatives should seek to minimize the drudgery of women. Technological fixes are not enough; though they make women's work more efficient in the short-term, larger interventions are needed to change the cultural norm of housework being a woman's domain. One strategy that has already been employed is electing women to village councils, and enforcing laws reserving seats for women. Villages with more reserved seats for women at the have higher food security and women spend less time on unpaid labor. Since council women are interested in issues that are important to women, they are more likely support infrastructure projects that reduce women's drudgery. Even though the law was changed in 1993 to reserve seats for women on village councils, the bill to reserve seats for women at the national level has still not been approved after 10 years. If women in reserved seats have positive impacts at the village level, it is likely that more women elected to the federal level would result in positive impacts for women nationally.

With more women in elected office more gender-sensitive initiatives can be mobilized and women may be better positioned to become more educated and empowered to ensure their families' food security.

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CHAPTER 5

Conclusion

Despite progress in addressing food insecurity, as measured by indicators like poverty reduction, economic growth, and self-sufficiency in food grains, India is home to a quarter of the world's food insecure people (World Food Program 2019). Food security, and particularly seasonal food insecurity, is likely to worsen with increased climatic shocks, like changes in precipitation and temperature. Natural resource dependent people in rainfed regions of India are particularly vulnerable to shocks and food insecurity. Addressing the "Indian Enigma," or the phenomenon of economic growth without concomitant food security, has puzzled researchers and development agents but remains urgent.

Women are often portrayed as the "key to food security" given the multiple ways that they increase food security within the household (Quisumbing 1995). Given the strong relationship between food security and gender equality, development agents and researchers are calling for a more gender-lens to be applied to food security (Rao et al. 2017). Similarly, many government programs and nonprofit initiatives are lauding benefits of "women's economic empowerment," and encouraging women to join the formal workforce as a means of improving food security and gender equity (Appendix A). This dissertation contributes to this gap in the literature by analyzing the dynamics of how women's empowerment and workload contribute to household food security. It also challenges the dominant narrative: when women earn incomes their families' food security and her empowerment increase. Within our study population of1,200 households, we found that women's decision-making was much more important to food security than earning higher incomes, and that that higher incomes were negatively associated with increased decision-making and empowerment.

We find that income diversity for men and women yield different results for food security. When women are employed in nonfarm labor, their household's food security benefits and there is only a marginal effect for men's nonfarm labor. When women in the household work more jobs in a month there are negative consequences for food security, but the number of jobs men do does not affect food security. These findings suggest that when women work more, it is not always associated with increased food security. A gendered-lens of income diversity indicates that the sector she works in and how many jobs she does at the same time both influence food security.

After recognizing that higher income diversity or more income streams at a time, does is not always associated with better food security outcomes, we tested whether higher incomes for women was associated with higher food expenditure, which is highly correlated with food security. We found that the level of income a woman earns does not have any association with food expenditure. However, we did find that when women control household incomes, much more is spent on food. Surprisingly, we found that earning higher incomes is not associated with more decision-making over the income. In fact, the more women earned, the less influence they had over their household budgets. We found that education and asset ownership were positively associated with decisions over income, confirming that women influence food security beyond the incomes they could earn.

Recognizing that women can limit their families' food security in a number of ways and have limited amount of resources, time, and energy, we quantified and compared the different pathways to determine how women could most efficiently impact food security. We found that influence over budgets was the most important pathway which was promoted by higher levels of education and asset ownership. In fact, female education had positive direct benefits for food

security and reinforced influence over decision-making, suggesting that female literacy efforts can have wide reaching impact. We also found that when women earn higher incomes not only does it not come with additional influence over the budget, it also does not reduce unpaid labor burdens. When women earn incomes, they still have to complete a litany of domestic chores that are unpaid and undervalued. Because of this, women who work in paid jobs have less leisure time, which is associated with self-efficacy and ultimately empowerment.

Overall, these findings suggest that economic empowerment is not a sufficient solution to increasing food security, reducing gender inequality, and empowering women. This approach puts the onus of poverty alleviation and rural development on a group of people who are already disenfranchised. Although it is a worthy cause to endow individual women with skills and resources to increase decision-making within her family, it is more important to change the structural barriers that prevent women from becoming equal decision-makers within the household. Seemingly magic-bullet solutions like micro-finance have not increased women's decision-making control in India and instead created more opportunities for women to go into debt. Instead, traditional approaches of increasing education for women and changing the legal status of women to inherit property are important for changing the status quo. However, even larger social change is required. Future research and policy should seek to better understand how to keep money in the hands of women and increase her decision-making power. Perhaps instead of focusing on how women can change the status of women, it is time to work with men to change cultural expectations. Men, and especially fathers of daughters, may also be a key demographic to target as potential advocates for social, cultural, and legal change so that efforts to improve gender equity can occur across multiple channels.

APPENDICES

Appendix A:
List of Multilateral Organizations, National Aid Initiatives, Nonprofits, and Programs

Listed here are multilateral organizations, national aid initiatives, nonprofits, and India-specific programs that have promoted and supported women's economic empowerment, encouraging women to join the workforce and reducing barriers to participation.

Multilateral

UN Women works to make the sustainable development goals centered on women a reality. By supporting inter-governmental bodies, providing financial support countries, and lead UN work on gender equality they try to improve the economic status of women. A cohort of this is Commission on the Status of Women. The commission is a global intergovernmental body solely focused on improving the gender equity of women that adopts multi-year programs of work to make further recommendations and accelerate action.

United Nations Development Program works to improve women's economic livelihoods by reducing women's unpaid work, developing and implementing gender-sensitive budget processes, and ensuring women's equal access to decent employment, resources, and finance. Partnered with UN Women and UNCDF to launch the Inclusive Economic Local Development Initiative. This initiative is aimed helping the private and governmental sector unlock barriers to women's economic empowerment.

The World Bank, the National Rural Livelihood Mission is aimed at mobilizing rural women in SHGs and creating access to loans. The World Bank supports this program with a budget of $1 billion. National Rural Economic Transformation Project is working to promote women-owned and women-led farm and non-farm enterprises. The Bihar Rural Livelihoods Project has mobilized more than 7 million women into SHGs. The Global Facility for Disaster Reduction and Recovery works to empower women after disasters through ensuring joint accounts in both husband and wife's names, equal property owning rights , participation in consultations with rebuilding work, and construction of toilets to protect women in giving them a private space.

The International Monetary Fund has five goals concerning women empowerment they are working towards. They support increasing female labor force participation, financial inclusion of women, pushing policy considering gender budgeting, and building on gender research along with inequality research.

National Aid Initiatives

The United States Government's Women's Global Development and Prosperity Initiative aims to reach 50 million women in the Global South through private-public partnerships, US government activities, and a fund at USAID by 2025.

USAID is a United States organization of aid from the American people to help global progress in realizing women's economic empowerment. It believes in advancing vocational vocational education, promoting entrepreneurship, and removing legal and cultural barriers that constrain

women. It partners with Girls Rising ENGAGE, SPRING Accelerator, Women and the Web Alliance, The Half the Sky Movement, and Women and Girls Lead Global.

The Overseas Private Investment Corporation is a US agency that supports business investing in the developing world. OPIC created the 2X Challenge which has a budget of $3 billion dollars supported by the U.S., the U.K., Canada, France, Japan, and Germany to economically empower women in the developing world.

Irish aid partners with International Land Rights Coalition to support equalizing women's rights to land in the developing world. They also support agricultural programs in multiple countries to increase women's livelihoods.

Japan International Cooperation Agency is a Japan governmental organization that works to support security and equity. They believe in the results of field-based work and are currently supporting/implementing training of female police officers in Afghanistan, gender training for agricultural based married couples in Kenya, and helps finance the Japan ASEAN Women Empowerment Fund.

The European Union believes women working leads to economies growing. They have partnered with UN Women to implement WeEmpowerAsia to increase private sector employment of women in China, India, Indonesia, Malaysia, Philippines, Thailand and Viet Nam. This program is part funded by their Partner Instrument budget. Programs they have already implemented included Win-Win in Latin America and We Empower.

Nonprofit Organizations
Heifer International is a US based non-profit organization that works to build incomes within communities. Women empowerment is a key piece in their work as they have multiple projects globally working to build gender equity and increase women income. They are partnered with multiple large-scale companies and over %75 of funding goes directly to projects on the ground.

Empower Women works to give women and men resources to become advocates for women economic empowerment. It is an online platform created by UN Women and Canada to help spread programs for women economic empowerment on a global scale.

CARE helps women achieve economic empowerment through financial inclusion, entrepreneurship, dignified work, inclusive value chains, and rebuilding livelihoods after emergencies. CARE works globally in over 14 countries. CARE is funded by private donors, and many multilateral and bilateral partners.

Women Deliver is a global advocacy group. Try to influence policy to invest in access to credit, SHGs, protection systems to enable women to enter workforce, create economic policy recognizing women's unpaid house labor, and invest in women’s Small and Medium Enterprises. Some of their supporters include Johnson & Johnson, Bill and Melinda Gates Foundation, Ministry of Foreign Affairs of Denmark, and Canada.

Center for Global Development works to inform policy makers with evidence to improve global development. They are researching micro level interventions with savings and business trainings for women. They are funded by grants, and corporate and individual contributions.

African Women's Development Fund is a grant making foundation that supports organizations aimed at improving women empowerment at a local, national, and global scale. AWDF supports initiatives aimed at increasing economic activity.

The Global Fund For Women works to create a global network of advisor and partners to empower the most marginalized women in the world. It is launching a collective effort to increase women economic power with multiple partners. This effort is funded by a $2.1 million greatn from the Bill and Melinda Gates Foundation.

Gates Foundation believes women's economic empowerment is a transformative process to enable women and girls to achieve power, voice, and choice at home and to have economic skills, resources, and opportunities available to them to benefit from economic gains. Women's economic empowerment can be achieved through access to income assets, control and benefit from economic gains, and power over decision making.

Bloomberg Philanthropies works to improve vocational training and skills by partnering with Women for Women NGO. Supports Relationship Coffee Institute to train smallholder farmers in Rural Communities. Partners with the NGO Nest to build market access for women. Partners with Library For All and Imbuto Foundation to work on improving reading and literacy for women. Invested in Equal Footing to increase technology access for women.

BRAC is a Bangladesh originated and now global NGO that aims to create opportunities for people living in poverty. They seek to improve community and women empowerment through building community institutions, strengthening local government, stopping violence, and increasing access to information.

Pradan is an India based NGO that works to bring women to SHGs and increase food security. They take a grassroots approach by teaching and training women. They also work to increase the income of women and are funded by Indian state governments, international organizations, foundations, and personal donors.

Samaj Pragati Sahayog is an Indian based organization that strives to improve livelihoods for Indian farmers. Kumbaya is a project that teaches women skills through creating garments to improve their economic status. They also have agricultural projects and SHG projects on the ground.

The International Center for Research on Women is a global research institute that works to inform policy and strategies for gender equity. WGCD Learning Agenda is an ongoing research project concerning women economic empowerment and ICRW has 17 finished research projects in the Global South. They are funded by multiple globally organizations and donors.

National Programs in India

Government of India: Ministry of Women and Child Development works to create democratic policy, plan programs, and ratify international conventions dealing with equal rights of women. For women and the economy the focus is designing and implementing macroeconomic policies and institutionalizing their participation.

Central Silk Board is within the Ministry of Textiles in the Indian Government. It works to maintain India as the leading producer of silk. They started implementing in 2016 the Catalytic Development Programme that works to increase rural employment, income distribution, and women empowerment. They are funded by the government of India.

National Commission for Women is an Indian governmental organization created by the National Commission for Women Act 1990. The commission reviews legislation to secure the rights of women and enforce laws.

The Self Employed Women's Association is a union of women laborers within India that are a part of the unorganized sector. They work to set up women with permanent employment to receive benefits and security. They provide savings opportunities, credit, health care, legal aid, insurance, and child care to working women.

Bharat Rural Livelihoods Foundation (BRLF) is a society set up by the government of India to advocate for society action. They support multiple projects to increase the livelihoods of farmers in India. Programme on Women's Economic Social and Cultural Rights is an Indian based organization that has an international initiative to work on gender based economic issues. They conduct research and provide advocacy for implementing government commitments.

Appendix B: Household Survey Collected Monthly from November 2016- 2017

Village ID	HH ID	Respondent name(s):	Age:	HH Phone number

Cash and in kind expenditure last month (household)

Items	In kind	Cash value of in kind (Rs.)	Cash value (Rs)	Items	In kind	Cash value of in kind (Rs.)	Cash value (Rs)
Raw food				Agricultural inputs			
Education				Domestic energy			
Medical expenses				Bribes/fines			
Asset creation				Consumer durables			
Veterinary costs				Social & cultural			
Fodder/feed				Loan repayment			
Other				"Other" details:			

Access to credit in last month (women and men)

Lending source	W: Access (1-3)	W: taken loan (1-4)	W: decision to take loan (1-4)	W: discretion over income (1-4)	Man: Access (1-3)	Man: taken loan (1-4)
NGO						
Formal (ex. bank)						
Informal (ex. money lender)						
Friends or relatives						
Group based micro finance (SHG)						
Other						

Access: 1=Yes; 2=No
Taken loan: 1=Yes, cash; 2= Yes, in kind; 3=Yes, cash and in kind; 4=No
Decision/Discretion: W=self (woman); M=spouse (man); 3=other household member; 4=other non household member

Income Sources from last month (household)

Income Activity	# W in hh	# M in hh	# people non hh	Amount received (in kind)	Cash value of in kind (Rs.)	Cash Salary (Rs.)	Gap (days btwn ended to paid)	Frequency (0-5)	W: Input activity (0-3)	W: Input income (0-3)

Frequency: 0= Never; 1=One time ever; 2=Once a month; 3=More than once a month; 4=Once a week; 5=More than once a week; 6=Daily
Input: 0=No decision made; 1=No input or input in few decisions; 2=Input into some decisions; 3= Input into most or all decisions

Household assets (household)

Asset	Number	Ownership	Asset	Number	Ownership
Rooms (mud)			Bicycle		
Rooms (cement)			Private 2-wheeler		
Water tank			Private 4-wheeler		
Private toilet			Generator		
Television			Commercial vehicle		
Bullock cart			Sim cards		

Ownership: M=man owns; W=woman owns; B=jointly owns

Livestock assets in last month (household)

	Stall-fed (#)	Grazed locally (#)	Migratory (#)	Ownership (1-3)
Cow & bull				
Breeding bull				
Buffaloes				
Goats				
Sheep				
Breeding ram				
Poultry				
Camels				
Pigs				

Ownership: M=man owns; W=woman owns; B=jointly owns

Agricultural assets in last month (household)

Asset	Personal (#)	Own. (1-3)	Share (# times)	Rent (# times)	Asset	Personal (#)	Own. (1-3)	Share (# times)	Rent (# times)
Plough					Dugwell				
Bullock					Borewell				
Tractor					Power tiller				
Thresher					Pumpset				
Sprayer					Irrigation pipe	N=0 Y=1			
Happas									

Ownership: M=man owns; W=woman owns; B=jointly owns

Garden/other food resources

If you have a kitchen garden, fruit trees, creepers or and other sources of food that is not on a farm plots:	
What foods are growing in your garden?	

Percent of natural resources used (not collected) in last month (household)

	Self Provision (%)	Commons (%)	Purchased (%)	Other private lands (%)	Total & unit
Fodder					
Feed					
Grazing					
Firewood					
NTFP					
Timber & construction					
Irrigation Water					
Drinking Water					
Dung collection					

Non-Timber Forest Products from the commons in last month (household)

NTFP	Not Used=0; Used=1	NTFP	Not Used=0; Used=1

Value of Commons in last month (household)

	Replacement difficulty (1-5)	Cost to replace (Rs.)
Common lands, not cultivated		
Privately owned commons, sometimes cultivated		
Surface water bodies		

Replacement difficulty: 1 =Very easy; 2= Easy; 3=Neutral; 4 = Difficult; 5=Very difficult

Foods eaten in the last 24 hours (woman and man)

	Food item	Who ate it?	Garden (%)	Other self grown (%)	Other (%) private resource	Forest & grassland (%)	Water bodies (%)	PDS (%)	Open Market (%)	Barter/ (%) local exchange
1										
2										
3										
4										
5										
6										
7										
8										
9										
10										
11										
12										
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38										

Who ate it?: B=both; M=man only; W=woman only

1) Ask woman to recall all foods eaten in last 24 hours and list them
2) Ask woman where all of the foods came from
3) Ask man to recall all foods eaten in last 24 hours. If the same as a woman, mark 1 in "who ate it?" If not, add the food item to the bottom of the list. At the end, ask where the food came from.
4) Follow up and ask the man if he ate any of the foods mentioned by the woman that he did not mention. If he has, add a 1 to the column and if not, add a 2 to that column.
5) Ask the woman if she ate any of the foods listed by the man. If she has, add 1 to column and if she

Food Frequency in the last 7 days (woman and man)

Food item	Type	#times woman ate	# times man ate	Garden (%)	Other self grown (%)	Other (%) private resource	Forest & grassland (%)	Water bodies (%)	PDS (%)	Open Market (%)	Barter/ (%) local exchange

Type: 1=Orange, red, yellow, white fleshy fruit: 2= Green leafy vegetables: 3= milk and diary products; 4=Veg protein (pulses, nuts); 5= Non-veg Protein (meat, fish, or egg)

Household Food Insecurity Access Scale (women)
1) In the past four weeks, did you worry that your household would not have enough food?

2) In the past four weeks, were you or any household member not able to eat the kinds of foods you preferred because of lack of resources?

3) In the past four weeks, did you or any household member have to eat a limited variety of foods due to lack of resources?

4) In the past four weeks, did you or any household member have to eat some foods that you really did not want to eat because of a lack of resources to obtain other types of food?

5) In the past four weeks, did you or any household member have to eat a smaller meal than you felt you needed because there was not enough food?

