Impact of Rural Women Time Allocation to Agricultural Production on Household Food Security in Pakistan

by Shahzad Kouser, Abedullah Abedullah, and David J. Spielman

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Shahzad Kouser,[1*] Abedullah Abedullah,[2] and David J. Spielman[3]
[1]COMSATS University Islamabad, Islamabad, Pakistan
[2]Pakistan Institute of Development Economics, Islamabad
[3]International Food Policy Research Institute, Washington DC, USA

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Abstract

Rural women's patterns of time-use in productive, reproductive and non-productive tasks are considered as important determinant of household food security in developing countries. However, there is lack of empirical evidence on how women's time poverty translates into household poor nutrition outcome. We address this gap by integrating recall food consumption data with time-use data from Pakistan rural household panel survey conducted from 2012-14. Rural women in our sample allocate 2.82 hours per day to productive activities, 5.03 hours per day to reproductive activities and 8.17 hours to non-productive activities. The results of intrahousehold fixed-effects panel regression further demonstrate that increased women's time to productive activities diminishes calorie consumption by 60 kcal per adult equivalent per day, household dietary diversity score by 21% and household nourishment level by 5%. We also observe that women make trade-offs for increased allocation of time to productive tasks with reproductive and/or leisure hours. This trade-off further explains negative nutritional effects of feminization of agriculture. This study provides the first empirical evidence of women's agricultural-related time burdens on household food security indicators.

Keywords: Women time burden; Food security; Household fixed-effects panel regression; Rural; Pakistan

JEL Classification: C25, C38, I24, I31, J12, J16, Q01

* Corresponding author: Tel. +92.51.90495424; E-mail: drskouser@comsats.edu.pk. This study acknowledged Pakistan Strategy Support Program for compilation of Pakistan Rural Household Survey. Any and all errors are the sole responsibility of the authors.

1. Introduction

Assuring food security is still a major challenge globally. Food security is the physical, social and economic access to adequate, hygienic and nutritious food to meet the basic dietary requirements for an active and healthy life of every individual (WFP, 1997). In low- and middle-income countries, about 2 billion people experience moderate or severe food insecurity; out of them, 60% undernourished population comprises the poorest and most vulnerable group particularly women (UN, 2019; UNDP, 2009). In addition, there are 165 million malnourished under-five children, whereas majority are girls. Besides, 41% of children under the age of 15 are being nurtured by a moderately or severely food insecure adult (UNICEF, 2017). Poor agricultural productivity and limited economic access are considered as major constraints to the basic diet.

Agriculture sector has potential to meet food security requirements. Agricultural interventions including adoption of advanced technologies and practices are aimed to give leverage for improving livelihood and food supply in rural areas. Majority of these interventions demand greater participation of women in agricultural works, which is not possible without recognizing their due share in the returns, a phenomenon stated as feminization of agriculture (Picchioni et al., 2020). Hence, agricultural interventions can alter patterns of women's time to productive agricultural tasks-sowing, weeding and harvesting, reproductive household tasks-child bearing and rearing and food acquisitioning and preparing, and non-productive tasks-relaxing, watching TV, attending social events, and sleeping. An increase in allocation of time to productive activities by women can increase their time poverty and can impair their reproductive tasks leading to poor child health and household nutrition outcome (Pandey et al., 2016; Ruel et al., 2018). Moreover, longer working hours or increased work intensity can have adverse effects on health and nutrition of poor women (Bamji and Thimayamma, 2000). Therefore, by ignoring time constraints of

women, extant systematic reviews have failed to document a clear evidence of nutritional improvement through agricultural interventions (Girard et al., 2012; Ruel and Alderman, 2013; Webb and Kennedy, 2014). Webb and Kennedy (2014) have argued that there is need to conduct better research evaluating pathways through which nutritional impacts of agricultural interventions are expected. Ruel and Alderman (2013) have emphasized that women are key mediators of the pathway from agricultural interventions to nutrition outcomes. Yet, there is lack of empirical evidence on how women's time trade-offs mediate household-level food security outcome.

