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Migration, gender labor division and food insecurity in Tajikistan☆

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ABSTRACT

In recent decades millions living in low-income countries like Tajikistan have migrated to support their livelihoods. This massive, predominantly male, out-migration has transformed the agricultural sector. On the one hand, household members with migrants who stay behind, usually female and children, might replace migrant member's previous tasks, leading to the feminization of agriculture. On the other hand, remittances can increase migrant households' income leading to a reduction in their work and increase in their food security as their purchasing power strengthens. We study the relationship between migration, food insecurity and gender labor division for two production systems in Tajikistan. Using propensity score matching with village fixed effects, we find non-migrant households are associated with having more months of food shortages and spending more days without eating food. In terms of the division of labor, women in migrant households were associated with being more involved in labor-intensive activities. Our results provide evidence that while migration is correlated with greater food security, the demand on women's time and labour increases. This has important implications for designing gender-inclusive agricultural and irrigation training and extension programs, which are usually targeted at males. Gender-sensitive design will be vital for improving countries like Tajikistan's food security, malnutrition, and water resource management.

1. Introduction

International migration increased by an estimated 119 million between 1990 and 2019, representing a 1.5 percent of annual growth rate (UNDESA, 2019). Today, roughly 3.5 percent of the world population live and work outside their birth countries (IOM, 2020). According to the International Monetary Fund (2020), in the last decade, total remittances from migration have increased considerably, surpassing $500 billion worldwide in 2016[1] (Hosny, 2020). Migration is a key livelihood strategy (Acharya & Leon-Gonzalez, 2014; Moniruzzaman, 2020) especially for agricultural households in low-income countries (Sunam & Adhikari, 2016; Duda et al., 2018). The decision to migrate is often taken collectively by the household, having a major impact on the everyday life of those remaining behind (Cebotari, 2018; Duda et al., 2018; de Brauw, 2019). Labor work in agricultural households is often divided by gender, where the distribution of tasks for men and women are determined by a society's values, beliefs, and norms (Bever, 2002; Mukhamedova & Wegerich, 2018; Kan & Aytimur, 2019); migration disrupts this distribution by reducing labor supply. However, migration also brings in remittances. Thus, migration affects household food security through changes in household food production due to changes in labor supply (Sunam &Adhikari, 2016) and the ability to purchase food through remittances (Karamba et al., 2010; Zezza et al., 2011; Craven & Gartaula, 2015; Regmi & Poudel, 2017). Migration also changes the labor burden of those left behind through both changes in household labor supply and remittances that may be used to hire wage laborers (Duda et al., 2018. Therefore, the overall consequences of migration on food security and the division of intra-household agricultural tasks

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[1] Actual remittances could be much higher as unrecorded remittances sent through informal channels are excluded (Hosny, 2020).

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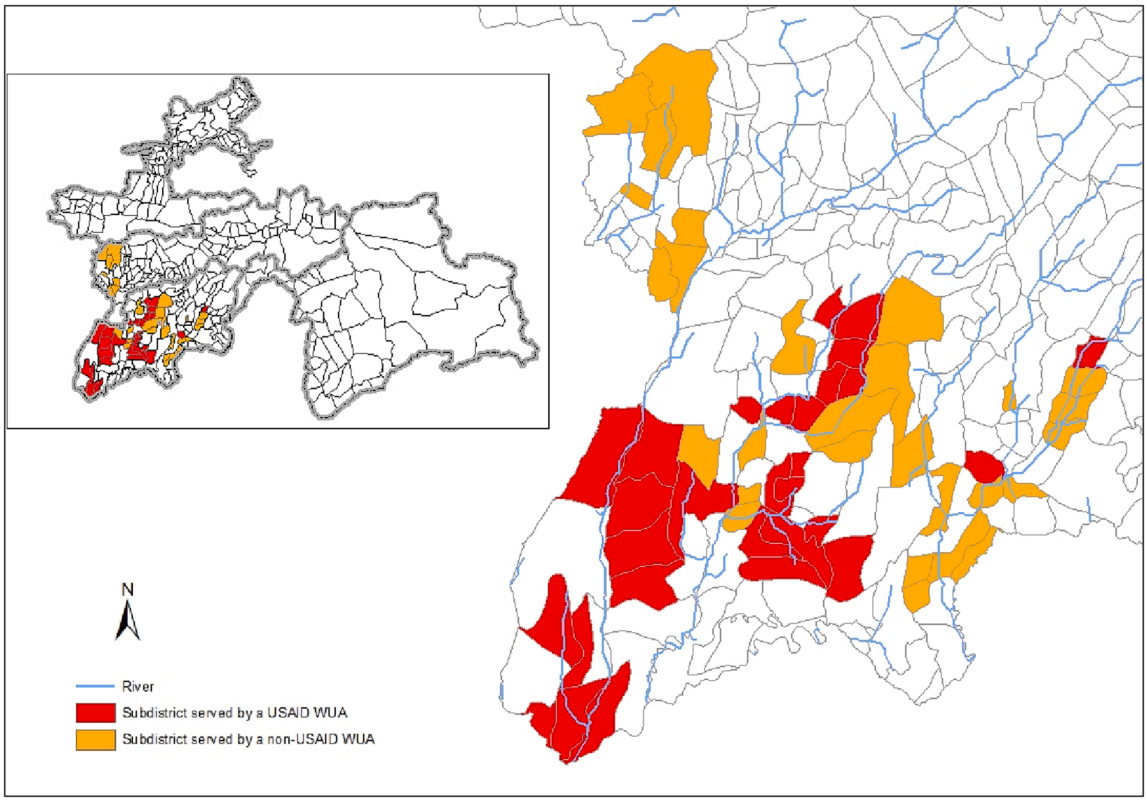

Fig. 1. Map of Tajikistan.

Table 1
Household Summary Statistics.

	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]
	Overall			**Migrant**			**Non-migrant**			
	N	**Mean**	**SD**	**N**	**Mean**	**SD**	**N**	**Mean**	**SD**	**Difference[a]**
Panel A: Household Characteristics, Training and Membership										
Completed secondary school (D)	1920	0.66	[0.47]	904	0.69	[0.46]	1016	0.64	0.48	−0.041
										(-1.91)
Household dependency ratio	1920	0.83	[0.67]	904	0.79	[0.7]	1016	0.86	[0.65]	0.070**
										(2.29)
Respondent and/or a household member received training related to waterand land management, crop cultivation or WUA governance (D)	1920	0.13	[0.34]	904	0.14	[0.35]	1016	0.13	[0.33]	−0.016
										(-1.00)
Respondent and/or household member is a memberof an agricultural and/or livestock group (D)	1920	0.03	[0.18]	904	0.03	[0.16]	1016	0.04	[0.18]	0.008
										(0.97)
Respondent and/or household member is a member of a WUA (D)	116	0.42	[0.5]	51	0.31	[0.47]	65	0.51	[0.5]	0.194**
										(2.12)
Panel B: Income, Remittances and Asset Index										
Total household income (USD)	1920	220.4	[495.2]	904	201.4	[512.3]	1016	237.4	[479.1]	35.95
										(1.59)
Total remittances received by the household (USD)	735	986.6	[1729.8]	735	986.6	[1729.8]	0	0	[0]	0
Household asset index	1919	0	[1.24]	904	−0.07	[1.22]	1015	0.06	[1.25]	0.129**
										(2.28)
Participated in income generating activities (D)	1920	0.78	[1.11]	904	0.63	[1.06]	1016	0.92	[1.14]	0.285*
										(5.66)

Notes: Columns 1,4 and 7 indicate the number of observations reported for each variable. Columns 2, 5 and 8 are the means of each variable. Columns 3, 6 and 9 are the standard deviation. Column 10 is the difference in means between migrant and non-migrant households. T-tests determine whether the difference in mean between migrant and non-migrant households is statistically significant. D indicates dummy variable, =1 if yes, =0 if no. [a]t-statistics in parentheses. *p < 0.10, **p < 0.05, ***p < 0.01.

Table 2
Plot Summary Statistics.

	[1] Overall N	[2] Mean	[3] SD	[4] Migrant N	[5] Mean	[6] SD	[7] Non-migrant N	[8] Mean	[9] SD	[10] Difference[a]
Panel A: Kitchen Garden										
Household has a kitchen garden (D)	1920	0.99	[0.11]	904	0.99	[0.11]	1016	0.99	[0.10]	0.003 (0.49)
Total area owned (hectares)	1897	0.13	[0.10]	892	0.13	[0.10]	1005	0.13	[0.11]	−0.003 (-0.59)
Total cultivated area to total area ratio (hectares)	1894	0.73	[0.31]	891	0.73	[0.28]	1003	0.74	[0.32]	0.006 (0.39)
Panel B: Presidential Plot										
Household has a presidential plot (D)	1920	0.34	[0.47]	904	0.36	[0.48]	1016	0.32	[0.47]	−0.043** (-1.98)
Total area owned (hectares)	651	0.11	[0.11]	327	0.11	[0.07]	324	0.11	[0.13]	0.007 (0.89)
Total cultivated area to total area ratio (hectares)	648	0.97	[0.17]	325	0.96	[0.19]	323	0.97	[0.16]	0.009 (0.63)
Panel C: Crops and Animal Products Kept for Self-consumption from Kitchen Garden and Presidential Plot										
# Crops grown on kitchen garden	1920	23.9	[19.7]	904	25.4	[20.7]	1016	22.6	[18.6]	−2.832** (-3.16)
# Crops grown on Presidential plot	1920	3.08	[6.87]	904	3.26	[7.08]	1016	2.92	[6.67]	−0.338 (-1.08)
Produced milk products (%)	1549	78.5	[34.5]	749	79.4	[34.1]	800	77.7	[34.9]	−1.74 (-0.99)
Produced eggs (%)	1549	23.6	[35.4]	749	22.3	[34.1]	800	24.7	[36.6]	2.445 (1.36)
Produced meat products (%)	1549	7.33	[17.3]	749	7.03	[17.6]	800	7.62	[17.1]	0.588 (0.67)

Notes: Columns 1,4 and 7 indicate the number of observations for each variable. Columns 2, 5 and 8 are means of each variable. Columns 3, 6 and 9 are standard deviation. Column 10 is the difference in means between migrant and non-migrant households. T-tests determine whether the difference in mean between migrant and non-migrant households is statistically significant. D indicates dummy variable, =1 if yes, =0 if no. [a]t-statistics in parentheses. *p < 0.10, **p < 0.05, ***p < 0.01.

becomes an empirical question, the answer to which can help guide effective future policies (Radel et al., 2010).