6) In the past four weeks, did you or any household member have to eat fewer meals than you felt you needed because there was not enough food?

7) In the past four weeks, was there ever no food to eat of any kind on your household because of the lack of resources to get food?

8) In the past four weeks, did you or any household member go to sleep at night hungry because there was not enough food?

9) In the past four weeks, did you or any household member go a whole day and night without eating anything because there was not enough food?

Question	No=0; Yes=1	Frequency
1		
2		
3		
4		
5		
6		
7		
8		
9		

Frequency: 1= Rarely (once or twice in the last four weeks)
2= Sometimes (three to ten times in the last four weeks)
3= Often (more than ten times in the last four weeks)

Labor allocation last month (woman)

Activity	# of times/30 days	# hours each day	Further details/description
Cooking			
Washing			
Drinking water			
Fodder collection			
Firewood collection			
Asset maintenance (home, happa)			
Home production (ex., basket, charcoal)			
Dung collection			
Kitchen gardening			
NTFP collection			
Grazing			
Fishing			
MNREGA wage labor			
Migratory wage labor			
Agricultural wage labor			
Skilled wage labor			
Unskilled wage labor			
Irrigation			
Compost management			
Sowing			
Weeding			
Harvesting			
Post-harvest processing			
Leisure			
Sleeping			
Volunteer (SHG, Asha)			

MREGA wage labor is all work that is done under this program
Migratory wage labor is labor outside of the block
Agricultural labor is any labor that involves agriculture, regardless of skill
Skill labor is and unskilled labor is

1. Migratory or Local
∧
2. Agriculture or Non-agriculture
∧
3. Skill or Unskill

Labor allocation last month (man)

Activity	# of times/30 days	# hours each time	Further details/description
Cooking			
Washing			
Drinking water			
Fodder collection			
Firewood collection			
Asset maintenance (home, happa)			
Home production (ex., basket, charcoal)			
Dung collection			
Kitchen gardening			
NTFP collection			
Grazing			
Fishing			
MNREGA wage labor			
Migratory wage labor			
Agricultural wage labor			
Skilled wage labor			
Unskilled wage labor			
Irrigation			
Compost management			
Sowing			
Weeding			
Harvesting			
Post-harvest processing			
Leisure			
Sleeping			
Volunteer (SHG, Asha)			

MREGA wage labor is all work that is done under this program
Migratory wage labor is labor outside of the block
Agricultural labor is any labor that involves agriculture, regardless of skill
Skill labor is and unskilled labor is

1. Migratory or Local
∧
2. Agriculture or Non-agriculture
∧
3. Skill or Unskill

Harvest: Crop yields and where they went (household)

	Crop	Start harvest month	Time of mon	Total yield	Unit	Eaten/ stored to be eaten	Barter & local exchange	Sold in open market	Damaged/ lost	Loan repay.	Stored for seed	Notes:
1												
2												
3												
4												
5												
6												
7												
8												
9												

Time of month: 1= beginning

Appendix C

Scaled Model Outputs for Hierarchical Model of Income Diversity and Food Security at the Household and Gender-Specific Levels

Independent variables in the scaled model are unit-less, which allows for comparison among them. The unscaled household model indicates nonfarm income and number of jobs has the same magnitude and opposite direction of impact on food security (Table C.1; Figure C.1). The Simpson's index was not significant. However, the variables associated with income diversity have a much smaller relative effect on food security as compared to site, season, caste, gender of household head, and whether or not a household farms. Similar to the household scaled models, the variables that were most associated with food security included site, season, caste, female-headed households, and farming households (Table C.2; Figure C.2).

Table C.1. Output table with effect sizes, standard errors and p values from scaled data to measure associations between household-level income diversity and food security, measured with the Household Food Insecurity Access Scale. Data was obtained from 1,200 households in Kutch district, Gujarat; Dewas district, Madhya Pradesh; Palamu district, Jharkhand; and Bankura district, West Bengal from 2016-2017.

Variables	Estimate	Std. Error	Pr(>|t|)	Sig.
(Intercept)	3.46E+00	1.54E-01	< 2e-16	***
Household Income Evenness	2.34E-02	3.60E-02	0.516455	
Percent of Income from Non-Farm Sources	2.20E-02	7.38E-03	0.002877	**
Total number of Jobs within Household	-1.56E-02	9.43E-03	0.098326	.
Total yield (kg)	4.74E-03	5.87E-03	0.42011	
Farming Household (Y/N)	-2.60E-01	7.52E-02	0.000547	***
Crop Diversity	8.85E-02	2.81E-02	0.001617	**
Family Size	5.04E-03	1.24E-02	0.683334	
Proportion of Women in Household	-9.66E-04	1.18E-02	0.934886	
Gender of Household Head (M/ F)	2.63E-01	9.34E-02	0.005083	**
Highest level of education in household	6.07E-02	1.25E-02	1.36E-06	***
Total land (ha)	6.48E-03	1.40E-02	0.643663	
Other Backward Castes	-2.00E-01	5.61E-02	0.000392	***
Scheduled Caste	-2.94E-01	6.34E-02	4.06E-06	***
Scheduled Tribe	-3.23E-01	5.95E-02	7.44E-08	***
Monthly Food Expenditure	1.54E-02	8.45E-03	0.069285	.
Monthly Income	1.61E-02	7.00E-03	0.021693	*
Reliance on Commons	-5.06E-02	1.20E-02	2.39E-05	***
Reserved Seats for Women on Village Councils	1.10E-01	6.53E-02	0.09783	.
Women's Empowerment in Agriculture Score	2.41E-02	9.65E-03	0.012631	*
Number of Distinct Livestock Assets	6.73E-03	1.06E-02	0.525802	
Dewas	-5.31E-01	1.69E-01	0.002405	**
Kutch	5.40E-01	1.93E-01	0.006549	**
Palamu	-9.17E-01	1.72E-01	1.06E-06	***
Rabi	1.48E-01	8.83E-02	0.121298	
Summer	-1.58E-01	8.83E-02	0.098904	.
Rabi * Dewas	-2.18E-01	3.74E-02	5.63E-09	***
Rabi * Kutch	-3.35E-01	4.01E-02	< 2e-16	***
Rabi * Palamu	-2.36E-01	4.11E-02	9.87E-09	***
Summer * Dewas	1.09E-01	3.60E-02	0.002394	**
Summer * Kutch	-8.63E-02	3.85E-02	0.025222	*
Summer * Palamu	-3.21E-02	3.94E-02	0.415172	

Figure C.1. Scaled variables in the household model show how much each variable is relatively associated with household food security, measured with the Household Food Insecurity Access Scale, in rainfed regions of India.

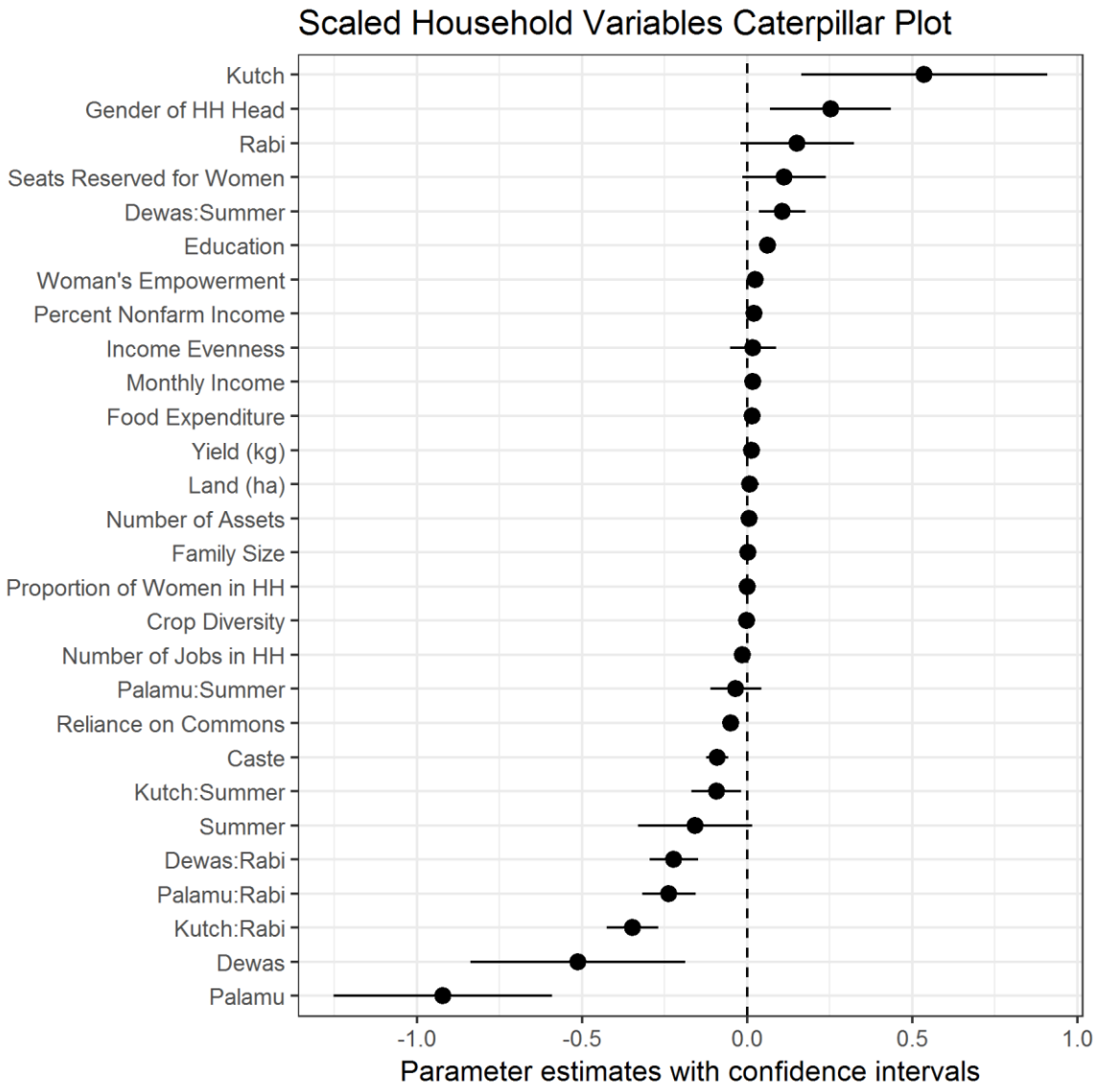
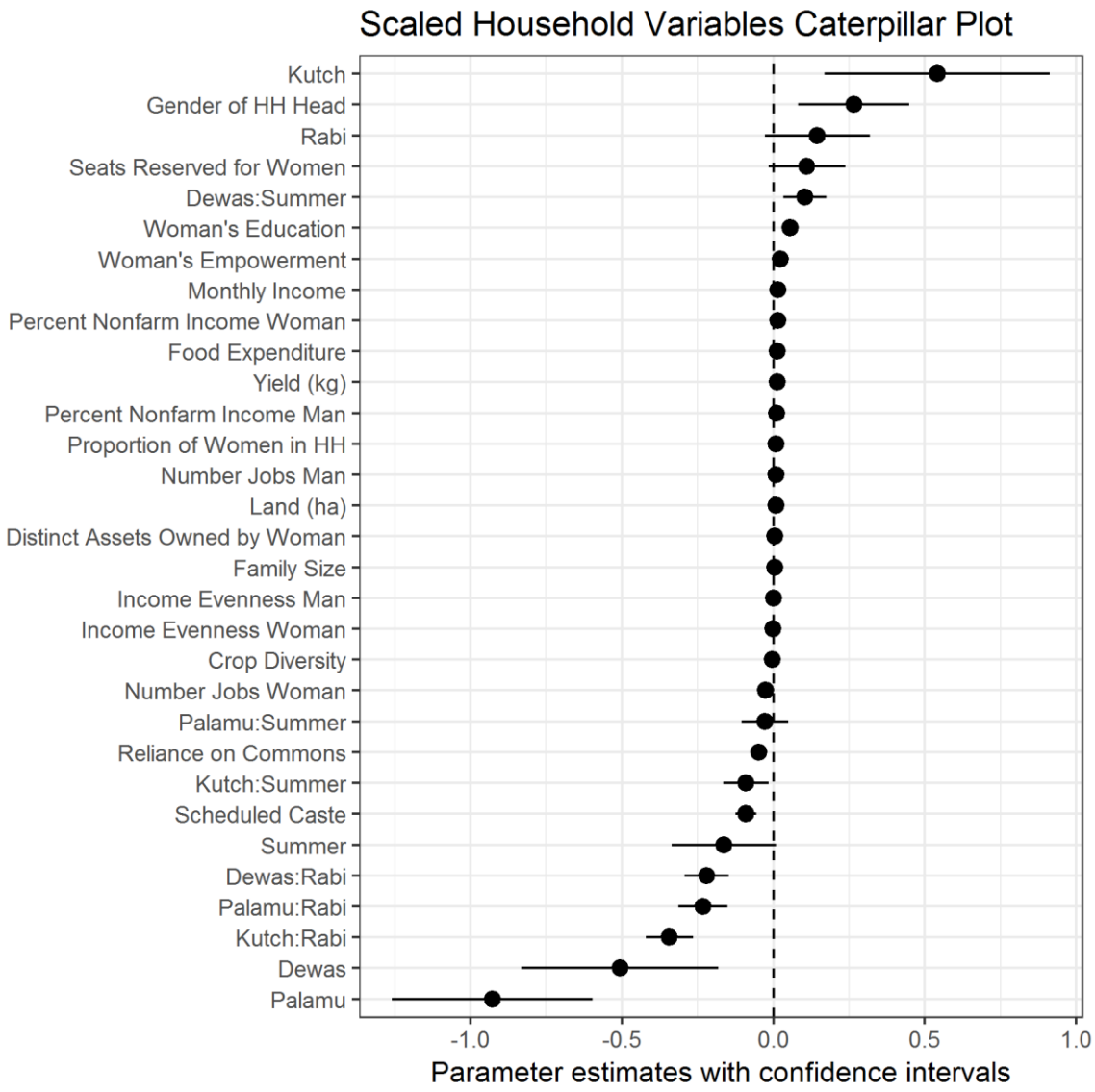


Table C.2. Output table with effect sizes, standard errors and p values from scaled data to measure associations between gender-level income diversity and food security, measured with the Household Food Insecurity Access Scale. Data was obtained from 1,200 households in Kutch district, Gujarat; Dewas district, Madhya Pradesh; Palamu district, Jharkhand; and Bankura district, West Bengal from 2016-2017.

Variables	Estimate	Std. Error	Pr(>|t|)	Sig.
(Intercept)	3.46E+00	1.54E-01	< 2e-16	***
Woman's Household Evenness	-2.66E-04	7.35E-03	0.9711	
Man's Household Evenness	2.75E-03	8.39E-03	0.742901	
Woman's Percent of Income from Nonfarm Sources	1.52E-02	7.09E-03	0.032312	*
Man's Percent of Income from Nonfarm Sources	1.16E-02	7.60E-03	0.126801	
Woman's Total Number of Jobs	-2.65E-02	9.18E-03	0.00386	**
Man's Total Number of Jobs	7.42E-03	9.20E-03	0.419983	
Total Yield (kg)	4.63E-03	5.88E-03	0.431005	
Farming Household (Y/N)	-2.71E-01	7.55E-02	0.000327	***
Crop Diversity	9.13E-02	2.81E-02	0.00117	**
Family Size	7.61E-03	1.22E-02	0.534267	
Proportion of Women in Household	8.56E-03	1.22E-02	0.482711	
Gender of Household Head	2.74E-01	9.36E-02	0.003486	**
Highest level of education in household	5.62E-02	1.26E-02	9.33E-06	***
Total Land (ha)	6.70E-03	1.40E-02	0.632872	
Other Backward Castes	-1.89E-01	5.62E-02	8.33E-04	***
Scheduled Caste	-2.89E-01	6.35E-02	6.13E-06	***
Scheduled Tribe	-3.16E-01	5.96E-02	1.50E-07	***
Monthly Food Expenditure	1.47E-02	8.46E-03	8.16E-02	.
Monthly Income	1.49E-02	7.19E-03	0.038117	*
Reliance on Commons	-4.86E-02	1.18E-02	4.12E-05	***
Reserved Seats for Women on Village Councils	1.09E-01	6.52E-02	0.098341	.
Women's Empowerment in Agriculture Score	2.34E-02	9.91E-03	0.017998	*
Number of Distinct Livestock Assets	7.20E-03	7.47E-03	0.33533	
Dewas	-5.25E-01	1.68E-01	2.64E-03	**
Kutch	5.44E-01	1.92E-01	0.006038	**
Palamu	-9.25E-01	1.71E-01	8.43E-07	***
Rabi	1.42E-01	8.84E-02	1.36E-01	
Summer	-1.64E-01	8.84E-02	0.08978	.
Rabi * Dewas	-2.15E-01	3.73E-02	8.31E-09	***
Rabi * Kutch	-3.31E-01	4.01E-02	< 2e-16	***
Rabi * Palamu	-2.31E-01	4.13E-02	2.31E-08	***
Summer * Dewas	1.07E-01	3.59E-02	0.002787	**
Summer * Kutch	-8.25E-02	3.86E-02	0.032502	*
Summer * Palamu	-2.57E-02	3.95E-02	0.515397	

Figure C.2. Scaled variables in the gender-specific model show how much each variable is relatively associated with household food security, measured with the Household Food Insecurity Access Scale, in rainfed regions of India.



Appendix D
Tables to Show Altonji and Oster Procedure for Unobserved Variable Bias

Table D.1. To calculate variation that would need to be explained by unobserved variables in order to negate the effect of income diversity (as measured by Simpson's index, proportion of nonfarm income and number of jobs) on food security. This table includes random effects.