The past decade has witnessed a remarkable surge of interest in time-use research for understanding gender dimensions of linkage between agricultural development and nutrition effects. Hitherto, employment data fails to capture women's unpaid agricultural and domestic works. Therefore, feminist research relies on time-use survey for measuring gender division of work and care in a household (Dixon-Mueller, 1985). Stevano et al. (2019) have developed a framework to conceptualize, operationalize and interpret time-use data to understand linkages between agriculture, gendered time-use and nutrition. Johnston et al. (2018) have conducted a systematic review of literature from developing world to explore gendered time trade-offs in agriculture-nutrition pathways. They have observed no (Bamji and Thimayamma, 2000) or positive (Blau et al., 1996) or negative (Paolisso et al., 2002; Pradeilles et al., 2019) nutritional effects for increased allocation of women's time in agriculture. Kadiyala et al. (2014) have elaborated that a woman's time in agriculture does not impact reproductive tasks if she has other household members to take on her responsibility. Nevertheless, measuring the nutritional impacts increased time poverty of women are complex and difficult. Moreover, given the complex nature of time-use methodology and its repercussions, existing studies have often ignored women's time trade-offs in productive, reproductive and non-productive (i.e., leisure) tasks and the simultaneous

performance of productive and reproductive activities (Johnston et al., 2018; Stevano et al., 2019). Without such underpinnings, nonetheless, it is difficult to draw causal links between women's work and household well-being in particular nutrition outcomes (Floud et al., 2011).

This article evaluates how patterns of rural women time allocation to productive, reproductive and non-productive tasks translate into household food security status in Pakistan. Pakistan is an agro-based economy, where agriculture sector contributes 19.3% to GDP and employs 42.3% of labour force (GoP, 2020). Despite food surpluses, Pakistan is one of the most food insecure countries in Asia (GFSI, 2018). The National Nutrition Survey reports that 36.9% of the households are food insecure in the country (NNS, 2018). Out of 120 districts, 38 districts (2 in Punjab province, 1 in Sindh province, 13 in Balochistan province, 18 in Khyber Pakhtunkhwa province, and 4 districts in northern areas) are recognized as extremely food-insecure (SDPI and WFP, 2003). The most vulnerable groups like women, the elderly, and children are more affected by severe food insecurity (Ansari et al., 2006). However, women play a central role in Pakistan agriculture by accounting for 39% of the rural workforce (Ahmad and Khan, 2016). While both men and women are involved in crop production and harvesting activities, women spend more time in seed cleaning, sowing, weeding, harvesting and basic value addition, and men mainly engage in outdoor activities related to production and marketing functions especially field preparation, water management, input provisioning, transportation and marketing (Samee et al., 2015). However, cultural norms, male dominance and traditional beliefs are critical constraints to women's participation in agriculture (Butt et al., 2010). Samee et al. (2015) suggest that greater women's involvement in earning income from agriculture can lead to their financial independence. To achieve SDG of zero hunger and food security, the Government of Pakistan is promoting gender-balanced agricultural development by improving women's capacity to increase food

production and value addition (Khan and Shah, 2011). Though increased women time poverty can deteriorate the agriculture-nutrition pathway (FAO, 2015). By using time-use and food consumption data collected from 1,930 rural households from the last wave of 2012-14 Pakistan Rural Household Panel Survey, this article maps pattern of women's time-use in productive, reproductive and non-productive activities in agricultural households and evaluates the net impact of women's time trade-offs on household food security indicators. The findings provide empirical evidence that how labour-intensive agricultural work exhausts women that negatively impact household nutrition outcome.

2. Materials and Methods

2.1. Study Sites

This article draws on data from the last round of 2012-14 Pakistan Rural Household Panel Survey (PRHPS) (IFPRI, 2017). The Pakistan Strategy Support Program (PSSP) carried out PRHPS in three rounds between March 2012 and June 2014 with the financial support from the United States Agency for International Development (USAID) and technical support from the International Food Policy Research Institute (IFPRI), Washington DC and the Innovative Development Strategies (IDS), Pakistan. A multistage stratified sampling technique was used to select rural households from three provinces of Pakistan. In the first stage, a total of 19 districts i.e., 12 districts from Punjab province, 5 districts from Sindh province and 2 districts from Khyber Pakhtunkhwa (KPK) province were selected using probability proportionate to size. However, due to security reasons, Balochistan province was not considered. In the second stage, 4 mouzas/communities (i.e., an administrative unit based on land revenue records) were chosen using an equal probability systematic selection in each district, comprising a total of 76 mouzas in the sample. In the last

stage, 28 households were randomly selected from the list of households in each mauza. After excluding 38 non-participating households, the final sample consists of 2,090 rural households. Distribution of rural households across districts and provinces have been illustrated in Table 1. However, the sample included in the final analysis consists of 1,930 households, where 160 households were excluded due to missing responses of women for food consumption and time allocation for reproductive tasks. The survey was administered by 19 teams, comprising a supervisor, and two male and two female trained enumerators.