The relationship between male migration and female labor is likely to vary, depending on the opportunity cost (actual and perceived) of female labor, the availability and price of wage labor for hire in the local market, and the alternative expenditures the household can make. For example, some studies (Deere, 2005; Garikipati, 2009; Pattnaik et al., 2017) find that women take over the tasks in agriculture left vacant by migrants, thereby increasing women's labor. Similarly, in Albania, Mendola & Carletto (2012) find that women in migrant households were 32% more likely to supply unpaid work.[2] On the other hand, some studies find no increase in female labor use in agriculture as remittances are used to augment labor supply, by hiring daily wage workers (de Brauw et. al., 2008; Urama et al., 2017; Liu et al., 2019). For example, Funkhouser (1992) finds that in Nicaragua, migrant households were less credit constrained due to remittances, and for each $100 increase in remittance income, the probability of labor force participation by women decreased by 5 percentage points. Several other studies also find a reduction in female labor use in agriculture with migration (Rodriguez & Tiongson, 2001; Amuedo-Dorantes & Pozo, 2006; Bever, 2002; Radel et al., 2012; Lokshin & Glinskaya, 2009; de Brauw et al., 2008; Kalaj, 2013).

The effect of male migration on food security is also likely to vary, depending on what remittances are used for, and whether household production of agricultural commodities changes due to changes in household labor supply. Several studies find evidence that remittances are used to purchase food items, and thus reduce food uncertainties and help diversify their diets (Moniruzzaman, 2020; Rahman & Mishra, 2020; Regmi & Paudel, 2017; Crush, 2013; Atuoye et. al. 2017; Mabrouk & Mekni 2018; Abebaw et al., 2020; Isoto & Kraybill, 2017; Sulemana et al., 2019). For example, in Mexico, Mora-Rivera & van Gameren (2021) find that both international as well as internal remittances have significantly decreased severe food insecurity from 14.27 percentage points to 2.69 percentage points in households. Conversely, some authors find that an increase in income from remittances is not necessarily correlated with improved food security (Sunam & Adhikari, 2016; Crush, 2013; Atuoye et al., 2017; Duda et al., 2018) as remittances can be used in other ways, e.g., housing and education (Adams & Page, 2005). Karamba et al. (2010), for example, find that migrant households consume significantly lower meat and fish, vegetables, and fruits, but had higher consumption of less nutritious foods such as sugary beverages. Furthermore, some authors note that the reliability of remittances to improve food security is tenuous due to increasing dependence on imported foods and decrease in the production capacity of households (Sunam & Adhikari, 2016; Craven & Gartaula, 2015).

In this paper, we estimate the relationship between migration on household division of labor and food security in Tajikistan. Our objective is two-fold: first, we examine how male out-migration relates to the division of agricultural labor by gender within the household. Second, we examine how migration affects food security. We find that non-migrant households faced more months of food shortages and spent more days without eating food; and women in migrant households were more involved in labor-intensive activities. While migrant households are more food secure, the demand on women's time and labour demand increases.

Previous studies in Tajikistan find that remittance-receiving households participate less in the labor market (Justino & Shemyakina, 2012; Piracha et al., 2013; Murakami et al., 2021). For example, Murakami et al. (2021) find that sending one migrant from the household reduces the labor supply of those left behind by 5.4 percentage points and receiving remittances reduced the family member's participation further by 10.2 percentage points. In a qualitative study Mukhamedova & Wegerich (2018) find evidence that women in the Sughd province of Tajikistan have taken over irrigation services with roles of *mahalla* (community) *mirobs* (water masters), positions traditionally mainly held by men. Several studies have explored food security challenges in

[2] Other examples of studies that show an increase in women's labor and migration are Maharjan et. al., 2012; Katz, 2002; de Brauw et al., 2021.

Table 3
Estimated Results for Factors Influencing the Decision to Migrate (Logit regression).

Variables	[1] Kitchen Garden	[2] Presidential Plot
Socio-Economic Characteristics		
Dependency ratio of household	−0.049*	−0.490**
	(0.02)	(0.23)
Respondent is married (D)	0.023	0.281
	(0.05)	(0.44)
Age of respondent (**years**)	0.008	0.023
	(0.06)	(0.06)
Age squared of respondent (years)	−0.0001	−0.001
	(0.00)	(0.00)
Respondent was head of household (D)	−0.035	0.310
	(0.05)	(0.53)
Respondent had graduate education (D)	0.015	1.405**
	(0.05)	(0.46)
Respondent was spouse of the household head (D)	−0.031	−0.157
	(0.03)	(0.46)
Total household earnings (USD)	0.0001*	0.000
	(0.00)	(0.00)
Household asset index	−0.015*	0.032
	(0.01)	(0.11)
Household has a Presidential plot (D)	0.048*	0.424
	(0.03)	(0.63)
Household has a Dehkan farm (D)	−0.118***	0.305
	(0.03)	(0.44)
Household member received a training related to water and land management, crop cultivation or WUA governance (D)	0.052	0.569*
	(0.04)	(0.32)
Water User Association (WUA) in village (D)	0.001	−0.330
	(0.01)	(0.33)
Household member of an agricultural and/or livestock group (D)	−0.063	−1.633**
	(0.07)	(0.62)
Economic		
Participate in income generating activities (D)	−0.206***	−0.998
	(0.03)	(0.28)
Environmental		
Household has a piped water source (D)	0.085	0.236
	(0.08)	(0.42)
Garden adjacent to house (D)	−0.075	−0.609
	(0.07)	(0.83)
Garden located at the middle of canal (D)	0.117**	−0.410
	(0.04)	(0.48)
Garden located at the tail of canal (D)	0.065	0.297
	(0.04)	(0.38)
Observations	1897	579

Notes: This table reports the coefficients of a logit regression evaluated at the means indicating variables that influence the likelihood of migrating. Standard errors are in parentheses. D indicates dummy variable, =1 if yes, =0 if no. *p < 0.10, **p < 0.05, ***p < 0.01.

Tajikistan (Akramov & Shreedhar, 2012; Asadov, 2013; Husenov et al., 2015; Clement et al., 2019; Kawabata et al., 2020). However, only one study, Azzarri & Zezza (2011), investigates the relationship between remittances and food security, focussing on child malnutrition. They find migration has a positive impact on overall child z-scores (the difference in standard deviations of a child's height-for-age from the median height-for-age of children from the same age and gender in a reference population) increasing it by 0.2 standard deviations. Additionally, migration had a positive and statistically significant effect on kilocalorie-intake. Overall, their results suggest that children living in migrant households have better nutritional access, which they attribute to the income effect of migrant remittances.

We contribute to the literature on migration-food security-labor in three ways. First, we are the first study we are aware of that analyzes the changes in specific labor division tasks by gender within a household due to migration, and the resulting relationship this has on food security.

Table 4
Migration and Household Food Security.

Dependent Variable	[1] Nearest Neighbor	[2] Kernel[a]
# Months with food shortage	−0.245**	−0.277***
	(0.08)	(0.08)
In the last 12 months, did your household ever		
Rely on cheap, less expensive food (D)	−0.056*	−0.051*
	(0.03)	(0.03)
Borrow money for food (D)	−0.027	−0.028
	(0.03)	(0.03)
Purchase food on credit (D)	−0.039	−0.035
	(0.03)	(0.03)
Eat seed saved for cultivation (D)	−0.047	−0.069**
	(0.03)	(0.03)
Sell any useable household items (D)	−0.070**	−0.072**
	(0.03)	(0.03)
Skip a meal or reduce quantity (D)	−0.054*	−0.053*
	(0.03)	(0.02)
Spend days without eating food (D)	−0.077***	−0.077***
	(0.02)	(0.02)
In the last four weeks, did your households ever		
Have no food to eat due to lack of resources (D)	−0.071**	−0.079**
	(0.03)	(0.03)
Sleep hungry at night due to food shortage (D)	−0.073***	−0.075***
	(0.02)	(0.02)
Go whole day without food due to food shortage (D)	−0.062***	−0.062***
	(0.02)	(0.02)
N		
Migrant	892	892
Non-migrant	825	993

Notes: Columns 1-2 report the PSM coefficients using Nearest Neighbor matching and Kernel matching with village fixed effects for food security variables in migrant and non-migrant households. Each line is a different outcome variable. D indicates dummy variable, =1 if yes, =0 if no. There were a total of 892 migrants and 1005 non-migrants. [a]Epanechnikov kernel with 0.06 bandwidth is used. Robust standard errors are reported in parentheses. *p < 0.10, **p < 0.05, ***p < 0.01.

Combining these concepts together offers a comprehensive and broader understanding of how migration affects food security conditions in rural households. Furthermore, studying gender labor division also provides insights into women and men's access and control over resources which can help guide better policies (Quisumbing and Doss, 2021). Second, we are the first study that analyzes these interactions among two types of land or production systems in Tajikistan – the kitchen garden and the presidential plot, defined below, allowing us to differentiate the effect of migration on labor and food security by production system type. Finally, we focus on specific labor tasks surrounding water and crop management in Tajikistan, as water is an important component in agricultural production and is traditionally managed by men (Akramov & Shreedhar, 2012). Given low rainfall rates, Tajikistan heavily relies on its water resources, using up to eighty-four percent of its surface and ground water for irrigation (Sehring, 2007). With its history of poorly managed irrigation systems which were revised through committed investments and efforts by the government and international development donors (Akramov & Shreedhar, 2012), we explore the management of irrigation systems as the gender composition of the agricultural work force changes.

2. Background

Tajikistan is a low-income, land locked country located in Central Asia (Clement, 2011; Zetova & Cohen, 2019). It has a population of 9 million people (Kawabata et al., 2020), occupying 142,000 square kilometers of which 93 percent is mountainous (Akramov & Shreedhar, 2012). Tajikistan gained its independence from the Soviet Union in 1991

Table 5
Migration and Gender Labor Division on Kitchen Gardens.

