Impact of Migration on Agricultural Gender Labor Division and Food Security in Tajikistan

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Abstract

In recent decades millions living in low-income countries like Tajikistan, have migrated to support their livelihoods. In 2019 alone, over 530,800 Tajik citizens left the country seeking better employment opportunities. This massive, predominantly male, out-migration has transformed the agricultural sector and food security in Tajikistan. On the one hand, non-migrating household members, usually female and children, must replace the migrant member's previous tasks, leading to the feminization of agriculture. On the other hand, remittances could increase income of the migrant household leading to reduction in their work and increase in their food security as their purchasing power strengthens.

We want to explore this linkage between migration, gender labor division and food security by comparing migrant and non-migrant households. However, estimators comparing migrant and non-migrant households will be biased because migration depends on unobserved factors that affect both the decision to migrate and our outcome variables of interest. To mitigate such bias, we use Propensity Score Matching (PSM), which enables the measurement of an average treatment effect on the treated (ATT) by matching migrant and non-migrant households in accordance with observable characteristics. The data we use in this paper was collected by the International Water Management Institute (IWMI) in 2016. It is a nationally representative dataset with a total of 1920 households. Since this study focuses on migrant and non-migrant households, amongst the 1,920 households surveyed, 904 households had one or more member(s) who migrated in 2015. These households are categorized as migrant households.

Our results show in households that own kitchen plots, non-migrant households face more months of food shortage and take more measures to mitigate food shortage, statistically significant

at the 1 percent level. However, these results are not consistent when comparing households that own president plots and Dehkan farms. In terms of gender labor division, women in migrant households are more involved in cleaning irrigation canal, setting up irrigation system, guiding irrigation water flow, deciding amount of irrigation water to use and when to apply irrigation water, all statistically significant at the one percent level among kitchen plot owners. However, again, these results are not consistent for presidential plot and Dehkan farm owners. On presidential plots, women from migrant households are more likely to speak with the irrigation service provider, statistically significant at 5 percent level. Women from migrant households that own Dehkan farm were more likely to purchase agricultural inputs, statistically significant at one percent level. Overall, the results provide evidence of the feminization of agriculture in Tajkistan.

This paper contributes to the ongoing migration literature in three ways. First, while previous studies have examined the link between migration and household labor allocation, this study focuses on labor tasks surrounding water management in Tajikistan. Second, this study adds to existing research on food security and remittances by analyzing food security conditions in migrant and non-migrant households through experience-based household food insecurity. Third, this is the first study we are familiar with that analyzes gender labor division and food security within the same household as combining these two concepts together can offer a comprehensive and broader understanding of migration on food security conditions in rural households. Furthermore, we analyze all of these interactions and linkages in three types of land or production system in Tajikistan –kitchen plot, presidential plot and Dehkan farm.

Résumé

Au cours des dernières décennies, des millions de personnes vivant dans des pays à faible revenu comme le Tadjikistan ont migré pour subvenir à leurs besoins. Rien qu'en 2019, plus de 530 800 citoyens tadjiks ont quitté le pays à la recherche de meilleures opportunités d'emploi. Cette émigration massive, majoritairement masculine, a transformé les secteurs agricoles et les problèmes de sécurité alimentaire au Tadjikistan. D'une part, les membres du ménage non migrants, généralement des femmes et des enfants, doivent remplacer les tâches antérieures du membre migrant, ce qui conduit à la féminisation de l'agriculture. D'un autre côté, les envois de fonds pourraient augmenter les revenus du ménage migrant, entraînant une réduction de leur travail et une augmentation de leur sécurité alimentaire à mesure que leur pouvoir d'achat se renforce.

Nous voulons explorer ce lien entre la migration, la division du travail entre les sexes et la sécurité alimentaire en comparant les ménages migrants et non migrants. Cependant, les estimateurs comparant les ménages migrants et non migrants seront biaisés, car la migration dépend de facteurs non observés qui affectent à la fois la décision de migrer et nos variables de résultat d'intérêt. Pour atténuer ce biais, nous utilisons la correspondance du score de propension (CSP), qui permet de mesurer un effet moyen du traitement sur les personnes traités (ATT) en faisant correspondre les ménages migrants et non migrants en fonction de caractéristiques observables. Les données que nous utilisons dans ce document ont été collectées par l'Institut international de gestion de l'eau (IIGE) en 2016. Il s'agit d'un ensemble de données représentatif au niveau national avec un total de 1920 ménages. Cette étude portant sur les ménages migrants et non migrants, parmi les 1 920 ménages enquêtés, 904 ménages comptaient un ou plusieurs membres ayant migré en 2015. Ces ménages sont classés comme ménages migrants.

Nos résultats montrent que dans les ménages qui possèdent des parcelles de cuisine, les ménages non migrants font face à plus de mois de pénurie alimentaire et prennent plus de mesures pour l'atténuer, à un niveau de signification statistique de 1%. Cependant, un résultat similaire n'est pas évident chez les ménages possédant des parcelles présidentielles et la ferme Dehkan. Sur le plan de la division sexuée du travail, les femmes sont plus impliquées chez les ménages migrants dans le nettoyage des canaux d'irrigation, mettre en place un système d'irrigation, guider le débit d'eau, décider de la quantité d'eau d'irrigation à utiliser et quand opter pour l'eau d'irrigation, tous

statistiquement significatifs au niveau de 1% chez les propriétaires de parcelles de cuisine. Cependant, les mêmes résultats ne sont pas cohérents pour les ménages possédants des lots présidentiels et la ferme Dehkan. Sur les parcelles présidentielles, les femmes issues de ménages de migrants sont plus susceptibles de parler avec le fournisseur de services d'irrigation, statistiquement significatif au niveau de 5%. Les femmes issues de ménages de migrants qui possèdent la ferme Dehkan étaient plus susceptibles d'acheter des intrants agricoles, statistiquement significatif au niveau de 1%. Dans l'ensemble, les résultats témoignent de la féminisation de l'agriculture au Tajkistan.

Cet article contribue à la littérature actuelle sur la migration de trois manières. Premièrement, alors que des études antérieures ont examiné le lien entre la migration et la répartition du travail des ménages, cette étude se concentre sur les tâches liées à la gestion de l'eau au Tadjikistan. Deuxièmement, cette étude complète les recherches existantes sur la sécurité alimentaire et les envois de fonds en analysant les conditions de sécurité alimentaire dans les ménages migrants et non migrants à travers l'insécurité alimentaire expérimentée des ménages. Troisièmement, il s'agit de la première étude que nous connaissons qui analyse la division du travail entre les sexes et la sécurité alimentaire au sein d'un même ménage, car la combinaison de ces deux concepts peut offrir une compréhension globale et plus large de la migration sur les conditions de sécurité alimentaire dans les ménages ruraux. De plus, nous analysons toutes ces interactions et liens dans trois types de terres ou de systèmes de production au Tadjikistan – parcelle de cuisine, parcelle présidentielle et ferme Dehkan.

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Contribution of Authors

Tinusha Ghimire, is the main author of this paper. She created and wrote every chapter in this thesis report. She cleaned all the data and conducted the data analysis. She also produced the literature review, all the tables and graphs presented in the paper along with the appendices.

Aurélie Harou, co-author and supervisor at McGill University, provided excellent and rigorous feedback on every chapter and helped with restructuring the thesis. She also shared her expertise in Propensity Score Matching and developing better research paper.

Soumya Balasubramanya, co-author, was part of the initial collection of the data and provided valuable inputs on research and drawing meaning to the results. She also provided the map for the study.

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Chapter I: Introduction

Millions living in low-income countries like Tajikistan migrate to support their livelihoods. The decision to migrate is often an important and collective decision made within the household (de Brauw, 2019) that depends on both environmental and socio-economic determinants (De Jong, 2000; Czaika & Haas 2017; Damania, 2020). Often, migrants are from rural areas with agriculture-based livelihoods and have limited prospects (Zezza et al., 2011). In 2019, over 530,800 Tajik citizens left the country seeking better employment opportunities, according to Delegation of the Ministry of Labor, Migration and Employment of Tajikistan[1]. This massive, predominantly male, out-migration has transformed agricultural sectors and food security issues (McCarthy et al., 2009) in Tajikistan.

1.1 Problem Statement

The departure of active male member(s) from a family can alter the household's agricultural labor supply as well as their food security conditions (Olimova et al., 2010). On the one hand, non-migrating household members, usually female and children, must replace the migrant member's previous tasks, leading to the feminization of agriculture (Justino et al., 2012; Mukhamedova & Wegerich, 2018), adding a burden on already time- and resource-constrained women. On the other hand, remittances could increase income of the migrant household leading to reduction in their need to work (de Brauw et al., 2008; Azizi, 2018) and increasing their food security as their purchasing power strengthens (Zeeza et al., 2011; Hosny, 2020). Hence, studies on migration are guided by the microeconomic theory of leisure-labor choice determining whether an income-effect or substitution effect is more dominant (Kan & Aytimur, 2019). The income-effect refers to

[1] Approximately 92 percent of the migrants were economically active male.

changes in purchasing power of a household due to an increase in income from e.g., remittances, while a substitution effect refers to the replacement of a migrant family member's work by non-migrating members (Varian, 2010).

The overall consequence of migration on food security is therefore unknown because while remittances reduce food insecurity, women are left with more to manage and do, due to the shortage in labor. Hence, the overall effect of migration on food security becomes an empirical question whose answer can help guide effective future policies (Radel, 2010). However, existing studies on migration and gender labor explore the overall participation of women on the labor supply (Rodriguez & Tiongson, 2001; Deere, 2005; Amuedo-Dorantes & Pozo, 2006; Garikipati, 2009; Pattnaik et al., 2018; Liu et. al., 2019; de Brauw et al., 2021). Research on gender division of specific tasks pertaining to agriculture in migrant and non-migrant household is largely missing. Our study attempts to fill this gap in literature by evaluating individual tasks related to irrigation and agricultural system management.

Food security depends both on a household's agricultural production, as well as its income, from all sources, including remittances, which allows families to purchase imported food, (Adams and Page, 2005; Pyakuryal et al., 2010; Regmi & Poudel, 2017; Mabrouk & Mekni, 2018; Moniruzzaman, 2020) which Tajikistan is heavily depended upon (Kawabata et. al. 2020). Migration also reduces the labor available which might hinder agricultural production, affecting a household's long-term food security (Karamba et al., 2010; Kuuire et al., 2013; Weiler et al., 2017). Past studies have found that in addition to reduced farm labor, (Jha, 2010; Maharjan et al., 2013; Sunam & Adhikari, 2016) remittances are rarely used for agricultural investments, leaving large cultivable land barren. This results in the reduction of local food production creating a dependency on food imports (Sunam & Adhikari, 2016). Malnutrition and food security are major

concerns in Tajikistan as in 2020, where the Global Hunger Index score for the country is categorized as "serious" and given the importance of migration to Tajikistan's GDP it is important to understand how the two phenomena are related (McCarthy et al., 2009; Azzarri & Zezza, 2011; Kawabata et al., 2020).

1.2 Study Objectives

The main objectives of this study are two-fold:

1) First, we would like to know how male out-migration effects the division of agricultural labor within the household. Do we observe the feminization of agriculture in Tajikistan?
2) Second, we are interested in learning how food security differs in migrant and non-migrant households.

More specifically, we test the following three hypotheses:

- Women hold more responsibilities and perform tasks previously filled by males due to migration, i.e., there is a feminization of agriculture in Tajikistan.
- Migrant households have overall better food security as remittances from migrants help alleviate food insecurity.
- In terms of the theory of labor-leisure choice, the substitution effect is more dominant than the income effect because women become substitute for farm labor work that has been left vacant from male outmigration.

1.3 Contribution to the Literature

This paper contributes to the ongoing migration literature in three ways. First, while previous studies have examined the link between migration and household labor allocation (Lastarria-

Cornhiel, 2006; Kalaj, 2009; Maharjan et al., 2012; Tamang et al., 2014; Mukhamedova & Wegerich, 2018; Kan & Aytimur, 2019; K.C. & Rage, 2020), this study focuses on labor tasks surrounding water management in Tajikistan. As water is an important component in agricultural production (Akramov & Shreedhar, 2012) we specifically explore the management of irrigation systems. In-depth knowledge into the division of labor by gender in water management will help guide development practitioners and government agencies on relevant gender, resource management and agricultural policies. Second, this study adds to the existing research on food security and remittances. Only a limited number of studies have explored the linkages between food security and migration. Studies (Zezza et al., 2011; Acharya & Leon-Gonzalez, 2014; Cebotari et al. 2016; Sulemana et al., 2019) have found a positive effect of remittances on food security while other studies find remittances do not affect food security (Craven & Gartaula, 2015; Duda et al., 2018) or the results are ambiguous (Karamba et al., 2011; Weiler et al. 2017). Third, this is the first study we are familiar with that analyzes gender labor division and food security within the same household as combining these two concepts together can offer a comprehensive and broader understanding of migration on food security conditions in rural households. Furthermore, we analyze all these interactions and linkages in three types of land or production systems in Tajikistan – the kitchen plot, presidential plot and Dehkan farm.

1.4 Result Summary

A total of 1920 households in 160 villages belonging to the 80 Jamoats were surveyed. Among the 1,920 households surveyed, 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.

In households that own kitchen plots (1897 households, almost our entire sample), non-migrant households face more months of food shortage, take more measures to mitigate food shortage, spend more days without eating, have more food shortages and sleep hungry at night compared to migrant households, statistically significant at the 1 percent level. Specifically, non-migrant households face 2.5 more months of food shortage, took 2.7 more measures to provide food and faced on average 1.3 times more total food shortage. Non-migrant households are more likely to eat seed saved for cultivation, sell useable household items, lack food due to limited resources and go hungry, statistically significant at the 1 or 5 percent level depending on the matching method.

We do not find similar results for households owning presidential plots or Dehkan farm. For presidential plot owners, households without migrants are 9 percentage points more likely sell usable items and more likely to go whole day without food due to food shortages, statistically significant at 5 percent level. Among Dehkan farm owners, migrant households are likely to have no food to eat at home due to lack of resources, statistically significant at 10 percent level. Our sample size is limited, however, due to the low number of Dekhan farms.

Women in migrant households are more involved in managing the water systems and farm production. More specifically, women in migrant households are 5 percentage points more involved in cleaning the irrigation canal, 6 percentage points more involved in setting up irrigation system and guiding irrigation water flow, 12 percentage points more likely to decide on the amount of irrigation water to use, 10 percentage points more likely to decide on when to apply irrigation water and 8 percentage points more likely to speak with irrigation service provider all statistically significant at one percent level. Similarly, in terms of farm management, women were more involved in migrant households than non-migrant households. Women were 8 percentage points

more likely to sow seeds, 11 percentage points more likely to spray pesticides, 12 percentage points more likely to apply fertilizers, 6 percentage points likely to decide on agricultural inputs to purchase, 9 percentage points likely to decide on which crops to grows, 10 percentage points more likely to decide on the amount of agriculture products to sell, consume, and store, all statistically significant at 1 percent level.

Again, these results do not hold on presidential plots or Dehkan farms. On presidential plots, women from migrant households were 7 percentage points more likely to speak with irrigation service provider statistically significant at 5 percent level. Women from migrant households that own Dehkan farm were 13 percentage points more likely to purchase agricultural inputs statistically significant at 1 percent level.

1.5 Paper Organization

The thesis is organized as follows. Chapter 2 provides a theoretical framework for the paper. Chapter 3 provides some background on migration, the feminization of agriculture, food production and irrigation and land reforms in Tajikistan. Chapter 4 discusses the relevant literature on gender labor division and food security in Tajikistan. Chapter 5 provides a description of the study site, the data and the methods used to analyze the empirical data. Chapter 6 presents the results. Chapter 7 discusses the results and its implications more broadly for policy. Finally, chapter 8 summarizes the main findings of the study and concludes.

Chapter II: Theoretical Motivation: Labor -Leisure Choice

In neoclassical economics an individual's labor supply function is determined through a choice between commodities purchased on the market and nonmarket activities such as leisure[2], in which an individual maximizes their utility function through these variables subject to budget and time constraint (Becker, 1965; Hartley & Revankar, 1974). Utility is a positive function expressed as

$$(2.1)\ U = f(C, LL)$$

where C is commodities and LL is leisure time. A person can either chose to work more in order to consume additional commodities or can choose to work less and consume more leisure (Altman, 2001). It is assumed everyone has certain income regardless of their involvement in the labor market. Remittances, for example, are referred to as non-labor income (Varian, 2010). The budget constraint can be written as follows:

$$(2.2)\ pC = R + wL$$

where p is price of consumption, C is the amount of consumption, w is wage rate and L is the amount of labor supplied and R is an endowment of non-labor income[3]. As one can only work certain hours per day, there is a time constraint an individual faces where they allocate time between leisure and labor. The time constraint can be written as:

$$(2.3)\ T = L + LL$$

where T is the total time available to the individual, where, again, L is the labor supplied and LL is leisure. It is not physiologically possible for the individual to work without rest, so the total labor supplied can be written as:

[2] We consider leisure as a normal good.
[3] If an individual no longer has to engage in work then their consumption can be defined as $\underline{C} = R/p$.

$$(2.4)\ L = T - LL$$

then new budget constraint is

$$(2.5)\ pC = R + w\,(T - LL)$$

The value of time is determined through the wage rate (Varian, 2010). As seen in (2.5), if there is an increase in wage and if the individual decides not to work additional time, they will forego this income, known as the opportunity cost of leisure[4] (Ashenfelter & Heckman, 1974; Kimball & Shapiro, 2008). For example, if an individual devoted 8 hours of work per day with a wage rate of 1 USD their income would be 8 USD plus their residual income. However, if their wage rate was increased to 2 USD their income doubles to 16 USD, every hour the individual decides to devote to leisure they would lose 2 USD amount of income.

It is assumed that a rational individual is always willing to work more hours as long as their market wage is greater than or equal to their reservation wage (Zaiceva, 2010). Remittances increase non-wage income, R, thereby increasing the reservation wage. Looking at our budget constraint (2.5), suppose the wage rate remains at 1 USD and there is an increase in reservation income due to remittance increasing from 10 USD to 20 USD. The purchasing power has increased from 26 USD to 36 USD, hence one can afford to buy more despite working less hours. Such increases reduce an individual's opportunity cost of leisure and thus the income-effect dominates the substitution effect[5]. This decreases the participation of left behind household members as the marginal rate of substitution[6] between consumption and leisure is equal to w/p (Varian, 2010). When there is an increase in the residual income one can afford as much commodities as before

[4] Opportunity cost of leisure refers to the loss either in wage or commodities an individual might incur if they forego working (Varian, 2010).
[5] Substitution effect in neoclassical economics can refer to either the substitution of consumption commodities or the substitution of labor between individuals. In this paper, we use the term substitution to refer to the latter.
[6] The rate at which an individual is willing to replace one good for another (Varian, 2010). The amount of wage one is willing to forgo in order to get one extra hour of leisure.

without compromising wage. In this paper we find, however, that remittances received do not impact income of migrant household to the extent that the left behind household members can afford to work less.