Table 1 is approximately here.

2.2. Data Collection

Data was collected using pretested and structured survey instruments from all male and female members of the household, comprising around 13,000 individuals in each round. The study design and questionnaires were approved from the Institutional Review Board (IRB) of the IFPRI. Full data is publicly available in the Harvard data archive at https://dataverse.harvard.edu/dataverse/IFPRI/?q=Pakistan+rural+household+panel+survey. Due to high rates of illiteracy in the study area, verbal informed consent was asked and recorded from all interviewee. For study objectives, household and female questionnaires were focused.

Household Questionnaire: The household questionnaire gathered information from the head of the household or the most knowledgeable male member on household composition, demographics, employment, income, land ownership, agriculture, livestock, assets, expenditures, and social safety nets.

Female Questionnaire: The female questionnaire gathered information from the spouse of household head and all 16 years and above females, comprising 4,375 women. Questions on education, employment, decision-making, assets and savings were included. In addition, the questionnaire also included a two-week household food composition recall, which is commonly used to assess household food security outcomes (Qaim and Kouser, 2013). Main woman was inquired about the quantity consumed of different food items and the corresponding monetary value. The consumption list contains all the food items and drinks that are considered necessary for the dietary requirement of Pakistani people. The questions covered food consumed from own production, market purchases, gifts, and transfers. Besides, a sequential time allocation of women in productive and reproductive activities was elicited using a 24-hour recall method using half-hour intervals. In consultation with the experts, respondents and enumerators, 16 waking hours were considered from 5 am to 9 pm in Pakistan, which are consistent with other studies from India (17 hours) and Nepal (18 hours) (Picchioni et al., 2020; Rao and Raju, 2020). The remaining time was considered as night-time for sleep. Contrary to existing studies, this article provides better measure of rural women time patterns by using available information from all eligible women in a rural household.

2.3. Data Analysis

2.3.1. Outcome Variable

We compute food security status of each household through daily food consumption approach. For this purpose, the quantity data for different food items was first converted into kcal according to the food consumption table of Pakistan (GoP, 2001). Then, total household calorie consumption from the 14-day recall period was divided by 14 to compute household calorie consumption per day. To adjust calorie consumption according to the age, gender and physical activity of the

household members, an adult equivalent (AE) score was calculated for each household member from the calorie requirement scale given in the Pakistan Dietary Guidelines issued with the collaboration of Food and Agriculture Organization (FAO) and Government of Pakistan in 2018 (FAO and GoP, 2018). AE scores for a male adult involved in farming, a female adult involved in farming, a male adult with lower physical activity and a female adult with lower physical activity are reported as 1.0, 0.8, 0.8 and 0.7, respectively. However, appropriate adjustments were made for calculating AE scores for children and adolescents (Nazli and Hamid, 1999; Qaim and Kouser, 2013). Then, total adult equivalent (TAE) score was calculated by summing AE scores of all household members. Finally, total calorie consumption per adult equivalent per day ($CAED$) was obtained by dividing total daily household calorie consumption by TAE score. $CAED$ is a continuous outcome variable that accurately measures actual per person caloric intake, after accounting for differences in age, gender and physical activity levels caused by household composition (Claro et al., 2010). However, food consumption data may overestimate caloric intakes as intra-household food wastes are difficult to adjust (Qaim and Kouser, 2013). Moreover, calorie consumption data from household survey may not precisely estimate household nutrition outcome (Bouis, 1994).

In addition to the $CAED$, we compute household dietary diversity score ($HDDS$) to capture diversity in the diets of households (Kennedy et al., 2011). Most of the calories consumed in rural Pakistan are drawn from cereals such as wheat, rice, millet, and sorghum that are rich in carbohydrates but are less nutritious in terms of protein and micronutrients. Households also obtain energy by consuming pulses, fruits, vegetables, and animal products (i.e., milk, milk products, meat, fish, and eggs). Following FAO (2010), we constitute 12 food groups from the consumed food items for analysis. The details of food groups are given in Table A1 in the appendix. A higher

diversity score indicates nutritional sufficiency and better economic conditions of households (Jensen and Miller, 2010).