Dependent Variable	[1] Nearest Neighbor	[2] Migrant	[3] Non-migrant	[4] Kernel[a]	[5] Migrant	[6] Non-migrant
A female was involved in the following Irrigation System Management						
Cleans irrigation canal (D)	0.059**	776	701	0.050**	658	734
	(0.03)			(0.02)		
Cleans smaller irrigation ditch (D)	0.017	673	705	0.059**	776	850
	(0.02)			(0.02)		
Sets up irrigation system (D)	0.059*	780	733	0.063**	779	864
	(0.03)			(0.03)		
Guides water flow (D)	0.073**	836	764	0.077**	835	924
	(0.03)			(0.03)		
Determines amount of irrigation water to apply (D)	0.147***	852	787	0.127***	849	935
	(0.03)			(0.03)		
Determines timing of irrigation (D)	0.095***	858	779	0.093***	857	941
	(0.03)			(0.03)		
Speaks with irrigation service provider (D)	0.095***	679	639	0.092***	677	769
	(0.03)			(0.03)		
A female was involved in the following Agriculture Crops Management						
Sows seeds (D)	0.077**	874	809	0.084**	874	955
	(0.03)			(0.03)		
Sprays pesticides (D)	0.087**	589	542	0.092**	589	665
	(0.03)			(0.03)		
Applies fertilizers (D)	0.104***	749	690	0.108***	749	823
	(0.03)			(0.03)		
Purchases agricultural inputs (D)	0.071**	857	795	0.072**	857	940
	(0.03)			(0.03)		
Determines which crops to cultivate (D)	0.075**	877	803	0.083**	877	966
	(0.03)			(0.03)		
Determines quantities of agricultural products to sell or consume (D)	0.086**	661	624	0.096**	660	749
	(0.03)			(0.03)		
Determines quantities of livestock to sell or consume (D)	0.068**	592	545	0.074**	592	659
	(0.03)			(0.03)		
Processes and stores crops (D)	0.062**	830	782	0.060**	830	935
	(0.03)			(0.03)		

Notes: Columns 1 and 4 report the PSM coefficients using Nearest Neighbor matching and Kernel matching, respectively, with village fixed effects. Columns 2, 3, 5 and 6 indicate the number of observations on each variable in migrant and non-migrant households. There were a total of 892 migrants and 1005 non-migrants who owned a kitchen garden. Each line is a different outcome variable. Robust standard errors are reported in parentheses. D indicates dummy variable, =1 if female, =0 if male. [a]Epanechnikov kernel with 0.06 bandwidth is used. *p < 0.10, **p < 0.05, ***p < 0.01.

and immediately after was engulfed in a civil war that lasted from 1992 to 1997 (Azzarri & Zezza, 2011; Kawabata et al., 2020). Subsequently, human, social and economic development declined (Jones et al., 2007). Tajikistan was historically the poorest country in the Soviet Union and is today still classified as one of the poorest countries in the world (Erlich, 2006; Azzarri & Zezza, 2011; Clement, 2011; Kan & Aytimur, 2019). Nearly three quarters of the poor reside in rural areas (Clement, 2011; Azzarri & Zezza, 2011; Akramov & Shreedhar, 2012; Balasubramanya et al., 2018) and approximately 71.1 percent are engaged in agricultural work (Olimova & Bosc, 2003; Kan & Aytimur, 2019, Socio-demographic Sector, 2019). The hardships from the civil war, persistent poverty, and unemployment lead to mass outmigration of the young Tajik population (Olimova & Bosc, 2003; Clement, 2011; Piracha et al., 2013; Zetova & Cohen, 2019). During the civil war, most migrants were refugees; however, from the mid 1990s, labor migration took precedence, leading to large out-migration mainly to Russia (Olimova & Bosc, 2003; Jones et al. 2007). The majority of the Tajik population speaks Russian and does not require a visa to travel to Russia, facilitating migration there (Azzarri & Zezza, 2011). In 2009 it was estimated that 12 percent of Tajikistan's population had migrated for work (Cebotari, 2018). In this study, which was conducted in 2015, around 47% of households had at least one migrant. Between 2010 and 2015, Tajikistan had the highest average percentage of GDP attributed to remittances globally, at approximately 40 percent (Hosny, 2020).

Crop yields have improved little since the fall of the Soviet Union and the decollectivizing of state farms, (Asadov, 2013) making Tajikistan heavily dependent on imported food (Kawabata et. Al. 2020). According to Akramov & Shreedhar (2012), it is estimated that 50 percent of cereals, 80 percent of poultry products and 75 percent of vegetable oil in Tajikistan are imported for consumption. This makes Tajikistan susceptible to external food shocks (Karamba et al., 2010). Food security concerns are even higher for poor, rural households who spend 60 percent of their expenditure on food, compared to better-off Tajik households who spend 40 percent of their expenditure on food (Kawabata et al., 2020).

After the dismantling of the Soviet Union and the end of the civil war, Tajikistan's government began to decollectivize state farms into private farms called *dehkan* farms (Behnke, 2008). The average *dehkan* farm is around 3–5 ha and is typically farmed by 3 households that are often related by blood. In 2011, these farms constituted 65% of arable land and produced 20% of the gross agricultural output (Buisson and Balasubramanya, 2019). Cotton is typically cultivated on *dehkan* farms in the summer, and wheat in the winter. However, only about 12–13% of households have access to such a farm, and these are usually socioeconomically better-off (Behnke, 2008; Boboyorov, 2012). In contrast, all rural households in Tajikistan have a *kitchen garden*, which are typically used to cultivate fruits and vegetables, and are adjacent to the dwelling of households (Behnke, 2008; Boboyorov, 2016; Buisson & Balasubramanya, 2019). Though they occupied only 20% of the arable land in 2011, *kitchen gardens* contributed to 65% of the gross agricultural output (Buisson & Balasubramanya, 2019). These gardens are an important production system for households' overall food security and livelihood (Mukhamedova & Wegerich, 2018). A third production system common in Tajikistan is *presidential plots*, which belong to economically

Table 6
Migration and Gender Labor Division on Presidential Plots.

Dependent Variable	[1] Nearest Neighbor	[2] Migrant	[3] Non-migrant	[4] Kernel[a]	[5] Migrant	[6] Non-migrant
A female was involved in the following Irrigation System Management						
Cleans irrigation canal (D)	0.002	203	167	0.002	201	204
	(0.04)			(0.04)		
Cleans smaller irrigation ditch (D)	−0.011	230	197	−0.010	228	241
	(0.04)			(0.04)		
Sets up irrigation system (D)	−0.021	230	203	−0.032	229	243
	(0.04)			(0.04)		
Guides water flow (D)	0.017	237	210	−0.023	235	248
	(0.04)			(0.04)		
Determines amount of irrigation water to apply (D)	−0.031	250	216	−0.038	246	256
	(0.05)			(0.05)		
Determines timing of irrigation (D)	0.031	248	213	0.006	245	255
	(0.05)			(0.05)		
Speaks with irrigation service provider (D)	0.085*	239	197	0.090**	238	228
	(0.04)			(0.04)		
A female was involved in the following Agriculture Crops Management						
Sows seeds (D)	−0.103*	246	210	−0.103*	243	246
	(0.06)			(0.06)		
Sprays pesticides (D)	0.037	141	119	0.028	140	165
	(0.02)			(0.03)		
Applies fertilizers (D)	0.005	229	183	0.025	223	224
	(0.04)			(0.04)		
Purchases agricultural inputs (D)	0.018	243	218	0.003	242	252
	(0.04)			(0.04)		
Determines which crops to cultivate (D)	0.004	264	228	−0.021	260	273
	(0.06)			(0.06)		
Determines quantities of agricultural products to sell or consume (D)	0.039	187	166	0.054	187	208
	(0.06)			(0.06)		
Determines quantities of livestock to sell or consume (D)	0.08	179	157	0.038	179	204
	(0.06)			(0.06)		
Processes and stores crops (D)	0.103*	243	194	0.158**	242	255
	(0.06)			(0.05)		

Notes: Columns 1 and 4 report the PSM coefficients using Nearest Neighbor matching and Kernel matching with village fixed effects. Columns 2, 3, 5 and 6 indicate the number of observations on each variable in migrant and non-migrant households. There were a total of 327 migrants and 324 non-migrants who owned a presidential plot. Each line is a different outcome variable. Robust standard errors are reported in parentheses. D indicates dummy variable, =1 if female, =0 if male. [a]Epanechnikov kernel with 0.06 bandwidth is used. *p < 0.10, **p < 0.05, ***p < 0.01.

disadvantaged households. They were distributed twice through Presidential Decrees[3] in 1995 and 1997 to households who had<0.15 ha of land for agricultural activities (Behnke, 2008; Boboyorov, 2012) to improve their food security (Boboyorov, 2012). In 2009, there were approximately 375,000 *presidential plots*, accounting for 9% of the total arable land (Lerman & Sedik, 2008).

3. Methodology and data

Data

The data used in this paper come from a study that was implemented in 2016 in Tajikistan (see Buisson et al., 2016), in three of the four regions of Tajikistan – Khatlon, Sughd and Districts of Republican Subordination in 80 *jamoats*[4] shown in Fig. 1. Forty *jamoats* were served by water user associations (WUAs) created by the government and 40 *jamoats* were served by WUAs created by USAID, under the Feed the Future Program. These two groups of *jamoats* were selected to be similar in observable characteristics such as agricultural patterns, sources of water for irrigation, population, access to infrastructure and markets. In each *jamoat*, two villages were selected with proportional random sampling (PRS)[5] with criteria for canal type and location of the village along the canal. In each selected village, 12 randomly selected households were surveyed. Households that were not engaged in farming were excluded from the study. The survey was administered to the women who knew most about the household's agricultural activities. The survey included detailed information on household characteristics, socioeconomic conditions, crops cultivated, water and irrigation management, land characteristics, migration, food security, and gender labor division, with separate modules specific to kitchen gardens, presidential plots and *dehkan* farms.

A total of 1,920 households in 160 villages were surveyed, of which 904 households had one or more member(s) who migrated in 2015. These households are categorized as migrant households and the remaining households, 1016, are categorized as non-migrant.

3.1. Methodology

A simple regression between migration and food security measures, and between migration and gender labor division, is prone to bias due to observed factors (e.g., education, age, migrant linkages) and unobserved factors (e.g., the migrant's internal motivation) that affect both the decision to migrate and the outcome variables of interest (Becker & Ichino, 2002; Caliendo & Kopeining, 2008; Zhang et al., 2019;

[3] Decrees of the President of the Republic of Tajikistan No 342 in 1995 and No 874 in 1997 (Boboyorov, 2012).

[4] Jamoat are sub-district local government structures that unite numerous rural settlements (Boboyorov, 2012).

[5] PRS is a method that allows researchers to divide a population into a smaller sample that represents the entire population being studied (Hirzel & Guisan, 2002).

Clougherty et al., 2016; Wooldridge, 2002). To reduce this bias, we use propensity score matching (PSM) to construct comparable groups of migrant and non-migrant households using observable characteristics that were both exogenous to migration[6] and similar in migrant and non-migrant households.[7]

We estimate the average treatment effect on the treated using PSM in two steps. We first construct propensity scores using a logit model (equation 1) where the dependent variable is the migration status of the household:

$$P(X_i) = Pr(\text{migration} = 1) = \beta_0 + \beta_1 A_i + \gamma E + \varnothing X + v_i + \varepsilon_i \quad (1).$$

where A_i indicates whether household *i* participated in income generating activities (IGA) other than the sale of agriculture and livestock products produced by the household[8], E is a vector of environmental factors (i.e., water access, need to pay for water, the presence of a piped water line in the household dwelling, and the location of a plot along the irrigation canal), and X is a vector of socio-economic characteristics (i.e., dependency ratio, education, age, marital status, earnings, the presence of a kitchen garden, asset index, relation to the household head, water and land management training, the presence of a water user association in the village, and membership of any groups in the village). Additionally, we control for village fixed effects, v_i, to reduce time-invariant unobserved factors that might affect local infrastructure, sociopolitical factors, geographic location and administrative differences. These environmental and socio-economic characteristics should either be fixed or measured before migration (Heckman & Robb, 1985; Caliendo & Kopeining, 2008). Without panel data or data that explicitly state when they were collected relative to migration, our cross-sectional data limit our ability to assess this. This first step will affect the subsequent propensity score matching estimators (Abadie and Imbens 2016). Therefore, further work and data are needed to refine our identification strategy and implementation, e.g., by using data that explicitly state whether they held true pre-migration or were recorded pre-migration. As a robustness check, however, we also estimate the propensity scores using a more parsimonious model, excluding earnings, asset index, dependency ratio and whether the household participated in an income generating activity (IGA), and we find that our results largely hold.