Chapter III: Background

3.1 Migration and Tajikistan

Global 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). Migration is a key livelihood strategy (Acharya & Leon-Gonzalez, 2014; Moniruzzaman, 2020) especially for rural 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). Migration is a crucial strategy to mitigate food insecurity (Crush, 2013), as remittances help mitigate resource constraints and smooth food consumption (Karamba et al., 2010; Zezza et al. 2011; Craven & Gartaula, 2015; Regmi & Poudel, 2017).

According to the International Monetary Fund (2020), in the last decade, total remittances have increased considerably, surpassing $500 billion worldwide in 2016[7] (Hosny, 2020). Tajikistan had the highest average percentage of GDP attributed to remittances between 2010-2015, at approximately 40 percent (Hosny, 2020). Income from agriculture is rarely sufficient in rural households to meet basic needs (Kawabata et al., 2020). In some Tajik households, remittances from migrants are the singular source of income used to purchase essential needs, including food (Piracha et al., 2013). Approximately 71 percent of migrants in Tajikistan are from poor rural households (Bakozoda et al., 2019), where the decision to migrate is based on economic need (Kan & Aytimur, 2019).

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

Tajikistan is a low-income, land locked country located in Central Asia (Clement, 2011; Zetova & Cohen, 2019). It has a population of 9 million (Kawabata et al., 2020), occupies 142,000 square kilometers where 93 percent of its land is mountainous (Akramov & Shreedhar, 2012). Tajikistan gained its independence from the Soviet Union in 1991 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). Approximately one third of the population lives below the absolute poverty line and nearly three quarters of the poor reside in rural areas (Clement, 2011; Azzarri & Zezza, 2011; Akramov & Shreedhar, 2012; Balasubramanya et. al. 2018). Households in these rural areas are mostly engaged in agricultural work[8] (Olimova & Bosc, 2003; Kan & Aytimur, 2019). The unemployment rate is estimated to be 5.5 percent in rural areas and 11 percent in urban areas (ILO, 2016). However, this percentage could be as high as 21-30 percent since only those registered for unemployment benefits were estimated (ADB, 2016; Kan & Aytimur, 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 of the migrants were refugees; however, starting in 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

[8] Agency on Statistics under the President of Tajikistan estimates 71.1 percent of working population were employed in agriculture in 2016.

for work (Cebotari, 2018). In 2016, the Asian Development Bank reported that approximately 750,000 to 1.5 million of the Tajik labor-force migrated each year, or between 8 to 17 percent of the total population. The majority of migrants are male from rural areas, with secondary or vocational schooling. As migrants in the destination country, they work in informal sectors as temporary or seasonal workers in agriculture and construction (Piracha et al., 2013; Mukhamedova & Wegerich, 2018; Kan & Aytimur, 2019; McNamara & Wood, 2019).

3.2 Feminization of Agriculture

In Tajikistan, migration is perceived as an essential component of the livelihood strategy that helps households diversity their income sources (De Haas, 2005; McCarthy et al., 2009; Zezza et al., 2011; Craven & Gartaula, 2015; Cebotari, 2018). The resulting outmigration of predominantly men from rural areas has changed the labor dynamics in the country (Angrist, 2002; Tumbe, 2015). Women have increasingly needed to be directly engaged in the agricultural sector than previously, leading to what others have coined the "feminization of agriculture" (Katz, 2002; Jha, 2004; Deere, 2005; Radel et. al., 2012; Kawabata et al., 2020). Traditionally, men have held more physically demanding and decision-management activities, like ploughing and building irrigation canals, while women have held tasks like sowing and crop processing (Jha, 2004; Mukhamedova & Wegerich, 2018; de Brauw et al., 2021). More specifically, in Tajikistan, men have managed irrigation, operated machinery and prepared the land for cultivation, whereas women have had the responsibilities of planting, harvesting, and weeding (Mukhamedova & Wegerich, 2018). Such divisions in labor have also hindered women's access to resources such as land, water, and new technologies as well as preventing them from being part of the decision-making process (Mukhamedova and Wegerich, 2018).

Some researchers have found that male outmigration from rural areas leads to a shortage of labor causing a decline in agricultural production (Sunam &Adhikari, 2016). Household members remaining at home, often women, have needed to replace the labor gap by working additional hours and performing new and different tasks (Duda et al., 2018). Ideally, households could hire replacement labor; however, markets are often imperfect, and households have credit constraints (Karamba et al., 2010). Thus, the reduction in labor, due to migration, can have negative effects on food production and subsequently on food security (Zezza et al., 2011; Crush, 2013).

3.3 Irrigation and Food Production

Irrigation water management and food production are connected in various ways. Well-developed irrigation systems can stabilize and enhance food cultivation and production (Akramov & Shreedhar, 2012). According to the World Bank (2020), 20 percent of the world total cultivated land is irrigated and contributes to 40 percent of food produced in the world, using 70 percent of world's fresh water each year. Indeed, efficiently managed irrigation systems can reduce water used in agriculture by 30-70 percent and increase crop yields by 20-90 percent in the world (Saccon, 2018). In Tajikistan, 84 percent of its water resources are used to irrigate agricultural fields, but its current water use is unsustainable (Sehring, 2007) as Tajikistan's irrigation systems are inadequate and rapidly deteriorating (Akramov & Shreedhar, 2012).

3.4 Tajikistan and Food Security

Crop yields have improved little since the fall of the Soviet Union and the restructuring of collective land, (Asadov, 2013) making Tajikistan heavily dependent on imported food (Kawabata et. al. 2020). 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).

3.5 Land Reforms

After the dismantling of the Soviet Union and the end of the civil war, Tajikistan's government began to split the land from state and collective farms into private farms (Behnke, 2008). State owned collective farms changed from 95 percent in 1990s to 27.5 percent in 2009 of total arable land (Akramov & Shreedhar, 2012). Through the reform, Tajikistan's agricultural system changed from large, state-owned farms to smaller household plots, *kitchen* and *presidential* plots, and medium-sized farms or *dehkan* farms (Lerman & Sedik, 2008). These different plot types are described below.

Kitchen gardens are small plots usually adjacent to the home and are owned by almost 100 percent of rural Tajik households, which are used mainly for subsistence farming (Behnke, 2008; Boboyorov, 2016; Buisson & Balasubramanya, 2019) and contribute to the overall food security and livelihood (Mukhamedova & Wegerich, 2018).

Presidential plots were distributed twice through the Presidential Decrees[9] in 1995 and 1997 to those households who had less than 0.15 hectares of land for agricultural activities (Behnke, 2008; Boboyorov, 2012). Officially referred to as "support land resource", recipients were often from lower economic standings and these plots were for overall food security of the households and wheat production (Boboyorov, 2012). Wheat flour is a staple food in Tajikistan accounting for

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

52 percent of household caloric intake (Muminjanov et al., 2016). The decrees were meant to provide farmers incentives to cultivate wheat for self-consumption (Buisson & Balasubramanya, 2019). However, approximately 40 percent of the wheat consumed in Tajikistan was still being imported in 2010 (Muminjanov et al., 2016). As of 2009, there were approximately 375,000 presidential plots, accounting for 9 percent of the total arable land (Lerman & Sedik, 2008).

Dehkan farms are larger plot of lands usually farmed by more than one household. They can be inherited, although they are still considered state property (Buisson & Balasubramanya, 2019). Between 1999 and 2007 nearly 700 collective farms were restructured[10] (Akramov & Shreedhar, 2012) into approximately 18,000 farms (Lerman and Sedik 2008). The average Dehkan farm is 18 hectares and in total accounts for 40 percent of total arable land in Tajikistan (Akramov & Shreedhar, 2012). Dehkan farms mostly cultivate cotton which accounts for 90 percent of the agricultural export and approximately 30 percent of Tajikistan's GDP (Boboyorov, 2016; Buisson & Balasubramanya, 2019). A limited number of household own Dehkan farms, approximately 3 percent, and they are generally considered economically better-off families (Behnke, 2008; Boboyorov, 2012).

[10] Previous state-run large land reforms are ongoing, as Government of Tajikistan continuously works towards land reforms, passing legislations and resolution to slowly shift the power of production decision towards farmers (Akramov & Shreedhar, 2012).

Chapter IV: Literature Review

This section discusses the main findings and studies on migration and its impacts on gender labor division and food security.

4.1 Gender Labor Division

Even though gender and sex have been used interchangeably, they are distinct concepts (Quisumbing et al., 2014). Sex refers to the biological differences present at birth which determines one as being male or female, while gender refers to roles ascribed to an individual based on their sex at birth (Oakley, 1972; Moser, 1989; Blackstone, 2003). These roles are formed through interactions of individuals and various environments such as history, politics, economics, religion, culture and customs which determine the responsibilities between men and women (West & Zimmerman, 1987; Quisumbing et al., 2014; Tiwari & Joshi, 2016). Men and women take cues from these environments and perform responsibilities deemed appropriate for them (Blackstone, 2003). Since gender is not biologically determined, shifts in environment, resources, policies and politics, change the norms of acceptable behavior for men and women (Quisumbing et al., 2014).

Agricultural labor work has traditionally been divided across 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). Boserup (1970) was the first researcher to bring attention to agriculture and gender labor division in her book *Woman's Role in Economic Development* which emphasized that the differences in work between men and women were due to social constructs and were not biological. The Women in Development (WID)[11] movement of

[11] WID advocated development projects to include women's needs and preferences in their design and implementation phases as well as played an important role in raising awareness in women's crucial role in agriculture and rural development (Rathgeber, 1990).

the 1970s and Gender and Development (GAD)[12] movement of the 1980s further highlighted the importance in understanding the differences in men and women in agriculture labor (Kalaj, 2009; Radel et al., 2012; Quisumbing et al., 2014).

Despite an overall decline in global agricultural employment since the 1950s, (Roser, 2013; Ofori & El-Gayar, 2021) the percentage of women working in agriculture has increased, especially in low-income countries (Lastarria-Cornhiel, 2006). Acknowledgment of women's contributions to agricultural production in recent decades is more pronounced (Radel et al., 2012), however quantitative studies on gender labor division and migration have been limited and the results are varied (Curran et al., 2006; Quisumbing et al., 2014; Kan & Aytimur, 2019).

Some authors (Deere, 2005; Garikipati, 2009; Pattnaik et al., 2018) find that women fulfill the roles in agriculture left vacant by migrants, thereby giving women a more crucial role in agricultural production (known as the substitution effect). On the contrary, others find no feminization of agriculture in labor or management as remittances from migrants allow for more flexibility in the labor supply, e.g., hiring daily workers (known as the income effect) (de Brauw et. al., 2008; Urama et al., 2016; Liu et. al., 2019; Bacud et al., 2019; Pandey, 2019). The literature on gender labor division can be categorized into these two main themes: those studies supporting a dominant income effect, and others supporting a dominant substitution effect. As seen in chapter 2, additional income from remittances allows individuals to work less, trading off work hours for leisure as they can afford the same or even more commodities than before (Kalaj, 2009). This is known as the income effect. On the other hand, agricultural labor work performed by the migrant is left vacant and substituted by those household members who have not migrated, increasing their

[12] GAD advocated the importance of studying roles of both men and women in rural development work and researching dynamics within a community such as gender-social norms, access to resources and opportunities and constrains faced by both (Rathgeber, 1990).

workload (Tamang et al., 2014; Lastarria-Cornhiel, 2006; Mukhamedova & Wegerich, 2018). This is referred to as the substitution effect.

4.1.1 Income Effect

There are multiple studies finding a dominant income effect. For example, Funkhouser (1992) studies the effect of the increase in male out migration following the military conflict in Nicaragua in 1980s. Using cross sectional data, Funkhouser examines the relationship between absentee male and women participation in the labor force and self-employment. He finds that migrant households are less credit constrained due to remittances; for each $100 increase in remittance income, the probability of labor force participation by women decreased by 5 percentage points. Similarly, Rodriguez & Tiongson (2001) use a probit analysis on 1991 data in the Philippines and find that the labor supply of those left behind lowered as households were able to substitute income for more leisure. The probability of male members who did not migrate in migrant households participating in the labor force was 9.4 percentage points less while for women it was twice as large. An additional thousand pesos (about 40 USD) from remittances decreased women's participation in the labor force by 0.2 percentage points.

In Mexico, Amuedo-Dorantes & Pozo (2006) use an instrumental variable (IV)-Tobit estimator and find that an increase of 100 pesos in remittances decreases overall female labor supply in rural areas by 6 hours per month or 4 percentage points in nonpaid employment. In the informal sector, female labor supply decreases by 12 hours per month or 7 percentage points. On the other hand, men's participation in the formal sector work decreased by 15 percentage points or 32 hours per month. In the informal sector, men's labor force participation increased by 14 percentage points or 30 hours per month. Additional studies in Mexico are consistent with the findings above -- women in households with migrants worked less in agriculture compared to non-

migratory households (Bever, 2002; Radel et al., 2012). In this context women do not seem to substitute the work previously done by men, but, rather, migrant households changed their strategies and behavior. (Radel et al., 2012).

Similar findings have been found in other contexts as well. Lokshin & Glinskaya (2009) find that in Nepal women's labor force participation decreased by 5.3 percentage point in households with male migrants. In Nigeria, Urama et al. (2016) find that weekly labor supplied by women in migrant households decreased by 1.65 hours; however, the results were statistically insignificant. De Brauw et al. (2008) examine the effect of migration on management decisions, proxied by decisions making in marketing and sales of produced goods, in China and find little evidence of the feminization of agriculture in China. In Albania, Kalaj (2009) uses PSM to compare households with remittances to those without and finds that remittances did not alter the behavior of men in the decision to participate in the labor force and the number of hours worked unlike women whose hours worked decreased by 2.8 hours per week if they were from migrant households. The author does not, however, address unpaid labor work.

4.1.2 Substitution Effect

The literature supporting a substitution effect of migration on labor in agriculture is more limited. Women in rural areas may take over agricultural work formerly considered to be male activities in order to fill the gap in the labor shortage left by the migrant (Gartaula et al., 2012; Bhandari & Reddy, 2015; Tamang et al., 2014). Since migration is highly male-dominated, women become de facto household heads and thus have increased responsibilities in subsistence agricultural production and food security (Boserup,1970; Preibisch et al. 2002; Lastarria-Cornhiel, 2006; Garikipati, 2009).

In Albania, Mendola & Carletto (2012) use an IV framework to control for the endogeneity of migration and find that paid female labor supply decreased while supply for unpaid work and self-employment increased. Women in migrant households were 32% more likely to supply unpaid work. The authors postulate that these results could be attributed to remaining members fulfilling duties of those who have migrated. The authors do not find such changes in the labor force for males in migrant households. Similarly, in Nepal, Maharjan et. al. (2012) evaluated the extent to which lost labor was being substituted and find an additional migrant per household leads to a 166 percent increase in likelihood of hiring female farm labor compared to 87 percent male labor hired., meaning missing labor is more likely to be substituted by women in the community. As migration is male-dominated, female labor supply is higher and they have lower wages. In Mexico, Katz (2003) finds women's employment in rural area increased from 16 percent to 26 percent in 1980 and 2000, respectively. In Bangladesh, de Brauw et al. (2021) observe that women in migrant households worked 1.8 percentage points more in terms of total number of days and hired 2.2 percentage points less female labor from outside the household compared to their counterparts.

4.1.3 Empirical Studies in Tajikistan

There are five main studies in Tajikistan on the feminization of agriculture: Justino & Shemyakina (2012), Piracha et al., (2013), Mukhamedova & Wegerich (2018), Kan & Aytimur (2019) and Murakami et al. (2021). Among the five, the results on the impact of migration on gender labor division vary. Justino & Shemyakina (2012), Piracha et al., (2013), Kan & Aytimur (2019) and Murakami et al. (2021) find that female labor supply decreases, but none of them analyze agriculture labor division among specific tasks, e.g., such as guiding irrigation water, spraying pesticides, purchasing agricultural inputs. In contrast, in a qualitative study,

Mukhamedova & Wegerich (2018) find that women are increasingly taking on roles of those who have migrated.

Justino & Shemyakina (2012) investigate the impact of remittances on conflict affected and non-conflict affected areas on total working hours for men and women. They use data from 2003 Tajik Living Standards Measurement Survey with 4160 observations. The authors use an OLS regression and a Tobit regression as a robustness check. The study finds, on average, remittance-receiving households participate less in the labor market, supplying fewer hours compared to their counterpart. They find that men in migrant households participate in the workforce, on average, 7.6 percentage points less than men in non-migrant households. However, women are only 4.9 percentage points less likely to participate in the workforce compared to women in non-migrant household. An increase in additional migrant in household family reduces male labor force participation by 5.4 percentage points and female by 3.9 percentage points. The authors argue that remittances increase income thereby relaxing credit constraints.

Piracha et al. (2013) research the impact of remittances on the occupational choice of migrant households. Using data from the 2007 Tajikistan Living Standards Survey they run a multinomial probit estimation to analyze the relationship between age and either working as a wage employee or in a household business. They find that that the amount of remittances received increases the probability of men being employed in their own business and decreases probability of working as wage employees. On the other hand, they find remittances have no impact on occupational outcomes of women. Unlike Justino and Shemyakina (2012), Piracha et al. (2013) find that the number of household members who migrate has no significant effect on labour market participation, but it increases the probability of working in a family business and decreases the probability of wage employment. The authors suggest that remittances are being invested in

household businesses thereby increasing men's participation in their own family business. The authors further elaborate that since women's occupation in Tajikistan is based on tradition and culture their participation in wage labor work were not statistically significant.

Mukhamedova & Wegerich (2018) focus their qualitative study in the Sughd province of Tajikistan. The authors chose this province to study because the Sughd province had a large population (2.5 million in 2015), of whom 75% live in rural areas. The province is also one of two provinces with the highest migration rates. Data for the study was collected in 2011 through semi-structured in-depth interviews (60 respondents), focus group discussions (5), and participant observation covering topics relating to the feminization of agriculture. The respondents were agricultural laborers in Dehkan farms and rural household members. Unlike Kan & Aytimur (2019), the authors conclude feminization of agriculture is evident in Tajikistan and existing social structure and power systems are being challenged due to male outmigration. The study notes women to some degree have taken over irrigation services with roles of Mahalla (community) Mirobs (water masters). These positions are traditionally mainly held by men. The authors write that kitchen garden plots play an important role in household food security and are primarily managed by female members of the households. Due to limited water sources and scarcity during peak irrigation seasons priorities are given to state run crops which increases the competition within the village. Due to the feminization of agriculture male Mirobs are being challenged. This is particularly interesting for our study as we analyze the gender labor division in irrigation management between migrant and non-migrant household.

Kan & Aytimur (2019) study whether women in Tajikistan compensate for lost labor by working more hours on their farms using panel of household Tajikistan Living Standard Survey (TLSS) data from 2007, 2009 and 2011. Their final sample size was 2454 observations with 818

women represented across the three years. The presence of a migrant within the household was used the main independent variable of interest to consider the relationship with the number of hours worked within the last 14 days. The authors employ an IV household fixed effects method with year fixed effects to control for unobservable heterogeneity. They find a negative but statistically insignificant result between migration and female labor hours. The authors find the same result with robustness check with random fixed effects, split sample analysis based on household business and employment type, remittances and consumption level. Additionally, the authors did not find any difference in paid and unpaid work and female labor force participation. However, the authors found having a farm increased hours worked by women by 10.8 hours per week which was statistically significant. They also find that daughters of the housework on average 7 hours less per week than other women. Age was also a bigger contributing factor to female labor force they conclude as labor hours increased every year up until the age of 43 for women.