Furthermore, we calculate household nourishment level (HNL) outcome variable and consider a household as well-nourished if daily caloric intake is greater than 2,243 kcal per AE (Qaim and Kouser, 2013). The benchmark of 2,243 kcal/AE/day was defined as a normative reference for sufficient nutrition, called average minimum dietary energy requirement for Pakistan by FAO in 2017 (FAO, 0217). Threshold of minimum caloric requirements varies in the literature (Fongar et al., 2019; Knößlsdorfer et al., 2021).

2.3.2. Independent Variables

Based on extant literature, various individual (i.e., women), household, community and regional covariates are included in the analysis. In particular, among demographic and socio-economic characteristics of women, age, education, marital status, and time-use in three activities - productive, reproductive and non-productive are included. Three time-use proxies are used to capture women's time poverty per day (Picchioni et al., 2020). In agricultural households of Pakistan, productive activities are performed to produces crop and/ livestock products and services, aimed to meet basic needs of life (Moser, 1989). Productive activities are paid or unpaid agricultural works including land preparation, sowing, weeding, harvesting, input and output marketing and looking after animals. However, reproductive activities are performed to maintain household unit. Reproductive activities are unpaid domestic work including caring of child, elders, diseased and disabled household members, cooking, cleaning, washing, and collecting water and solid fuels (Moser, 1989). Furthermore, non-productive activities reflect free-time activities (i.e., resting and watching TV) as well as social and personal commitment (i.e., attending weddings,

deaths and community meetings, and visiting patients). Respondents were mainly asked about primary activities in the PRHPS. We compute total time allocated to productive, reproductive and non-productive activities for every female participant out of 16 waking hours (i.e., 960 minutes).

Household characteristics include household size, total agricultural land, number of crops grown during 2012-13 rabi and 2013 kharif seasons, ownership of livestock (small and large ruminants), and income poverty status. Recent literature has found positive association between higher levels of farm production diversity and dietary diversity in small farm households (Sibhatu and Qaim, 2018). A crop calendar of major crops grown in study sites is given in Table 2. Household total farm and non-farm monthly income variable was used to measure the income poverty status of households. Poverty is an important economic indicator as it reduces affordability and accessibility of households to secure adequate, safe and nutritious foods (Obayelu and Orosile, 2015). Household poverty status was measured using the international poverty line of US$ 1.90 purchasing power parity (PPP) (Rs 293) (Knößlsdorfer et al., 2021). A binary variable of poor vs non-poor household was constructed by assigning a value of "1" if income per capita is less than US$ 1.90 per day (PKR 293, i.e., international poverty line) and "0", otherwise.

Table 2 is approximately here.

Two regional dummy variables for Punjab and Sindh provinces are included to account for unobserved food consumption variation across provinces. Khyber Pakhtunkhwa (KPK) province is assumed as a control category.

2.3.2. Regression Model

The net impacts of women's time-use in productive and reproductive activities on household food security indicators after controlling for possible confounding factors are evaluated as follows:

$$CAED_h = \beta_o + \mu_h + \beta_1 WPT_{wh} + \beta_2 WRT_{wh} + \beta_3 W_{wh} + \beta_4 H_h + \beta_5 R_r + \varepsilon_{wh} \quad (1)$$

$$HDDS_h = \beta_o + \mu_h + \beta_1 WPT_{wh} + \beta_2 WRT_{wh} + \beta_3 W_{wh} + \beta_4 H_h + \beta_5 R_r + \varepsilon_{wh} \quad (2)$$

$$HNL_h = \beta_o + \mu_h + \beta_1 WPT_{wh} + \beta_2 WRT_{wh} + \beta_3 W_{wh} + \beta_4 H_h + \beta_5 R_r + \varepsilon_{wh} \quad (3)$$

where $CAED_h$ is total calorie consumption per adult equivalent per day of each farm household h ranges from 1-1,930, which is an outcome variable in equation 1. WPT_{wh} is the productive time allocated by each woman w (ranges from 1- 3,665) in a household, where a negative and significant coefficient of β_1 would confirm the hypothesis that increased physical exertion faced by a woman during agricultural activities diminishes total daily caloric consumption per AE. WRT_{wh} is the reproductive time allocated by each woman in a household, where a positive and significant coefficient of β_2 would confirm the hypothesis that a woman's greater allocation of time in family care and food preparation increases total daily caloric consumption per AE. W_{wh} is a vector of woman demographic and socio-economic characteristics, H_h is a vector of household demographic and socio-economic characteristics, R_r is a vector of two regional dummies created for Punjab and Sindh provinces and KPK province is considered as a control category. β_3, β_4, β_5 are vectors of coefficients of respective woman, household and regional confounders, respectively. β_o is intercept. μ_h represents household fixed effects. ε_{wh} is a random error term.