In the second step, we estimate the average treatment effect on the treated (ATT) (Rosenbaum & Rubin, 1983) using two matching methods, Nearest Neighbor Matching (NNM) with replacement and Kernel Matching (KM)[9]:

$$E[Y_{i1} - Y_{i0} \,|D_i = 1] = E[E\{Y_{i1}|D_i = 1, p(X_i)\} - E\{Y_{i0}|D_i = 0, p(X_i)\}|D_i = 1] \quad (2).$$

where Y_{i1} (Y_{i0}) is the outcome of interest, defined below, for a household with (without) a migrant and D_i is an indicator equal to 1 (0) if household i has (not) migrated. More specifically, we define migration = 1 if a household had one or more members that were migrants at the time of the survey in 2015.[10] The estimator from (2) yields consistent estimates of ATT if the covariates, X, properly characterize migration. As aforementioned, we control for environmental factors (Barrios et al., 2006; Damania, 2020) and socio-economic characteristics (Todaro 1969; De Jong, 2000; Czaika & Haas, 2017) to match migrant and non-migrant households for comparison. However, as we cannot control for all covariates affecting migration, our ATT are not purely causal. Furthermore, because some households we define as non-migrants may in fact have recently experienced migration, they may not constitute an ideal control. Finally, PSM methods have garnered additional recent criticisms, e.g., attempting to create a randomized experiment rather than a blocked randomized experiment (King and Nielsen, 2019). Therefore, the relationships we examine are strong associations or correlations. Further work is needed to reduce this bias, for example, by using different estimation methods, like instrumental variables or a randomized controlled trial. Note, however, that the study of migration using a randomized controlled trial design is particularly difficult given the importance and weight of participating in migration.

3.2. Outcome variables

We measure gender labor division by asking whether women or men decided on or performed specific tasks relating to managing the household irrigation system (i.e., cleaning the irrigation canal, cleaning irrigation ditches, setting up the irrigation system, guiding water flow, applying irrigation water, speaking with the irrigation service provider), and managing agricultural crop production decisions (i.e., making input purchases and use, choosing what crops to grow, selling crops, making consumption decisions, processing and storing crops, selling livestock, making and using purchases).

The definition of food security has evolved over the last few decades and new measures have been introduced both at national and household levels to reflect these changes (Izraelov & Silber, 2019). Here we measure household food security in three ways given the data we have available. First, we study the number of months the respondent's household reported facing food shortages in the last twelve months. Second, we create binary variables indicating whether respondents reported taking certain measures to tide over shortages (e.g., rely on cheaper food or borrow money for food). Finally, we again create indicators if households experienced any of the following hardships in the four weeks preceding the survey due to food shortages: had no food to eat at home, went to bed hungry at night, and went a whole day without food.

4. Results

4.1. Summary statistics

Almost 48% of households in our sample had at least one member who was a migrant in 2015, the majority of whom, or 94.5%, migrated to Russia. Of the 904 households with migrants, 98% of migrating members were male with an average age of 32 years. Migrants were

[6] This is known as the Conditional Independence Assumption (Smith & Todd, 2005). The observable covariates used should be stable across time and/or measurable before migration, so they are not confounded with outcomes (Heckman & Robb, 1985).

[7] This in known as the Common Support Assumption (CSA) (Caliendo & Kopeining, 2008; Smith & Todd, 2005). The probability of being in a migrant household is the same as the probability of being in a non-migrant household based on each possible value of observable covariates used (Lechner & Strittmatter, 2017).

[8] More specifically, income generating activity refers to participating in any activity that earns an income, except for the sale of agriculture and livestock products produced by the household. This includes wages from agricultural labor performed, incomes from small businesses, salaries from white-collar employment, etc. It is a dummy variable to capture that the household has other sources of income than just those from sale of agricultural/livestock products produced by the household.

[9] Different matching algorithms exist and differ in how they assign weights to observations based on observable characteristics (Dehejia & Wahba, 2001; Smith & Todd, 2005). We choose the matching methods with the greatest common support and closest mean, which are Nearest Neighbor Matching (NNM) and Kernel Matching (KM).

[10] The survey question asked "How many people from your household were migrant laborers in 2015?". Therefore migration is defined by individuals who were living away from their homes in the year 2015. These individuals might have left in 2015 or before 2015. Furthermore, the survey does not capture an individual that might have returned back home, since in 2015, they were no longer living away.

away for as little as 1 month and as much as 48 months[11]. Migrants who were previously working on their own agricultural farms stayed away for a shorter duration, approximately 8 months on average, compared to migrants who were unemployed before migration who stayed away for approximately 10 months, on average. Employment on one's own farm was the most commonly-held job before migration (34%). However, 39% percent of migrants were previously unemployed.

Table 1 shows household summary statistics by household migrant status. Households with migrants had fewer dependents than non-migrant households ($p < 0.05$). Only 13% of all households benefited from training related to water and land management, crop cultivation, or water user association (WUA) governance in the last five years. Migrant households were less likely to be a member of a WUA and had a lower asset index (Table 1, $p < 0.05$).

Table 2 shows summary statistics at the plot level. Almost all migrant and non-migrant households owned kitchen plots, which were similar in size across both groups (Table 2, panel A). However, more migrant households owned presidential plots (36 %) compared to non-migrant households (32%; $p < 0.05$). Panel C shows that 23 percent of the crop harvested from kitchen gardens was retained for self-consumption compared to presidential plots in which only approximately 3 percent was retained for self-consumption. Migrant households cultivated a larger number of crops in their kitchen gardens, statistically significant at the 5-percent level. Tables A1-A3 in the appendix show summary statistics for the outcome variables. Table 1A shows that more than the majority, 52% of households, skip a meal or reduce the quantity consumed, showing relative high food insecurity.

4.2. Propensity score estimation

Table 3 shows the marginal effects estimated at the means of a logit regression used to estimate the propensity scores (equation 1). Since we estimate some effects at the plot-level, we report propensity scores both among all households (who all own kitchen plots) (column 1) and also among the subset of households who own and cultivate a presidential plot (column 2). For all households (with kitchen plots), those with more dependents were 4.9 percentage points less likely to be a migrant household ($p < 0.10$). Households that participated in income-generating activities were 20.6 percentage points less likely to be a migrant household ($p < 0.01$). Households that owned a presidential plot were 4.8 percentage points more likely to be a migrant household ($p < 0.10$), while households that owned a *dehkan* farm were 11.8 percentage points less likely to be a migrant household ($p < 0.01$). These results were used to calculate propensity scores for each household, and then NNM and KM selected similar pairs of migrant and non-migrant households. Table A4 in the appendix shows the differences in observed characteristics between migrant and non-migrant households before matching through NNM and KM.

4.3. Migration, food security and labor division

Table 4 reports the relationship between migration and household food security using NNM and KM PSM with village fixed effects. We comment on the NNM results here, but the results hold when matching by KM. Migrant households faced 0.25 fewer months of food shortages in the last twelve months compared to non-migrant households ($p < 0.05$). In the past twelve months, migrant households were 5.6 percentage points less likely to rely on cheaper food ($p < 0.1$), 7 percentage points less likely to sell useable household items ($p < 0.05$), 5 percentage points less likely to skip a meal or reduce the quantity consumed ($p < 0.10$), and 7 percentage points less likely to spend days without eating ($p < 0.01$). Migrant households were 7 percentage points less likely to not have had food to eat at least once in the last four weeks due to lack of resources ($p < 0.05$), 7 percentage points less likely to have slept hungry at least once in the last four weeks ($p < 0.01$), and 6 percentage points less likely to have gone a whole day without eating anything at least once in the last four weeks ($p < 0.01$). These results are robust when we additionally control for the interaction between migration and ownership of a presidential plot (Appendix A5).

Table 5 estimates the relationship between migration and labor division by gender using NNM and KM with village fixed effects for households with kitchen gardens. Women in migrant households were 5 percentage points more likely to be involved in cleaning the irrigation canal, and 7 percentage points more likely to guide irrigation water flow ($p < 0.05$ in all cases). Similarly, women in migrant households were 6 percentage points more likely to be involved in setting up the irrigation system ($p < 0.1$). Women in migrant households were 15 percentage points more likely to determine the amount of irrigation water to apply, 9 percentage points more likely to determine the timing of irrigation and 9 percentage points more likely to speak with irrigation service providers ($p < 0.01$ in all cases). Likewise, women in migrant households were 7 percentage points more likely to sow seeds, 8 percentage points more likely to spray pesticides, 7 percentage points more likely to purchase agricultural inputs, 8 percentage points more likely to determine which crops to cultivate, and 7 percentage points more likely to determine quantities of agricultural products to sell or consume ($p < 0.05$ in all cases). Women in migrant households were 11 percentage points more likely to apply fertilizers ($p < 0.01$). These results, which cannot be taken as directly causal for reasons discussed above, are consistent with the narrative provided by respondents. The majority, or 62.72% of households with migrants, indicated they had personally experienced an increase in their workload, while 37.28% had not.

Table 6 shows the labour division breakdown by gender on presidential plots. Women in migrant households were 9 percentage points more likely to speak with the irrigation service provider ($p < 0.1$) and 10 percentage points more likely to process and store crops ($p < 0.1$) than women in non-migrant households. Migrant households were 10 percentage points more likely to sow seeds ($p < 0.1$).Table A5.

Our results are robust when we exclude potentially endogenous variables that might influence migration and be influenced by migration – earnings, asset index, dependency ratio and whether the household participated in an IGA. The results, shown in Appendix Tables A6-A8, are consistent with those reported above. Furthermore, given the large number of outcome variables we examine, we correct for multiple hypothesis testing by estimating sharpened q-values. These are reported in Appendix Tables A9-A10, and we see that our results hold when we correct for multiple hypotheses.