	Rmax	S	Bo	Ro	B~	R~	B*	S*	R*max:
Inc only-simpson	0.89	0.50	0.04	0.68	0.02	0.69	-0.22	0.05	0.71
Inc only-nonfarm	0.89	0.50	0.03	0.68	0.02	0.69	-0.05	0.16	0.75
Inc only-num jobs	0.89	0.50	-0.02	0.68	-0.02	0.69	0.02	0.22	0.78

Table D.2. To calculate variation that would need to be explained by unobserved variables in order to negate the effect of income diversity (as measured by Simpson's index, proportion of nonfarm income and number of jobs) on food security. This table excludes random effects.

	Rmax	S	Bo	Ro	B~	R~	B*	S*	R*max
Inc only-simpson	0.43	0.50	0.04	0.00	0.02	0.33	0.02	3.87	1.09
Inc only-nonfarm	0.43	0.50	0.03	0.00	0.02	0.33	0.02	12.56	2.81
Inc only-num jobs	0.43	0.50	-0.02	0.00	-0.02	0.33	-0.02	17.76	3.82

Appendix E
Results from Logistic Regression Analysis from Chapter 2

This appendix provides further analysis and explanation of similar models that were found in Chapter 2. The difference is that these results are based on a logistic regression between households that were food secure and those that were not. Specifically, those that were not food secure included those that were mildly, moderately, and severely food secure according to the Household Food Insecurity Access Scale (Coates et al. 2007). In order to evaluate the variables that were most associated with being food secure or not, we ran a logistic regression using the mgcv package in R (Brown 2011). We scaled all variables, or divided them by their standard deviation and centered them, so that the model would more easily converge and interpretation was more straightforward. In using the scaled data, we can compare the relative size of association between the variables and food security. We included a random effect for villages and households since households were nested within villages and village nested within site.

Description of Household-Level Model:

After controlling for all other variables, one standard deviation in nonfarm income and number of jobs is associated with an 18% and 22% increase in the odds of being food secure, respectively. This indicates that both having more nonfarm income and more jobs is associated with higher food security, though the evenness of jobs as measured by the Simpson's Index was not significant. After controlling for all other variables, gender of household head had the largest association with household food security. Female headed households were associated with 197% higher food security than male headed households that were otherwise similar across all other variables. A one standard deviation in household income and land, both measures of wealth, were associated with a 15% and 10% higher odds of being food secure. A one standard deviation of women's empowerment and level of education were associated with 13% and 23% increase in the odds of being food secure. Other significant, positive variables include cash expenditure and the total amount of village infrastructure which were associated with a 72% and 9% increase in the odds of being food secure, respectively.

Surprisingly, a one standard deviation in harvest yield and crop diversity were associated with a 12% and 10% decrease the odds of being food secure, respectively, controlling for all other variables. Similarly, households with a one standard deviation increase in reliance on the commons for natural resource use were associated with a 8% decrease in odds of being food secure. Households that were from other backward castes, scheduled castes, and scheduled tribes were associated with a 30 decrease in the odds of being food secure as compare to those in the general caste. Households with one standard deviation in number of reserved seats for women was associated with a 14% decrease in the odds of being food secure.

The odds of being food secure in Kutch is no different than Bankura once controlling for other variables, even though Kutch has higher food security on average. However, the odds of a household in Dewas and Palamu being food secure are both 97% lower compared to households in Bankura, controlling for all other variables. Kharif, or the second growing season, which is from X to X, is associated with the highest levels of food security. As compared to the Kharif season and holding all other variables constant, the odds of a household being food secure is 14 % lower in the Rabi, or harvest, season and 37% lower in the summer season. The summer season is associated with the highest rates of food insecurity; this lean season is likely due to dwindling food supplies from the previous year's harvest while they wait for the next round of crops to grow.

Table E.1. Logistic Regression model results to evaluate the associations between household-level income diversity and food security as measured by the Household Food Insecurity Access Scale in rainfed regions of India.

	Estimate	Std. Error	z value	Pr(>|z|)	Significance
(Intercept)	0.96088	156.0928	0.006	0.995088	
Income Evenness	-0.0780	0.16586	-0.47	0.638316	
Nonfarm Income	0.16362	0.03055	5.357	8.47E-08	***
Number of Jobs Per Household	0.20103	0.04255	4.724	2.31E-06	***
Total Harvest Yield	-0.1323	0.03823	-3.461	0.000539	***
Crop Diversity	-0.1044	0.03694	-2.827	0.004699	**
Family Size	-0.0355	0.03284	-1.081	0.2798	
Proportion of Women in the Household	0.03305	0.02914	1.134	0.256752	
Household Head Gender	1.08449	0.24893	4.357	1.32E-05	***
Highest Education	0.21006	0.03261	6.441	1.19E-10	***
Total Land	0.0908	0.03403	2.669	0.007617	**
Other Backward Castes	-0.3518	0.03751	-9.38	< 2e-16	***
Food Expenditure	0.54186	0.03424	15.823	< 2e-16	***
Average Monthly Income	0.13854	0.03581	3.869	0.000109	***
Average Reliance on Commons	-0.0814	0.04667	-1.745	0.081058	.
Number of Reserved Seats for Women	-0.1540	0.04473	-3.442	0.000578	***
Women's Empowerment Score	0.12149	0.03588	3.386	0.00071	***
Household Distinct Assets	0.02722	0.04645	0.586	0.557863	
Village Infrastructure	0.0869	0.03833	2.267	0.023373	*
Distance to Road	-2.8089	1477.235	-0.002	0.998483	
Percent Literate Women in Village	-0.035	0.02842	-1.25	0.211363	
Dewas	-3.6097	0.13507	-26.72	< 2e-16	***
Kutch	-0.1445	0.11063	-1.31	0.190049	
Palamu	-3.3723	0.13469	-25.04	< 2e-16	***
Rabi Season	-0.1507	0.07327	-2.057	0.039704	*
Summer Season	-0.4650	0.07373	-6.306	2.86E-10	***

Description of Gender-Level Model:

After controlling for all other variables, one standard deviation in nonfarm income with a 9% and 12% increase in the odds of being food secure, for women and men respectively, after controlling for all other variables. Additionally, a standard deviation in the number of jobs done by men was associated with an increase of 19% increase in the odds of being food secure, holding covariates constant. No other income diversity variables were statistically significant. Similar to the household-level model, household gender had the largest association with food security. Even though female-headed households, on average, had lower food security, once we controlled for all other variables, they had 209% higher odds to be food secure than male-headed households. Similarly, a one standard deviation increase in women's education and women's empowerment score were associated with at 21% and 23% increase in the odds of being food secure, respectively. Other variables related to wealth that were also positively and significantly

associated with food security were monthly household income, land size, food expenditure. A one standard deviation increase in each of these was associated with 21%, 16%, and 73% increase in the odds that a household would be food secure.

Those from other backward castes, scheduled caste, and scheduled tribe were associated with a 32% decrease in the odds of being food secure, after controlling for other variables in the model. The number of seats reserved for women and the number of livestock assets owned by women were also negatively and significantly associated with food security. For a one standard deviation increase in reserved seats for women and livestock assets was associated with a 9% and 27% decrease in the odds of being food secure. The relationships between the sites and the seasons were almost the exact same between the two models.

Table E.2. Logistic Regression model results to evaluate the associations between gendered-level income diversity and food security as measured by the Household Food Insecurity Access Scale in rainfed regions of India.

	Estimate	Std. Error	z value	Pr(>|z|)	Signif.
(Intercept)	2.03221	0.35733	5.687	1.29E-08	***
Women's Income Evenness	0.01243	0.03785	0.328	0.7426	
Men's Income Evenness	0.04956	0.04061	1.221	0.22225	
Women's Percent Nonfarm Income	0.1004	0.03151	3.186	0.00144	**
Men's Percent Nonfarm Income	0.10184	0.03252	3.132	0.00174	**
Number of Jobs Women work	-0.06402	0.04525	-1.415	0.15717	
Number of Jobs men Work	0.13899	0.04585	3.031	0.00243	**
Total Harvest Yield	-0.06147	0.03919	-1.568	0.11677	
Farming Yes/No	-0.84917	0.39263	-2.163	0.03056	*
Crop Diversity	0.22432	0.14673	1.529	0.1263	
Family Size	-0.02708	0.03263	-0.83	0.40667	
Proportion of Women in Household	0.09447	0.03051	3.096	0.00196	**
Household Head Gender	1.07947	0.24821	4.349	1.37E-05	***
Highest Education of Women	0.18483	0.03267	5.657	1.54E-08	***
Total Land	0.1483	0.03455	4.292	1.77E-05	***
Other Backward Castes	-0.38052	0.03624	-10.5	< 2e-16	***
Food Expenditure	0.54101	0.0347	15.59	< 2e-16	***
Average Monthly Income	0.197	0.03741	5.266	1.39E-07	***
Average Reliance on Commons	-0.0184	0.03469	-0.53	0.59584	
No. Reserved Seats for Women	-0.10531	0.04448	-2.368	0.0179	*
Women's Empowerment Score	0.18161	0.03669	4.95	7.42E-07	***
Women's Distinct Assets	-0.30705	0.03852	-7.97	1.58E-15	***
Dewas	-3.53732	0.13773	-25.68	< 2e-16	***
Kutch	-0.29164	0.1196	-2.438	0.01475	*
Palamu	-3.38941	0.12947	-26.18	< 2e-16	***
Rabi Season	-0.17907	0.07399	-2.42	0.01552	*
Summer Season	-0.45544	0.07403	-6.152	7.64E-10	***