In addition to the $CAED_h$, we also estimate regression models with $HDDS_h$ given as a dependent variable in equation 2, which indicates diversity in household food consumption.

Similarly, in equation 3, HNL_h is another dependent variable, which is used to measure household nourishment level. Equations 1-3 have been analyzed using intrahousehold fixed-effects panel regression to account for within household endogeneity in allocating time in productive and reproductive activities by different women in a household. Picchioni et al. (2020) have observed that women's time variables are endogenous and dependent on many observed and unobserved demographic and socio-economic characteristics of women and households. To account for endogeneity, finding rigorous instrument is very difficult. However, building on recent work and benefiting from having information for more than one female participant for each household, we use intrahousehold fixed-effects panel regression to estimate address potential issues of selection bias in the agriculture-nutrition pathway (Kaul, 2018).

3. Results and Discussions

3.1. Descriptive Statistics

Table 3 presents descriptive statistics of various demographic and socio-economic characteristics of the 3,665 participating women in PRHPS. The average age of rural women in our sample is 34.12 years. Majority of sample rural women are illiterate (91.70%), with 3.68% as primary qualified, 3.57% as secondary qualified and 0.82% as tertiary qualified. About 65.46% women are currently married. Female literacy rate is abysmal in rural Pakistan. These statistics are in line with the latest results from Pakistan Demographic and Health Survey (NIPS, 2018).

Table 3 is approximately here.

The lower part of Table 3 provides a snapshot of allocation of women's time in productive, reproductive and non-productive activities in rural households. Women spend 2.82 hours per day on productive agricultural tasks, 5.03 hours per day on reproductive domestic tasks, and 8.17 hours per day on non-productive activities. All sample women are directly or indirectly engaged in paid and unpaid agricultural works, contradicting the stereotype of productive work being the domain of men (Doss et al., 2018). However, productive time seems to reflect a very small share of women's time. This may be due to agricultural works being contributed by other members of the household too or the time devoted to agricultural activities being under-reported owing to performed simultaneously with other primary activities. PRHPS only asks for primary activities, while ignoring secondary activities. Yet, rural women spend large proportion of their time on domestic works, implying that reproductive tasks in Pakistan still remain a feminized sphere. This finding is in line with the studies from the third world (Picchioni et al., 2020; Rao and Raju, 2020).

Table 4 shows descriptive statistics for all participating households in the sample. On an average, a rural household in Pakistan has 8.44 members. The average agricultural land (owned and rented in) cultivated by farmers is 4.94 acres, of which majority is cultivated with major crops such as wheat, rice, maize, sugarcane and cotton. The average crop production diversity is 2.15, whereas average livestock owned by farm households is 8.02. The average monthly farm income is Rs 20,349. About 52% of all households fall below the extreme poverty line of US$ 1.90 PPP, while 48% of the households are non-poor. Similar results are reported for rural poor farm households in Côte d'Ivoire (Knößlsdorfer et al., 2021).

Table 4 is approximately here.

Bottom of Table 4 reports household food security indicators. We measured food security status of household by developing three indicators such as total calorie consumption per adult equivalent per day, household dietary diversity score and household nourishment level. In our sample, the average calorie consumption is about 1,766 kcal per adult equivalent per day, which is considerably below than the minimum dietary requirement threshold of 2,243 kcal per AE per day (FAO, 0217). Average household dietary diversity score is 9.12, implying that households are deriving energy from nine food groups, which represents high household dietary diversity (Kennedy et al., 2011). Sibhatu and Qaim (2018) conclude that high production diversity is one of the major reasons behind high dietary diversity of farm households. However, 83% sample households are undernourished by consuming less than 2,245 kcal per AE per day. Only 16.56% households are well-nourished. These findings indicate poor food security status of rural households in Pakistan.