5. Discussion

The literature on whether and how migration affects the food security of those left behind is mixed, with some studies suggesting that migration improves food security (such as Justino & Shemyakina 2010; Azzarri & Zezza 2011; Akramov & Shreedhar, 2012; Crush, 2013; Atuoye et. al. 2017; Mabrouk and Mekni 2018 Abebaw et al., 2020), while others find no such relationship (e.g. Craven & Gartaula, 2015; Duda et al., 2018; Karamba et al., 2010; Weiler et al., 2017). Our findings support the former – we find that migrant households in Southern Tajikistan that owned kitchen gardens and presidential plots were more food secure than households with no migrants. Migrant households faced fewer months of reported food shortages and were less likely to resort to coping strategies to tide over periods of food shortages, e.g., distress asset sales, switching to poorer quality foods, or reducing meals.

Similarly, existing studies on migration and agricultural labor report

[11] If the respondent answered positively to the aforementioned survey question (see footnote 10), then she was asked other questions about the migrant's gender, age, destination, duration, and job before departure. For duration, the respondent was asked the number of months that the migrant had left. Therefore, this variable captures the number of months that the individual has been away from the time of the interview.

a mix of results, with some studies suggesting that women take up roles previously performed by family members who migrated (e.g. Deere, 2005; Garikipati, 2009; Pattnaik et al., 2017) and others suggesting that remittances are used to hire labor to perform tasks previously done by migrant members (de Brauw et. al., 2008; Urama et al., 2017; Liu et. al., 2019). We find that women in migrant households owning kitchen gardens were more likely to perform tasks pertaining to land and water management, and were more likely to make cultivation-related decisions. For households that owned presidential plots, on the other hand, women in migrant households were on the whole no more likely to perform land and water management tasks than those in non-migrant households. Since we collected data on whether households hired any labor, we can explicitly test whether households with a migrant hired more or less labor than non-migrant households using the same propensity score estimation strategy as described above. We find that migrant households are 1.1 percentage points more likely to hire labor than non-migrant households, though this is not statistically significant.

Our results highlight that in assessing the effect of migration on food security and labor, the production system matters, as does the nature of the labor tasks performed. While kitchen gardens are traditionally thought to be managed by women (Mukhamedova & Wegerich, 2018), we find that in fact the migration of men results in women performing several additional tasks on kitchen gardens, specifically involving the management of the irrigation canal as well as the management of agricultural crops. So, in fact, men do perform tasks on kitchen gardens, but those tasks are replaced by women in households with migrants. On the other hand, we do not find much effect of migration on labor on presidential plots. This could be because of one of two reasons. First, we may not have the statistical power needed to detect a significant difference in labor on presidential plots because fewer households cultivated a presidential plot. Second, as aforementioned, presidential plots were distributed to the poorest households. Therefore, there could be characteristics unique to these households that make them less likely to replace labor tasks by women. For example, households cultivating presidential plots may have more household members so that the migration of one male member matters less to the overall household labor supply.

Furthermore, our results point out that the decision to migrate engenders a trade-off for households between improving their food security on the one hand, and imposing additional tasks for those members who stay at home, on the other. Because we see an improvement in food security in migrant households, at least some of the remittances the households receive are likely used to supplement household income to purchase necessary food items. This in turn leads to a reliance on sufficient food supply being available in markets, either from local or national production or food imports.

6. Policy implications

Tajikistan is one of the most food insecure countries in Asia, where 21% of households are estimated to be food insecure (WFP, 2022). Strengthening irrigation is important for food security, as it enables year-round production in an environment where agriculture would not be possible without irrigation (Balasubramanya, 2019). However, migration and the resulting effect on domestic labor supply and household food production have important implications for food security, especially when labor tasks are mediated by gender. If men make decisions and implement tasks surrounding irrigation and the management of water, and a large proportion of men are migrating, should training and extension programs for agricultural and water management be implemented differently?

Our study sheds light on these issues. Because water management decisions are not outsourced, but rather are assumed by the women left behind, existing training and extension programs seeking to improve food security through irrigation should be targeted towards both women and men, and not just at lead male farmers as has generally been the case (Balasubramanya, 2018). The expected increasing demands on water from climate change make sound irrigation policies ever more pressing as Tajikistan seeks to increase its food security and decrease its reliance on food imports.

CRediT authorship contribution statement

Tinusha Ghimire: Conceptualization, Methodology, Formal analysis, Data curation, Writing – original draft, Writing – review & editing, Visualization. **Aurélie P. Harou:** Conceptualization, Methodology, Writing – original draft, Writing – review & editing, Visualization, Supervision. **Soumya Balasubramanya:** Conceptualization, Methodology, Investigation, Data curation, Writing – review & editing, Visualization, Project administration.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A

Table A1
Mean Differences in Outcome: Food Security.

	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]
	Overall			**Migrant**			**Non-migrant**			
	N	**Mean**	**SD**	**N**	**Mean**	**SD**	**N**	**Mean**	**SD**	**Difference[a]**
# Months with Food Shortage	1920	1.56	[1.57]	904	1.44	[1.57]	1016	1.67	[1.57]	0.228** (3.17)
In the last 12 months, did your household ever										
Rely on cheap, less expensive food (D)	1920	0.60	[0.49]	904	0.57	[0.49]	1016	0.62	[0.49]	0.046* (2.06)
Borrow money for food (D)	1920	0.34	[0.47]	904	0.32	[0.47]	1016	0.35	[0.48]	0.028 (1.27)
Purchase food on credit (D)	1920	0.58	[0.49]	904	0.57	[0.49]	1016	0.59	[0.49]	0.017 (0.73)
Eat seed saved for cultivation (D)	1920	0.43	[0.50]	904	0.41	[0.49]	1016	0.45	[0.50]	0.034 (1.52)
Sell any useable household items (D)	1920	0.38	[0.49]	904	0.35	[0.48]	1016	0.41	[0.49]	0.061** (2.72)
Skip a meal or reduce quantity (D)	1920	0.52	[0.50]	904	0.50	[0.50]	1016	0.54	[0.50]	0.038

(*continued on next page*)

Table A1 (*continued*)

	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]
	Overall			**Migrant**			**Non-migrant**			
	N	**Mean**	**SD**	**N**	**Mean**	**SD**	**N**	**Mean**	**SD**	**Difference[a]**
Spend days without eating food (D)	1920	0.17	[0.38]	904	0.14	[0.35]	1016	0.20	[0.40]	(1.67) 0.066*** (3.80)
In the last four weeks, did your households ever										
Have no food to eat due to lack of resources (D)	1920	0.47	[0.50]	904	0.43	[0.50]	1016	0.50	[0.50]	0.068** (2.96)
Sleep hungry at night due to food shortage (D)	1920	0.13	[0.34]	904	0.10	[0.30]	1016	0.16	[0.37]	0.060*** (3.87)
Go whole day without food due to food shortage (D)	1920	0.08	[0.27]	904	0.06	[0.24]	1016	0.10	[0.30]	0.038** (3.02)

Notes: Columns 1,4 and 7 indicate the number of observations reported for each variable. Columns 2, 5 and 8 are the means of each variable. Columns 3, 6 and 9 are the standard deviation. Column 10 is the difference in means between migrant and non-migrant households. T-tests determine whether the difference in mean between migrant and non-migrant households is statistically significant. D indicates dummy variable, =1 if yes, =0 if no. [a]tstatistics in parentheses. *p < 0.10, **p < 0.05, ***p < 0.01.

Table A2
Mean Differences in Outcome: Gender Labor Division in Kitchen Garden.

	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]
	Overall			**Migrant**			**Non-migrant**			
	N	**Mean**	**SD**	**N**	**Mean**	**SD**	**N**	**Mean**	**SD**	**Difference[a]**
A female was involved in the following Irrigation System Management										
Cleans irrigation canal (D)	1447	0.13	[0.34]	685	0.15	[0.36]	762	0.11	[0.31]	−0.042* (-2.35)
Cleans smaller irrigation ditch (D)	1659	0.22	[0.41]	780	0.24	[0.43]	879	0.20	[0.40]	−0.035 (-1.71)
Sets up irrigation system (D)	1671	0.27	[0.45]	788	0.30	[0.46]	883	0.25	[0.43]	−0.056** (-2.58)
Guides water flow (D)	1779	0.34	[0.47]	836	0.37	[0.48]	943	0.31	[0.46]	−0.063** (-2.78)
Determines amount of irrigation water to apply (D)	1799	0.37	[0.48]	852	0.42	[0.49]	947	0.33	[0.46]	−0.095*** (-4.19)
Determines timing of irrigation (D)	1811	0.42	[0.49]	858	0.46	[0.50]	953	0.38	[0.49]	−0.075** (-3.24)
Speaks with irrigation service provider (D)	1524	0.23	[0.42]	706	0.27	[0.45]	818	0.19	[0.39]	−0.085*** (-3.97)
A female was involved in the following Agriculture Crops Management										
Sows seeds (D)	1841	0.54	[0.50]	874	0.58	[0.49]	967	0.50	[0.50]	−0.073** (-3.14)
Sprays pesticides (D)	1291	0.26	[0.44]	608	0.32	[0.47]	683	0.21	[0.41]	−0.105*** (-4.32)
Applies fertilizers (D)	1586	0.32	[0.47]	752	0.36	[0.48]	834	0.27	[0.45]	−0.090*** (-3.85)
Purchases agricultural inputs (D)	1809	0.30	[0.46]	857	0.33	[0.47]	952	0.27	[0.44]	−0.061** (-2.85)
Determines which crops to cultivate (D)	1855	0.49	[0.50]	877	0.52	[0.50]	978	0.45	[0.50]	−0.070** (-3.03)
Determines quantities of agricultural products to sell or consume (D)	1441	0.55	[0.50]	673	0.59	[0.49]	768	0.52	[0.50]	−0.068* (-2.58)
Determines quantities of livestock to sell or consume (D)	1307	0.35	[0.48]	611	0.37	[0.48]	696	0.32	[0.47]	−0.047 (-1.77)
Processes and stores crops (D)	1784	0.77	[0.42]	837	0.80	[0.40]	947	0.75	[0.43]	−0.043* (-2.15)

Notes: Columns 1,4 and 7 indicate the number of observations reported for each variable. Columns 2, 5 and 8 are the means of each variable. Columns 3, 6 and 9 are the standard deviation. Column 10 is the difference in means between migrant and non-migrant households. T-tests determine whether the difference in mean between migrant and non-migrant households is statistically significant. D indicates dummy variable, =1 if yes, =0 if no. [a]t-statistics in parentheses. *p < 0.10, **p < 0.05, ***p < 0.01.

Table A3
Mean Differences in Outcome: Gender Labor Division in Presidential Plot.