Appendix F: Additional Graphs from Chapter 2

Figure F.1

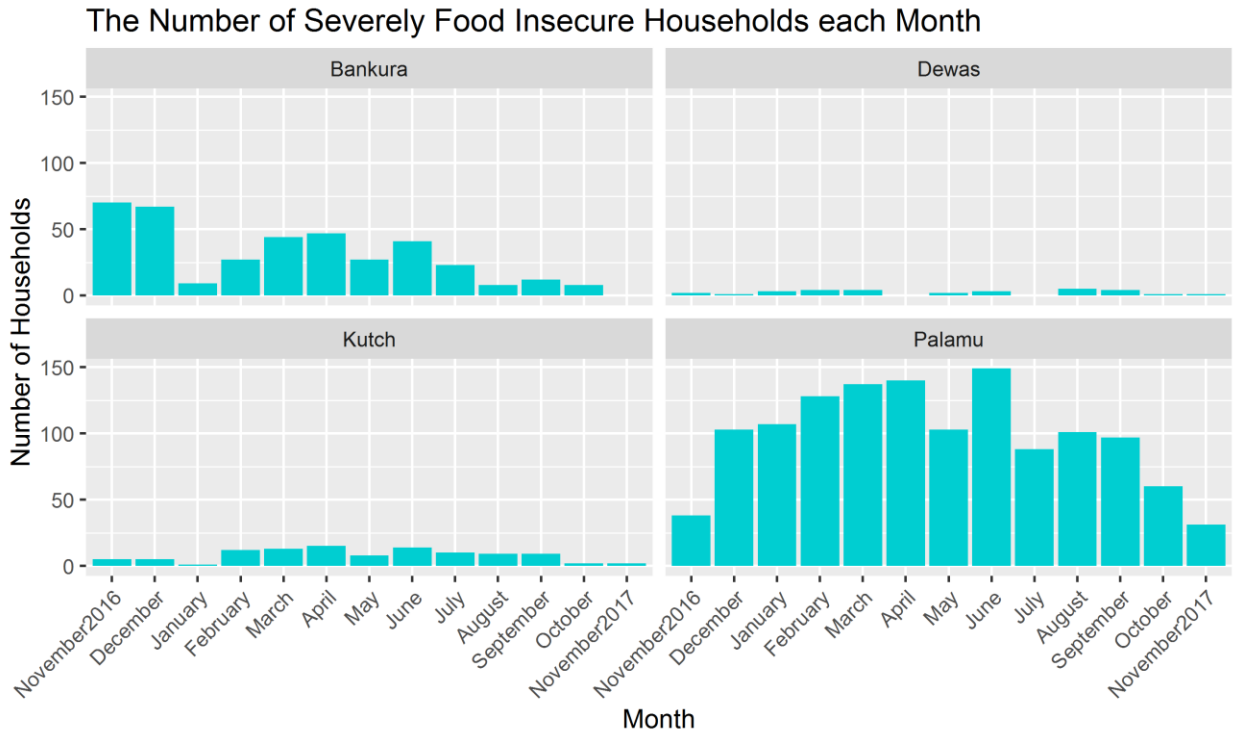


Figure F.2

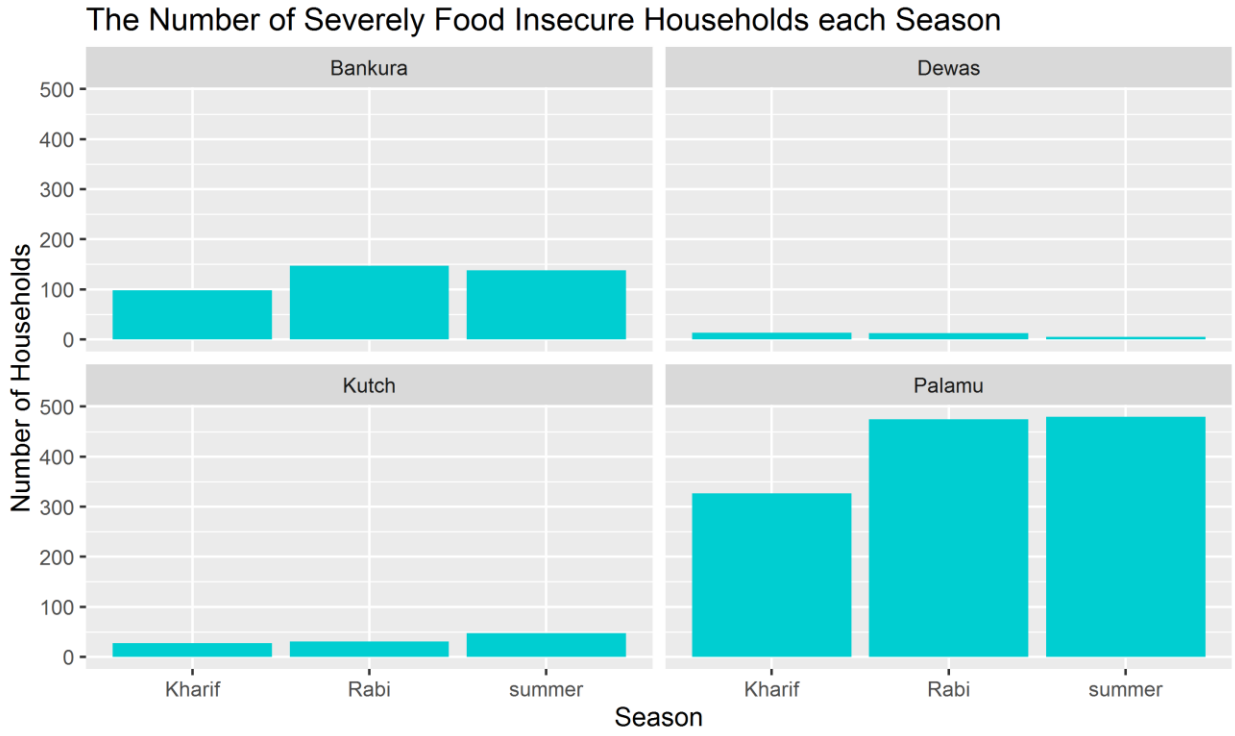


Figure F.3

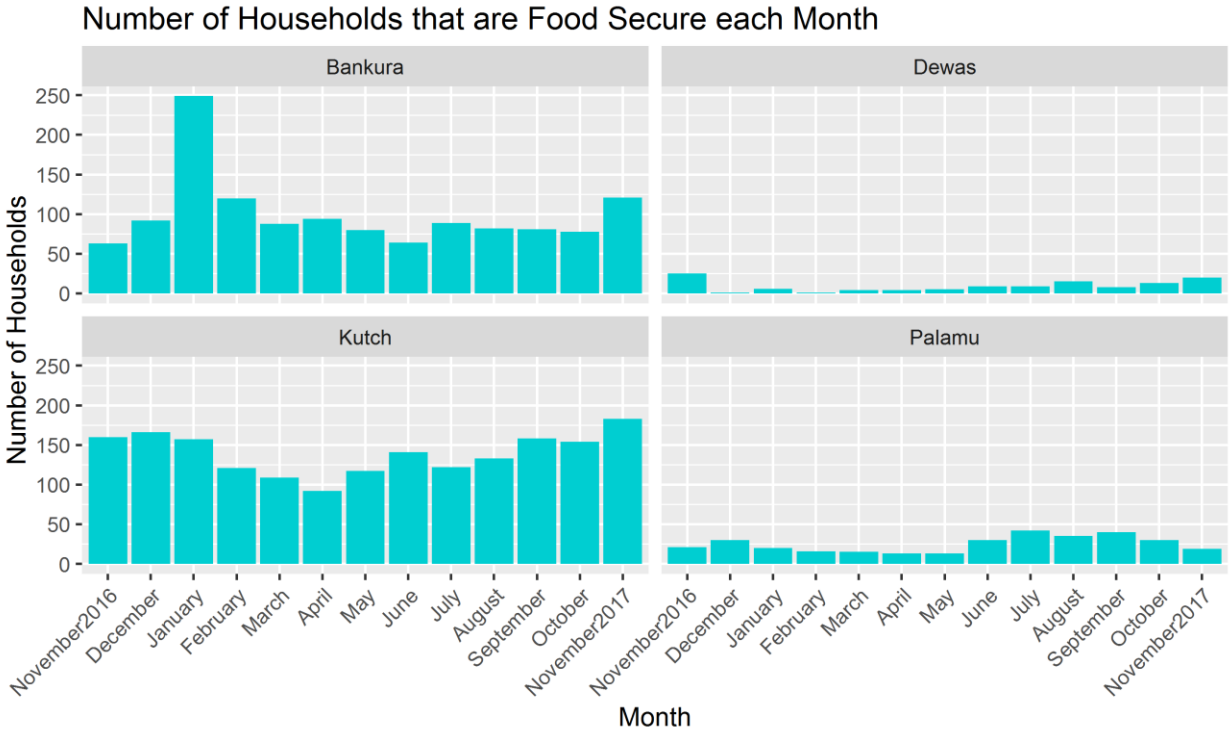


Figure F.4

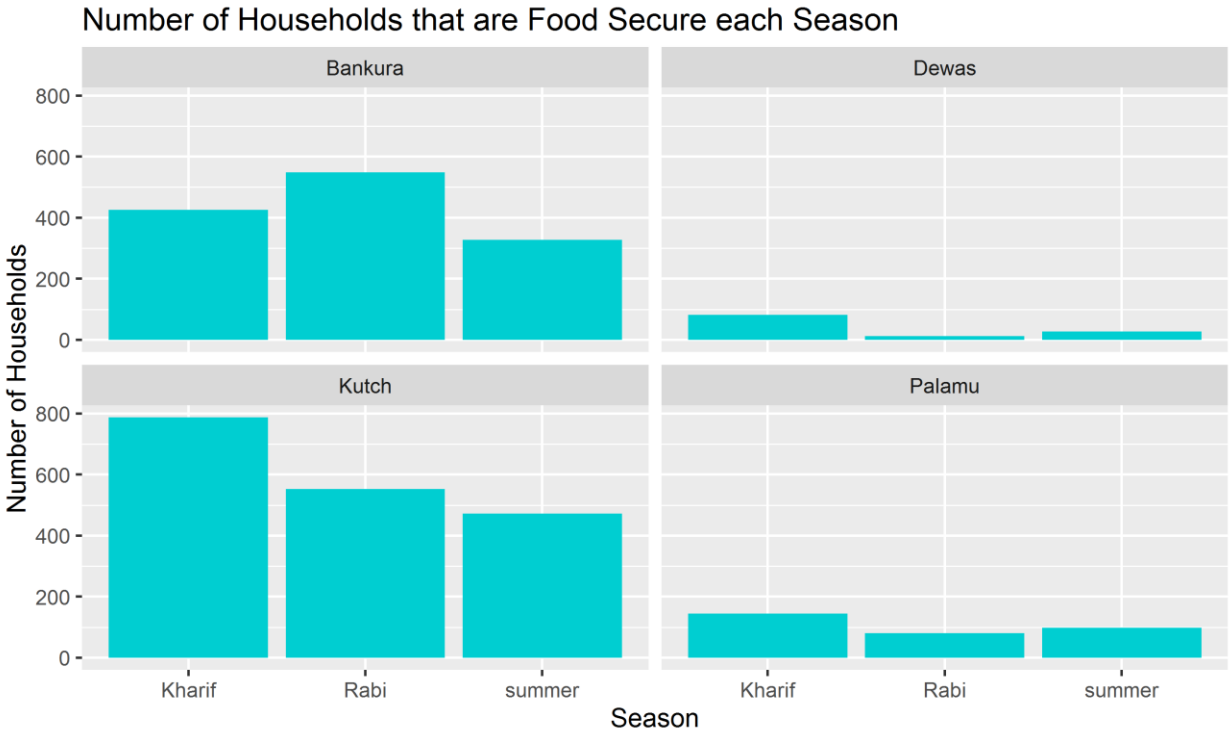


Figure F.5

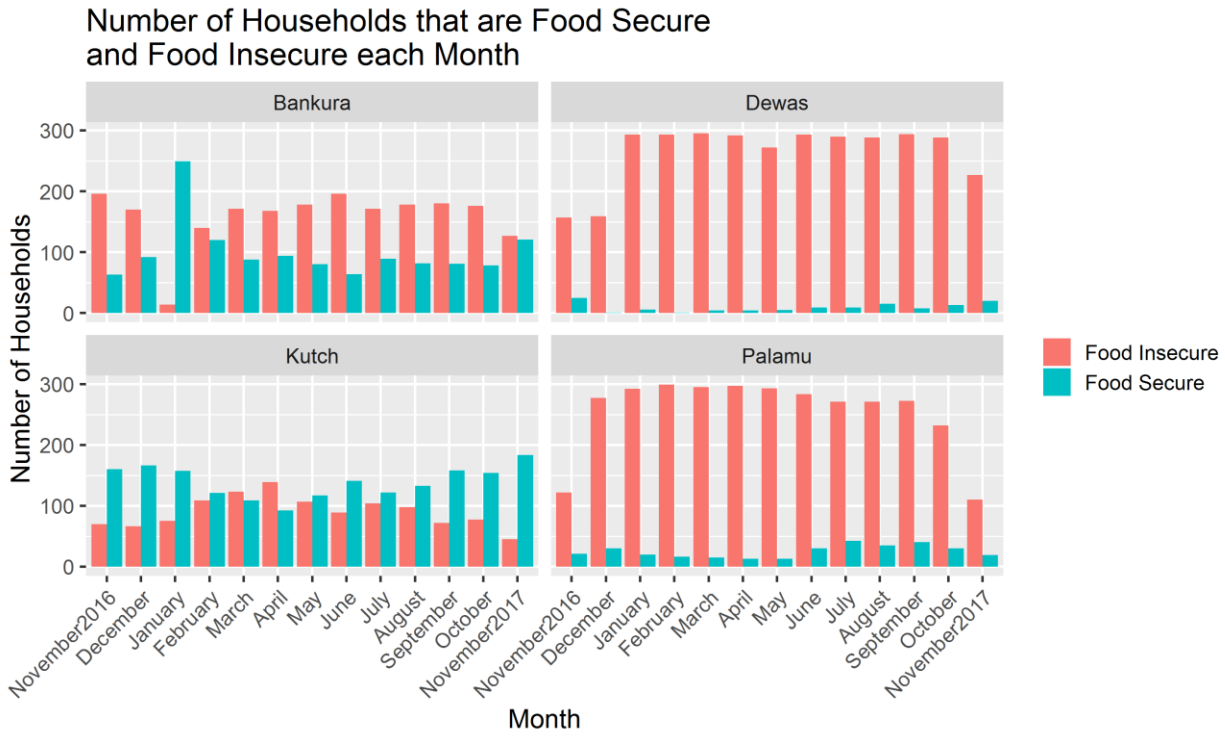


Figure F.6

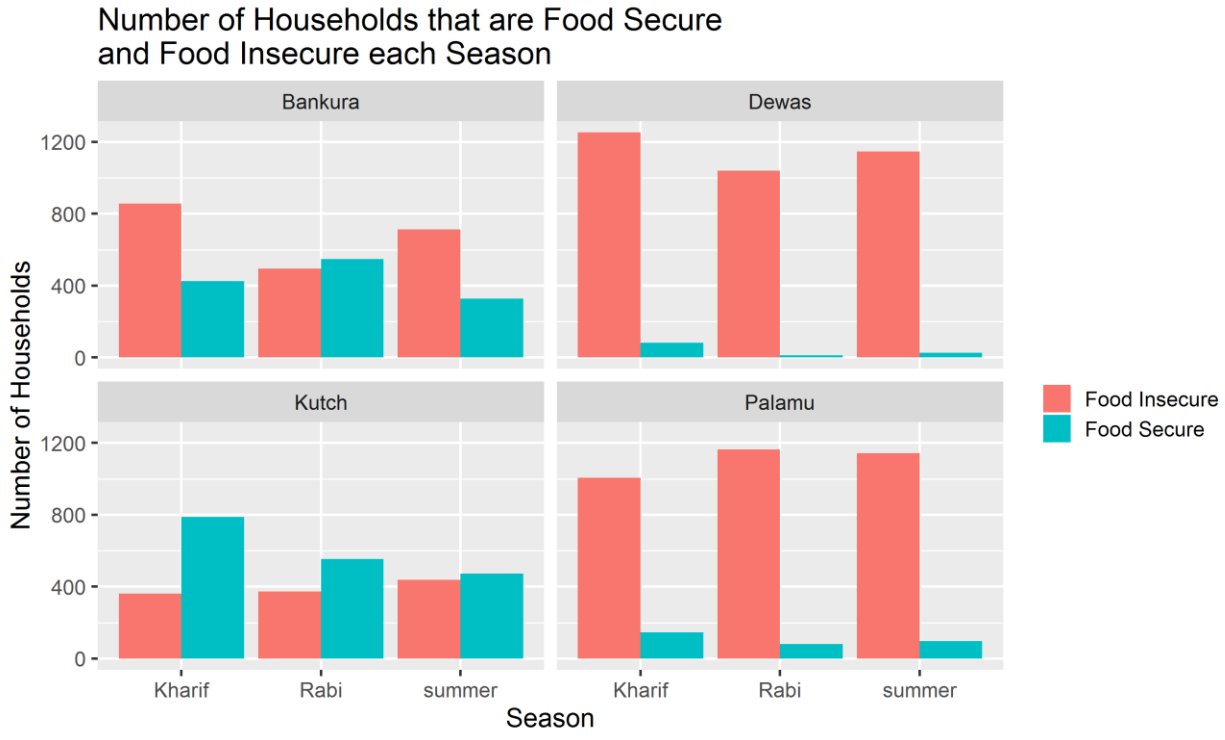


Figure F.7

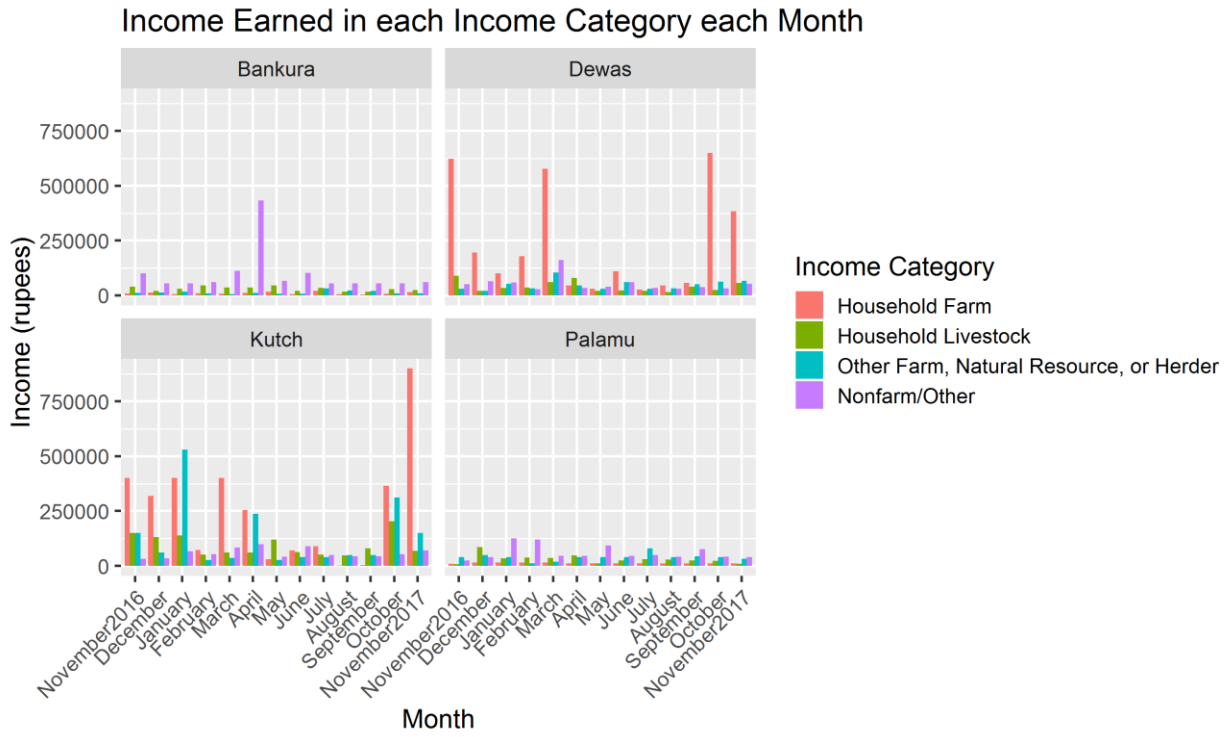