In a recent study, Murakami et al. (2021) explore the impact of migration and remittances in the labor market in Tajikistan using a telephone-based high frequency panel survey called, Listening to Tajikistan (L2TJK). The authors employ a control function approach to endogenous switching regression to mitigate endogeneity and selection bias on panel data from 2015 and 2017. They find that remittances reduces participation in employment and economic activity by those left behind. More precisely, they find that sending one migrant from the household reduces the labor supply of those left behind family members by 5.4 percentage points and receiving remittances reduced the family member's participation further by 10.2 percentage points.

The literature discussed above focuses on labor supply, number of hours worked and self-employment, but does not look at specific labor and management tasks, especially regarding agriculture and food production, e.g., irrigation system management and agriculture crops

management. In irrigation system management we explore specific tasks: cleaning irrigation canal, cleaning smaller irrigation ditch, setting up irrigation system, guiding water flow, deciding on amount irrigation water to use and when to apply irrigation water finally speaking with irrigation service provider. In agriculture crop management we explore sowing seeds, spraying pesticides, applying fertilizers, purchasing agricultural inputs, deciding on which crops to grow, deciding the amount of agricultural products to sell, consume and store, deciding on amount of livestock to sell and consume and processing and storing crops. This paper will attempt to fill this gap in the literature by analyzing the effect of migration on the division of labor by gender in different plot or production system in Tajikistan.

4.2 Food Security

Even though there is considerable literature on migration and food security independently, there is limited empirical research on the relationship between the two (Crush, 2013; Sadiddin et al., 2019). Moreover, findings from previous research on the interactions between food security and migration are divided (Crush, 2013). Some authors find that remittances play a vital role in rural economies and livelihoods, household expenditure, income and consumption (Zezza et al., 2011; Acharya & Leon-Gonzalez, 2014; Cebotari et al. 2016; Sulemana et al., 2019), while others argue that remittances in itself are not enough to improve food security (Craven & Gartaula, 2015; Duda et al., 2018) or the results are ambiguous (Karamba et al., 2011; Weiler et al. 2017). On the one hand, agricultural production decreases as a result of labor lost to migration causing overall decline in food security (Zezza et al., 2011; Crush, 2013). On the other hand, additional income from remittances increases purchasing power of the household as a result household are able to purchase more commodities (De & Ratha, 2012).

4.2.1 Improve Food Security

Several studies find evidence that remittances strengthen households coping mechanisms related to food uncertainties and even help diversify their diets. Moniruzzaman (2020), examine the impact of international remittances on household food security in Bangladesh, using IV and Generalised Method of Moments (GMM). Results from the study indicate remittances reduced uncertainties related to food and provided migrant households with better coping strategies. Furthermore, the author finds that remittances were positively correlated to food consumption and expenditure as well as improved diet. These findings are supported by Rahman & Mishra (2020) who use nationally representative panel survey of 25,000 Indian rural household and an IV method to control for endogeneity issue to examine remittances and consumption patterns. The authors find that households receiving larger sums of remittances spend more on non-cereal food items as well as on eggs, fish, and meat products. Moreover, the study adds that migration diversifies cultural practices around food from exposure to new diets while migrating, giving households greater diversity and therefore better nutrition.

In Mexico Mora-Rivera & van Gameren (2021) find that both international as well as internal remittances have significant positive effects on food insecurity. The authors find that remittances can decrease severe food insecurity from 14.27 percentage points to 2.69 percentage points in households. However, the authors point out that remittances are not adequate to eradicate food insecurity completely from rural households. They can only be considered as a supplementary step which cannot replace the role of government. Similarly, in Nepal, Regmi & Paudel (2017), interview 395 subsistence farming households to understand the impact of remittances on children, adult and food security. The paper uses an IV-ordered probit regression model with clustered

robust standard errors and control for other explanatory variables. They find that an increase in annual remittances of NRs. 10,000 (100 USD) significantly increases the probability of households being more food secure by 4.6 percentage points.

Several studies in African countries have also shown remittances provide a possible pathway for households to escape food insecurity (Crush, 2013; Atuoye et. al. 2017; Mabrouk and Mekni 2018). In Ethiopia (Abebaw et al., 2020) remittances from migration improved the food security of households by providing them with additional income necessary for food consumption. Controlling for the potential endogeneity of migration, the authors combine difference-in-difference (DID) model and an inverse-probability of treatment weighting (IPTW) approach to find that outmigration has significantly reduced the severity of food poverty by 4 percentage points. Receiving remittances improved the amount of daily calories consumed per adult by approximately 22 percentage points. This is further supported by Isoto and Kraybill (2017) who study the effects of receiving remittances on macronutrients and micronutrients consumption in Tanzania. The authors use data from 2008-2010 Kilimanjaro Livelihood and Climate Survey, with an IV strategy to counter the endogeneity and self-selection bias from net income and remittances. They find that remittances increase investments in the intake of nutrients such as proteins, vitamin A, vitamin C and calcium, in poorer households, improving health of adults and children. Research (Sulemana et al., 2019) on 32 sub-Saharan African countries found that the frequency at which a household receives remittances impacts food security. After controlling for other covariates with country fixed effects, the authors find a unit increase in frequency of remittances is correlated with a 0.049 percentage point increase in the food security status.

Other papers reviewing a number of articles on remittances and food security also find a positive effect. Thow et al. (2016) review 20 articles on the relationship between remittance

income and food security, defined broadly as food consumption, nutritional status and dietary intake. Overall, the studies point to remittances smoothing consumption, decreasing household's vulnerability to food insecurity and increasing their ability to purchase food. However, the authors find that remittances generally had little effect on undernourishment and that food purchased were higher in calories but lower in nutrition. Zezza et al. (2010) synthesize nutrition case studies from seven countries including Tajikistan. The authors write that migrant households are better able to withstand food related shocks such as sudden increase in prices and children in migrant households had 6 percentage points lower stunting rate.

4.2.2 No Impact on Food Security

Conversely some authors find that an increase in income from remittances is not necessarily correlated with improved food security (Sunam & Adhikari, 2016) as remittances can be used in other ways, e.g., housing and education (Adams, 2005). Sunam and Adhikari (2016) write that the improvement in food security through remittances is only a short-term fix since migration leads to a dependency on imported foods. Craven and Gartaula (2015) add remittances might increase a household's ability to access immediate physical access to food but threaten longer term food security especially since migration and remittances are temporary fixes susceptible to economic downturns in destination country.

Karamba et al., (2010) use nationally representative data from 4130 households in the Ghana living Standard Survey 2005-2006 with an IV and find that remittances did not affect food expenditure per capita or food expenditure patterns. The authors also find that migrant households consume significantly lower meat and fish, vegetables and fruits. Moreover, the authors find that in areas with high migration rates the expenditure for food increases resulting in consumption of

potentially less nutritious foods such as sugary beverages. Similarly, Crush (2013) explored agriculture activities in 11 African cities to find 61 percentage points of migrant households were food insecure compared to 48 percentage points of non-migrant households. Additionally, 38 percentage points of non-migrant households consumed food from seven or more food groups compared to 28 percentage points of migrant households. The study also found non-migrant households had greater access to land thus were likely to grow own food for consumption compared to migrant household.

In Ghana, Atuoye et al., (2017) conclude remittances do not ameliorate food insecurity situation as they find rural households regardless of their migrant status report being severely food insecure. Duda et al. (2018) uses PSM with 900 rural household to find rural-urban migration worsens the food security status of migrant households in terms of access, availability and stability. The authors write that low agricultural productivity due to loss in labor reduces food security status which cannot be alleviated by remittances hence food insecurity to persist in rural households.

4.2.3 Empirical Studies in Tajikistan

Several studies have explored food security challenges in Tajikistan (Akramov & Shreedhar, 2012; Asadov, 2013; Husenov et al., 2015; Clement et al., 2019; Kawabata et al., 2020). However, only one study, Azzarri and Zezza (2011), investigates the relationship between remittances and food security, focussing on child malnutrition. The authors use statistically representative national level household survey from 2007 Tajikistan Living Standard Study (TLSS). Azzarri and Zezza (2011) use a two-stage stratified random sample framework with 4860 households and a total of 30,778 individuals. They estimate both an OLS model as well as an IV to deal with endogeneity bias. They find migration has positive impact on overall child z-score (difference in standard deviations of child's height for age from median height for age of children from same age and

gender in reference population) increasing it by 0.2 standard deviations. Additionally, migration had a positive and statistically significant effect on kilocalories intake; however, they did not find any evidence on migration and breast-feeding habits. Results suggest that children living in migrant households have better nutritional access. The authors attribute this to income effect of migrant remittances.

As the above literature shows there are limited number of studies exploring the linkages between food security and migration, even scarcer in Tajikistan one of the world's highest recipient of remittances. This paper fills the gap in literature by evaluating the food security conditions in Tajikistan.

Chapter V: Methods

5.1 Data

The data we use in this paper to explore the hypotheses outlined in chapter one, was collected by the International Water Management Institute (IWMI) in 2016 and is a nationally representative dataset. Tajikistan is divided into four regions: Sughd Region, Khatlon Region, the Autonomous Region of Gorno-Badakhshan, and the Region of Republican Subordination with a total of 58 districts that are further divided into 367 subdistricts known as Jamoat[13]. Initially the data was collected to study the impact of a USAID-funded project Feed the Future (FTF) which aimed to organize and strengthen Water User Associations (WUAs) and improve their capacity to manage irrigation water resources. The main objective of the survey was to analyze the changing role of women in agriculture and their water use due to the intervention. Detailed information was collected on household characteristics, socio-economic conditions, crops, water, and irrigation management as well as plot characteristics, migration, food security, and gender labor division. Some of these modules prompted farmers to differentiate these questions by plot type (i.e., kitchen gardens, presidential plots and Dekhan farms).

The project was based in the three main agricultural producing regions of Tajikistan – Khatlon, Sughd and Districts of Republican Subordination. The survey was conducted in 80 Jamoats, which were grouped into 3 categories i) Jamoats in USAID-WUAs program ii) Jamoats that had WUAs but were not part of the USAID program iii) Jamoats without any WUAs. Then 40 Jamoats that did not participate or did not have WUAs in their Jamoats were selected on their resemblance to the USAID-WUA program in terms of observable characteristics like agricultural patterns, sources of water for irrigation, population, access to infrastructure and markets, etc. In

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

each Jamoat, two villages were selected with proportional random sampling (PRS)[14] with criteria for canal types and location of the village along the canal. Thus, in each village using PRS, 12 households were surveyed who shared the same irrigation water source. Households that were not engaged in farming were excluded from the study. All of the respondents selected were knowledgeable women of the household who were able and likely to respond to the questions in the survey.

A total of 1920 households in 160 villages belonging to the 80 Jamoats were surveyed. Among the 1,920 households surveyed, 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.

[14] This is a probability sampling that allows researchers to a sample size that represents the entire population being studied (Hirzel & Guisan, 2002).

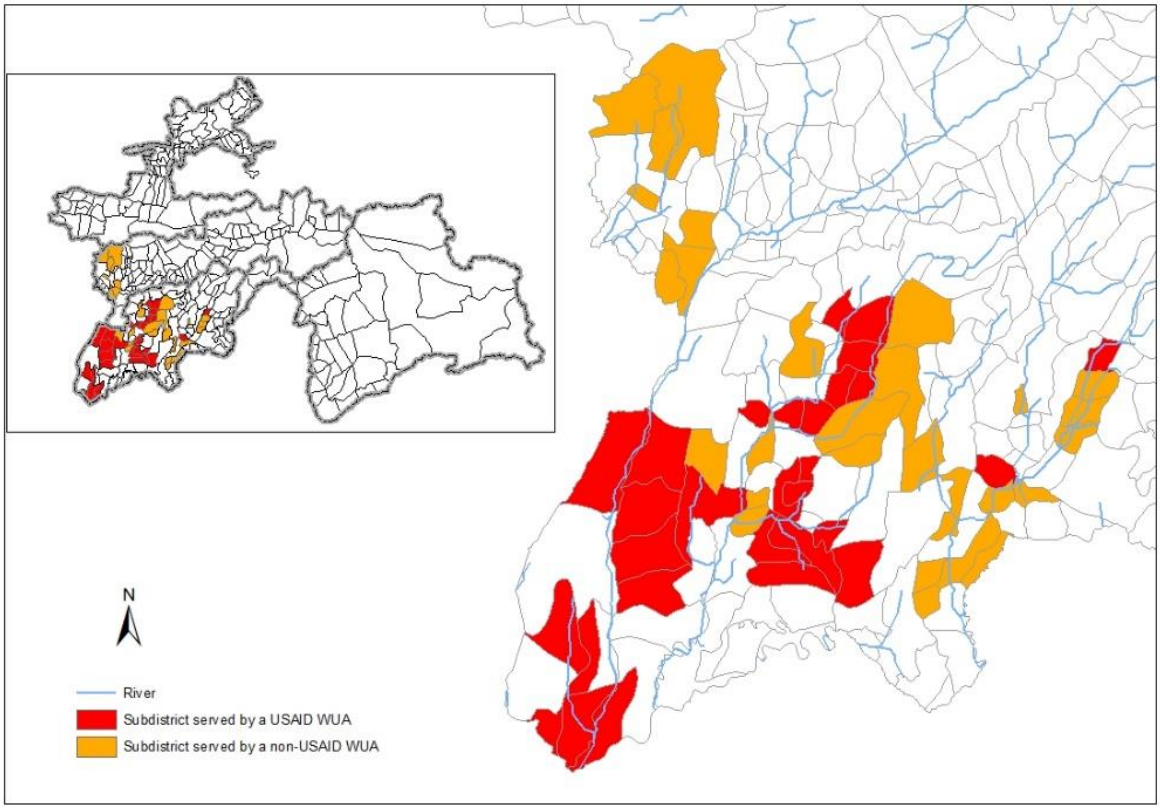

Figure 1: Map of Tajikistan

5.2 Methodology

The purpose of this study is to compare food security and gender labor division among migrant and non-migrant households. Since migration depends on a host of characteristics, any comparison between migrant and non-migrant households will be biased 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 outcome variables of interest (Becker & Ichino, 2002; Caliendo & Kopeining, 2008; Zhang et al., 2019). This main issue at hand is the difficulty in finding a counterfactual – we cannot observe outcomes for households with a migrant, had they not had a migrant. In other words, while E ($Y_{i1}|D_i=1$) and E($Y_{i0}|D_i=0$) are observed, E ($Y_{i1}|D_i=0$) and E($Y_{i0}|D_i=1$) are not (Rosenbaum & Rubin, 1983). E(.) denotes an expectation

operator; *i* is subscript for "household"; Y_{i1} (Y_{i0}) is an outcome of interest for a household with (without) a migrant; D_i is an indicator equal to 1 (0) if household i has (not) migrated. The observed and unobserved factors result in endogeneity bias, which potentially results in selection bias, simultaneity, and omitted variable bias (Clougherty et al., 2016; Wooldridge, 2002).

To reduce the issue of endogeneity bias, we can build a counterfactual by using propensity score matching (PSM) (Caliendo & Kopeining, 2008). PSM is a matching method through which migrant and non-migrant households with a similar mean in observable characteristics can be matched (Dehejia & Wahba, 2001). The observable characteristics must meet two key assumptions: 1) they must be exogenous, i.e., they should not be a cause or result of migration, known as the Conditional Independence Assumption (CIA) (Smith & Todd, 2001); and 2) they must be similar in migrant and non-migrant households, known as the Common Support Assumption (CSA) (Caliendo & Kopeining, 2008; Smith & Todd, 2001).

Under the CIA, the socio-economic and environmental factors affecting migration are independent of the motivations for migration. The CIA is denoted mathematically as $(Y_{i0},Y_{i1}) \perp D_i p(X)_i$ where $p(X)_i$ is the probability of a household being a migrant household, and X are observable characteristics. Controlling for these covariates, the outcomes can be considered independent of biases (Rosenbaum & Rubin, 1983; Caliendo & Kopeining, 2008). Although CIA cannot be directly tested, the observable covariates used should be stable across time and/or measurable before migration, so they are not confounded with outcomes (Heckman & Robb, 1985). We use economic factors (Todaro 1969; Czaika & Haas, 2017), environmental factors (Barrios et al., 2006; Damania, 2020), and socio-economic characteristics (De Jong, 2000) to match migrant and non-migrant households for comparison.

According to the Common Support Assumption (CSA), the socio-economic and environmental factors occur in similar patterns. In mathematical terms, the means of these characteristics, in propensity scores, must be similar in migrant and non-migrant households. The CSA is denoted as $0 < P(D_i = 1|X) < 1$, meaning that the probability of being in a migrant household is same as the probability of being in a non-migrant household based on each possible value of X within the interval unit (Lechner & Strittmatter, 2017). Meeting this assumption, we are able to select households with the same probability of being either a migrant or non-migrant household (Caliendo & Kopeining, 2008).

These two assumptions together enable us to measure the average treatment effect on the treated (ATT) (Rosenbaum & Rubin, 1983), since

$$(5.1) \quad E[Y_{1i} - Y_{0i} | D_i=1] = E[E\{Y_{1i}|D_i=1, p(X_i)\} - E\{Y_{0i}|D_i=0, p(X_i)\}|D_i=1]$$

With ATT we can now compare two households that have similar socio-economic and environmental characteristics to ensure that the differences observed in gender labor división and food security are due to having a migrant or not having a migrant.

5.3 Analysis

The first step in using PSM to estimate the ATT is to estimate the propensity scores. We use a probit model to estimate the probability of migration:

$$(5.2) \quad \Pr(\text{migration}_i = 1) = \beta_0 + \beta_1 U_i + \gamma E + \emptyset X + \varepsilon_i$$

where *migration=1* signifies a household with a migrant, *U* is a variable for unemployment (i.e., the number of household members participation in income generating activities), *E* is a vector for

environmental factors (i.e., the presence of a piped water line in household, location of plot in comparison to household, and the household's location of plot along the canal), and *X* is a vector for the socio-economic characteristics (i.e., dependency ratio in the household, and marital status, age, age squared, household head, graduate education, spouse of the household head of the respondent, earnings and asset index of household, household has kitchen plot, presidential plot and Dehkan farm, member or respondent in the household have received benefits of trainings, the presence of a WUAs in the village, and membership of any groups in the village of respondent or member of the family). Our results from the probit not only give us the propensity scores, but they also indicate which factors influence migration.