3.2. Average Net Household Food Security Effects of Women's Time-Use

We have analyzed the average net food security effects of rural women time devotion to productive, reproductive and non-productive tasks after controlling for demographic and socio-economic characteristics of women, household and regions. Results are estimated with household fixed-effects panel regression to account for intrahousehold labour dynamics and are reported in Table 4. Column I presents the results of total calorie consumption per adult equivalent per day. Age, education and marital status of women have no association with caloric intake. Increased devotion of women's time to productive activities diminishes calorie consumption by 60 kcal/AE/day. This implies that women's physical exertion caused by increased agricultural work leads to reduce food intake by members of the household. This is consistent with the findings of

Picchioni et al. (2020) that increase work burden leads to reduced energy intake by women. However, increased allocation of women in reproductive tasks leads to increase calorie consumption by 22 kcal/AE/day. This implies that women's reproductive works in particular family care and food preparation are important for the proper functioning of the household. Although women's reproductive work is rarely recognized as real work (Rao, 2012). Contrarily, women's time is considered as limitless (Doss et al., 2018).

Table 5 is approximately here.

Among household characteristics, we find significant association of calorie consumption with household size, crop production diversity, livestock ownership and poverty status. Household size and poverty status decrease caloric intake but crop diversity and land ownership increase caloric intake. Recent studies have concluded that increased agricultural production diversity leads to increase household food consumption (Sibhatu and Qaim, 2018). Nonetheless, poverty reduces affordability and accessibility of households to secure adequate, safe and nutritious foods (Obayelu and Orosile, 2015).

Among regional characteristics we did not find significant differences in calorie consumption of households in Punjab and KPK provinces. Though households of Sindh province are significantly consuming 306 more kcal/AE/day.

Column II estimates net household dietary diversity effects of rural women's time-use by household fixed-effects panel regression. We find that greater allocation of time to agricultural work by women reduces household dietary diversity score by 5%, whereas reproductive time increases dietary diversity by 3%. Similarly, column III estimates net household nutrition effects of rural women's time-use by household fixed-effects panel logistic regression. We observe that women's productive time diminishes household nourishment level by 20%, while women's

reproductive time improves nourishment by 5%. The results of confounding factors were almost consistent across three models.

3.3. Average Net Household Food Security Effects of Women's Time-Tradeoffs

Table 6 estimates average net household food security effects of women's time-tradeoffs between work burdens and leisure. This would help to identify two channels through which agriculture-nutrition effects are possible. For this purpose, we generate two unique time-tradeoff covariates such as a ratio of productive time to leisure time and a ratio of productive time to reproductive time. Column 1 presents estimates of calorie consumption model. Our results demonstrate that increase in productive time forces a woman to substitute her leisure hours, which increase physical exertion of a woman leading to reduce caloric intake by about 31 kcal/AE/day. This finding is also consistent with Picchioni et al. (2020) that increased time constraints lead to reduce women's energy levels. Moreover, women's time poverty negatively influences household food consumption by reducing their time for relaxing and interacting with the neighbours. In rural settings of the developing world, neighbours also play important reproductive role in the absence of main female member in the household.

In addition, we find that if increased woman productive time leads to reduce reproductive time i.e., time for food preparation diminishes calorie consumption by 75 kcal/AE/day. This second channel finds to have more food security damaging effects of feminization of agriculture. FAO (2015) reports that women time poverty can affect household food security and prosperity, with additional effects on their health and wellbeing. Jackson and Palmer-Jones (1998) explain that no-trade-offs are assumed in women allocation of time and income in evaluating increasing women's role agriculture. Ruel and Alderman (2013) also conclude that opportunities of income

generation lead to trade-off between productive and reproductive time. However, increased productive time may reduce time for reproductive tasks and non-productive tasks i.e., leisure. Hence, capturing such time trade-offs may help to provide precise estimates for wellbeing of women and households (Rao and Raju, 2020). This article provides first empirical evidence of real time trade-offs between productive, reproductive and non-productive activities in rural households of Pakistan. We find almost similar results for the rest of two food security indicators reported in columns II and III of Table 6.

Table 6 is approximately here.