	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]
	Overall			**Migrant**			**Non-migrant**			
	N	**Mean**	**SD**	**N**	**Mean**	**SD**	**N**	**Mean**	**SD**	**Difference[a]**
A female was involved in the following Irrigation System Management										
Cleans irrigation canal (D)	492	0.08	[0.26]	242	0.07	[0.26]	250	0.08	[0.27]	0.010 (0.41)
Cleans smaller irrigation ditch (D)	553	0.09	[0.28]	275	0.08	[0.28]	278	0.09	[0.28]	0.003 (0.11)
Sets up irrigation system (D)	556	0.08	[0.28]	274	0.08	[0.27]	282	0.09	[0.28]	0.005 (0.21)
Guides water flow (D)	570	0.11	[0.31]	284	0.10	[0.29]	286	0.12	[0.32]	0.024 (0.92)
Determines amount of irrigation water to apply (D)	590	0.21	[0.41]	294	0.21	[0.41]	296	0.20	[0.40]	−0.008 (-0.24)
Determines timing of irrigation (D)	585	0.20	[0.40]	290	0.22	[0.41]	295	0.19	[0.39]	−0.027 (-0.82)
Speaks with irrigation service provider (D)	557	0.17	[0.37]	276	0.19	[0.39]	281	0.14	[0.35]	−0.046 (-1.46)
A female was involved in the following Agriculture Crops Management										
Sows seeds (D)	571	0.19	[0.39]	290	0.17	[0.38]	281	0.21	[0.41]	0.041 (1.24)
Sprays pesticides (D)	396	0.09	[0.28]	186	0.09	[0.28]	210	0.09	[0.28]	−0.000 (-0.01)
Applies fertilizers (D)	536	0.11	[0.31]	267	0.12	[0.32]	269	0.10	[0.31]	−0.012 (-0.38)
Purchases agricultural inputs (D)	576	0.16	[0.37]	287	0.16	[0.37]	289	0.15	[0.36]	−0.012 (-0.38)
Determines which crops to cultivate (D)	611	0.30	[0.46]	308	0.30	[0.46]	303	0.30	[0.46]	−0.005 (-0.13)
Determines quantities of agricultural products to sell or consume (D)	483	0.34	[0.47]	231	0.35	[0.48]	252	0.33	[0.47]	−0.025 (-0.59)
Determines quantities of livestock to sell or consume (D)	463	0.33	[0.47]	221	0.34	[0.47]	242	0.33	[0.47]	−0.009 (-0.20)
Processes and stores crops (D)	576	0.47	[0.50]	290	0.47	[0.50]	286	0.47	[0.50]	−0.000 (-0.01)

Notes: Columns 1,4 and 7 indicate the number of observations reported for each variable. Columns 2, 5 and 8 are the means of each variable. Columns 3, 6 and 9 are the standard deviation. Column 10 is the difference in means between migrant and non-migrant households. T-tests determine whether the difference in mean between migrant and non-migrant households is statistically significant. D indicates dummy variable, =1 if yes, =0 if no. [a]t-statistics in parentheses. *p < 0.10, **p < 0.05, ***p < 0.01.

Table A4
Balancing Test on Covariates - Nearest Neighbor Matching and Kernel Matching.

	[1]	[2]	[3]
	Pre-matching	**Post-matching**	
		Nearest Neighbor Matching	**Kernel Matching**
Socio-Economic Characteristics			
Dependency ratio of household	−2.44**	−0.27	−0.71
Respondent is married (D)	0.73	−0.00	0.12
Age of respondent (years)	−0.8	−0.27	−0.32
Age squared of respondent (years)	−1.04	−0.29	−0.33
Respondent was head of household (D)	−1.11	0.32	−0.14
Respondent had graduate education (D)	−0.36	−0.57	0.1
Respondent was spouse of the household head (D)	−0.51	0.58	0.23
Total household earnings (USD)	−1.60*	−0.47	−0.12
Household asset index	−2.15**	−0.27	−0.58
Household has a Presidential plot (D)	1.98*	0.83	0.16
Household has a Dehkan farm (D)	−2.60**	−0.78	−0.93
Household member received a training related to water and land management, crop cultivation or WUA governance (D)	0.96	0.11	0.5
Water User Association (WUA) in village (D)	−0.28	−1.52	−0.2
Household member of a agricultural and/or livestock group (D)	−0.84	−0.53	0.08
Economic			
Participate in income generating activities (D)	−7.13 ***	0.31	0.17

(*continued on next page*)

Table A4 (*continued*)

	[1] Pre-matching	[2] Post-matching Nearest Neighbor Matching	[3] Kernel Matching
Environmental			
Household has a piped water source (D)	0.7	−1.41	0.04
Garden adjacent to house (D)	−1.39	0.15	−0.33
Garden located at the middle of canal (D)	−1.33	0.86	−0.2
Garden located at the tail of canal (D)	2.46**	0.06	0.59
Pseudo R2	0.034	0.003	0.001
Median Absolute Bias	5	1.3	1
N			
Migrant	904	892	891
Non-migrant	1016	941	1005

Notes: This table reports the differences in mean values between migrant and non-migrant households before and after matching. D indicates dummy variable, =1 if yes, =0 if no. T-tests show the statistical significance of the differences in means, *p < 0.10, **p < 0.05, ***p < 0.01.

Table A5
Migration and Household Food Security fixed effects with added control: interaction between migration and ownership of a presidential plot (with village fixed effects).

Dependent Variable	[1] Kitchen Garden Nearest Neighbor	[2] Kernel[a]
# Months with food shortage	−0.274**	−0.312**
	(0.11)	(0.11)
In the last 12 months, did your household ever		
Rely on cheap, less expensive food (D)	−0.030	−0.035
	(0.04)	(0.04)
Borrow money for food (D)	−0.001	−0.016
	(0.03)	(0.03)
Purchase food on credit (D)	−0.030	−0.021
	(0.04)	(0.03)
Eat seed saved for cultivation (D)	−0.028	−0.053*
	(0.04)	(0.03)
Sell any useable houehold items (D)	−0.029	−0.051*
	(0.03)	(0.03)
Skip a meal or reduce quantity (D)	−0.034	−0.060*
	(0.04)	(0.03)
Spend days without eating food (D)	−0.069**	−0.080**
	(0.03)	(0.03)
In the last four weeks, did your households ever		
Have no food to eat due to lack of resources (D)	−0.059*	−0.074**
	(0.04)	(0.03)
Sleep hungry at night due to food shortage (D)	−0.080**	−0.075**
	(0.03)	(0.02)
Go whole day without food due to food shortage (D)	−0.045**	−0.044**
	(0.02)	(0.02)
N		
Migrant	892	891
Non-migrant	820	993

Notes: Columns 1–2 report the PSM coefficients using Nearest Neighbor matching and Kernel matching with interaction variable for food security variables in migrant and non-migrant households. Each line is a different outcome variable. D indicates dummy variable, =1 if yes, =0 if no. [a]Epanechnikov kernel with 0.06 bandwidth is used. Robust standard errors in parentheses. *p < 0.10, **p < 0.05, ***p < 0.01.

Table A6
Robustness: Migration and Household Food Security excluding Earnings, Asset Index, Dependency Ratio and Participated in IGA.

	[1] Nearest Neighbor	[2] Kernel[a]
# Months with food shortage	−0.246**	−0.238**
	(0.08)	(0.08)
In the last 12 months, did your household ever		
Rely on cheap, less expensive food (D)	−0.065**	−0.051
	(0.03)	(0.03)
Borrow money for food (D)	−0.036	−0.030
	(0.03)	(0.03)
Purchase food on credit (D)	−0.031	−0.036
	(0.03)	(0.03)
Eat seed saved for cultivation (D)	−0.061*	−0.055*
	(0.03)	(0.03)
Sell any useable household items (D)	−0.090**	−0.089**
	(0.03)	(0.03)
Skip a meal or reduce quantity (D)	−0.066*	−0.050
	(0.03)	(0.03)
Spend days without eating food (D)	−0.073**	−0.084***
	(0.02)	(0.02)
In the last four weeks, did your households ever		
Have no food to eat due to lack of resources (D)	−0.084**	−0.081**
	(0.03)	(0.03)
Sleep hungry at night due to food shortage (D)	−0.078***	−0.084***
	(0.02)	(0.02)
Go whole day without food due to food shortage (D)	−0.055**	−0.061***
	(0.02)	(0.02)
N		
Migrant	892	892
Non-migrant	993	993

Notes: Columns 1–2 report the PSM coefficients using Nearest Neighbor matching and Kernel matching with village fixed effects excluding earnings, asset index, dependency ratio and unemployment measures for food security variables in migrant and non-migrant households. Each line is a different outcome variable. D indicates dummy variable, =1 if yes, =0 if no. [a]Epanechnikov kernel with 0.06 bandwidth is used. Robust standard errors in parentheses. *p < 0.10, **p < 0.05, ***p < 0.01.

Table A7
Robustness: Migration and Gender Labor Division on Kitchen Gardens excluding Earnings, Asset Index, Dependency Ratio and Participated in IGA.

Dependent Variable	[1] Nearest Neighbor	[2] Migrant	[3] Non-migrant	[4] Kernel[a]	[5] Migrant	[6] Non-migrant
A female was involved in the following Irrigation System Management						
Cleans irrigation canal (D)	0.042*	667	623	0.043**	667	734
	(0.02)			(0.02)		
Cleans smaller irrigation ditch (D)	0.062**	776	732	0.056**	776	850
	(0.02)			(0.02)		
Sets up irrigation system (D)	0.054*	780	756	0.055**	780	864
	(0.03)			(0.03)		
Guides water flow (D)	0.068*	836	791	0.069**	836	924
	(0.03)			(0.03)		
Determines amount of irrigation water to apply (D)	0.070**	858	818	0.111***	852	935
	(0.03)			(0.03)		
Determines timing of irrigation (D)	0.078**	858	803	0.076**	858	941
	(0.03)			(0.03)		
Speaks with irrigation service provider (D)	0.084**	679	637	0.087***	679	769
	(0.03)			(0.02)		
A female was involved in the following Agriculture Crops Management						
Sows seeds (D)	0.064**	874	821	0.061**	874	955
	(0.03)			(0.03)		
Sprays pesticides (D)	0.109***	589	569	0.082**	589	665
	(0.03)			(0.03)		
Applies fertilizers (D)	0.083**	749	707	0.084**	749	823
	(0.03)			(0.03)		
Purchases agricultural inputs (D)	0.072**	857	792	0.070**	857	940
	(0.02)			(0.02)		
Determines which crops to cultivate (D)	0.073**	877	829	0.077**	877	966
	(0.03)			(0.03)		
Determines quantities of agricultural products to sell or consume (D)	0.066*	661	636	0.078**	661	749
	(0.03)			(0.03)		
Determines quantities of livestock to sell or consume (D)	0.070*	592	564	0.058*	592	659
	(0.03)			(0.03)		
Processes and stores crops (D)	0.023	830	809	0.032	830	935
	(0.02)			(0.02)		

Notes: Columns 1 and 4 report the PSM coefficients using Nearest Neighbor matching and Kernel matching respectively with village fixed effects excluding earnings, asset index, dependency ratio and unemployment measures. Columns 2, 3, 5 and 6 indicate the number of observations on each variable in migrant and non-migrant households which were dissimilar. Each line is a different outcome variable. Robust standard errors are reported in parentheses. D indicates dummy variable, =1 if female, =0 if male. [a]Epanechnikov kernel with 0.06 bandwidth is used. *p < 0.10, **p < 0.05, ***p < 0.01.