Figure F.8

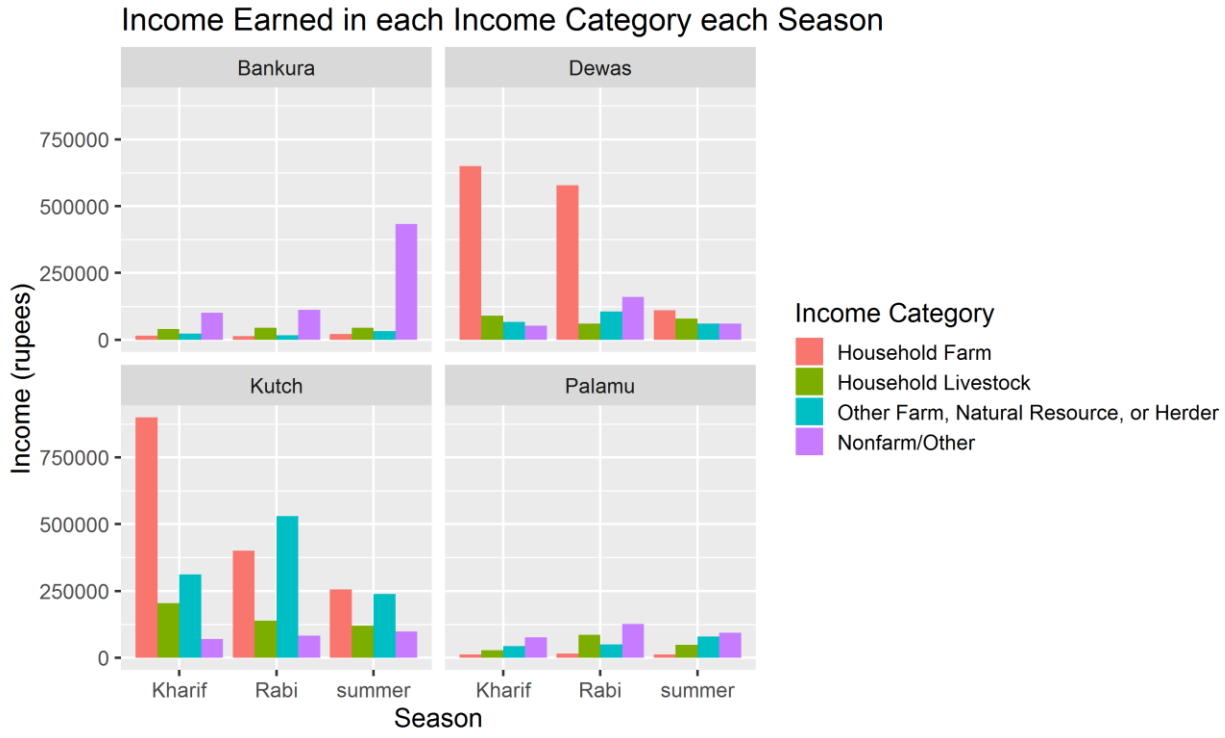


Figure F.9

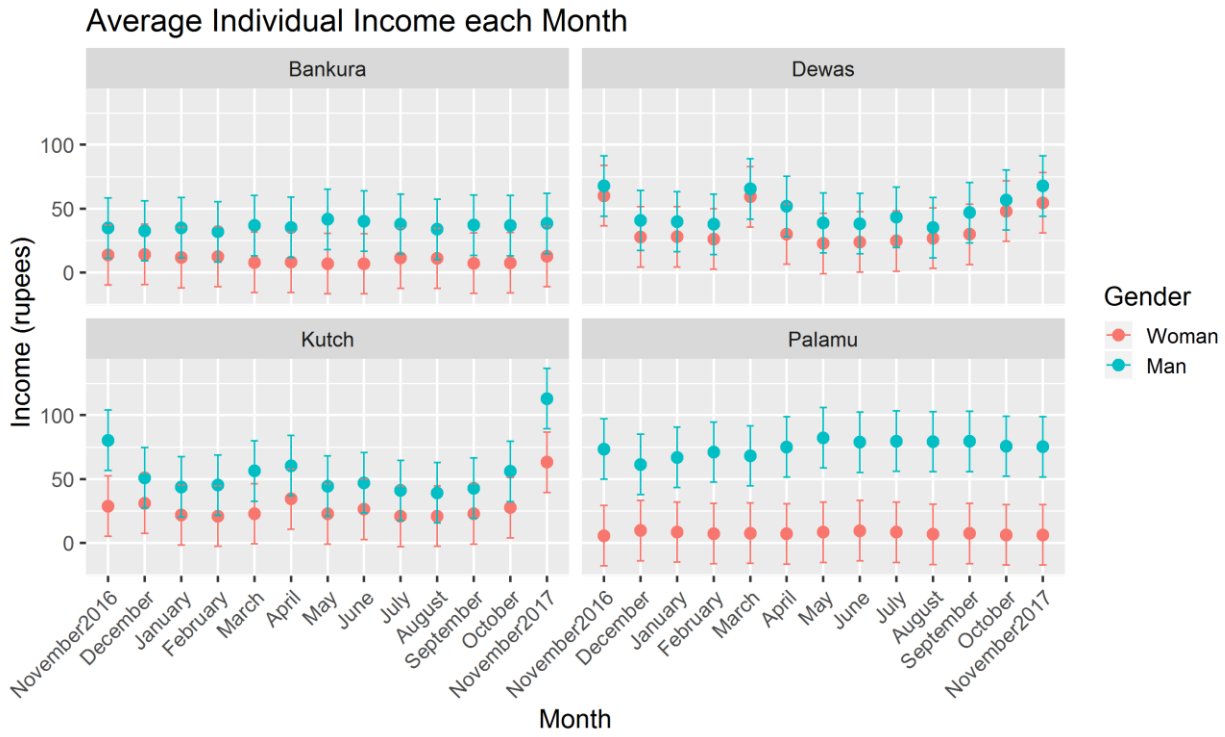


Figure F.10

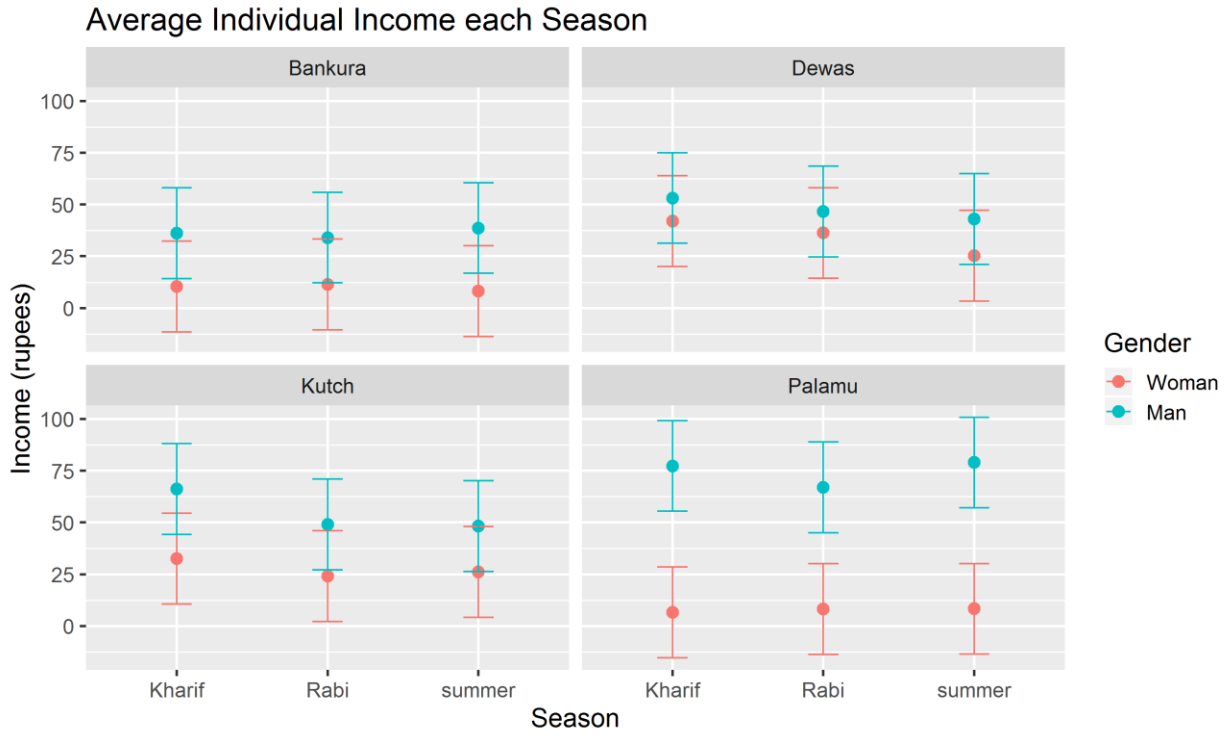


Figure F.11

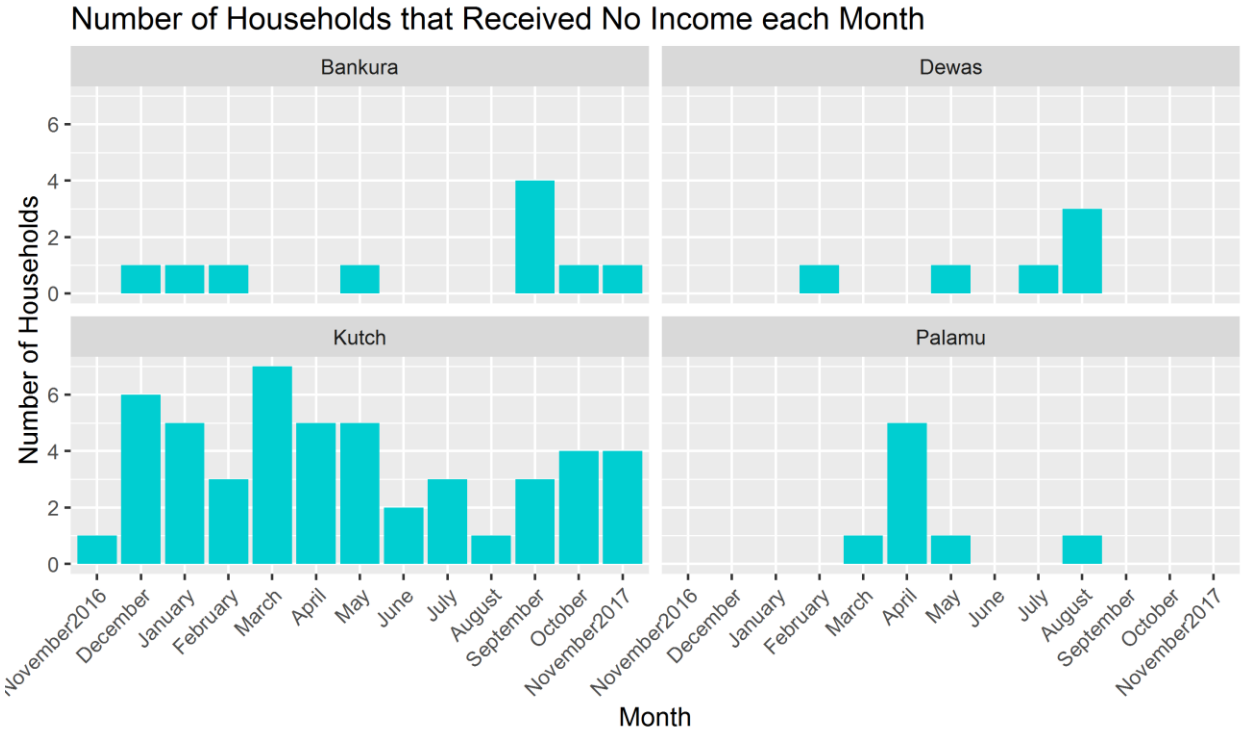


Figure F.12

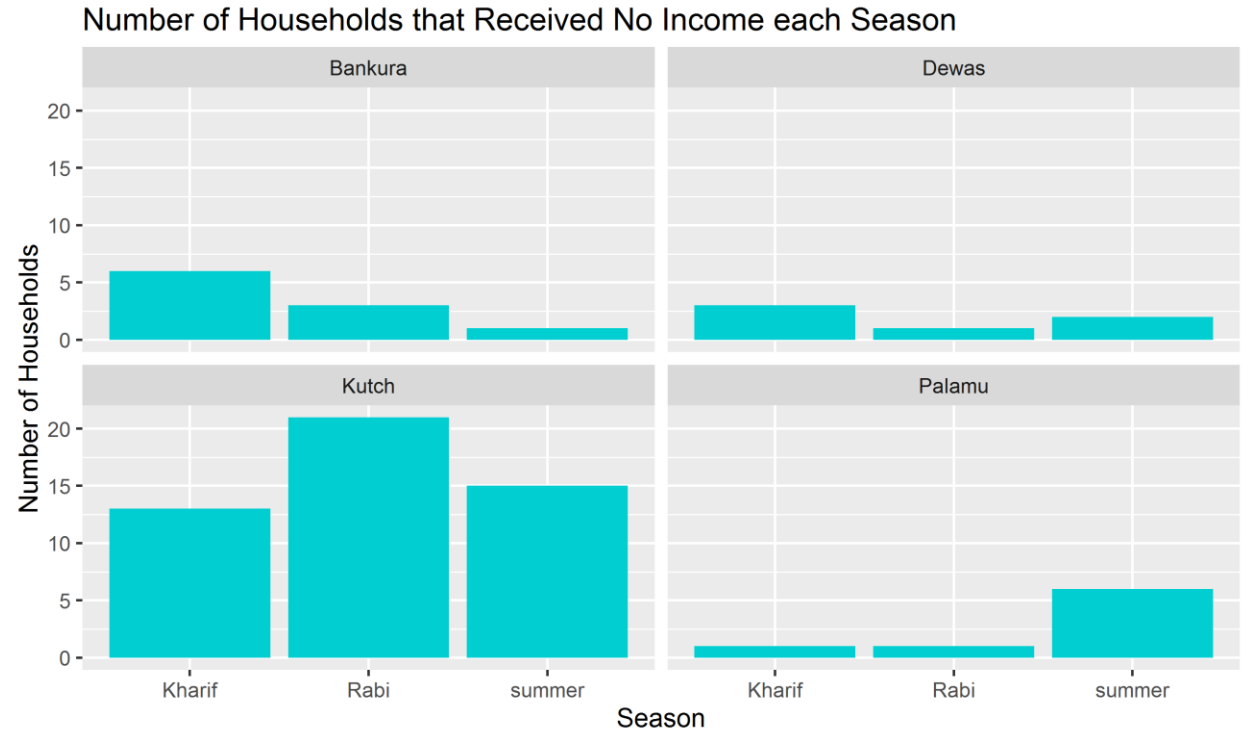


Figure F.13

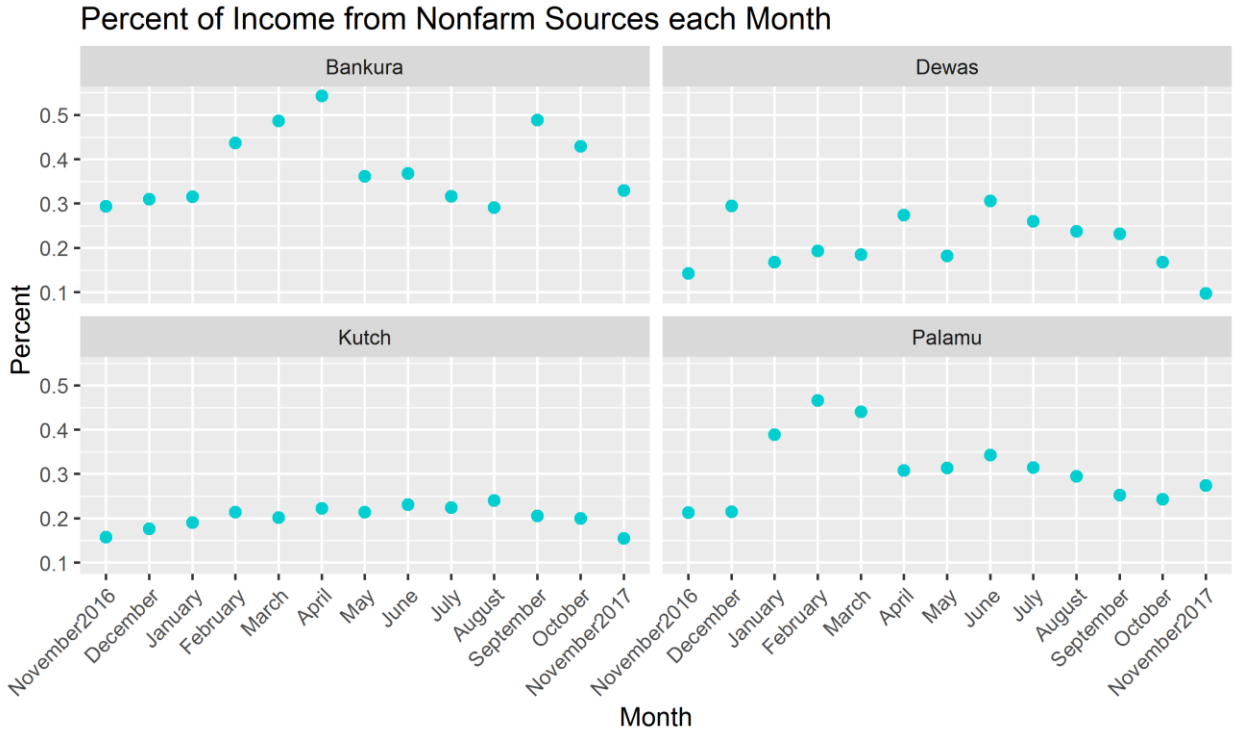


Figure F.14

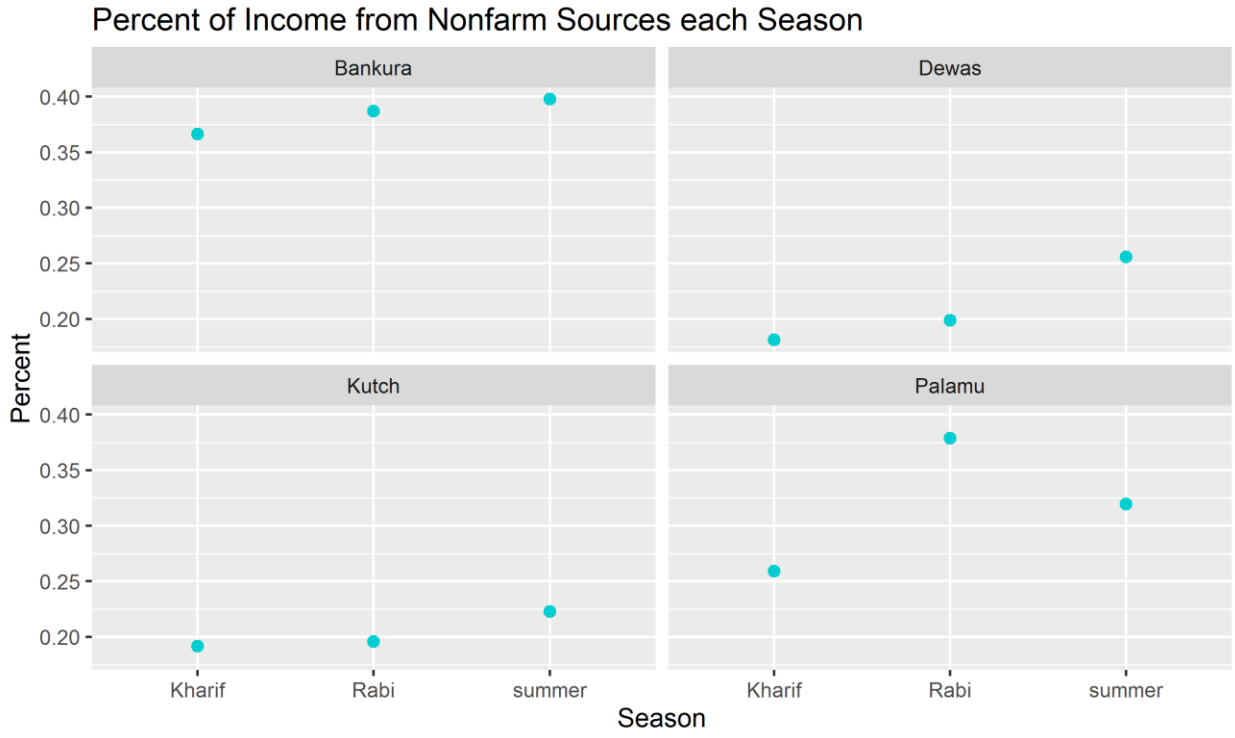