The second step in using PSM to estimate the ATT is to choose a method of matching migrant and non-migrant households. Using the propensity scores derived in (5.2), we can choose a matching algorithm. Different matching algorithms exist and differ in how they assign weights to observations based on observable characteristics (Dehejia & Wahba, 2001; Smith & Todd, 2001). We choose the matching methods with the greatest common support and closest mean, which are Nearest Neighbor Matching (NNM) and Kernel Matching (KM). NNM matches a migrant household to the non-migrant household with the closest propensity score. Matching households can be replaced or not. If replaced, non-migrant households can be matched more than once. If not replaced, non-migrant households can only be matched once with a migrant household (Caliendo & Kopeinig, 2008). Without replacement reduces the variance (Smith & Todd, 2001), however, it creates poorer matches, thereby increasing bias. KM is a nonparametric matching estimator that uses weighted averages of multiple non-migrant households to create a counterfactual. Similarly, to above, this also reduces the variance, but the results could be biased due to lower quality matches (Caliendo & Kopeinig, 2008; Smith & Todd, 2005).

Additionally, to check the robustness of PSM we use village fixed effects. This reduces the unobserved and observed biases affecting local infrastructure, sociopolitical factors, geographic location and administrative. Furthermore, we check for robustness by excluding variables unemployment, earnings and asset index from our probit regression as they could be endogenous or influenced by migration.

5.4 Measures

As mentioned in section 5.2, we are interested in evaluating food security and gender labor division in migrant and non-migrant households. In order to evaluate this link we first need to define the indicators.

5.4.1 Gender Labor Division Measure

Measuring gender equality and empowerment is crucial to tracking progress in achieving gender equality (Crookston et al., 2021). Various tools have been developed to measure gender parity. For example, the World Economic Forum introduced a framework in 2006 called Global Gender Gap Index (GGGI) which tracks progress in gender equality on political, education, economic and health sectors at national level (Hausmann et al. 2014). The United Nations Development Programme (UNDP) uses two indices to evaluate changes in gender parities: the Gender Development Index (GDI) which measures gender gaps in knowledge, health and living standard, and the Gender Inequality Index (GII) which measures gender disparities in reproductive health (UNDP, 2021).

There are limited tools that measure women's contribution in agriculture (Alkire et al., 2012; Malapit et al., 2019), even though in the last few decades, women's role in agriculture is recognized as an important factor in agriculture growth, production and development (Crookston et al., 2021).

One such tool, Women's Empowerment in Agriculture Index (WEAI) developed by the International Food Policy Research Institute (IFPRI) questions men and women separately on, 5 empowerment areas, i.e., agricultural production decision, access and power to make decision on productive resources, control and use on earnings, involvement in community leadership and time allocated to different tasks (Alkire et al., 2012; Quisumbing et al. 2020). The index assesses empowerment levels of women in each of the 5 categories to guide policy makers on areas that needs further work to have equity amongst men and women (Alkire et al., 2012).

In this paper we measure gender labor division by measuring whether women or men perform specific tasks relating to i) managing the household irrigation system , e.g., cleaning the irrigation canal, cleaning smaller irrigation ditches, set up the irrigation system, guiding the irrigation water flow, deciding on the amount of irrigation water to use, when to apply irrigation water and speaking with irrigation service provider; ii) managing agriculture crop production decisions, e.g., when to sow seeds, whether to spray pesticides, what fertilizers to apply, purchasing agriculture inputs, deciding on crops to grow, deciding on the amount of agricultural products to sell, consume and store, deciding on the amount of livestock to sell and consume, and processing and storing crops.

5.4.2 Food Security Measurement

The definition of food security has evolved over the last few decades and new measures have been introduced both at national as well as household levels (Izraelov & Silber, 2019). Food Security is often defined to have three different components— availability, access, and utilization (Swindale & Bilinsky, 2006; Barrett, 2010; Jones et al., 2013). Availability is measured through the food supply chain and supplies as well as improvements in the agriculture sector. Access is calculated through food distribution within households. Finally, utilization is measured through

household's knowledge, sufficiency as well as quality and hygiene (Wolfe & Frongillo, 2001; Napoli, 2011; Izraelov & Silber, 2019).

Based on this definition various measurement framework have been developed (Wolfe & Frongillo, 2001). As food security is an important concern, due to its implications on health, political stability and economic productivity, many disciplines are engaged in its definition and measurements (Jones et al., 2013). These food security measurements are often categorized into four different types of indicators i) caloric intake; ii) household income and expenditure on food; iii) dietary diversity; and iv) perceptions and experience-based of food insecurity measurement scales. (Wolfe & Frongillo, 2001; Carolan, 2012; Jones et. al, 2013; Headey & Ecker, 2013; Izraelov & Silber, 2019).

i) **Caloric intake:** Caloric intake is usually measured at the national level through "national food balance sheets". At the household level, caloric intake can be measured by calculating the weight of food consumed or from the recollection of food consumed by respondents (Perez-Escamilla & Segall-Correa, 2008).

ii) **Household income and expenditure surveys:** Household income and expenditure surveys, questions respondents on the amount of money that they have spent on food and other commodities. This measures the ability of a household to purchase food and other necessities given their budget constraints (Perez-Escamilla & Segall-Correa, 2008; Headey & Ecker, 2013).

iii) **Dietary diversity:** An additional method in calculating food security is dietary diversity, first developed by Food and Nutrition Technical Assistance (FANTA) project of the United States Agency of International Development (USAID), called Household Dietary Diversity Score (HDDS) (Swindale & Bilinsky, 2006). HDDS aims

to measure the variety of food consumed by household members during a certain period, reflecting the quality of diet consumed through twelve food groups (Swindale & Bilinsky, 2006; Izraelov & Silber, 2019). HDDS is considered an effective measurement of food security as it calculates both micro- and macronutrients which enables indicators to capture not only if individuals are consuming enough calories per day but also if they have a balanced diet (Headey & Ecker, 2013).

iv) **Experience based food insecurity measurement:** Experience based food insecurity measurement uses perceived food insecurity in each household (Perez-Escamilla & Segall-Correa, 2008). One such index is known as Household Food Insecurity and Access Scale (HFIAS) developed also through USAID FANTA project, in which participants are asked to indicate the frequencies in which they experienced food insecurity in a certain period (Coates et al., 2007;). In the survey households recall different food insecurity experienced by them, such as diversity and availability of food, food satisfaction and access to food in the last four weeks (Headey & Ecker, 2013). Another experience-based index developed in the United States is the Household Food Security Survey Module (HFSSM), which questions households on their experiences on food insecurity based on concerns on food supplies, inadequacy in quality and quantity of food and reduced food intake in adults and children in the house (Wolfe & Frongillo, 2001; Jones et al, 2013; Izraelov & Silber, 2019). Furthermore, Food Insecurity Experience Scale (FIES), is also an experience-based index, developed by the FAO's Voices of the Hungry (VOH) project, which measures food insecurity through socio-economic characteristics, such as education, networks, social capital, household income and employment (Ballard & Cafiero, 2013).

In this paper, we measure food security in three ways, which are built on the experience-based household food insecurity indices, such as HFSSM and HFIAS, as mentioned above. First, we measure the number of months a household faced food shortages. Second, we examine what measures were taken by the households to provide food for the family, i.e., rely on cheaper food, borrow money for food, purchase food on credit, eat seed saved for cultivation, sell any usable household items, skip a meal, spend days without eating. Third, we measure food security by household conditions in the last four weeks, i.e., no food to eat at home due to lack of resources, sleep hungry at night due to food shortage and go whole day without food due to food shortage. The dummy variable (=1) if the respondent said yes. We were limited with the data collected with our survey; thus, other metrics used to measure food security could not be applied.

Chapter VI: Results

6.1 Summary Statistics

As aforementioned, 47.8 percent of our sample include at least one member who migrated. Of the 904 households with migrants, 98.1 percent of them were men with an average age of 32 who migrated to their destination country[15] for 8-10 months. Migrants who were employed in their own agricultural farms stayed the shortest duration in the destination country -- approximately 8 months. Employment at one's own farm was also the most commonly held job before migration (34.15 percent). However, 38.9 percent were unemployed before migration.

The household characteristics of migrants and their families differ from those of non-migrant households, as summarized in Table 1. As panel A shows, households with migrants were younger and more likely to be married, although this difference is not statistically significant. Households with migrants also had fewer dependents than non-migrant households, and the difference was statistically significant at the 5-percent level. Secondary education was held by 68.58 percent of participants in migrant households, compared to 64.47 percent in non-migrant households.

On average, only 13 percent of the respondents benefited from training related to water and land management, crop cultivation, or water user association (WUA) governance in the last five years. Among the 116 households who were members of a WUA, 51 were from migrant households and 65 from non-migrant households. Non-migrant households have a higher asset index as seen in Panel B, the differences are statistically significant at 5 percent level.

[15] 94.5 % of households migrated to Russia.

Table 2 presents the summary statistics of the three plot types, kitchen, presidential and Dekhan, as well as crop and animal products kept for self-consumption. In panels A-C we can see the summary of the plots in terms of total area and total area cultivated as well as ownership of the plots. Almost all migrant and non-migrant households hold kitchen plots, which are similar in size across both groups (Panel A, Table 2). On the other hand, in Panel B, we see that migrant households are more likely to own presidential plots (36 percent) compared to non-migrant households (32 percent), statistically significantly different at the 5 percent level. Non-migrant households are more likely to own Dehkan plots compared migrant households (Panel C, Table 2)—16 percent v. 12 percent statistically significantly different at the 1 percent level. The mean total area and mean total area cultivated, however, are not statistically significantly different. Panel D shows 23 percent of crops grown in the kitchen plot are kept for self-consumption compared to presidential plot which is approximately 3 percent. Migrant households grow more crops in their kitchen plot, statistically significant at the 5-percent level. Migrant households keep approximately 25 percent of harvest compared to non-migrant households who keep about 22 percent for self-consumption.

6.2 Mean Difference in Outcomes by Migrant Status

Tables 3 to 8 show the differences in outcome variables of interest on food security and gender labor division respectively by migrant and non- migrant households in 3 different plots.

6.2.1 Food Security

In kitchen plot, mean differences in food security parameters in migrant and non-migrant households are shown in Table 3. Non-migrant households face more food shortages and take

greater measures to provide food. Non-migrant households spend more days without eating food and are more likely to sleep hungry at night, statistically significantly different at the 1 percent level. Furthermore, non-migrant households are more likely to experience months with a food shortage, sell useable household items and go whole day without food, statistically significant at the 5 percent level. In households that own presidential plot such vast differences were not visible as shown in table 4. However non-migrant households were more inclined to sell useable household items and go whole day without food due to food shortage, statistically significantly different at 5 percent and 10 percent level respectively. Table 5 depicts mean differences in Dehkan plot but differences were not statistically significant.

6.2.2 Gender Labor Division

Table 6 shows the differences in mean in gender labor division among migrant and non-migrant households with kitchen plots. More women are involved in labor-intensive work and play a greater role in decision-making in-migrant households than non-migrant households. For example, women in migrant households are more likely to spray pesticides and apply fertilizers, statistically significant at the 1 percent level. They are also more likely to sow seeds, set up an irrigation system and guide water flow through furrows/ around trees, statistically significant at the 5 percent level. Women are more likely to make decisions in migrant households. Such decisions include speaking with irrigation service providers and choosing the amount of irrigation water to apply, statistically significantly different at the 1 percent level. Mean differences in gender labor division in households that had presidential plot were not statistically significant as shown in table 7. In households that own Dehkan farm women in migrant households were more inclined to purchase agricultural inputs than non-migrant households. The differences were statistically significant at 1 percent level as shown in table 8.

6.3 Propensity Score Estimation

Table 9 depicts the results from estimating (5.2), the probability of migration using a probit regression. The dependency ratio is negatively correlated with migration and statistically significant at the 5 percent level implying that households with more dependents are less likely to migrate. Households that participate in income generating activities are also less likely to have a migrant member, statistically significant at 1 percent level. Interestingly, households that own a presidential plot are more likely to migrate statistically significant at 10 percent level while households that own Dehkan farm are less likely to migrate statistically significant at 1 percent level.

6.4 Common Support Assumption – Balance test

Table 10 presents the differences in means on the observable characteristics in migrant and non-migrant households pre and post-matching. The distribution in propensity score means are similar after matching in migrant and non-migrant households and not statistically significant at any levels. The dependency ratio that was statistically significant at 5 percent level, after matching the households to compare have similar dependents. Similarly, employment level was statistically significant at the one percent level. After matching, differences in migrant and non-migrant households are negligible. NNM selects 904 migrant households and 964 non-migrant households while KM selects 903 migrant and 1016 non-migrant households that have similar means to analyze migration impact on food security conditions. The common support for gender labor division outcomes differs depending on the number of observations for each variable. Both nearest neighbor and kernel matching reduces the differences between migrant and non-migrant households. Figures 2-7 show the distribution of means in observable characteristics between

migrant and non-migrant households before and after matching in NNM. We can see households after matching have similar means.

6.6 Estimated Impacts of Migrant Status

6.6.1 Food Security

Table 11 reports the results of ATT on food security by plot ownership. In households that own kitchen plots, almost our entire sample 1897 households, non-migrant households face more months of food shortage, take more measures to mitigate food shortage, spend more days without eating, have more food shortages and sleep hungry at night compared to migrant households, statistically significant at the 1 percent level. Specifically, non-migrant households face 2.5 more months of food shortage, took 2.7 more measures to provide food and faced on average 1.3 times more total food shortage. Non-migrant households are more likely to eat seed saved for cultivation, sell useable household items, lack food due to limited resources and go hungry, statistically significant at the 1 or 5 percent level depending on the matching method.

For presidential plot owners, households without migrants are 9 percentage points more likely sell usable items and more likely to go whole day without food due to food shortages, statistically significant at 5 percent level. Among Dehkan farm owners, migrant households are likely have no food to eat at home due to lack of resources, statistically significant at 10 percent level. Our sample size is limited, however, due to the low number of Dekhan farms.

6.6.2 Gender Labor Division

Tables 12 to 14 show the estimated ATT for labor division by gender for both matching methods, NNM and KM. Table 12 shows results for gender labor division on kitchen plots. In

irrigation system management and agriculture crops management women in migrant households are more involved. Women in migrant households are 5 percentage points more involved in cleaning the irrigation canal, 6 percentage points more involved in setting up irrigation system and guiding irrigation water flow, 12 percentage points more likely to decide on the amount of irrigation water to use, 10 percentage points more likely to decide on when to apply irrigation water and 8 percentage points more likely to speak with irrigation service provider all statistically significant at one percent level. Similarly, in terms of agriculture crops management women were more involved in migrant households than non-migrant households. Women were 8 percentage points more likely to sow seeds, 11 percentage points more likely to spray pesticides, 12 percentage points more likely to apply fertilizers, 6 percentage points likely to decide on agricultural inputs to purchase, 9 percentage points likely to decide on which crops to grows, 10 percentage points more likely to decide on the amount of agriculture products to sell consume and store all statistically significant at 1 percent level.

On presidential plots women from migrant households were 7 percentage points more likely to speak with irrigation service provider statistically significant at 5 percent level. Women from migrant households that own Dehkan farm were 13 percentage points more likely to purchase agricultural inputs statistically significant at 1 percent level.

6.7 Robustness Check

As mentioned in chapter 5, we use village fixed effects and exclude potentially endogenous variables (i.e., unemployment, earnings and asset index), to check the robustness of our results.

6.7.1 Village Fixed Effects and Exclusion of Potentially Endogenous Variables

We include village fixed effects to account for biases resulting from geographical or administrative units such as infrastructure and sociopolitical factors which could influence migration. As seen in tables 15-18, our results are robust to this specification. Note, however, that the number of observations decreases slightly with village fixed effects. In tables 19-22, we drop earnings, asset index and unemployment from our observable characteristics as these factors could be endogenous to migration. We find similar results as our previous analysis. In both robustness checks we find migrant households with kitchen plots are more food secure and spend fewer days without eating food, face less total food shortage in the past 4 weeks, sleep hungry at night and have fewer days in which they have to go a whole day without food due to food shortages, all statistically significant at the 1 percent level. Similarly, in households with presidential plots migrant households face less months of food shortage, take fewer measures to provide food and are less likely to purchase food on credit, all statistically significant at the 5 percent level. Our results on households with Dehkan plots, on the other hand, are not robust, as they now show migrant households being more likely to borrow money for food, statistically significant at 5 the percent level.

In terms of gender labor division, our previous results hold when adding village fixed effects and dropping the aforementioned potentially endogenous variables. Again, migrant households with kitchen plots have women members who are more engaged in tasks such as making decisions on applying irrigation water, speaking with irrigation service providers, guiding irrigation water flow and cleaning small irrigation canals, all statistically significant at the 5 percent level. Migrant households with presidential plot women are more likely to sow seeds statistically significant at 10 percent level. We find our outcome variables are now more significant compared to before and

more robust. Households that own Dehkan farms show women in non-migrant households are more involved in purchasing agricultural inputs, statistically significant at the 10 percent level.

Chapter VII: Discussion

The aim of this paper was to investigate the linkages between migration, food security and the division of labor by gender as it relates to water management in Tajikistan. We account for endogeneity of migration and find evidence of a dominating substitution effect of labor on kitchen plots where women in migrant households work more on typically male-dominated tasks. Similarly, we find that migrant households were more food secure. We discuss possible reasons for these results below.

7.1 Gender Labor Division

Studying gender labor division is useful as it gives insights into women and men's influence, access and control over resources and can help in policy development (Bennett et al., 2008). However, the literature on the feminization of agriculture has been limited (Garikipati, 2009). The majority of studies (Rodriguez & Tiongson, 2001; Deere, 2005; Amuedo-Dorantes & Pozo, 2006; Garikipati, 2009; Pattnaik et al., 2018; Liu et. al., 2019; de Brauw et al., 2021) focus on the overall supply of female labor and not on individual agricultural tasks. One of the objectives of this paper was to fill this gap and focus specifically on roles held by men and women regarding the management of irrigation systems.

We find evidence for the feminization of agriculture on kitchen plots as more women in migrant households perform tasks related to the management of its irrigation system. As mentioned in chapter 3, almost all households (nearly 99%) in Tajikistan own a kitchen plot, a small plot usually adjacent to the home (Behnke, 2008; Boboyorov, 2016). In our dataset, too, 99 percent of the household had a kitchen plot (table 2). Women in migrant households were 5 to 12 percentage points more likely to engage in irrigation related and agriculture crop management, tasks compared

to non-migrant households, significant at 1 percent level. It is important to note that kitchen gardens are generally primarily managed by female members of the households (Kan & Aytimur, 2019).

We do not find such strong relationships on presidential plots. Women in migrant households were approximately 6 percentage points more involved in speaking with the irrigation service provider, statistically significant at 10 percent level. According to our dataset, 34 percent of the households had a presidential plot. As aforementioned in chapter 3, presidential plots were distributed beginning in 1990s to those households that had less than 0.15 hectares of agricultural land, to provide for food security and wheat production since these households belonged to poorer Tajik population (Boboyorov, 2012). And as wheat is a staple food in Tajikistan such production was to help households become more food secure (Buisson & Balasubramanya, 2019). Usually those who have presidential plot in Tajikistan belong to poorer household (Boboyorov, 2012) and as seen in our probit result, table 9, were 11.8 percentage points more likely to migrate.