Table A8
Robustness: Migration and Gender Labor Division on Presidential Plot excluding Earnings, Asset Index, Dependency Ratio and Participated in IGA.

Dependent Variable	[1] Nearest Neighbor	[2] Migrant	[3] Non-migrant	[4] Kernel[a]	[5] Migrant	[6] Non-migrant
A female was involved in the following Irrigation System Management						
Cleans irrigation canal (D)	0.027	203	172	0.023	202	205
	(0.02)			(0.03)		
Cleans smaller irrigation ditch (D)	0.011	230	200	0.023	230	241
	(0.03)			(0.03)		
Sets up irrigation system (D)	−0.030	230	206	−0.018	230	243
	(0.03)			(0.03)		
Guides water flow (D)	−0.025	237	205	−0.003	237	248
	(0.03)			(0.03)		
Determines amount of irrigation water to apply (D)	−0.012	248	213	−0.038	250	256
	(0.04)			(0.04)		
Determines timing of irrigation (D)	−0.004	248	214	−0.008	247	255
	(0.05)			(0.04)		
Speaks with irrigation service provider (D)	0.092**	239	198	0.086**	239	232
	(0.04)			(0.04)		
A female was involved in the following Agriculture Crops Management						
Sows seeds (D)	−0.105**	246	206	−0.100*	245	245
	(0.05)			(0.05)		
Sprays pesticides (D)	0.009	141	124	0.009	139	165
	(0.03)			(0.03)		
Applies fertilizers (D)	0.028	229	184	0.028	228	224
	(0.03)			(0.03)		
Purchases agricultural inputs (D)	0.028	243	205	0.023	243	252

(*continued on next page*)

Table A8 (*continued*)

Dependent Variable	[1] Nearest Neighbor	[2] Migrant	[3] Non-migrant	[4] Kernel[a]	[5] Migrant	[6] Non-migrant
	(0.04)			(0.04)		
Determines which crops to cultivate (D)	−0.033	264	230	−0.043	264	273
	(0.05)			(0.05)		
Determines quantities of agricultural products to sell or consume (D)	0.026	187	173	0.018	187	208
	(0.06)			(0.06)		
Determines quantities of livestock to sell or consume (D)	0.020	179	149	−0.004	179	204
	(0.06)			(0.06)		
Processes and stores crops (D)	0.070	243	220	0.086*	242	255
	(0.06)			(0.05)		

Notes: Columns 1 and 4 report the PSM coefficients using Nearest Neighbor matching and Kernel matching with village fixed effects excluding earnings, asset index, dependency ratio and unemployment measures. Each line is a different outcome variable. Columns 2, 3, 5 and 6 indicate the number of observations of each variable in migrant and non-migrant households. Robust standard errors are reported in parentheses. D indicates dummy variable, =1 if female, =0 if male. [a]Epanechnikov kernel with 0.06 bandwidth is used. *p < 0.10, **p < 0.05, ***p < 0.01.

Table A9
Migrant and Household Food Security Multiple Hypothesis Testing.

	[1]
Dependent Variable	
# Months with food shortage	−0.245**
p-value	[0.003]
sharpened q-value	[0.006]
In the last 12 months, did your household ever	
Rely on cheap, less expensive food (D)	−0.056*
p-value	[0.047]
sharpened q-value	[0.037]
Borrow money for food (D)	−0.027
p-value	[0.346]
sharpened q-value	[0.107]
Purchase food on credit (D)	−0.039
p-value	[0.190]
sharpened q-value	[0.094]
Eat seed saved for cultivation (D)	−0.047
p-value	[0.110]
sharpened q-value	[0.059]
Sell any useable household items (D)	−0.070**
p-value	[0.018]
sharpened q-value	[0.020]
Skip a meal or reduce quantity (D)	−0.054*
p-value	[0.072]
sharpened q-value	[0.042]
Spend days without eating food (D)	−0.077***
p-value	[0.001]
sharpened q-value	[0.004]
In the last four weeks, did your households ever	
Have no food to eat due to lack of resources (D)	−0.071**
p-value	[0.019]
sharpened q-value	[0.020]
Sleep hungry at night due to food shortage (D)	−0.073***
p-value	[0.000]
sharpened q-value	[0.001]
Go whole day without food due to food shortage (D)	−0.062***
p-value	[0.001]
sharpened q-value	[0.004]

Notes: Columns 1 reports the coefficient, p-value and the sharpened q-values for all outcomes in the table. Each line is a different outcome variable. D indicates dummy variable, =1 if yes, =0 if no. *p < 0.10, **p < 0.05, ***p < 0.01.

Table A10
Migration and Gender Labor Division on Kitchen Garden and Presidential Plot Multiple Hypothesis Testing.

Dependent Variable	[1] Kitchen Garden	[2] Presidential Plot
A female was involved in the following Irrigation System Management		
Cleans irrigation canal (D)	0.059**	0.002
p-value	[0.002]	[0.669]
sharpened q-value	[0.011]	[0.354]
Cleans smaller irrigation ditch (D)	0.017	−0.011
p-value	[0.018]	[0.802]
sharpened q-value	[0.034]	[0.383]
Sets up irrigation system (D)	0.059*	−0.021
p-value	[0.037]	[0.556]
sharpened q-value	[0.044]	[0.324]
Guides water flow (D)	0.073**	0.017
p-value	[0.012]	[0.633]
sharpened q-value	[0.028]	[0.354]
Determines amount of irrigation water to apply (D)	0.147***	−0.031
p-value	[0.000]	[0.495]
sharpened q-value	[0.001]	[0.316]
Determines timing of irrigation (D)	0.095***	0.031
p-value	[0.001]	[0.523]
sharpened q-value	[0.007]	[0.316]
Speaks with irrigation service provider (D)	0.095***	0.085*
p-value	[0.000]	[0.035]
sharpened q-value	[0.001]	[0.044]
A female was involved in the following Agriculture Crops Management		
Sows seeds (D)	0.077**	−0.103*
p-value	[0.013]	[0.070]
sharpened q-value	[0.028]	[0.076]
Sprays pesticides (D)	0.087**	0.037
p-value	[0.008]	[0.127]
sharpened q-value	[0.028]	[0.104]
Applies fertilizers (D)	0.104***	0.005

(*continued on next page*)

Table A10 (*continued*)

Dependent Variable	[1] Kitchen Garden	[2] Presidential Plot
p-value	[0.000]	[0.194]
sharpened q-value	[0.001]	[0.141]
Purchases agricultural inputs (D)	0.071**	0.018
p-value	[0.009]	[0.669]
sharpened q-value	[0.028]	[0.354]
Determines which crops to cultivate (D)	0.075**	0.004
p-value	[0.011]	[0.937]
sharpened q-value	[0.028]	[0.392]
Determines quantities of agricultural products to sell or consume (D)	0.086**	0.039
p-value	[0.012]	[0.516]
sharpened q-value	[0.028]	[0.316]
Determines quantities of livestock to sell or consume (D)	0.068**	0.080
p-value	[0.049]	[0.174]
sharpened q-value	[0.055]	[0.139]
Processes and stores crops (D)	0.062**	0.103*
p-value	[0.012]	[0.085]
sharpened q-value	[0.028]	[0.080]

Notes: Columns 1 reports the coefficient, p-value and the sharpened q-values for all outcomes in the table. Each line is a different outcome variable. D indicates dummy variable, =1 if yes, =0 if no. *p < 0.10, **p < 0.05, ***p < 0.01.

References

Abadie, A., Imbens, G., 2016. Notes and comments: Matching on the estimated propensity score. Econometrica 84 (2), 781–807.

Abebaw, D., Admassie, A., Kassa, H., Padoch, C., 2020. Can rural outmigration improve household food security? Empirical evidence from Ethiopia. World Development 129.

Acharya, C.P., Leon-Gonzalez, R., 2014. How do Migration and Remittances Affect Human Capital Investment? The Effects of Relaxing Information and Liquidity Constraints. Journal of Development Studies 50 (3), 444–460.

Adams, R.H., Page, J., 2005. Do international migration and remittances reduce poverty in developing countries? World Development 33 (10), 1645–1669.

Akramov, K. T., & Shreedhar, G. (2012). Economic Development, External Shocks, and Food Security in Tajikistan. *IFPRI Discussion Paper*, *01163*.

Amuedo-Dorantes, C., Pozo, S., 2006. Remittances as insurance: evidence from mexican immigrants. Journal of Population Economics 19 (2), 227–254.

Asadov, S., 2013. Food Security and the Agricultural Cooperation Agenda in Central Asia with a Focus on Tajikistan. SSRN Electronic Journal.

Atuoye, K.N., Kuuire, V.Z., Kangmennaang, J., Antabe, R., Luginaah, I., 2017. Residential remittances and food security in the upper west region of ghana. International Migration 55 (4), 18–34.

Azzarri, C., Zezza, A., 2011. International migration and nutritional outcomes in Tajikistan. Food Policy 36 (1), 54–70.

Balasubramanya, S., 2019. Effects of training duration and the role of gender on farm participation in water user associations in Southern Tajikistan: Implications for irrigation management. Agricultural Water Management 216, 1–11.

Balasubramanya, S., Price, J.P.G., Horbulyk, T.M., 2018. Impacts Assessments without True Baselines: Assessing the Relative Effects of Training on the Performance of Water User Associations in Southern Tajikistan. Water Economics and Policy 4 (3).

Barrios, S., Bertinelli, L., Strobl, E., 2006. Climatic change and rural-urban migration: The case of sub-Saharan Africa. Journal of Urban Economics 60 (3), 357–371.

Becker, S., Ichino, A., 2002. Estimation of Average Treatment Effects Based on Propensity Scores. The Stata Journal 2 (4), 358–377.

Behnke, R.H., Organization, N.A.T., 2008. NATO Advanced Research Workshop on The Socio-economic Causes and Consequences of Desertification in Central Asia (2006: Bishkek, Kyrgyzstan), The socio-economic causes and consequences of desertification in central Asia. Springer.

Bever, S., 2002. Migration And The Transformation Of Gender Roles And Hierarchies In Yucatan. Urban Anthropology and Studies of Cultural Systems and World Economic Development 31 (2), 199–230.

Boboyorov, H., 2012. Personal networks of agricultural knowledge in the cotton growing communities of Southern Tajikistan. Demokratizatsiya 20 (4), 409.

Boboyorov, H., 2016. Constraints and concerns for farming and cropping types and strategies in Southern Tajikistan. In: Hornidge, A.-.-K., Shtaltovna, A., Schetter, C. (Eds.), Agricultural Knowledge and Knowledge Systems in Post-Soviet Societies. Peter Lang, p. 301.