4. Conclusions

Achieving food security is a major development challenge for every developing country. This article estimates rural women's patterns of time-use in productive, reproductive and non-productive tasks on household food security indicators. However, there is limited research on how women's time poverty translates into poor nutrition outcome. We contribute by integrating recall food consumption data with time-use data from Pakistan rural household panel survey and employing household fixed-effects panel repression. Household fixed-effects control for intrahousehold labour dynamics in a household. Due to under-reporting of women's work, we use time-use as an indicator of the work burdens associated with livelihood activities. Rural women devote 2.82 hours per day to productive activities, 5.03 hours per day to reproductive activities and 8.17 hours to non-productive activities. Our results suggest that increased allocation of women's time to productive activities deteriorates calorie consumption by 60 kcal per adult equivalent per day, household dietary diversity score by 21% and household nourishment level by 5%. We further identify two possible channels of women's time trade-offs between productive,

reproductive and non-productive, due to incentive of increased income. We find that increased time to productive tasks by a woman diminishes her time for reproductive and non-productive tasks that ultimately leads to reduce household food security status. More focus of this article on women's time poverty would help policy makers to understand and plan to reduce unintended negative nutritional consequences of increasing women productivity through agricultural interventions. Future research should inquire about women's time in both primary and secondary activities and evaluate seasonality in productive tasks to improve study design and findings.

This study suggests that for improving household food and nutrition outcome, there is either need to reduce productive burdens of women or need to compensate her work with better wages. Moreover, agricultural, health and nutrition interventions should be linked to minimize detrimental impacts of women's time burden (Johnston et al., 2018). However, policy makers in developing countries hardly put efforts to link such interventions to mature maximum welfare gains (Doss, 2018). This study highlights the need to estimate broader welfare impacts of increased participation of women in productive activities.

Conflict of Interest

The author(s) declare(s) that there is no conflict of interest regarding the publication of this article.

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Table 1: Distribution of rural households across districts and provinces

Punjab province		Sindh province		Khyber Pakhtunkhwa province	
Districts	**Households**	**Districts**	**Households**	**Districts**	**Households**
Attock	112	Dadu	112	Mansehra	112
Bahawalnagar	111	Hyderabad	112	Nowshera	112
Bhakkar	112	Jacobabad	110	**Total**	**224**
Dera Ghazi Khan	108	Sanghar	111		
Faisalabad	102	Thatta	112		
Jhang	111	**Total**	**557**		
Kasur	106				
Khanewal	106				
Multan	111				
Rahim Yar Khan	107				
Sargodha	111				
Vehari	112				
Total	**1309**				

Table 2: Crop calendar for study sites in Pakistan

Crops	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Wheat												
Rice												
Barley												
Maize												
Millet												
Sorghum												
Cotton												
Sugarcane												

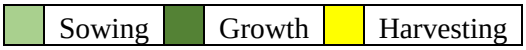

Table 3: Individual (rural woman) descriptive statistics

Variables	Mean	Standard Deviation
Age (years)	34.12	14.72
Illiterate (%)	91.79	27.46
Primary education (%)	3.68	18.84
Secondary education (%)	3.57	18.57
Tertiary education (%)	0.82	9.01
Marital Status (%)	65.46	47.56
Productive time (hours/day)	2.82	1.51
Reproductive time (hours/day)	5.03	3.19
Non-productive time (hours/day)	8.17	3.74

Data source: Pakistan Rural Household Panel Survey 2014

Table 4: Rural household descriptive statistics

Variables	Mean	Standard Deviation
Family Size (No.)	8.44	4.26
Total agricultural land (acres)	4.94	14.06
Crop diversity (No.)	2.15	1.59
Total livestock (No.)	8.02	11.08
Total farm income (Rs/month)	20,349	3.75
Poor households (%)	52.06	49.96
Non-poor households (%)	47.94	49.96
Total calorie consumption per adult equivalent per day (kcal)	1765.80	987.21
Household dietary diversity (No.)	9.12	1.44
Well-nourished households (%)	16.56	37.17
Under-nourished households (%)	83.44	37.17