Finally, women in migrant households that owned a Dehkan farm were 13 percentage points more likely to make decision on purchasing agricultural inputs, statistically significant at the 1 percent level. However, other tasks were not statistically significantly different. Dehkan farms contribute to 30 percent of Tajikistan's GDP (Boboyorov, 2016; Buisson & Balasubramanya, 2019) and account for 40 percent of total arable land in Tajikistan (Akramov & Shreedhar, 2012). Households that own Dehkan farm are better off in Tajikistan (Boboyorov, 2016). Interestingly, as seen in table 5, our probit result show that households with Dehkan farms were 29 percentage points less likely to migrate. Our lack of evidence of the feminization of agriculture on Dekhan farms is contrary results found in other studies. Balasubramanya (2019) finds that male outmigration has increased women operating Dehkan farms from 21 percent in 2014 to 35 percent

in 2016. Mukhamedova & Wegerich (2018) also find that while historically Tajikistan' irrigation systems on Dehkan farms have been managed mostly by men, this trend is shifting due to out migration. We must note, however, that our results, or lack thereof, could be driven by the low sample size of Dekhan farm holders in our data. Another possible reason for our lack of results on Dekhan farms could be the nature of the crops cultivated on the different plots. Cotton, a cash crop, is often grown on Dehkan farms, whereas wheat and subsistence crops are typically grown on kitchen and presidential plots. The crop type may therefore also influence the involvement of male and female workers.

Furthermore, our study highlights the importance of studying gender labor division on different tasks and not just on aggregate female labor supply. Certain tasks may be substituted over others. Thus, focussing just on the labor supply of women conceals important factors that determine access and control over resources (Grace, 2004; Mengesha 2010). Additionally, evaluating gender labor division provides a clearer picture on which production or plot type feminization of agriculture is more dominant, giving development practitioner and government agencies areas to focus.

7.2 Food Security

In Tajikistan, access to food is affected by various factors such as fluctuations in food prices and decreases in household income, especially declines in remittances (Kawabata et al., 2020). However, research on the linkages between food security and remittances are largely missing from the literature (Crush, 2013; Sadiddin et al., 2019). Thus, one of the objectives of this paper has been to fill this gap and add to the growing literature on migration and food security. We evaluate food security through respondent perspectives on food shortages in the past year.

The results were varied among the different plots households owned. For kitchen plot owners, the majority of our sample, we find that migrant households were more food secure compared to non-migrant households. Households with no migrants face 2 more months of food shortage, were two times more likely to take measures to provide food and were 14 percentage points more likely to have food shortages in the last one month, statistically significant at 1 percent level. Kitchen gardens are an important source of food security for the households and are mainly used for subsistence farming (Behnke, 2008; Mukhamedova & Wegerich, 2018). According to our own dataset, table 2 panel D, migrant households keep 25 percent of the crops grown in kitchen garden for self-consumption compared to 22.6 percent of non-migrant, statistically significantly different at the 5 percent level. In addition to remittances that allow migrant households to purchase food, this may be another reason why migrant households are more food secure.

On presidential plots, migrant households were 10 percentage points more likely to sell unusable household items statistically significant at 1 percent level and 4 percentage points more likely to go a whole day without food due to food shortage, statistically significant at 5 percent level. According to our data, table 2 panel D, migrant households keep 3.2 percent of the crops grown in presidential plot while non-migrant households only keep 2.9 percent; these differences are not statistically significant. Further research is needed to understand growing wheat for self-consumption in presidential plot and food security, which is beyond the scope of this study. Finally, migrant households with Dehkan farms were 10 percentage points more likely to have no food to eat at home due to lack of resources compared to non-migrant households, statistically significant at the 10 percent level. However, other variables measuring food security were not statistically significant.

Several studies (Justino & Shemyakina 2010; Azzarri & Zezza 2011; Akramov & Shreedhar, 2012; Crush, 2013; Atuoye et. al. 2017; Mabrouk and Mekni 2018 Abebaw et al., 2020) have indicated remittances play an instrumental role in poverty reduction and improves food and nutrition security. Contrarily, (Craven & Gartaula, 2015; Duda et al., 2018) other results are ambiguous (Karamba et al., 2011; Weiler et al. 2017) and find that remittances alone do not alleviate food insecurity issues within a household. Our results support the former studies as the impact of remittances on food security show migration households are better suited to mitigate food insecurity challenges. However, since the results vary in households that own presidential and Dehkan farm it is important to study the effects of remittances at different levels of plot ownership. Since, presidential plots are mostly owned by poorer households and Dehkan farm holders are better off compared to other Tajik households (Boboyorov, 2016) their methods to mitigate food insecurity would certainly not be similar. Therefore, an in-depth study on food security and remittances on households with different plots in Tajikistan would provide better indicators for policy makers.

7.3 Theory of Labor-leisure Choice

Labor-leisure theory permits evaluation of economic conditions and its impacts on labor supply (Kalaj, 2009). As seen in chapter 2, the literature on migration and gender labor division can be constructed into two categories: studies that find an income effect dominates and those others that find substitution effect dominates (Kan & Aytimur, 2019). A dominant substitution effect predicts that women take over the roles and responsibilities of male migrants, leading to the feminization of agriculture (Justino et al., 2012; Mukhamedova & Wegerich, 2018). With a dominating income effect, remittances sent by migrants act as extra income for the household

reducing the opportunity cost of those left behind, reducing their labor supply and increasing their demand for labor (de Brauw et al., 2008; Azizi, 2018).

Previous studies exploring the linkages between migration and women's labor supply find evidence supporting an income effect (Amuedo-Dorantes & Pozo, 2006; de Brauw et al., 2008; Lokshin & Glinskaya, 2009; Kalaj, 2009), while others find evidence of a dominant substitution effect (Mendola & Carletto, 2012; Maharjan et. al., 2012; de Brauw et al., 2021). Our study tends to support the latter studies, a substitution effect, as we find evidence of women performing previously male-dominated tasks on kitchen plots.

7.4 Limitations of the study

This study uses cross-sectional data collected in 2016. Due to the nature of our dataset, we cannot analyze the impact of migration on household's gender labor division and food security conditions overtime. Thus, our results are indicative of the time reported. Furthermore, panel data would help us deal with the endogeneity of migration. PSM only reduces selection bias, so that the results cannot be interpreted as causal since unobserved characteristics endogenous to households that affect migration could be unaccounted for.

VIII: Conclusion

This paper set out to explore two main questions: first, how does male out-migration effect household agricultural labor division. Do we observe feminization of agriculture in Tajikistan? Second, how does food security differ in migrant and non-migrant household? In order to answer these questions, we explored three hypotheses: first, women hold more responsibilities and perform tasks previously filled by males due to migration, i.e., there is a feminization of agriculture in Tajikistan. Second, migrant households have overall better food security as remittances from migrants help alleviate food insecurity. Third, in theory of labor-leisure choice substitution effect is more dominant than income effect because women become substitute for farm labor work that has been left vacant through male outmigration.

Our results indicate, overall evidence supporting feminization of agriculture in Tajikistan and migrant households as more food secure. Women in migrant households are 5 to 12 percentage points more involved in irrigation system management and agriculture crops management compared to non-migrant household. We also find migrant household report less months of food shortage, take fewer measures to mitigate food insecurity and have faced less food shortage in the last month.

These results are important as they enhance our understanding within gender labor division and food security after migration in agricultural production and in rural economies. As we find there is a need to not only study the differences within tasks of agricultural labor, it is also important to evaluate these tasks with in different plots or production system. Furthermore, research of food security should also not be limited to purchasing power but also food production within the communities. Future studies should focus on linking this gap, migration, food production and food security.

In a country like Tajikistan where half a million people each year leave seeking better opportunities, there is a need to better understand the relationship between remittances and food security to develop effective programs (Crush, 2013; Mabrouk & Mekni, 2018). Food prices can be unstable (Zezza et al. 2010) especially in countries like Tajikistan which are greatly dependent on food imports (Karamba et al., 2010). Migration and remittance flows are, likewise, unstable as they are greatly impacted by economic volatility in the destination country. Thus, additionally measuring differences in agricultural work in male and female household members will further add to understanding methods and policies that would enhance agricultural production (Alkire et al., 2012; Malapit et al., 2019) which will help countries like Tajikistan increase its food security.

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Figures

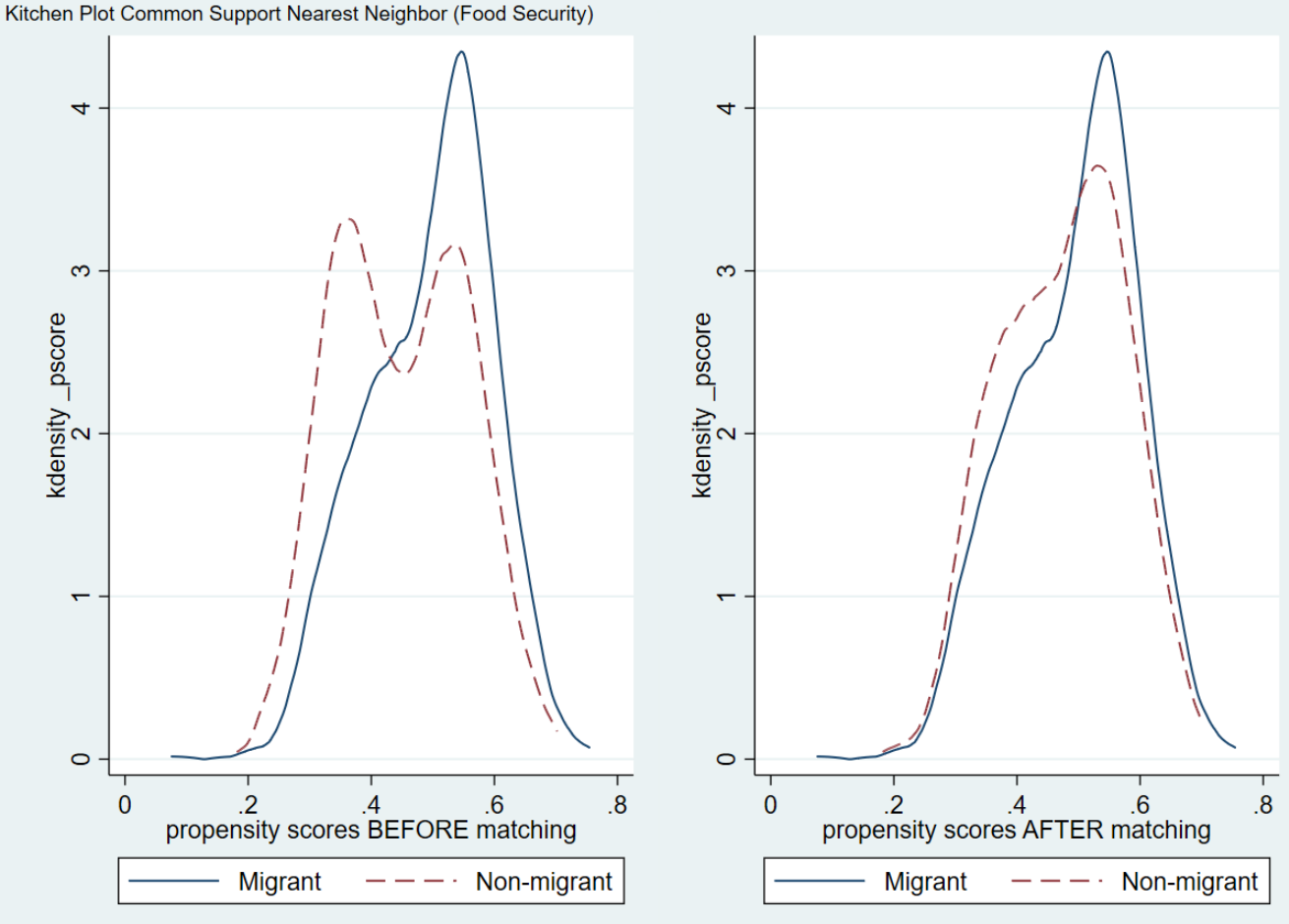

Figure 2: Kitchen Plot Common Support Nearest Neighbor Matching (Food Security)

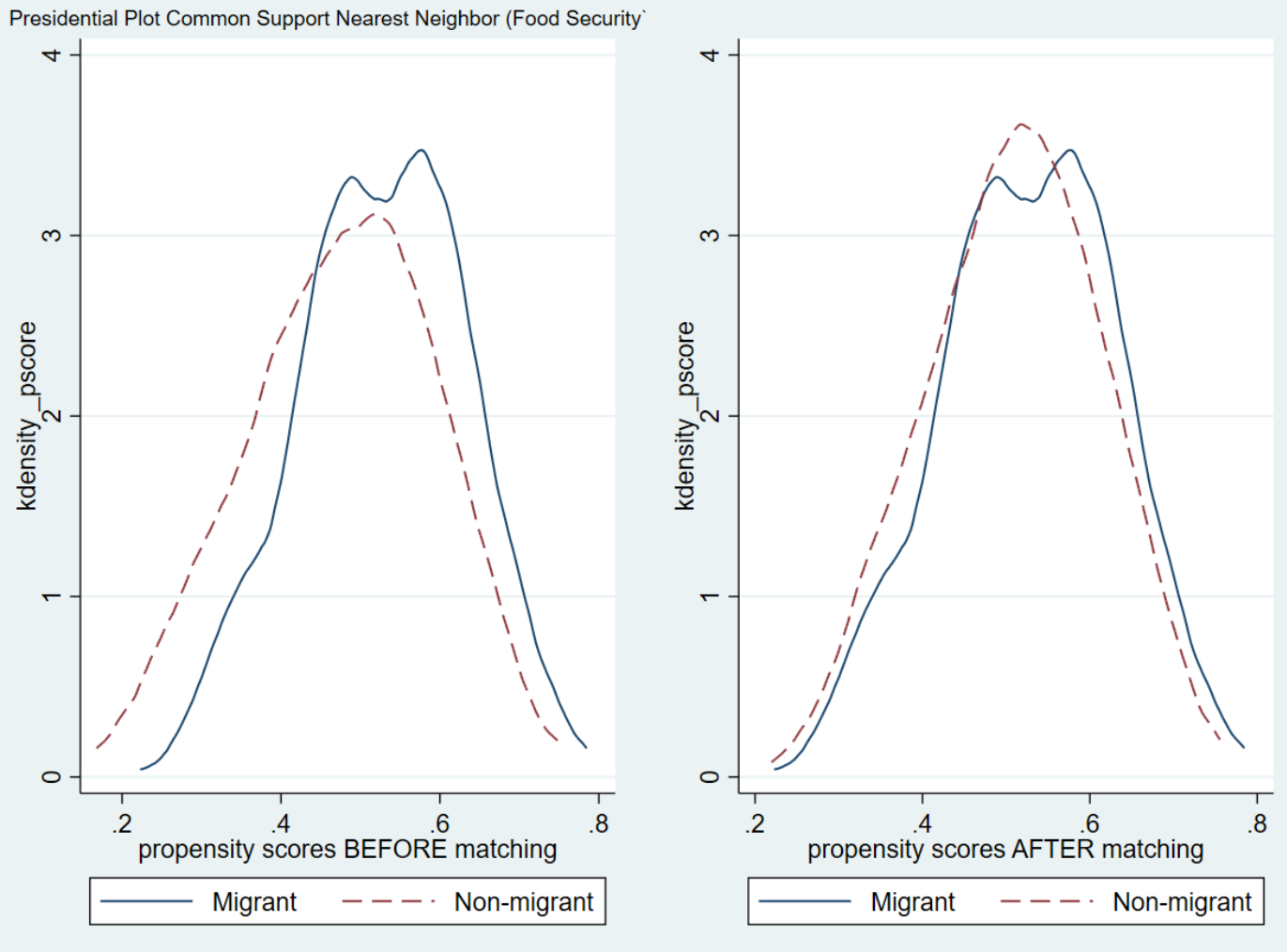

Figure 3: Presidential Plot Common Support Nearest Neighbor Matching (Food Security)

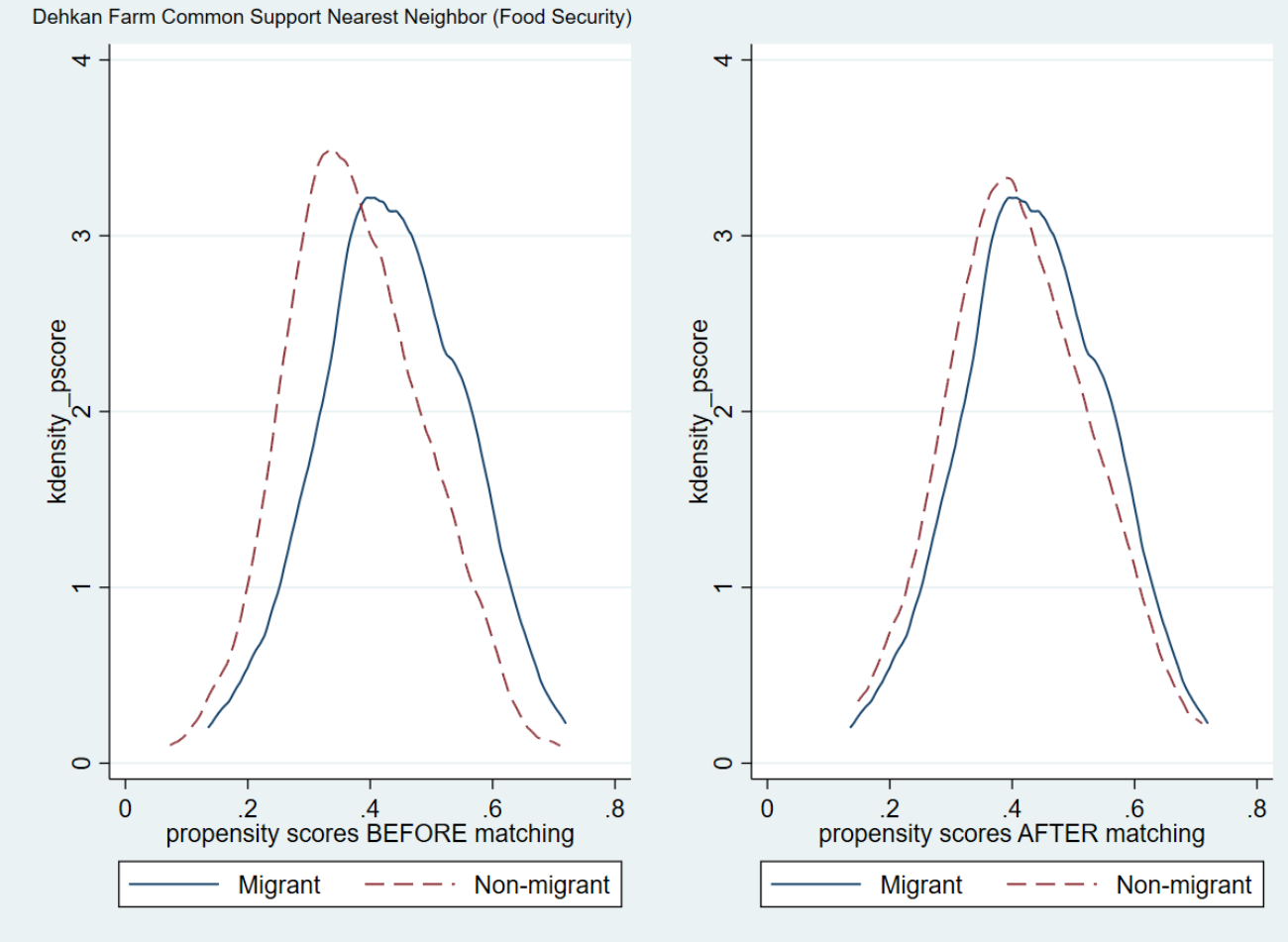

Figure 4: Dehkan Farm Common Support Nearest Neighbor Matching (Food Security)