Figure F.15

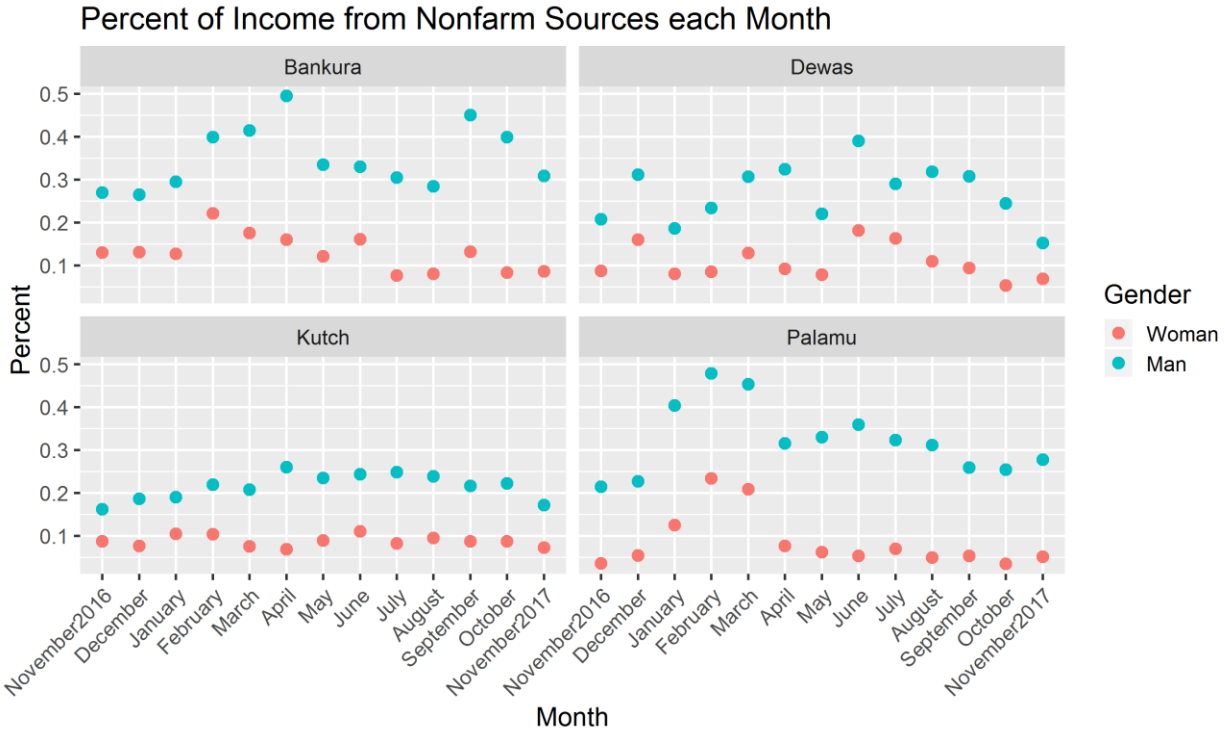


Figure F.16

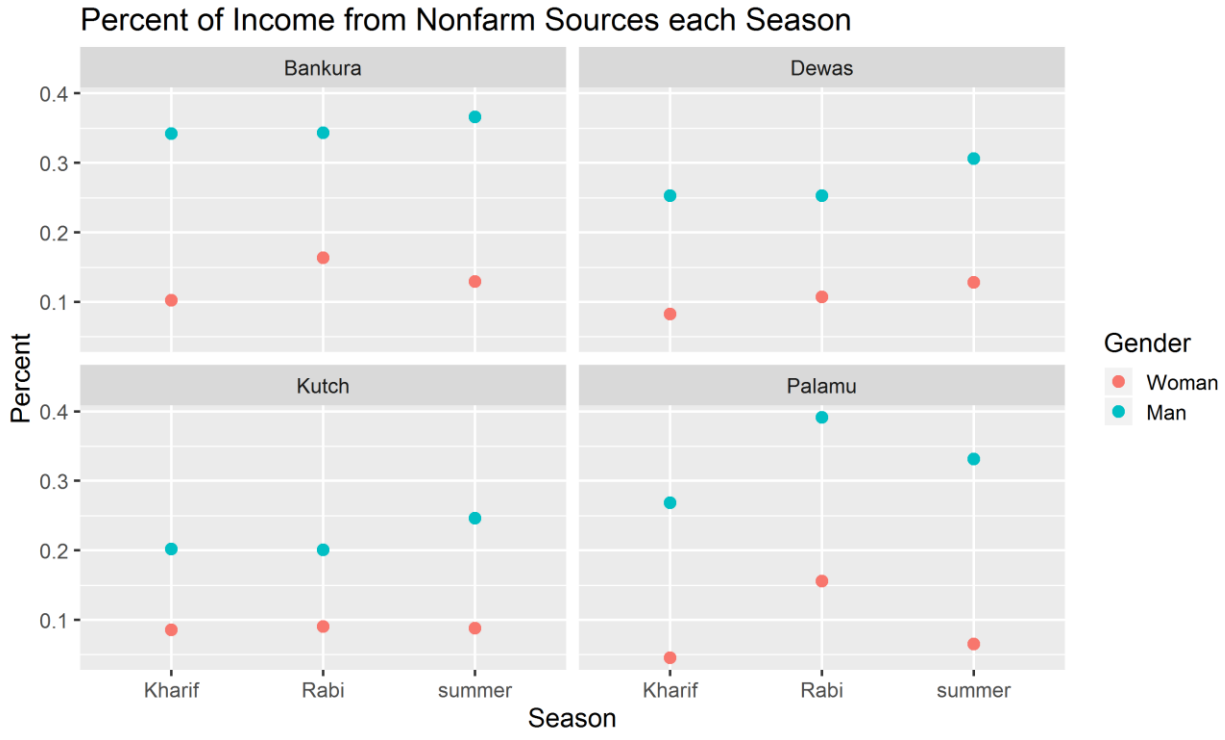


Figure F.17

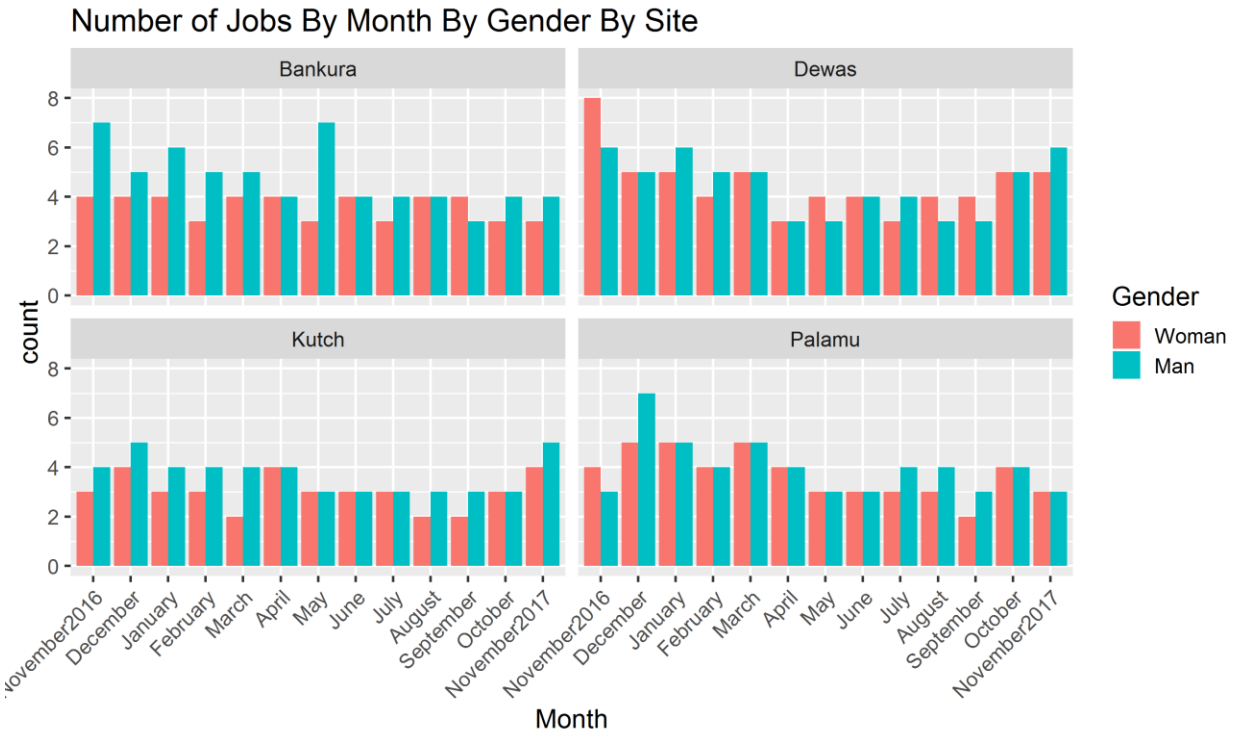


Figure F.18

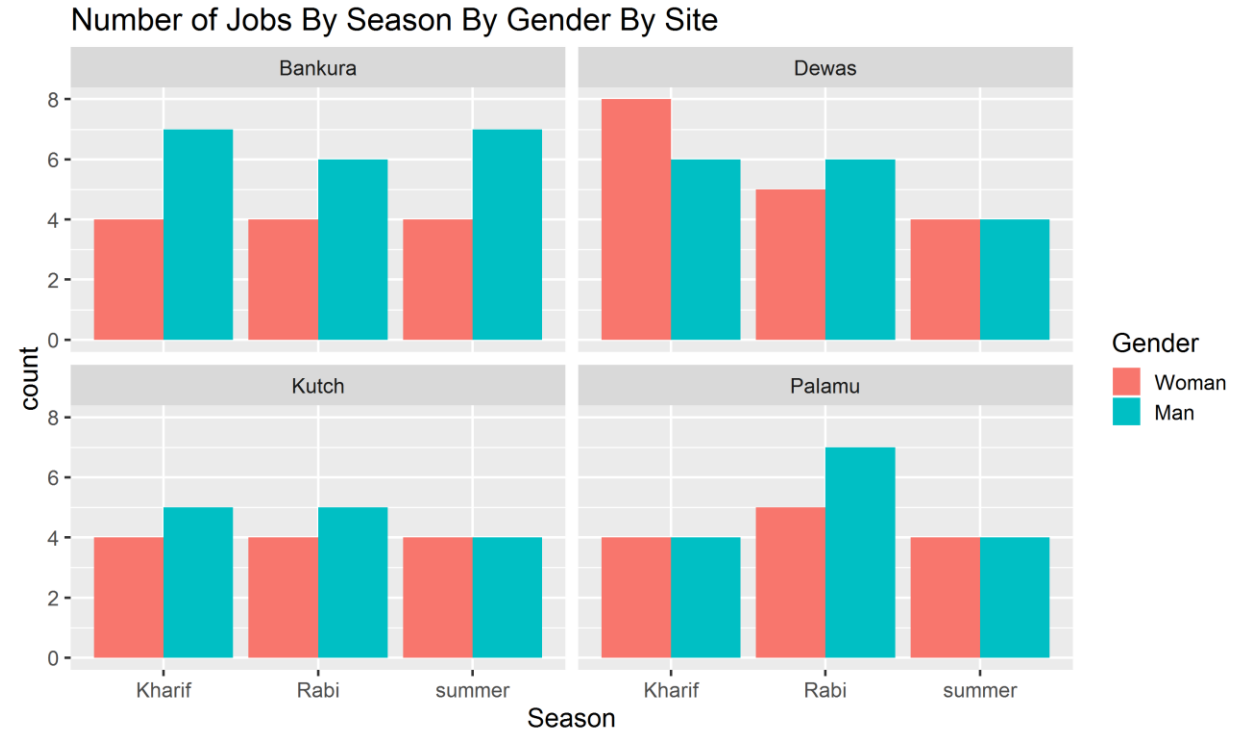


Figure F.19.

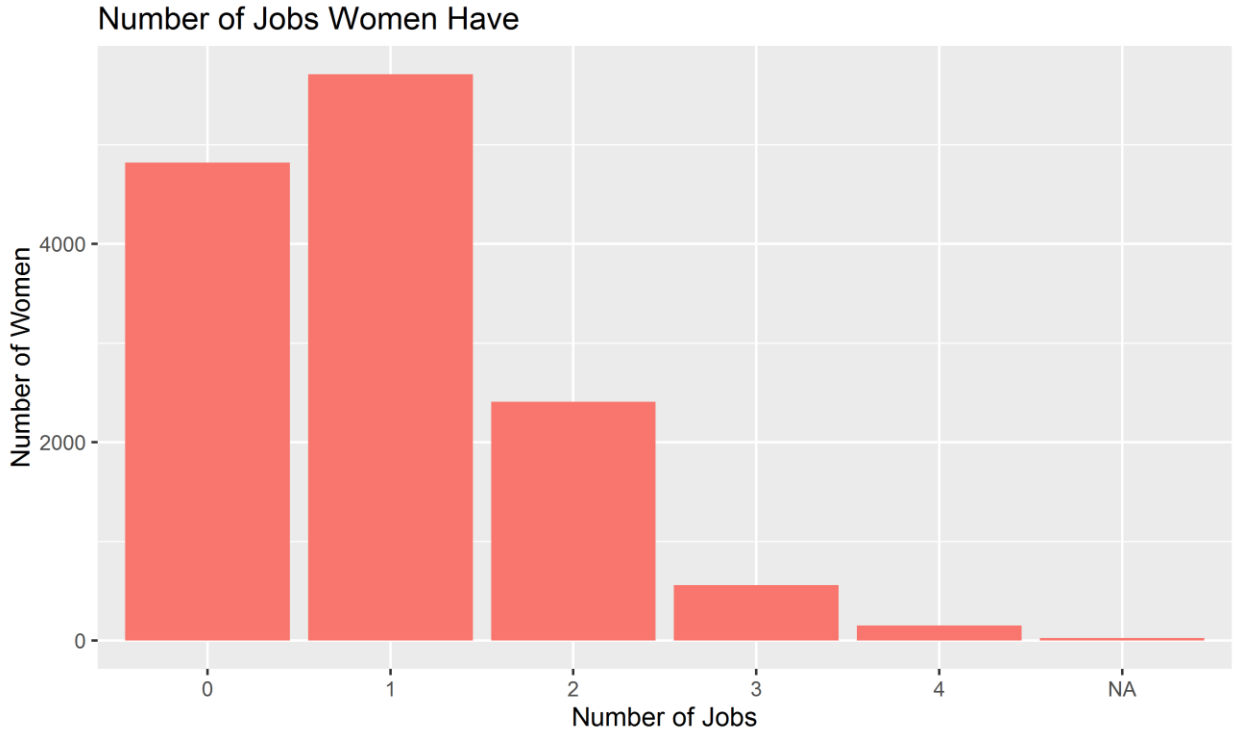


Figure F.20.

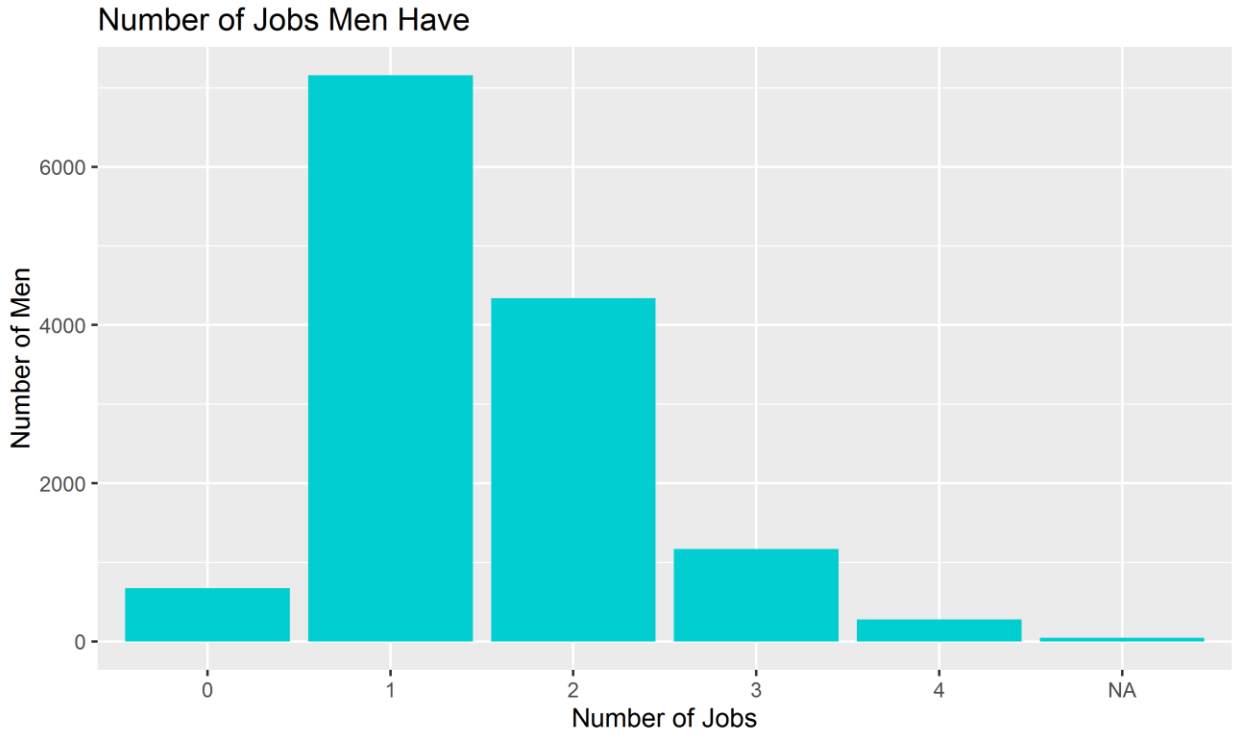


Figure F.21.

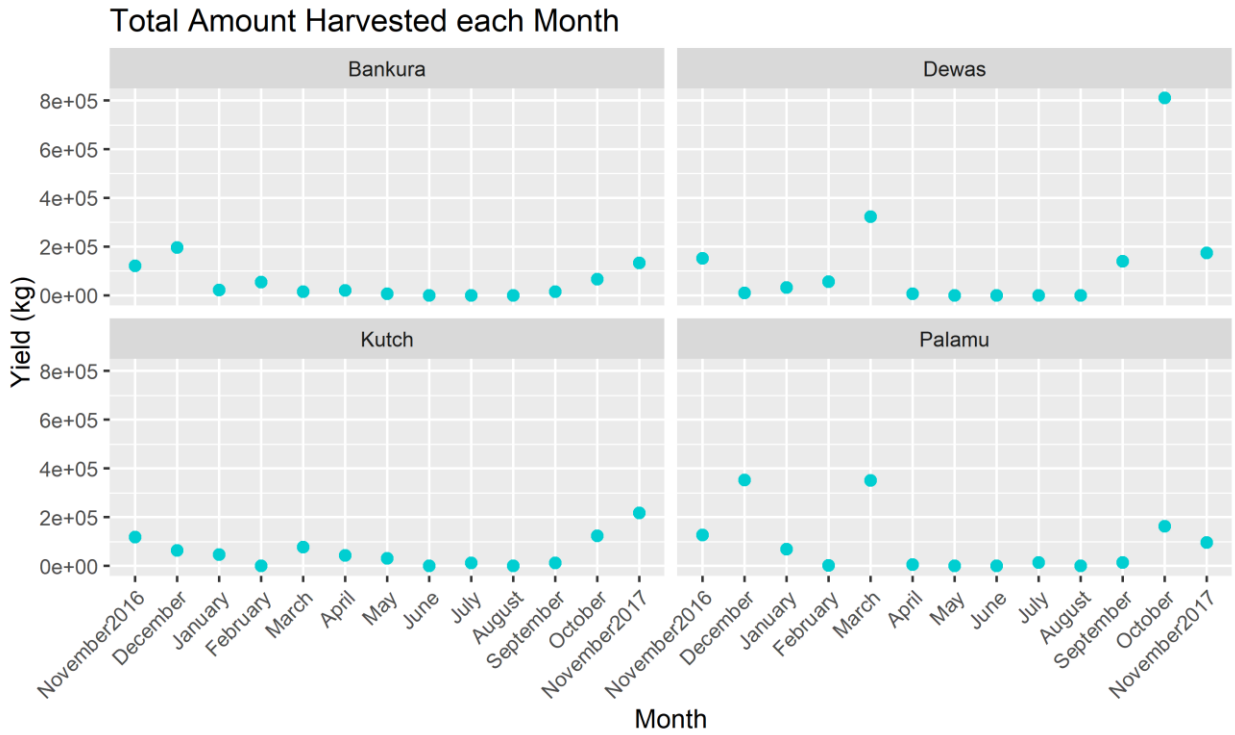


Figure F.22.