Buisson, M.C., Balasubramanya, S., 2019. The effect of irrigation service delivery and training in agronomy on crop choice in Tajikistan. Land Use Policy 81 (July 2018), 175–184.

Caliendo, M., Kopeinig, S., 2008. Some practical guidance for the implementation of propensity score matching. Journal of Economic Surveys 22 (1), 31–72.

Cebotari, V., 2018. Transnational migration, gender and educational development of children in Tajikistan. Global Networks 18 (4), 564–588.

Clement, F., Buisson, M.-C., Leder, S., Balasubramanya, S., Saikia, P., Bastakoti, R., Karki, E., van Koppen, B., 2019. From women's empowerment to food security: revisiting global discourses through a cross-country analysis. Global Food Security 23, 160–172.

Clougherty, J.A., Duso, T., Muck, J., 2016. Correcting for Self-selection Based Endogeneity in Management Research: Review. Recommendations and Simulations. *Organizational Research Methods* 19 (2), 286–347.

Craven, L.K., Gartaula, H.N., 2015. Conceptualising the Migration-Food Security Nexus: Lessons from Nepal and Vanuatu. Australian Geographer 46 (4), 455–471.

Crush, J., 2013. Linking Food Security, Migration and Development. International Migration 51 (5), 61–75.

Czaika, M., De Haas, H., 2013. Determinants of Migration to the UK. The Migration Observatory at the University of Oxford 1–8.

Damania, R., 2020. The economics of water scarcity and variability. Oxford Review of Economic Policy 36 (1), 24–44.

de Brauw, A., 2019. Rural youth: Determinants of migration throughout the world. Retrieved October 1, 2021, from. https://www.ifad.org/documents/38714170/41187395/15_de+Brauw_2019+RDR+BACKGROUND+PAPER.pdf/8a67f25f-749f-be91-f90f-beed3d524364.

de Brauw, A., Li, Q., Liu, C., Rozelle, S., Zhang, L., 2008. Feminization of Agriculture in China? Myths Surrounding Women's Participation in Farming. The China Quarterly 194, 327–348.

de Brauw, A., Kramer, B., Murphy, M., 2021. Migration, labor and women's empowerment: Evidence from an agricultural value chain in Bangladesh. World Development 142.

De Jong, G.F., 2000. Expectations, gender, and norms in migration decision-making. Population Studies 54 (3), 307–319.

Deere, C. D., (2005). The Feminization of Agriculture? Economic Restructuring in Rural Latin America. Geneva: United Nations Research Inst. For Social Development (Occasional Paper, 1). Available online at: www.unrisd.org.

Duda, I., Fasse, A., Grote, U., 2018. Drivers of rural-urban migration and impact on food security in rural Tanzania. Food Security 10 (4), 785–798.

Erlich, A., 2006. Tajikistan: From Refugee Sender to Labor Exporter. Migration Policy Institute, Washington DC.

Funkhouser, E., 1992. Migration from Nicaragua: some recent evidence. World Development 20 (8), 1209–1218.

Garikipati, S., 2009. Landless but not assetless: Female agricultural labour on the road to better status, evidence from India. The Journal of Peasant Studies 36 (3), 517–545.

Heckman, J.J., Robb, R., 1985. Alternative methods for evaluating the impact of interventions. Journal of Econometrics 30 (1–2), 239–267.

Hirzel, A., Guisan, A., 2002. Which is the optimal sampling strategy for habitat suitability modelling. Ecological Modelling 157 (2), 331–341.

Hosny, A., 2020. Remittance Concentration and Volatility: Evidence from 72 Developing Countries. International Economic Journal 34 (4), 553–570.

Husenov, B., Garkava-Gustavsson, L., Makhkamov, M., Muminjanov, H., Johansson, E., 2015. Breeding for wheat quality to assure food security of a staple crop: the case study of tajikistan. Agriculture & Food Security 4 (1), 1–8.

International Organization for Migration (IOM). (2020). World Migration Report 2020. https://publications.iom.int/system/files/pdf/wmr_2020.pdf.

Isoto, R.E., Kraybill, D.S., 2017. Remittances and household nutrition: evidence from rural kilimanjaro in tanzania. Food Security: The Science, Sociology and Economics of Food Production and Access to Food 9 (2), 239–253.

Izraelov, M., Silber, J., 2019. An assessment of the global food security index. Food Security 11 (5), 1135–1152.

Jones, L., Black, R., & Skeldon, R. (2007). Migration and poverty reduction in Tajikistan. … *Studies, Sussex Centre for Migration, February*, 1–30. http://www.migrationdrc.org/publications/working_papers/WP-C11.pdf.

Justino, P., & Shemyakina, O. N. (2012). Remittances and Labour Supply in Post-Conflict Tajikistan. *IDS Working Papers* (388): 1-37.

Kalaj, E.H., 2013. Munich Personal RePEc Archive Do Remittances Alter Labor Market Participation? A Study of Albania. 48271.

Kan, S., Aytimur, R.E., 2019. Labor force participation of women left behind in Tajikistan. Oxford Development Studies 47 (1), 1–28.

Karamba, W.R., Quiñones, E.J., Winters, P., 2010. Migration and food consumption patterns in Ghana. Food Policy 36 (1), 41–53.

Kawabata, M., Berardo, A., Mattei, P., de Pee, S., 2020. Food security and nutrition challenges in Tajikistan: Opportunities for a systems approach. Food Policy 96 (February), 101872.

King, G., Nielsen, R., 2019. 'Why propensity scores should not be used for matching'. Political Analysis 27, 435–454.

Lechner, M., Strittmatter, A., 2017. Practical Procedures to Deal with Common Support Problems in Matching Estimation, IZA Discussion Papers, No. 10532. Institute of Labor Economics (IZA), Bonn.

Lerman, Z., Sedik, D., 2008. The Economic Effects of Land Reform in. The Case of Tajikistan. Discussion Papers, Central Asia.

Liu, J., Xu, Z., Zeng, Q., Hua, L., 2019. Is the feminization of labor harmful to agricultural production? The decision-making and production control perspective. Journal of Integrative Agriculture 18 (6), 1392–1401.
Lokshin, M., Glinskaya, E., 2009. The effect of male migration on employment patterns of women in Nepal. The World Bank Economic Review 23 (3), 481–507.
Mabrouk, F., Mekni, M.M., 2018. Remittances and food security in african countries. African Development Review 30 (3), 252–263.
Mendola, M., Carletto, C., 2012. Migration and gender differences in the home labour market: Evidence from Albania. Labour Economics 19 (6), 870–880.
Moniruzzaman, M., 2020. The Impact of remittances on household food security: Evidence from a survey in Bangladesh. Migration and Development 1–20.
Mora-Rivera, J., van Gameren, E., 2021. The impact of remittances on food insecurity: evidence from mexico. World Development 140.
Mukhamedova, N., Wegerich, K., 2018. The feminization of agriculture in post-Soviet Tajikistan. Journal of Rural Studies 57, 128–139.
Murakami, E., Yamada, E., Sioson, E.P., 2021. The impact of migration and remittances on labor supply in Tajikistan. Journal of Asian Economics 73.
Olimova, S., Bosc, I., 2003. Labour migration from Tajikistan. International Organization for Migration, Dushanbe.
Pattnaik, I., Lahiri-Dutt, K., Lockie, S., Pritchard, B., 2017. The feminization of agriculture or the feminization of agrarian distress? Tracking the trajectory of women in agriculture in India. Journal of the Asia Pacific Economy 23 (1), 138–155.
Piracha, M., Randazzo, T., Vadean, F., 2013. Remittances and Occupational Outcomes of the Household Members Left-Behind. IZA Discussion Paper 7582.
Quisumbing, A.R., Doss, C.R., 2021. Gender in agriculture and food systems. Handbook of Agricultural Economics 5, 4421–4549.
Radel, C., Schmook, B., McCandless, S., 2010. Environment, transnational labor migration, and gender: Case studies from southern Yucatán, Mexico and Vermont, USA. Population and Environment 32 (2), 177–197.
Radel, C., Schmook, B., McEvoy, J., Méndez, C., Petrzelka, P., 2012. Labour migration and gendered agricultural relations: The feminization of agriculture in the Ejidal sector of Calakmul. Mexico. *Journal of Agrarian Change* 12 (1), 98–119.
Rahman, A., Mishra, S., 2020. Does non-farm income affect food security? evidence from india. The Journal of Development Studies 56 (6), 1190–1209.
Regmi, M., Paudel, K.P., 2017. Food security in a remittance based economy. Food Security : The Science, Sociology and Economics of Food Production and Access to Food 9 (4), 831–848.
Rodriguez, E.R., Tiongson, E.R., 2001. Temporary migration overseas and household labor supply: evidence from urban philippines. International Migration Review 35 (135), 709–725.
Rosenbaum, P., Rubin, D., 1983. The Central Role of the Propensity Score in Observational Studies for Causal Effects. Biometrika 70 (1), 41–55.
Sehring, J., 2007. Irrigation reform in Kyrgyzstan and Tajikistan. Irrigation and Drainage Systems 21, 277–290.
Smith, J.A., Todd, P.E., 2005. Does matching overcome LaLonde's critique of nonexperimental estimators? In. Journal of Econometrics 125. Issues 1–2 SPEC. ISS.
Sulemana, I., Bugri Anarfo, E., Quartey, P., 2019. International remittances and household food security in sub-saharan africa. Migration and Development 8 (2), 264–280.
Sunam, R., Adhikari, J., 2016. How does Transnational Labour Migration Shape Food Security and Food Sovereignty? Evidence from Nepal. *Anthropological Forum* 26 (3), 248–261.
Todaro, M.P., 1969. A Model of Labor Migration and Urban Unemployment in Less Developed Countries. The American Economic Review 59 (1), 138–148.
Urama, N.E., Nwosu, E.O., Yuni, D.N., Aguegboh, S.E., 2017. International Migrant Remittances and Labour Supply in Nigeria. International Migration 55 (1), 37–50.
Weiler, A.M., McLaughlin, J., Cole, D.C., 2017. Food security at whose expense? a critique of the canadian thosemporary farm labour migration regime and proposals for change. International Migration 55 (4), 48–63.
WFP. 2022. Tajikistan quarterly household food security and market update. Available at : file:///C:/Users/WB585127/Downloads/WFP-0000141661.pdf.
Wooldridge, J.M., 2002. Econometric analysis of cross section and panel data. MIT Press, Cambridge, MA.
Zezza, A., Carletto, C., Davis, B., Winters, P., 2011. Assessing the impact of migration on food and nutrition security. Food Policy 36 (1), 1–6.
Zhang, Z., Lan, Q., Ding, L., Wang, Y., Hassanpour, N., & Greiner, R. (2019). Reducing Selection Bias in Counterfactual Reasoning for Individual Treatment Effects Estimation: 1–8.