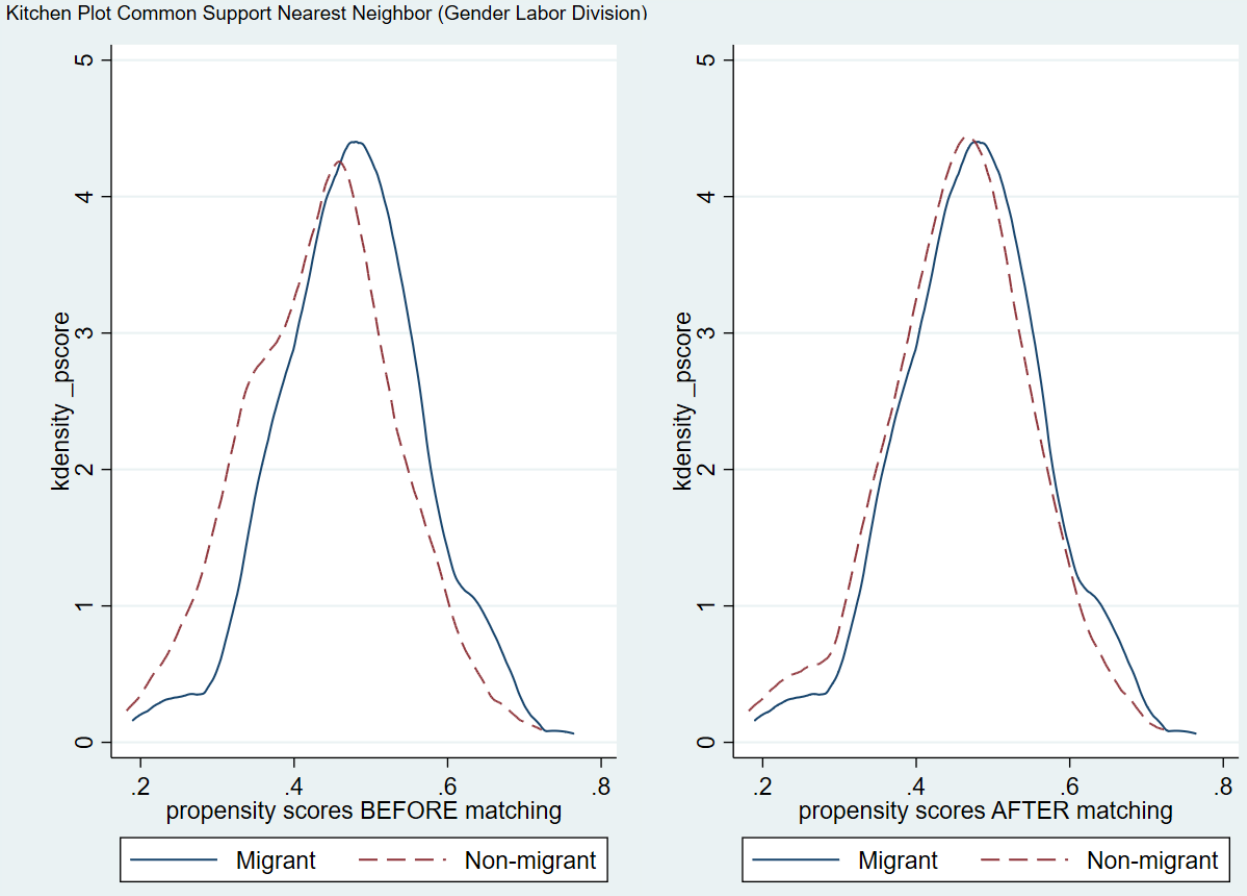

Figure 5: Kitchen Plot Common Support Nearest Neighbor Matching (Gender Labor Division)

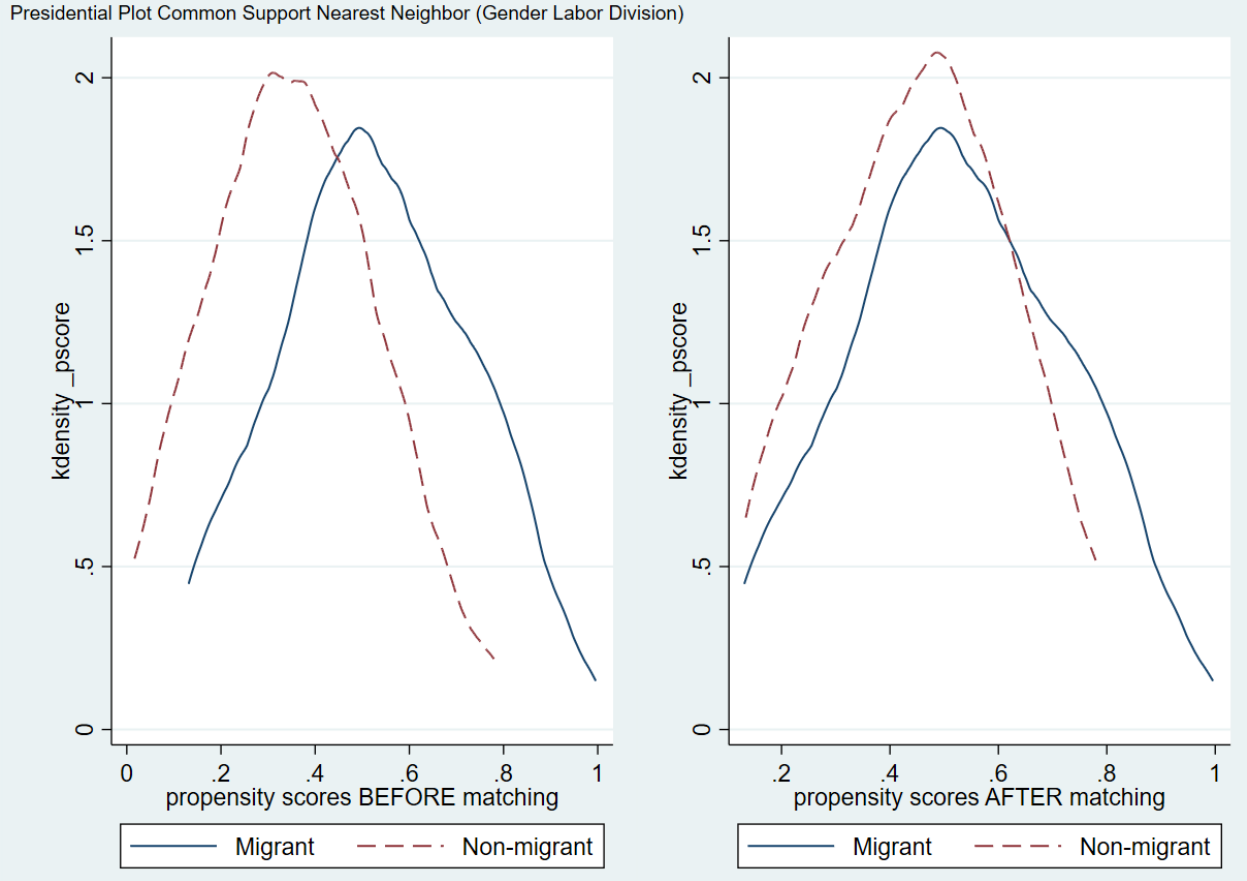

Figure 6: Presidential Plot Common Support Nearest Neighbor Matching (Gender Labor Division)

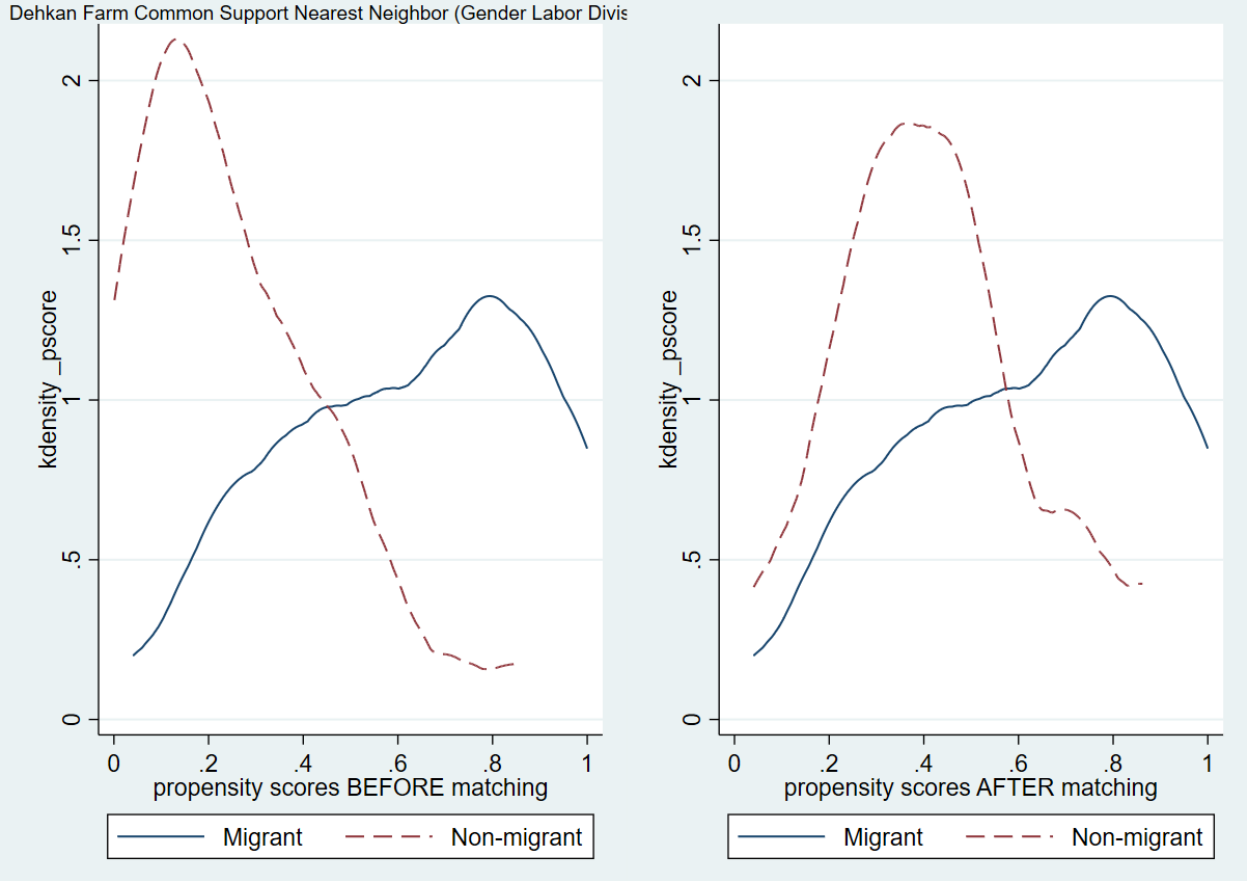

Figure 7: Dehkan Farm Common Support Nearest Neighbor Matching (Gender Labor Division)

Tables

Table 1: Household Summary Statistics

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
		Overall			Migrant Household			Non-migrant Household		Difference[a]
	N	mean	sd	N	mean	sd	N	mean	sd	
Panel A: Household Characteristics, Training and Membership										
Age	1920	44.7	12.8	904	44.4	12.5	1016	44.9	13.1	0.511
										(0.87)
Married	1920	0.86	0.35	904	0.87	0.34	1016	0.85	0.35	-0.014
(D)										(-0.88)
Dependency	1920	0.83	0.67	904	0.79	0.70	1016	0.86	0.65	0.070**
Ratio										(2.29)
Benefited from	1920	0.13	0.34	904	0.14	0.35	1016	0.13	0.33	-0.016
Training (D)										(-1.00)
Member of	1920	0.032	0.18	904	0.028	0.16	1016	0.035	0.18	0.008
a Group (D)										(0.97)
Member of	116	0.42	0.50	51	0.31	0.47	65	0.51	0.50	0.194**
a WUA (D)										(2.12)
Panel B: Income, Remittances and Asset Index										
Total Household	1920	220.4	495.2	904	201.4	512.3	1016	237.4	479.1	35.95
Income (USD)										(1.59)
Total Remittances	735	986.6	1729.8	735	986.6	1729.8	0	0	0	
Received (USD)										
Asset Index	1919	0.000	1.24	904	-0.068	1.22	1015	0.061	1.25	0.129**
										(2.28)

Notes: Columns 1,4 and 7 indicate the number of observations in each variables.Columns 2, 5 and 8 are means of each variable. Columns 3, 6 and 9 are standard deviation.Column 10 is the differences in means between migrant and non-migrant households. T-test used for differences in mean. 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)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
		Overall		Migrant Household			Non-migrant Household			Difference[a]
	N	mean	sd	N	mean	sd	N	mean	sd	
Panel A: Kitchen Plot										
Household has Plot (D)	1920	0.99	0.11	904	0.99	0.11	1016	0.99	0.10	0.003 (0.49)
Total Area (Hectare)	1897	0.13	0.10	892	0.13	0.097	1005	0.13	0.11	-0.003 (-0.59)
Total Area Cultivated (Hectare)	1897	0.087	0.075	892	0.088	0.078	1005	0.085	0.072	-0.003 (-0.99)
Panel B: Presidential Plot										
Household has Plot(D)	1920	0.34	0.47	904	0.36	0.48	1016	0.32	0.47	-0.043** (-1.98)
Total Area (Hectare)	651	0.11	0.11	327	0.11	0.072	324	0.11	0.13	0.007 (0.89)
Total Area Cultivated (Hectare)	651	0.11	0.11	327	0.10	0.073	324	0.11	0.13	0.009 (1.03)
Panel C: Dehkan Plot										
Household has Plot (D)	1920	0.14	0.35	904	0.12	0.33	1016	0.16	0.37	0.042*** (2.60)
Total Area (Hectare)	276	5.46	17.5	110	6.09	22.3	166	5.05	13.5	-1.040 (-0.48)
Total Area Cultivated (Hectare)	276	4.55	15.3	110	5.10	21.2	166	4.19	9.65	-0.918 (-0.49)
Panel D: Crops and Animal Products Kept for Self-consumption										
Crops grown in Kitchen plot	1920	23.9	19.7	904	25.4	20.7	1016	22.6	18.6	-2.832** (-3.16)
Crops grown in Presidential plot	1920	3.08	6.87	904	3.26	7.08	1016	2.92	6.67	-0.338 (-1.08)
Percentage milk products produced	1549	78.5	34.5	749	79.4	34.1	800	77.7	34.9	-1.740 (-0.99)
Percentage eggs produced	1549	23.6	35.4	749	22.3	34.1	800	24.7	36.6	2.445 (1.36)
Percetage meat products produced	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 in each variables.Columns 2, 5 and 8 are means of each variable. Columns 3, 6 and 9 are standard deviation.Column 10 is the differences in means between migrant and non-migrant households. T-test used for differences in mean. 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 3: Mean Differences in Outcome: Kitchen Plot Food Security

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
		Overall			Migrant Household			Non-migrant Household		Difference[a]
	N	mean	sd	N	mean	sd	N	mean	sd	
Food Shortage										
Months with food shortage (D)	1920	1.56	1.57	904	1.44	1.57	1016	1.67	1.57	0.228**
										(3.17)
Total measures taken to provide food (D)	1920	3.03	2.00	904	2.87	1.96	1016	3.16	2.03	0.289**
										(3.16)
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)
Skip a meal (D)	1920	0.52	0.50	904	0.50	0.50	1016	0.54	0.50	0.038
										(1.67)
Spend days without eating food (D)	1920	0.17	0.38	904	0.14	0.35	1016	0.20	0.40	0.066***
										(3.80)
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 houehold items (D)	1920	0.38	0.49	904	0.35	0.48	1016	0.41	0.49	0.061**
										(2.72)
Total food shortage in the past 4 weeks (D)	1920	0.68	0.87	904	0.59	0.81	1016	0.76	0.92	0.165***
										(4.15)
4 weeks- no food to eat at lack of resources (D)	1920	0.47	0.50	904	0.43	0.50	1016	0.50	0.50	0.068**
										(2.96)
4 weeks- Sleep hungry at night (D)	1920	0.13	0.34	904	0.10	0.30	1016	0.16	0.37	0.060***
										(3.87)
4 weeks-Go whole day without food due to food shortage (D)	1920	0.081	0.27	904	0.061	0.24	1016	0.098	0.30	0.038**
										(3.02)

Notes: Columns 1,4 and 7 indicate the number of observations in each variables. Columns 2, 5 and 8 are means of each variable. Columns 3, 6 and 9 are standard deviation.Column 10 is the differences in means between migrant and non-migrant households. T-test used for differences in mean. 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 4: Mean Differences in Outcome: Presidential Plot Food Security

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
		Overall			Migrant Household			Non-migrant Household		Difference[a]
	N	mean	sd	N	mean	sd	N	mean	sd	
Food Shortage										
Months with food shortage (D)	651	1.45	1.38	327	1.42	1.40	324	1.48	1.36	0.066
										(0.61)
Total measures taken to provide food (D)	651	3.05	1.99	327	2.93	1.98	324	3.17	1.99	0.243
										(1.56)
Rely on cheap, less expensive food (D)	651	0.60	0.49	327	0.59	0.49	324	0.60	0.49	0.018
										(0.46)
Skip a meal (D)	651	0.52	0.50	327	0.52	0.50	324	0.51	0.50	-0.014
										(-0.35)
Spend days without eating food (D)	651	0.16	0.36	327	0.14	0.35	324	0.17	0.38	0.029
										(1.02)
Borrow money for food (D)	651	0.32	0.47	327	0.32	0.47	324	0.31	0.47	-0.006
										(-0.17)
Purchase food on credit (D)	651	0.56	0.50	327	0.52	0.50	324	0.59	0.49	0.070
										(1.79)
Eat seed saved for cultivation (D)	651	0.50	0.50	327	0.48	0.50	324	0.51	0.50	0.034
										(1.52)
Sell any useable houehold items (D)	651	0.41	0.49	327	0.35	0.48	324	0.47	0.50	0.114**
										(2.98)
Total food shortage in the past 4 weeks (D)	651	0.65	0.84	327	0.60	0.78	324	0.71	0.89	0.117
										(1.77)
4 weeks- no food to eat at lack of resources (D)	651	0.47	0.50	327	0.45	0.50	324	0.48	0.50	0.038
										(0.97)
4 weeks- Sleep hungry at night (D)	651	0.12	0.32	327	0.10	0.30	324	0.13	0.34	0.032
										(1.26)
4 weeks-Go whole day without food due to food shortage (D)	651	0.072	0.26	327	0.049	0.22	324	0.096	0.29	0.047*
										(2.31)