Data source: Pakistan Rural Household Panel Survey 2014

Table 5: Determinants of food security indicators of rural households

Variables	Total calorie consumption per adult equivalent per day	Household dietary diversity	Household nutrition status
Woman characteristics			
Age (years)	-1.395 (1.487)	0.004 (0.003)	-0.007 (0.006)
Education (years)	0.314 (8.657)	0.022 (0.016)	-0.006 (0.035)
Marital Status (dummy)	49.971 (48.752)	-0.196** (0.089)	0.191 (0.198)
Productive time (hours/day)	-60.262*** (13.498)	-0.054** (0.025)	-0.206*** (0.065)
Reproductive time (hours/day)	21.600*** (6.915)	0.033*** (0.013)	0.049** (0.025)
Household characteristics			
Family Size (No.)	-47.167*** (5.122)	-0.054*** (0.009)	-0.183*** (0.026)
Total agricultural land (acres)	-1.787 (1.221)	0.002 (0.002)	0.003 (0.004)
Crop diversity (No.)	48.505*** (12.623)	0.096*** (0.023)	0.260*** (0.048)
Livestock owned (No.)	8.196*** (1.943)	0.008** (0.004)	0.032*** (0.007)
Poor household (dummy)	-83.401** (38.887)	-0.254*** (0.017)	0.148 (0.150)
Regional characteristics			
Punjab (dummy)[a]	-79.028 (56.304)	0.028 (0.103)	-0.501** (0.232)
Sindh (dummy)[a]	306.030*** (72.542)	0.205 (0.132)	0.681*** (0.271)
Intercept	2193.829*** (99.406)	8.532*** (0.181)	-
Model Statistics			
F-stat (12)	15.32***	9.48***	-
LR chi^2 (12)	-	-	156.00***
Observations	3,665	3,665	3,665

***, **, * Significant at 1%, 5% and 10% level, respectively.

[a] The control category is Khyber Pakhtunkhwa province.

Note: Coefficients are shown with standard errors in parentheses.

Data source: Pakistan Rural Household Panel Survey 2014

Table 6: Determinants of food security indicators of rural households

Variables	Total calorie consumption per adult equivalent per day	Household dietary diversity	Household nutrition status
Woman characteristics			
Age (years)	-1.112 (1.450)	0.003 (0.003)	-0.007 (0.006)
Education (years)	1.707 (8.527)	0.021 (0.016)	-0.003 (0.035)
Marital Status (dummy)	66.010 (48.167)	-0.185** (0.088)	0.249 (0.198)
Productive/leisure time ratio	-30.925* (17.845)	-0.035 (0.033)	-0.128* (0.069)
Productive/reproductive time ratio	-75.029*** (22.325)	-0.096** (0.041)	-0.136** (0.063)
Household characteristics			
Family Size (No.)	-47.215*** (5.066)	0.053*** (0.009)	-0.184*** (0.026)
Total agricultural land (acres)	-1.679 (1.212)	0.002 (0.002)	0.004 (0.004)
Crop diversity (No.)	50.602*** (12.490)	0.096*** (0.023)	0.268*** (0.049)
Livestock owned (No.)	8.394*** (1.932)	0.008** (0.004)	0.033*** (0.007)
Poor household (dummy)	-93.799** (38.412)	-0.264*** (0.071)	0.108 (0.149)
Regional characteristics			
Punjab (dummy)[a]	-100.244* (55.280)	0.028 (0.101)	-0.575*** (0.231)
Sindh (dummy)[a]	333.359*** (69.350)	0.264** (0.127)	0.741*** (0.260)
Intercept	2189.960*** (86.663)	8.651*** (0.159)	-
Model Statistics			
F-stat (12)	14.45***	9.22***	
LR chi^2 (12)	-	-	148.62***
Observations	3,495	3,495	3,495

***, **, * Significant at 1%, 5% and 10% level, respectively.

[a] The control category is Khyber Pakhtunkhwa province.

Note: Coefficients are shown with standard errors in parentheses.

Data source: Pakistan Rural Household Panel Survey 2014

Appendix 1: Table A1: Food groups for household diversity score in Pakistan

Food groups	**Origin**
Food group 1	**Plant origin**
1- Cereals and Grain Products	Wheat, Rice, Sorghum, Maize, Millet, Barley
2- Tubers and Roots	Potato, Turnip
3- Legumes, Nuts and Seeds	Pulses, Beans, Lentils, Peas, Nuts and Seeds
4- Vegetables	Vitamin A rich vegetables, dark green leafy vegetables, other vegetables
5- Fruits	Vitamin A rich fruits, other fruits
Food group 2	**Animal Origin**
6- Meat	Organ meat, flesh meat, poultry
7- Eggs	Chicken eggs
8- Fish and Other Sea Foods	Fresh and Dry
9- Milk and Milk Products	Milk, cheese, yogurt, butter
Food group 3	**Others**
10- Oils and Fats	Ghee, Butter, Vegetable oils
11- Sweets	Sugar, Honey, gur, sweetened soda, juice drinks, chocolate, candies, cookies cakes
12- Spices, Condiments and Beverages	salt, pepper, condiments, tea and coffee

Source: FAO (2010)