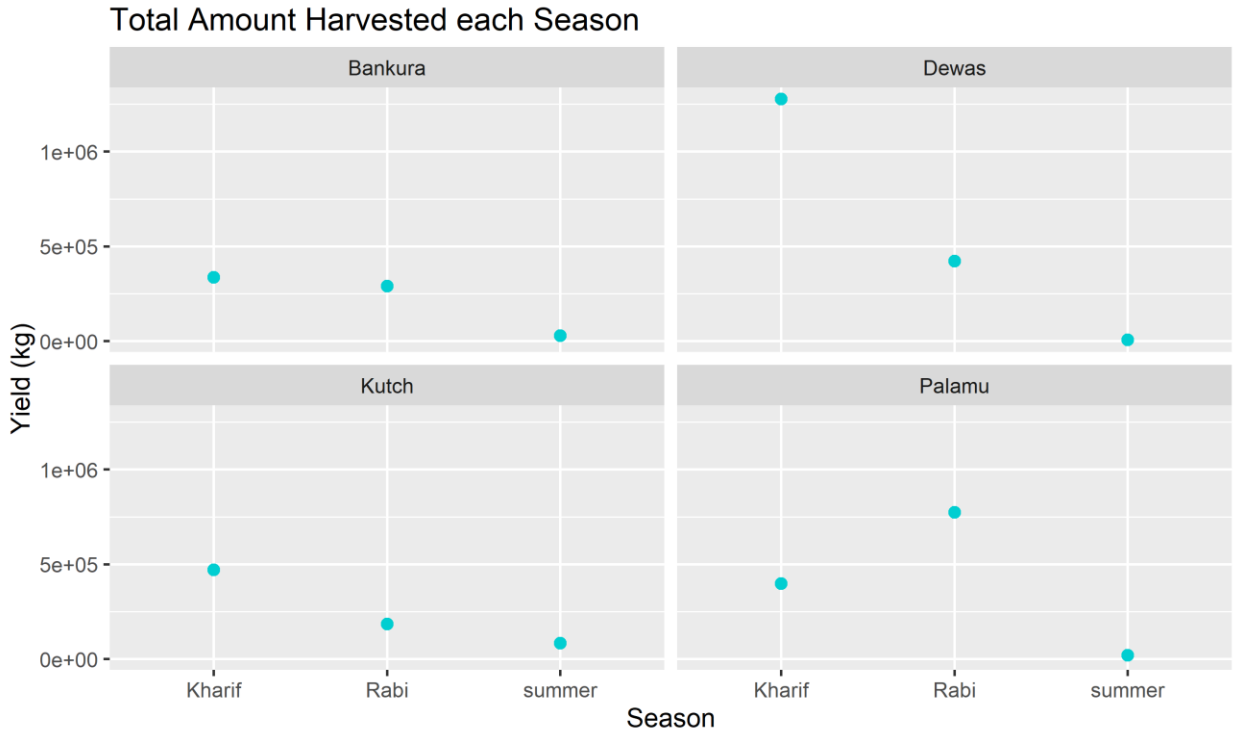


Figure F.23.

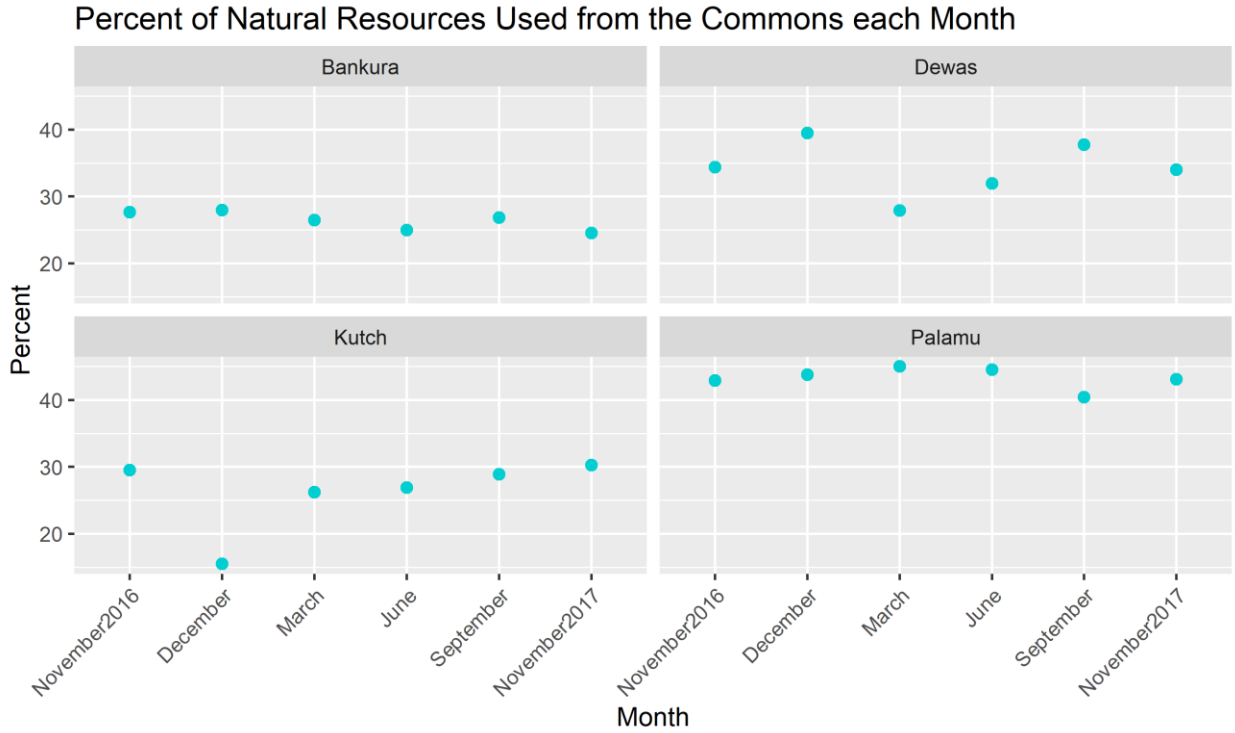
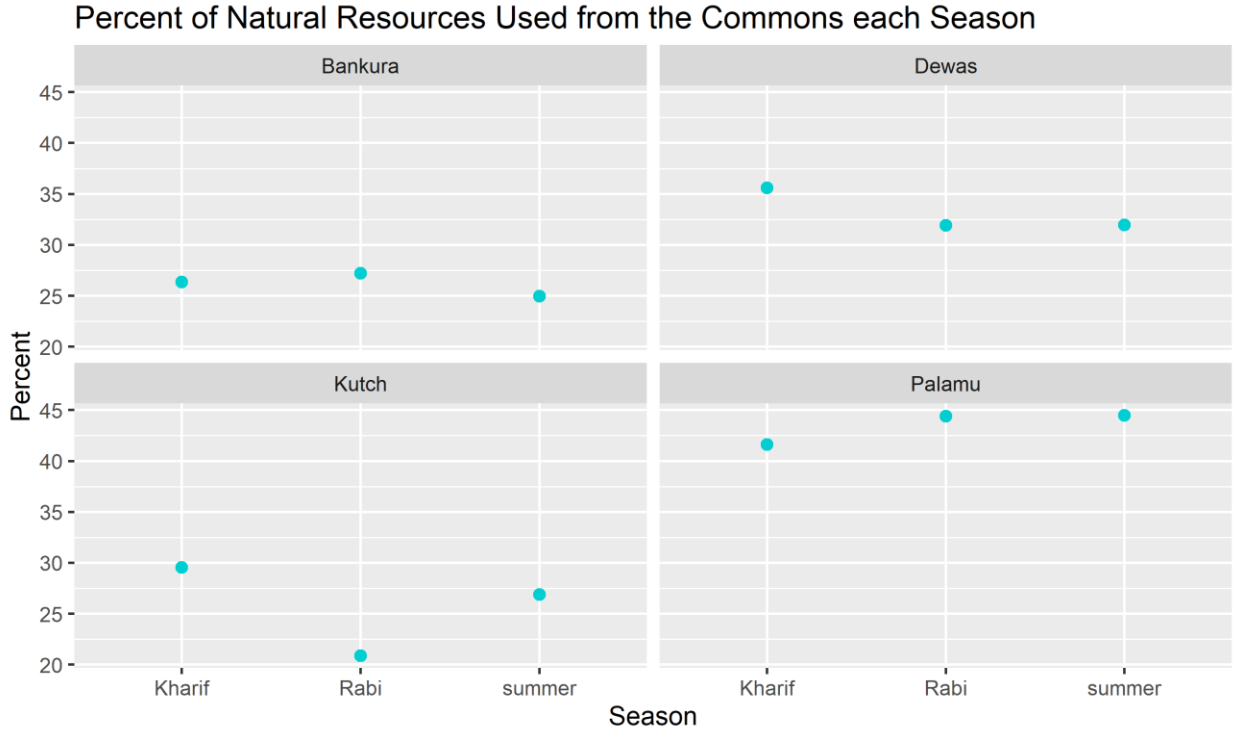


Figure F.24.