Notes: Columns 1,4 and 7 indicate the number of observations in each variables. Columns 2, 5 and 8 are means of each variable. Columns 3, 6 and 9 are standard deviation.Column 10 is the differences in means between migrant and non-migrant households. T-test used for differences in mean. 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 5: Mean Differences in Outcome: Dehkan Plot Food Security

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
		Overall			Migrant Household			Non-migrant Household		Difference[a]
	N	mean	sd	N	mean	sd	N	mean	sd	
Food Shortage										
Months with food shortage (D)	276	1.25	1.39	110	1.10	1.33	166	1.35	1.43	0.249
										(1.46)
Total measures	276	3.20	2.10	110	3.36	2.03	166	3.10	2.14	-0.267
taken to provide food (D)										(-1.04)
Rely on cheap,	276	0.61	0.49	110	0.65	0.48	166	0.58	0.50	-0.067
less expensive food (D)										(-1.12)
Skip a meal (D)	276	0.53	0.50	110	0.55	0.50	166	0.51	0.50	-0.033
										(-0.54)
Spend days without	276	0.15	0.36	110	0.15	0.35	166	0.16	0.36	0.011
eating food (D)										(0.25)
Borrow money for food (D)	276	0.33	0.47	110	0.39	0.49	166	0.29	0.45	-0.102
										(-1.76)
Purchase food on credit (D)	276	0.59	0.49	110	0.62	0.49	166	0.57	0.50	-0.052
										(-0.86)
Eat seed saved for	276	0.47	0.50	110	0.52	0.50	166	0.45	0.50	-0.072
cultivation (D)										(-1.18)
Sell any useable	276	0.53	0.50	110	0.50	0.50	166	0.55	0.50	0.048
houehold items (D)										(0.78)
Total food shortage	276	0.59	0.83	110	0.59	0.76	166	0.59	0.88	-0.001
in the past 4 weeks (D)										(-0.01)
4 weeks- no food to eat at	276	0.42	0.49	110	0.46	0.50	166	0.39	0.49	-0.072
lack of resources (D)										(-1.19)
4 weeks- Sleep hungry at	276	0.10	0.30	110	0.082	0.28	166	0.11	0.32	0.033
night (D)										(0.88)
4 weeks-Go whole day without	276	0.069	0.25	110	0.045	0.21	166	0.084	0.28	0.039
food due to food shortage (D)										(1.25)

Notes: Columns 1,4 and 7 indicate the number of observations in each variables. Columns 2, 5 and 8 are means of each variable. Columns 3, 6 and 9 are standard deviation.Column 10 is the differences in means between migrant and non-migrant households. T-test used for differences in mean. 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 6: Mean Differences in Outcome: Kitchen Plot Gender Labor Division

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
		Overall			Migrant Household			Non-migrant Household		Difference[a]
	N	mean	sd	N	mean	sd	N	mean	sd	
Kitchen Plot Gender Labor Division										
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)
Amount irrigation water (D)	1799	0.37	0.48	852	0.42	0.49	947	0.33	0.47	-0.095*** (-4.19)
When to apply irrigation water (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)
Agriculture Crops Management										
Sow 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)
Decision on which crops to grow (D)	1855	0.49	0.50	877	0.52	0.50	978	0.45	0.50	-0.070** (-3.03)
Amount of agricultural products to sell, consume and store (D)	1441	0.55	0.50	673	0.59	0.49	768	0.52	0.50	-0.068* (-2.58)
Amount of livestock to sell and 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 in each variables. Columns 2, 5 and 8 are means of each variable. Columns 3, 6 and 9 are standard deviation.Column 10 is the differences in means between migrant and non-migrant households. T-test used for differences in mean. 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 7: Mean Differences in Outcome: Presidential Plot Gender Labor Division

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
		Overall			Migrant Household			Non-migrant Household		Difference[a]
	N	mean	sd	N	mean	sd	N	mean	sd	
Presidential Plot Gender Labor Division										
Irrigation System Management										
Cleans irrigation canal (D)	492	0.075	0.26	242	0.070	0.26	250	0.080	0.27	0.010 (0.41)
Cleans smaller irrigation ditch (D)	553	0.085	0.28	275	0.084	0.28	278	0.086	0.28	0.003 (0.11)
Sets up irrigation system (D)	556	0.083	0.28	274	0.080	0.27	282	0.085	0.28	0.005 (0.21)
Guides water flow (D)	570	0.11	0.31	284	0.095	0.29	286	0.12	0.32	0.024 (0.92)
Amount irrigation water (D)	590	0.21	0.41	294	0.21	0.41	296	0.20	0.40	-0.008 (-0.24)
When to apply irrigation water (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)
Agriculture Crops Management										
Sow 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	0.086	0.28	186	0.086	0.28	210	0.086	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 (-0.44)
Purchases agricultural inputs (D)	576	0.16	0.37	287	0.16	0.37	289	0.15	0.36	-0.012 (-0.38)
Decision on which crops to grow (D)	611	0.30	0.46	308	0.30	0.46	303	0.30	0.46	-0.005 (-0.13)
Amount of agricultural products to sell, consume and store (D)	483	0.34	0.47	231	0.35	0.48	252	0.33	0.47	-0.025 (-0.59)
Amount of livestock to 463 sell and consume (D)	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 in each variables. Columns 2, 5 and 8 are means of each variable. Columns 3, 6 and 9 are standard deviation.Column 10 is the differences in means between migrant and non-migrant households. T-test used for differences in mean. 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 8: Mean Differences in Outcome: Dehkan Farm Gender Labor Division

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
		Overall			Migrant Household			Non-migrant Household		Difference[a]
	N	mean	sd	N	mean	sd	N	mean	sd	
Dehkan Farm Gender Labor Division										
Irrigation System Management										
Cleans irrigation canal (D)	202	0.0099	0.099	73	0.014	0.12	129	0.0078	0.088	-0.006 (-0.41)
Cleans smaller irrigation ditch (D)	220	0.027	0.16	85	0.035	0.19	135	0.022	0.15	-0.013 (-0.58)
Sets up irrigation system (D)	233	0.043	0.20	92	0.043	0.21	141	0.043	0.20	-0.001 (-0.03)
Guides water flow (D)	230	0.061	0.24	91	0.088	0.28	139	0.043	0.20	-0.045 (-1.39)
Amount irrigation water (D)	243	0.091	0.29	96	0.10	0.31	147	0.082	0.27	-0.023 (-0.60)
When to apply irrigation water (D)	247	0.12	0.33	97	0.13	0.34	150	0.11	0.32	-0.021 (-0.48)
Speaks with irrigation service provider (D)	227	0.066	0.25	89	0.090	0.29	138	0.051	0.22	-0.039 (-1.16)
Agriculture Crops Management										
Sow seeds (D)	212	0.10	0.31	94	0.13	0.34	118	0.085	0.28	-0.043 (-1.02)
Sprays pesticides (D)	175	0.023	0.15	67	0.030	0.17	108	0.019	0.14	-0.011 (-0.49)
Applies fertilizers (D)	198	0.056	0.23	79	0.051	0.22	119	0.059	0.24	0.008 (0.25)
Purchases agricultural inputs (D)	256	0.082	0.27	103	0.16	0.36	153	0.033	0.18	-0.123*** (-3.58)
Decision on which crops to grow (D)	267	0.17	0.38	106	0.21	0.41	161	0.15	0.36	-0.059 (-1.24)
Amount of agricultural products to sell, consume and store (D)	254	0.23	0.42	101	0.27	0.44	153	0.20	0.40	-0.065 (-1.20)
Amount of livestock to sell and consume (D)	236	0.29	0.46	98	0.31	0.46	138	0.28	0.45	-0.024 (-0.39)
Processes and stores crops (D)	249	0.38	0.49	101	0.39	0.49	148	0.37	0.48	-0.015 (-0.23)

Notes: Columns 1,4 and 7 indicate the number of observations in each variables. Columns 2, 5 and 8 are means of each variable. Columns 3, 6 and 9 are standard deviation.Column 10 is the differences in means between migrant and non-migrant households. T-test used for differences in mean. 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 9: Estimated Results for Factors Influencing Decision to Migrate (Probit)

Variables	Migrant Households
Socio-Economic Characteristics	
Dependency ratio	-0.119**
	(0.046)
Married (D)	0.056
	(0.113)
Age (years)	0.020
	(0.014)
Age squared (years)	-0.002
	(0.000)
Household head (D)	-0.091
	(0.135)
Graduate education (D)	0.042
	(0.117)
Spouse of the household head (D)	-0.094
	(0.084)
Total household earnings (USD)	0.0002*
	(0.000)
Asset index	-0.044*
	(0.024)
Have a Presidential plot (D)	0.118*
	(0.318)
Have a Dehkan farm (D)	-0.290***
	(0.318)
Benefitted from training (D)	0.110
	(0.089)
Water User Association (WUA) in village (D)	-0.090
	(0.080)
Household member of a group (D)	-0.221
	(0.080)
Economic	
Participate in income generationg activities (D)	-0.508***
	(0.070)
Environmental	
Piped water source (D)	0.204
	(0.204)
Plot adjacent to house (D)	-0.192
	(0.167)
Plot Located at the middle of canal (D)	0.303**
	(0.109)
Plot Located at the tail of canal (D)	0.139
	(0.090)
Constant	0.029
	(0.417)
Observations	1920
Pseudo R2	0.039

Notes: Coefficients are results from probit indicating variables influence on propensity to migrate. Standard errors are in parentheses. D indicates dummy variable, =1 if yes, =0 if no
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 10: Balancing Test on Covariates - Nearest Neighbor Matching and Kernel Matching

	Pre-Match	Post-Match	
		Nearest Neighbor Matching	Kernel Matching
Socio-Economic Characteristics			
Dependency ratio	-2.44**	-0.27	-0.71
Married (D)	0.73	-0.00	0.12
Age (years)	-0.80	-0.27	-0.32
Age squared (years)	-1.04	-0.29	-0.33
Household Head (D)	-1.11	0.32	-0.14
Graduate education (D)	-0.36	-0.57	0.10
Spouse of the household head (D)	-0.51	0.58	0.23
Total household earnings (USD)	-1.60*	-0.47	-0.12
Asset index	-2.15**	-0.27	-0.58
Have a Presidential Plot (D)	1.98*	0.83	0.16
Have a Dehkan Farm (D)	-2.60**	-0.78	-0.93
Benefitted from training (D)	0.96	0.11	0.50
Water User Association (WUA) in village (D)	-0.28	-1.52	-0.20
Household member of a group (D)	-0.84	-0.53	0.08
Economic			
Participate in income generating activities (D)	-7.13 ***	0.31	0.17
Environmental			
Piped water source (D)	0.70	-1.41	0.04
Kitchen plot adjacent to house (D)	-1.39	0.15	-0.33
Kitchen plot located at the head of canal (D)	-1.33	0.86	-0.20
Kitchen plot Located at the middle of canal (D)	2.46**	0.06	0.59
Pseudo R2	0.034	0.003	0.001
Median Absolute Bias	5.0	1.3	1.0
N			
Migrant	904	892	891
Non-migrant	1016	941	1005

Notes: Coefficient shows the means before and after matching.D indicates dummy variable, =1 if yes, =0 if no. Indicated are difference in mean t-values

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 11: Migrant Effect on Household Food Security (ATT) by Nearest Neighbor Matching and Kernel Matching

	(1)	(2)	(3)	(4)	(5)	(6)
Dependent Variable	Kitchen Plot		Presidential Plot		Dehkan Plot	
	Nearest Neighbor	Kernel [a]	Nearest Neighbor	Kernel [a]	Nearest Neighbor	Kernel [a]
Months with	-0.231***	-0.263***	-0.136	-0.098	-0.252	-0.193
food shortage (D)	(0.079)	(0.074)	(0.124)	(0.115)	(0.182)	(0.170)
Total measures	-0.242**	-0.290***	-0.204	-0.172	0.176	0.232
taken to provide food (D)	(0.099)	(0.093)	(0.170)	(0.157)	(0.281)	(0.258)
Rely on cheap,	-0.027	-0.038	0.006	-0.0026	0.041	0.064
less expensive food (D)	(0.025)	(0.023)	(0.042)	(0.039)	(0.066)	(0.062)
Borrow money	-0.023	-0.031	0.006	0.011	0.077	0.099*
for food (D)	(0.024)	(0.022)	(0.040)	(0.038)	(0.062)	(0.059)
Purchase food	-0.003	-0.001	-0.060	-0.041	0.045	0.072
on credit (D)	(0.025)	(0.023)	(0.043)	(0.040)	(0.067)	(0.063)
Eat seed saved	-0.051**	-0.051**	-0.027	-0.029	0.055	0.032
for cultivation (D)	(0.025)	(0.023)	(0.043)	(0.041)	(0.067)	(0.062)
Sell any useable	-0.061**	-0.063***	-0.095**	-0.104***	-0.028	-0.076
houehold items (D)	(0.024)	(0.023)	(0.042)	(0.039)	(0.0697)	(0.062)
Skip a meal (D)	-0.021	-0.041*	0.003	0.011	0.016	0.040
	(0.025)	(0.023)	(0.042)	(0.040)	(0.065)	(0.062)
Spend days	-0.056***	-0.061***	-0.037	-0.017	-0.030	0.001
without eating food (D)	(0.018)	(0.018)	(0.032)	(0.028)	(0.050)	(0.046)
Total food shortage	-0.145***	-0.158***	-0.119	-0.092	0.015	0.063
in the past 4 weeks (D)	(0.042)	(0.040)	(0.073)	(0.066)	(0.109)	(0.101)
No food to eat at home	-0.067***	-0.066***	-0.034	-0.027	0.075	0.106*
due to lack of resources (D)	(0.025)	(0.023)	(0.043)	(0.041)	(0.067)	(0.063)
Sleep hungry at night	-0.047***	-0.056***	-0.029	-0.019	-0.021	-0.012
due to food shortage (D)	(0.016)	(0.016)	(0.028)	(0.025)	(0.038)	(0.035)
Go whole day without food	-0.032**	-0.037***	-0.056**	-0.046**	-0.039	-0.031
due to food shortage (D)	(0.013)	(0.013)	(0.024)	(0.021)	(0.032)	(0.031)
N						
Migrant	892	891	327	327	110	110
Non-migrant	941	1005	308	324	152	164

Notes: Columns 1-6 report coefficient of PSM result Nearest Neighbor matching and Kernel matching for food security variables in migrant and non-migrant households. D indicates dummy variable, =1 if yes, =0 if no.[a]Epanechnikov kernel with 0.06 bandwidth is used. Robust standard errors in parenthese
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 12: Kitchen Plot: Migrant Effect on Household Gender Labor Division (ATT) by Nearest Neighbor and Kernel Matching)

Dependent Variable	(1) Nearest Neighbor	(2) Migrant	(3) Non-Migrant	(4) Kernel [a]	(5) Migrant	(6) Non-Migrant
Irrigation System Management						
Cleans irrigation canal (D)	0.056*** (0.018)	685	725	0.052*** (0.018)	684	762
Cleans smaller irrigation ditch (D)	0.017 (0.022)	673	705	0.048** (0.021)	778	879
Sets up irrigation system (D)	0.066*** (0.024)	788	821	0.075*** (0.022)	787	883
Guides water flow (D)	0.066*** (0.024)	788	821	0.085*** (0.023)	835	943
Amount irrigation water (D)	0.120*** (0.024)	852	872	0.122*** (0.022)	851	947
When to apply irrigation water (D)	0.105*** (0.024)	858	895	0.109*** (0.023)	857	953
Speaks with irrigation service provider (D)	0.089*** (0.023)	697	758	0.087*** (0.021)	705	818
Agriculture Crops Management						
Sow seeds (D)	0.080*** (0.026)	874	897	0.092*** (0.024)	873	967
Sprays pesticides (D)	0.110*** (0.026)	608	632	0.123*** (0.024)	607	683
Applies fertilizers (D)	0.121*** (0.025)	752	770	0.112*** (0.023)	751	834
Purchases agricultural inputs (D)	0.069*** (0.023)	857	874	0.067*** (0.022)	855	952
Decision on which crops to grow (D)	0.093*** (0.025)	877	908	0.091*** (0.023)	876	978
Amount of agricultural products to sell, consume and store (D)	0.102*** (0.028)	673	705	0.094*** (0.026)	672	768
Amount of livestock to sell and consume (D)	0.057** (0.027)	606	643	0.052** (0.026)	611	696
Processes and stores crops (D)	0.0539** (0.022)	837	880	0.063*** (0.021)	836	947

Notes: Columns 1 and 4 report coefficient of PSM result Nearest Neighbor matching and Kernel matching respectively. Columns 2, 3, 5 and 6 indicate the number of observations on each variable inmigrant and non-migrant households which were dissimilar. Thus each outcome has different level of common support. Robust standard errors 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 13: Presidential Plot: Migrant Effect on Household Gender Labor Division (ATT) by Nearest Neighbor and Kernel Matching)

Dependent Variable	(1) Nearest Neighbor	(2) Migrant	(3) Non-Migrant	(4) Kernel [a]	(5) Migrant	(6) Non-Migrant
Irrigation System Management						
Cleans irrigation	0.031	242	232	-0.011	242	247
canal (D)	(0.030)			(0.025)		
Cleans smaller	0.003	275	250	-0.004	275	275
irrigation ditch (D)	(0.026)			(0.025)		
Sets up irrigation	-0.001	274	257	-0.010	274	279
system (D)	(0.026)			(0.025)		
Guides water	-0.026	284	254	-0.030	284	283
flow (D)	(0.029)			(0.027)		
Amount irrigation water (D)	0.011	294	274	0.012	294	294
	(0.035)			(0.033)		
When to apply	0.055*	290	277	0.041	290	292
irrigation water (D)	(0.033)			(0.032)		
Speaks with irrigation	0.075**	276	264	0.063*	275	278
service provider (D)	(0.031)			(0.030)		
Agriculture Crops Management						
Sow seeds (D)	-0.004	290	250	-0.037	290	276
	(0.034)			(0.033)		
Sprays pesticides (D)	-0.003	186	195	-0.011	186	206
	(0.032)			(0.027)		
Applies fertilizers (D)	0.028	267	242	0.016	267	267
	(0.027)			(0.027)		
Purchases agricultural	0.001	287	262	0.023	287	286
inputs (D)	(0.033)			(0.030)		
Decision on which	0.037	308	278	0.049	308	300
crops to grow (D)	(0.038)			(0.035)		
Amount of agricultural products	0.068	231	215	0.047	231	247
to sell, consume and store (D)	(0.044)			(0.043)		
Amount of livestock to	0.028	221	229	0.029	220	242
sell and consume (D)	(0.045)			(0.043)		
Processes and	0.054	290	272	0.034	290	283
stores crops (D)	(0.045)			(0.043)		