Appendix G: Additional Graphs from Chapter 3

Figure G.1

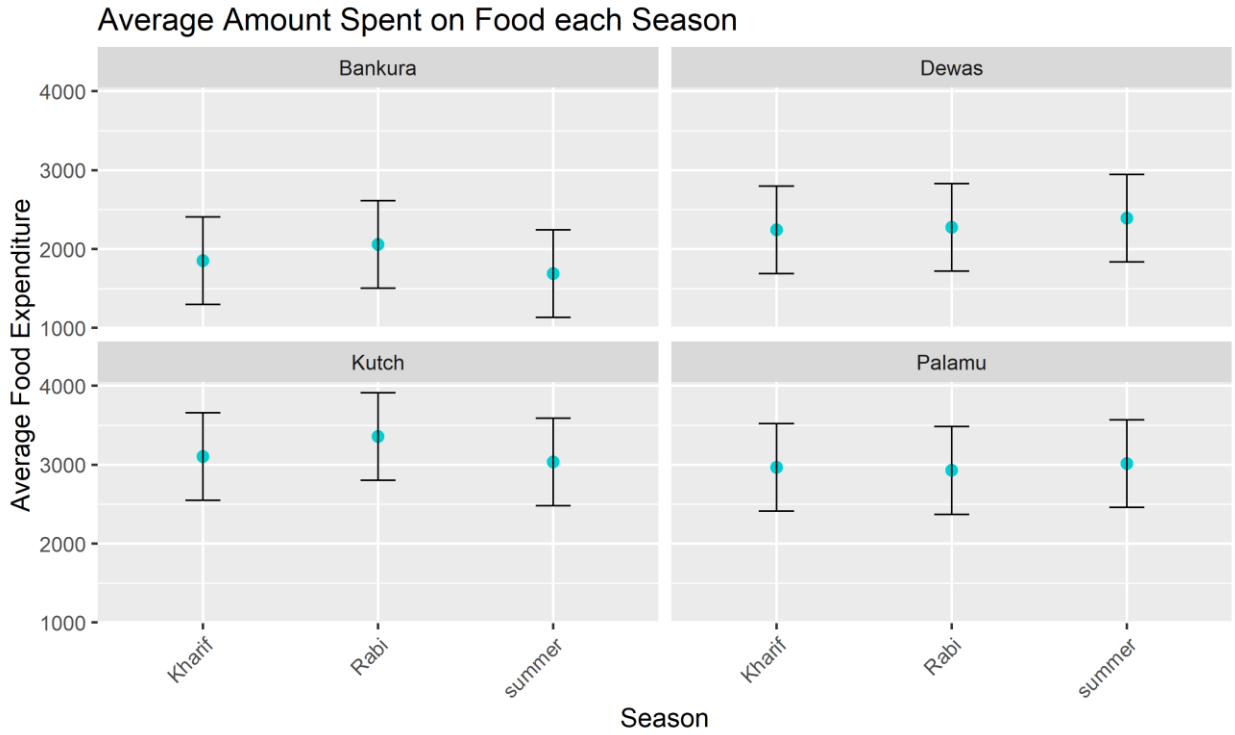


Figure G.2

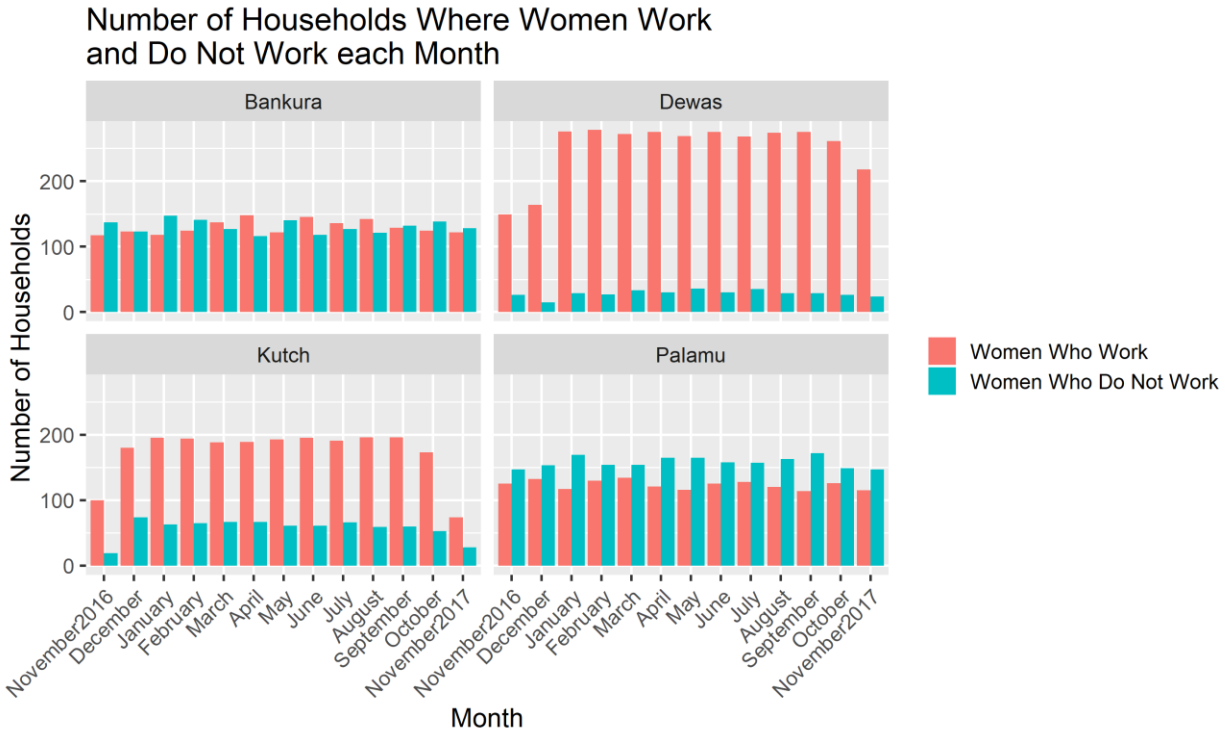


Figure G.3

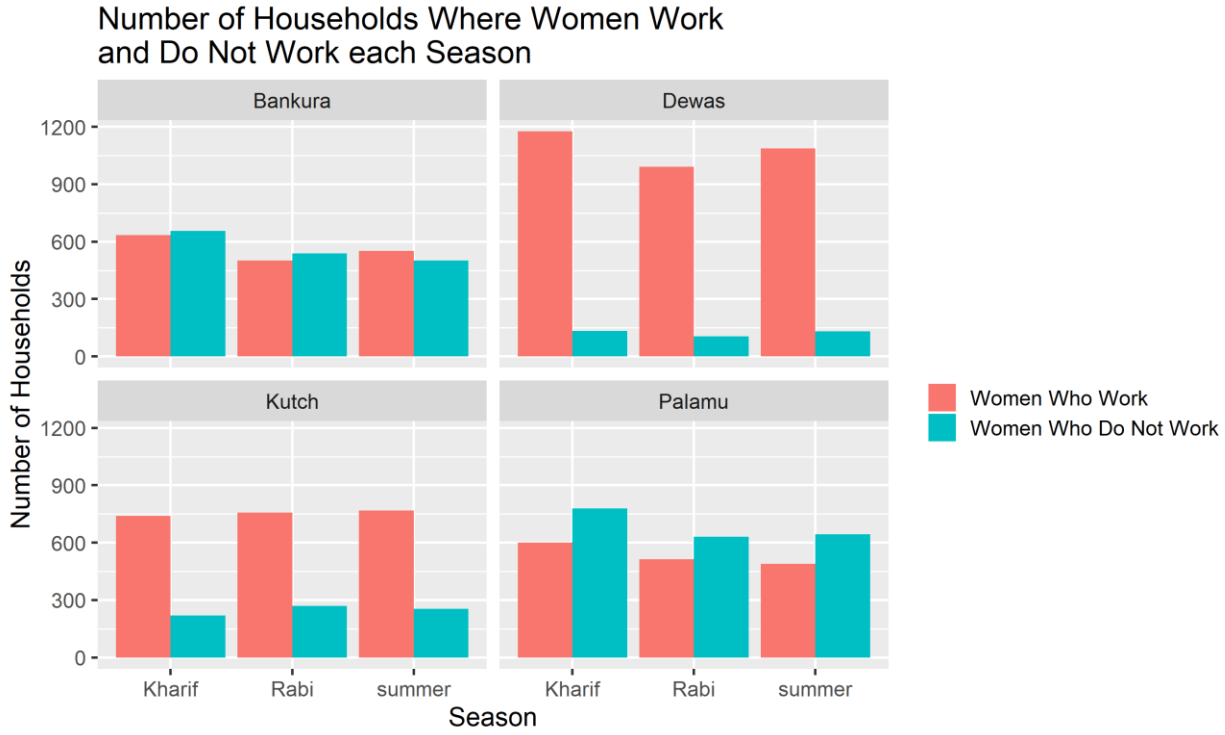


Figure G.4

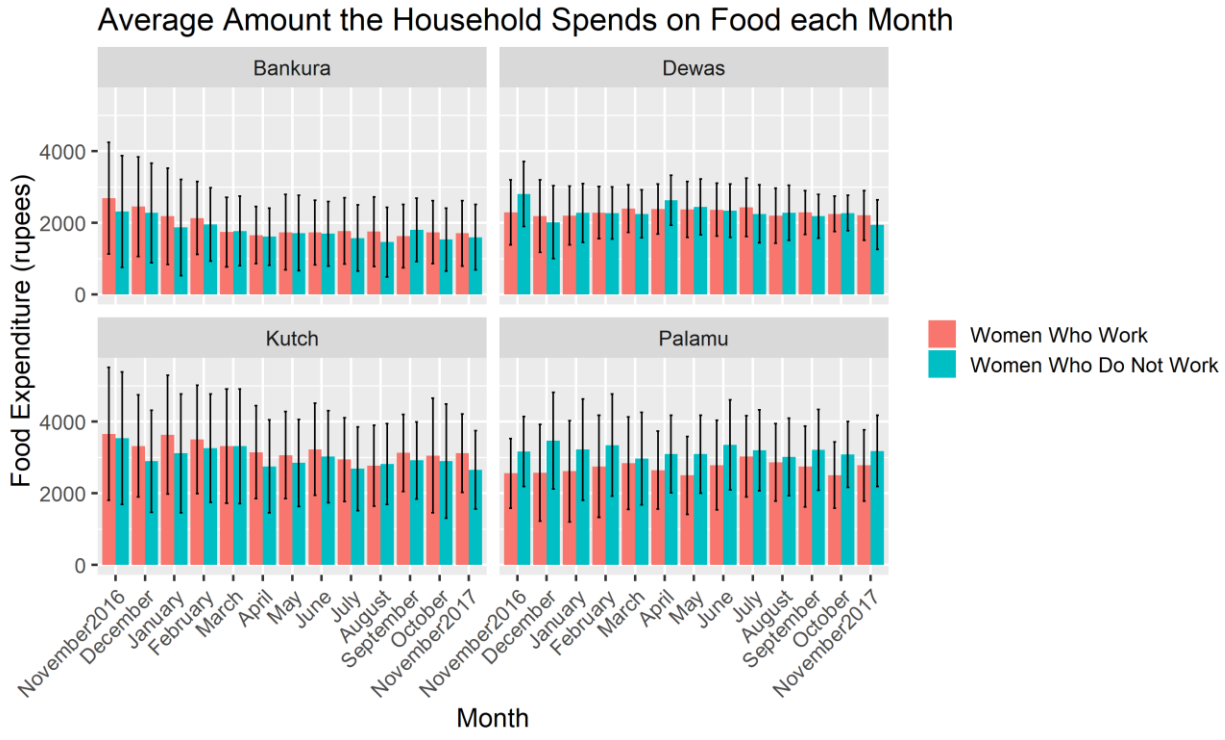


Figure G.5

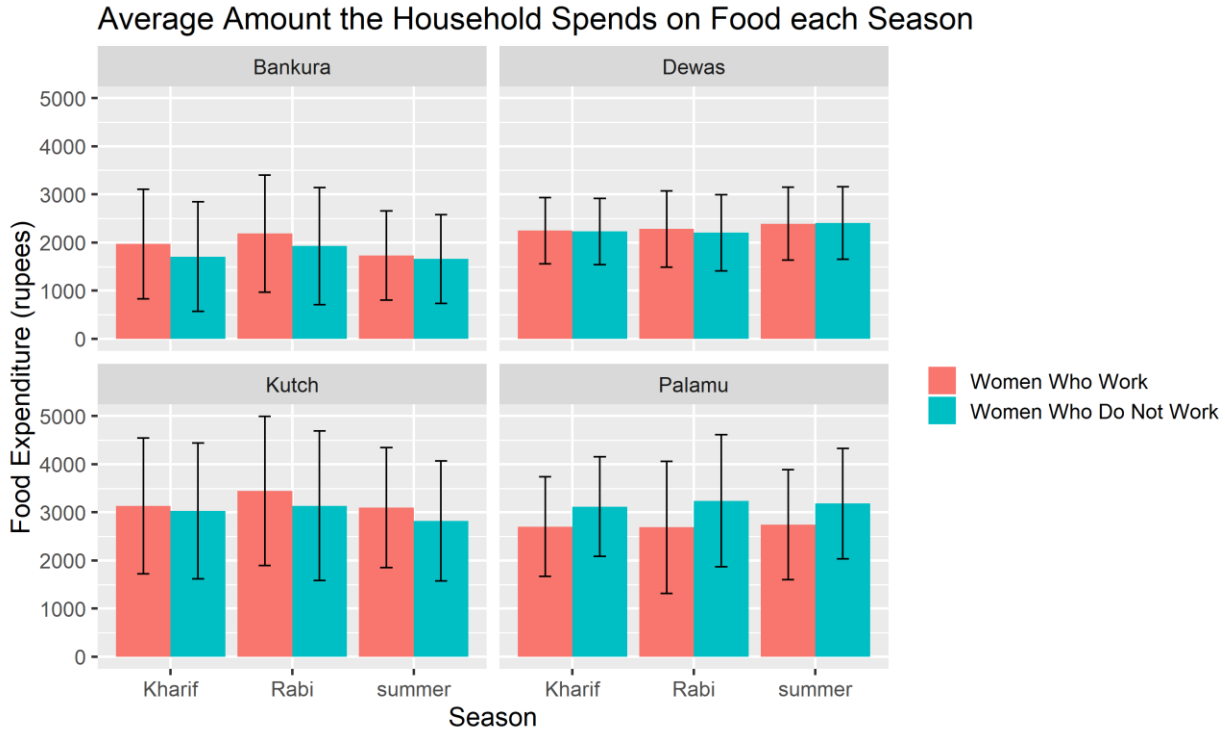


Figure G.6

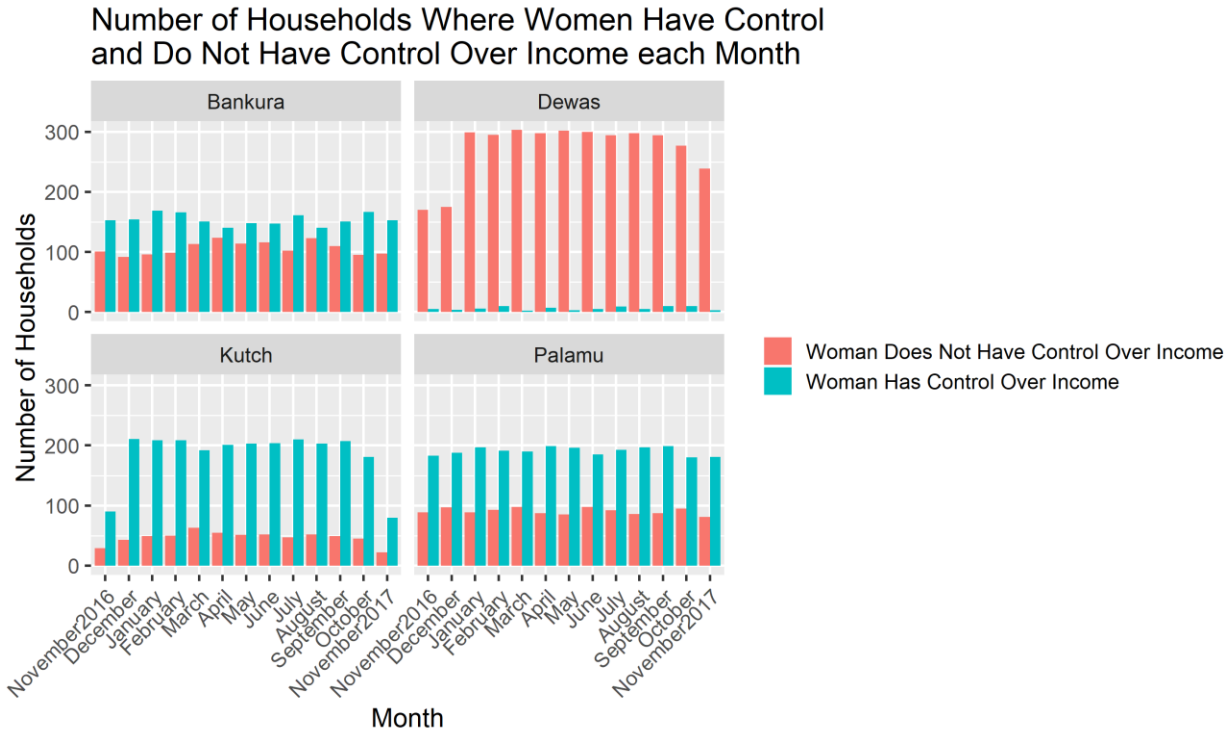


Figure G.7

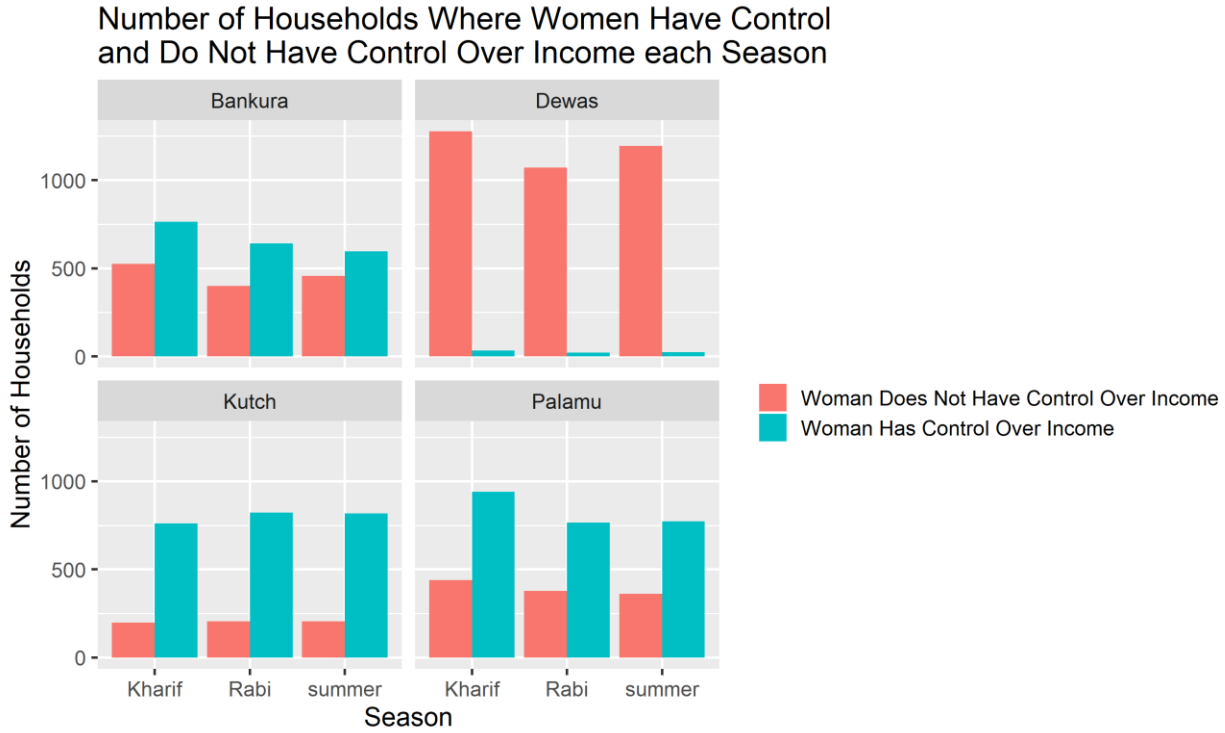


Figure G.8

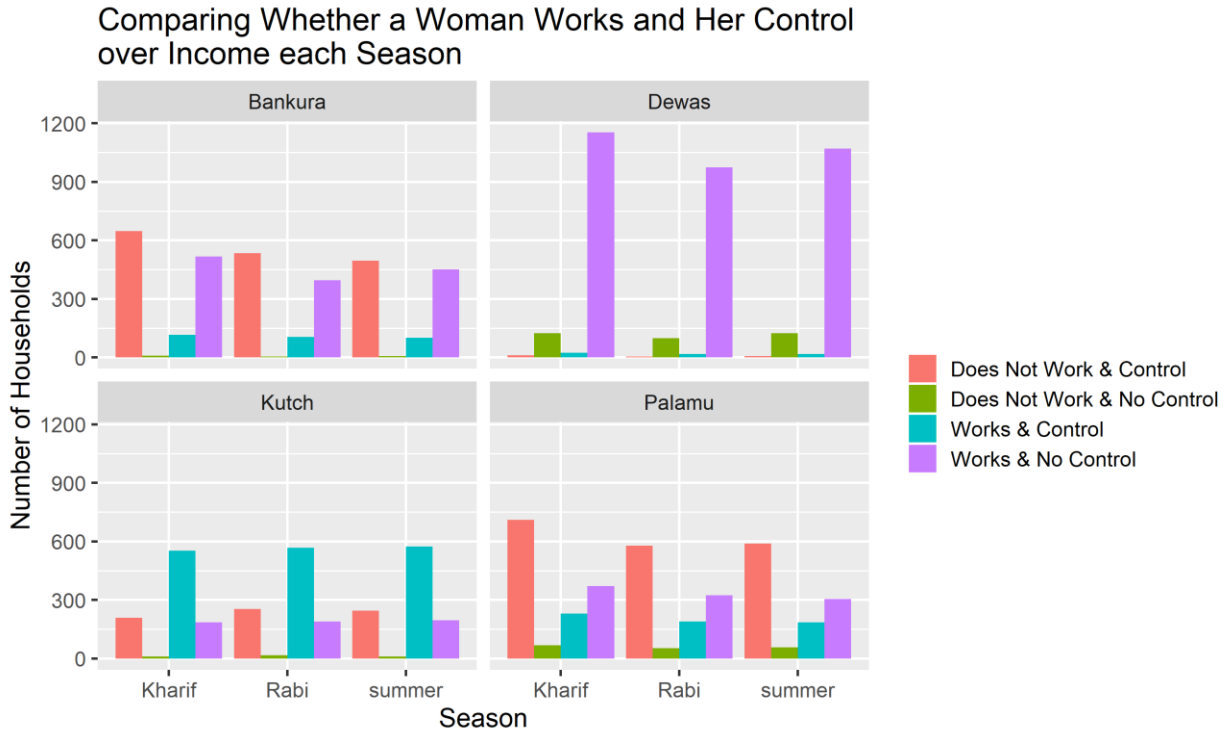
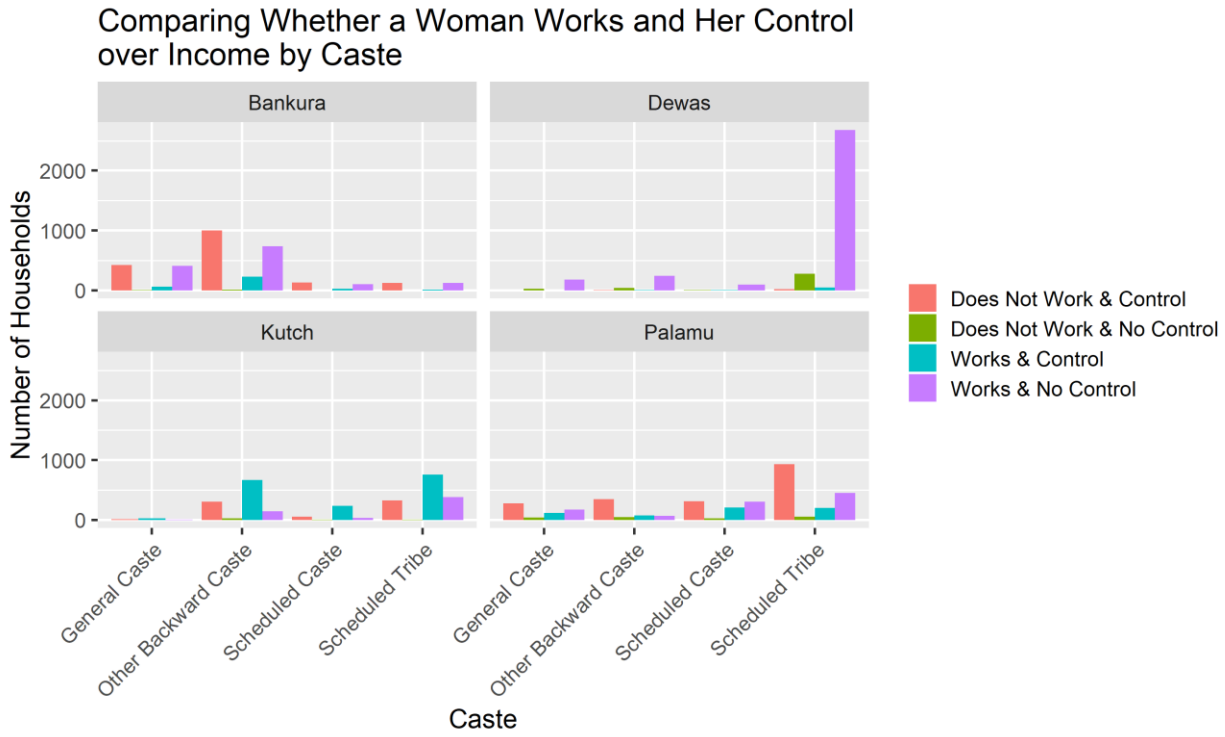


Figure G.9


Comparing Whether a Woman Works and Her Control over Income by Caste
Bankura
Dewas
Kutch
Palamu
Number of Households
2000
1000
0
General Caste
Other Backward Caste
Scheduled Caste
Scheduled Tribe
Caste
Does Not Work & Control
Does Not Work & No Control
Works & Control
Works & No Control