Notes: Columns 1 and 4 report coefficient of PSM result Nearest Neighbor matching and Kernel matching respectively. Columns 2, 3, 5 and 6 indicate the number of observations on each variable inmigrant and non-migrant households which were dissimilar. Thus each outcome has different level of common support. Robust standard errors 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 14: Dehkan Farm: Migrant Effect on Household Gender Labor Division (ATT) by Nearest Neighbor and Kernel Matching)

Dependent Variable	(1) Nearest Neighbor	(2) Migrant	(3) Non-Migrant	(4) Kernel [a]	(5) Migrant	(6) Non-Migran
Irrigation System Management						
Cleans irrigation canal (D)	0.012 (0.015)	73	103	0.006 (0.017)	73	127
Cleans smaller irrigation ditch (D)	0.024 (0.025)	85	116	0.020 (0.023)	85	132
Sets up irrigation system (D)	-0.002 (0.029)	92	123	-0.002 (0.028)	91	137
Guides water flow (D)	0.027 (0.037)	91	119	0.032 (0.036)	91	135
Amount irrigation water (D)	0.015 (0.043)	96	129	0.033 (0.037)	96	142
When to apply irrigation water (D)	0.025 (0.046)	97	129	0.037 (0.042)	97	145
Speaks with irrigation service provider (D)	0.041 (0.032)	89	112	0.032 (0.033)	89	130
Agriculture Crops Management						
Sow seeds (D)	0.046 (0.044)	94	111	0.062 (0.045)	94	117
Sprays pesticides (D)	0.015 (0.024)	67	91	0.015 (0.027)	67	104
Applies fertilizers (D)	0.006 (0.027)	79	102	0.005 (0.028)	78	117
Purchases agricultural inputs (D)	0.134*** (0.037)	103	138	0.122*** (0.037)	103	152
Decision on which crops to grow (D)	0.091 (0.049)	106	137	0.071 (0.048)	106	160
Amount of agricultural products to sell, consume and store (D)	0.104* (0.053)	101	135	0.081 (0.051)	101	152
Amount of livestock to sell and consume (D)	0.005 (0.068)	98	117	0.011 (0.063)	98	137
Processes and stores crops (D)	0.078 (0.065)	101	135	0.003 (0.069)	101	145

Notes: Columns 1 and 4 report coefficient of PSM result Nearest Neighbor matching and Kernel matching respectively. Columns 2, 3, 5 and 6 indicate the number of observations on each variable inmigrant and non-migrant households which were dissimilar. Thus each outcome has different level of common support. Robust standard errors 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 15: Migrant Effect on Household Food Security (ATT) by Nearest Neighbor and Kernel Matching and Village Fixed Effects

Dependent Variable	(1) Kitchen Plot	(2)	(3) Presidential Plot	(4)	(5) Dehkan Plot	(6)
	Nearest Neighbor	Kernel [a]	Nearest Neighbor	Kernel [a]	Nearest Neighbor	Kernel [a]
Months with	-0.245**	-0.277***	-0.378**	-0.372**	0.134	0.063
food shortage (D)	(0.083)	(0.081)	(0.121)	(0.121)	(0.244)	(0.239)
Total measures	-0.370**	-0.384**	-0.555**	-0.521**	0.757*	0.576
taken to provide food (D)	(0.120)	(0.113)	(0.201)	(0.201)	(0.385)	(0.374)
Rely on cheap,	-0.056*	-0.051*	-0.095*	-0.065	0.138	0.080
less expensive food (D)	(0.029)	(0.028)	(0.050)	(0.051)	(0.098)	(0.096)
Borrow money	-0.027	-0.028	-0.049	-0.065	0.226**	0.212**
for food (D)	(0.029)	(0.027)	(0.050)	(0.051)	(0.094)	(0.090)
Purchase food	-0.039	-0.035	-0.115**	-0.112**	0.069	0.112
on credit (D)	(0.029)	(0.028)	(0.055)	(0.052)	(0.097)	(0.092)
Eat seed saved	-0.047	-0.069**	-0.116**	-0.113**	0.293*	0.237**
for cultivation (D)	(0.030)	(0.028)	(0.055)	(0.054)	(0.097)	(0.097)
Sell any useable	-0.070**	-0.072**	-0.112*	-0.133**	0.011	-0.006
houehold items (D)	(0.030)	(0.028)	(0.058)	(0.057)	(0.123)	(0.112)
Skip a meal (D)	-0.054*	-0.053*	-0.016	0.009	0.035	-0.025
	(0.030)	(0.023)	(0.055)	(0.055)	(0.095)	(0.094)
Spend days	-0.077***	-0.077***	-0.051	-0.043	-0.014	-0.033
without eating food (D)	(0.022)	(0.022)	(0.039)	(0.037)	(0.084)	(0.079)
Total food shortage	-0.206***	-0.216***	-0.234*	-0.216*	0.114	0.074
in the past 4 weeks (D)	(0.055)	(0.052)	(0.104)	(0.066)	(0.140)	(0.150)
No food to eat at home	-0.071**	-0.079**	-0.095*	-0.099*	0.085	0.055
due to lack of resources (D)	(0.031)	(0.028)	(0.057)	(0.055)	(0.108)	(0.107)
Sleep hungry at night	-0.073***	-0.075***	-0.052	-0.037	0.024	0.023
due to food shortage (D)	(0.021)	(0.016)	(0.038)	(0.034)	(0.038)	(0.045)
Go whole day without food	-0.062***	-0.062***	-0.088**	-0.081**	0.006	-0.004
due to food shortage (D)	(0.018)	(0.017)	(0.037)	(0.033)	(0.036)	(0.042)
N						
Migrant	892	892	286	286	65	61
Non-migrant	825	993	240	293	71	89

Notes: Columns 1-6 report coefficient of PSM result Nearest Neighbor matching and Kernel matching with village fixed efffects for food security variables in migrant and non-migrant households. D indicates dummy variable, =1 if yes, =0 if no.[a]Epanechnikov kernel with 0.06 bandwidth is used. Robust standard errors in parenthese.* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 16: Kitchen Plot: Migrant Effect on Household Gender Labor Division (ATT) by Nearest Neighbor Matching and Kernel Matching with Village Fixed Effects

Dependent Variable	(1) Nearest Neighbor	(2) Migrant	(3) Non-Migrant	(4) Kernel [a]	(5) Migrant	(6) Non-Migrant
Irrigation System Management						
Cleans irrigation	0.059**	776	701	0.050**	658	734
canal (D)	(0.025)			(0.020)		
Cleans smaller	0.017	673	705	0.059**	776	850
irrigation ditch (D)	(0.022)			(0.024)		
Sets up irrigation	0.059*	780	733	0.063**	779	864
system (D)	(0.028)			(0.027)		
Guides water	0.073**	836	764	0.077**	835	924
flow (D)	(0.029)			(0.027)		
Amount irrigation water (D)	0.147***	852	787	0.127***	849	935
	(0.027)			(0.026)		
When to apply	0.095***	858	779	0.093***	857	941
irrigation water (D)	(0.029)			(0.027)		
Speaks with irrigation	0.095***	679	639	0.092***	677	769
service provider (D)	(0.026)			(0.025)		
Agriculture Crops Management						
Sow seeds (D)	0.077**	874	809	0.084**	874	955
	(0.031)			(0.029)		
Sprays pesticides (D)	0.087**	589	542	0.092**	589	665
	(0.033)			(0.031)		
Applies fertilizers (D)	0.104***	749	690	0.108***	749	823
	(0.028)			(0.028)		
Purchases agricultural	0.071**	857	795	0.072**	857	940
inputs (D)	(0.027)			(0.025)		
Decision on which	0.075**	877	803	0.083**	877	966
crops to grow (D)	(0.030)			(0.028)		
Amount of agricultural products	0.086**	661	624	0.096**	660	749
to sell, consume and store (D)	(0.034)			(0.032)		
Amount of livestock to	0.068**	592	545	0.074**	592	659
sell and consume (D)	(0.034)			(0.031)		
Processes and	0.062**	830	782	0.060**	830	935
stores crops (D)	(0.028)			(0.025)		

Notes: Columns 1 and 4 report coefficient of PSM result 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 which were dissimilar. Thus, each outcome has different level of common support.Robust standard errors 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 17: Presidential Plot: Migrant Effect on Household Gender Labor Division (ATT) by Nearest Neighbor Matching and Kernel Matching with Village Fixed Effects

Dependent Variable	(1) Nearest Neighbor	(2) Migrant	(3) Non-Migrant	(4) Kernel [a]	(5) Migrant	(6) Non-Migrant
Irrigation System Management						
Cleans irrigation	0.002	203	167	0.002	201	204
canal (D)	(0.036)			(0.037)		
Cleans smaller	-0.011	230	197	-0.010	228	241
irrigation ditch (D)	(0.042)			(0.040)		
Sets up irrigation	-0.021	230	203	-0.032	229	243
system (D)	(0.035)			(0.040)		
Guides water	0.017	237	210	-0.023	235	248
flow (D)	(0.036)			(0.041)		
Amount irrigation water (D)	-0.031	250	216	-0.038	246	256
	(0.049)			(0.051)		
When to apply	0.031	248	213	0.006	245	255
irrigation water (D)	(0.045)			(0.049)		
Speaks with irrigation	0.085*	239	197	0.090**	238	228
service provider (D)	(0.040)			(0.038)		
Agriculture Crops Management						
Sow seeds (D)	-0.103*	246	210	-0.103*	243	246
	(0.057)			(0.056)		
Sprays pesticides (D)	0.037	141	119	0.028	140	165
	(0.024)			(0.026)		
Applies fertilizers (D)	0.005	229	183	0.025	223	224
	(0.044)			(0.037)		
Purchases agricultural	0.018	243	218	0.003	242	252
inputs (D)	(0.041)			(0.043)		
Decision on which	0.004	264	228	-0.021	260	273
crops to grow (D)	(0.055)			(0.057)		
Amount of agricultural products	0.039	187	166	0.054	187	208
to sell, consume and store (D)	(0.060)			(0.055)		
Amount of livestock to	0.080	179	157	0.038	179	204
sell and consume (D)	(0.059)			(0.062)		
Processes and	0.103*	243	194	0.158**	242	255
stores crops (D)	(0.059)			(0.052)		

Notes: Columns 1 and 4 report coefficient of PSM result 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 which were dissimilar. Thus, each outcome has different level of common support.Robust standard errors 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 18: Dehkan Farm: Migrant Effect on Household Gender Labor Division (ATT) by Nearest Neighbor Matching and Kernel Matching with Village Fixed Effects

Dependent Variable	(1) Nearest Neighbor	(2) Migrant	(3) Non-Migrant	(4) Kernel [a]	(5) Migrant	(6) Non-Migrant
Irrigation System Management						
Cleans irrigation canal (D)	0.024 (0.025)	42	43	0.021 (0.025)	33	64
Cleans smaller irrigation ditch (D)	0.023 (0.023)	51	43	0.011 (0.028)	28	64
Sets up irrigation system (D)	0.001 (0.028)	59	52	-0.032 (0.036)	36	75
Guides water flow (D)	0.112* (0.052)	58	52	0.088* (0.047)	36	73
Amount irrigation water (D)	0.005 (0.067)	58	58	0.011 (0.067)	52	76
When to apply irrigation water (D)	0.012 (0.068)	58	58	0.014 (0.069)	52	77
Speaks with irrigation service provider (D)	-0.019 (0.047)	55	44	-0.006 (0.060)	40	57
Agriculture Crops Management						
Sow seeds (D)	0.066 (0.074)	52	34	0.024 (0.076)	39	45
Sprays pesticides (D)	0.023 (0.024)	34	29	-0.013 (0.017)	14	29
Applies fertilizers (D)	0.026 (0.032)	48	36	0.040 (0.052)	32	51
Purchases agricultural inputs (D)	0.108* (0.057)	68	62	0.104* (0.057)	58	85
Decision on which crops to grow (D)	-0.002 (0.073)	70	60	0.009 (0.073)	60	88
Amount of agricultural products to sell, consume and store (D)	-0.037 (0.091)	62	63	-0.031 (0.090)	58	82
Amount of livestock to sell and consume (D)	-0.001 (0.117)	51	43	0.093 (0.083)	54	73
Processes and stores crops (D)	0.191* (0.083)	61	60	0.161* (0.087)	54	81

Notes: Columns 1 and 4 report coefficient of PSM result 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 which were dissimilar. Thus, each outcome has different level of common support.Robust standard errors 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 19: Migrant Effect on Household Food Security (ATT) by Nearest Neighbor and Kernel Matching and Village Fixed Effects excluding Earnings, Asset Index and Unemployment

	(1)	(2)	(3)	(4)	(5)	(6)
Dependent Variable	Kitchen Plot		Presidential Plot		Dehkan Plot	
	Nearest Neighbor	Kernel [a]	Nearest Neighbor	Kernel [a]	Nearest Neighbor	Kernel [a]
Months with	-0.212**	-0.213**	-0.40**	-0.350**	0.013	0.030
food shortage (D)	(0.080)	(0.078)	(0.126)	(0.119)	(0.247)	(0.248)
Total measures	-0.348**	-0.355***	-0.492**	-0.505**	0.607*	0.760*
taken to provide food (D)	(0.115)	(0.108)	(0.215)	(0.201)	(0.394)	(0.374)
Rely on cheap,	-0.042*	-0.046*	-0.028*	-0.039	0.158*	0.182*
less expensive food (D)	(0.028)	(0.027)	(0.052)	(0.049)	(0.099)	(0.096)
Borrow money	-0.026	-0.023	-0.068	-0.080*	0.233**	0.212**
for food (D)	(0.027)	(0.025)	(0.050)	(0.049)	(0.090)	(0.087)
Purchase food	-0.039	-0.029	-0.121**	-0.123**	0.054	0.114
on credit (D)	(0.029)	(0.027)	(0.052)	(0.048)	(0.102)	(0.098)
Eat seed saved	-0.040	-0.053*	-0.117*	-0.108**	0.211*	0.212**
for cultivation (D)	(0.028)	(0.027)	(0.055)	(0.052)	(0.101)	(0.095)
Sell any useable	-0.072**	-0.081**	-0.144**	-0.143**	-0.096	-0.058
houehold items (D)	(0.029)	(0.027)	(0.057)	(0.054)	(0.099)	(0.099)
Skip a meal (D)	-0.043*	-0.043*	0.024	0.037	0.092	0.109
	(0.029)	(0.027)	(0.054)	(0.053)	(0.099)	(0.096)
Spend days	-0.085***	-0.081***	-0.039	-0.050	-0.046	-0.011
without eating food (D)	(0.023)	(0.021)	(0.038)	(0.038)	(0.079)	(0.073)
Total food shortage	-0.224***	-0.215***	-0.200*	-0.206**	0.145	0.113
in the past 4 weeks (D)	(0.053)	(0.050)	(0.098)	(0.093)	(0.144)	(0.131)
No food to eat at home	-0.079**	-0.075**	-0.084*	-0.089*	0.134	0.141
due to lack of resources (D)	(0.029)	(0.027)	(0.054)	(0.051)	(0.106)	(0.103)
Sleep hungry at night	-0.087***	-0.082***	-0.051	-0.049	0.023	0.003
due to food shortage (D)	(0.021)	(0.019)	(0.037)	(0.036)	(0.045)	(0.045)
Go whole day without food	-0.058***	-0.058***	-0.065**	-0.067**	-0.012	-0.031
due to food shortage (D)	(0.018)	(0.016)	(0.032)	(0.031)	(0.040)	(0.039)
N						
Migrant	892	892	286	286	71	64
Non-migrant	858	993	247	293	73	89

Notes: Columns 1-6 report coefficient of PSM result Nearest Neighbor matching and Kernel matching with village fixed efffects excluding earnings, asset index and unemployment measures for food security variables in migrant and non-migrant households. D indicates dummy variable, =1 if yes, =0 if no.
[a]Epanechnikov kernel with 0.06 bandwidth is used. Robust standard errors in parenthese.
[a]* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 20: Kitchen Plot: Migrant Effect on Household Gender Labor Division (ATT) by Nearest Neighbor Matching and Kernel Matching with Village Fixed Effects excluding Earnings, Asset Index and Unemployment

Dependent Variable	(1) Nearest Neighbor	(2) Migrant	(3) Non-Migrant	(4) Kernel [a]	(5) Migrant	(6) Non-Migrant
Irrigation System Management						
Cleans irrigation	0.042*	667	623	0.050**	667	734
canal (D)	(0.022)			(0.019)		
Cleans smaller	0.061**	776	706	0.061**	776	850
irrigation ditch (D)	(0.023)			(0.023)		
Sets up irrigation	0.066**	780	723	-0.060**	780	864
system (D)	(0.027)			(0.026)		
Guides water	0.059**	836	788	0.071**	836	924
flow (D)	(0.028)			(0.026)		
Amount irrigation water (D)	0.124***	852	802	0.118***	852	935
	(0.027)			(0.026)		
When to apply	0.078**	858	803	0.084**	858	941
irrigation water (D)	(0.028)			(0.027)		
Speaks with irrigation	0.079**	679	659	0.086***	679	769
service provider (D)	(0.027)			(0.025)		
Agriculture Crops Management						
Sow seeds (D)	0.057*	874	814	0.057**	874	955
	(0.029)			(0.027)		
Sprays pesticides (D)	0.086**	589	552	0.084**	589	665
	(0.031)			(0.030)		
Applies fertilizers (D)	0.101***	749	704	0.089***	749	823
	(0.028)			(0.027)		
Purchases agricultural	0.061**	857	812	0.068**	857	940
inputs (D)	(0.026)			(0.024)		
Decision on which	0.076**	877	820	0.081**	877	966
crops to grow (D)	(0.029)			(0.027)		
Amount of agricultural products	0.061*	661	629	0.075**	661	749
to sell, consume and store (D)	(0.033)			(0.031)		
Amount of livestock to	0.078**	592	560	0.065**	592	659
sell and consume (D)	(0.032)			(0.030)		
Processes and	0.033	830	800	0.035*	830	935
stores crops (D)	(0.024)			(0.023)		

Notes: Columns 1 and 4 report coefficient of PSM result Nearest Neighbor matching and Kernel matching respectively with village fixed effects excluding earnings, asset index 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. Thus, each outcome has different level of common support.Robust standard errors 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 21: Presidential Plot: Migrant Effect on Household Gender Labor Division (ATT) by Nearest Neighbor Matching and Kernel Matching with Village Fixed Effects excluding Earnings, Asset Index and Unemployment

Dependent Variable	(1) Nearest Neighbor	(2) Migrant	(3) Non-Migrant	(4) Kernel [a]	(5) Migrant	(6) Non-Migrant
Irrigation System Management						
Cleans irrigation	0.026	203	168	0.023	202	205
canal (D)	(0.025)			(0.025)		
Cleans smaller	0.029	230	191	0.020	229	241
irrigation ditch (D)	(0.028)			(0.029)		
Sets up irrigation	0.020	230	209	-0.029	229	243
system (D)	(0.034)			(0.036)		
Guides water	0.029	237	215	-0.017	236	248
flow (D)	(0.040)			(0.035)		
Amount irrigation water (D)	-0.031	250	211	-0.018	249	256
	(0.049)			(0.043)		
When to apply	-0.004	248	214	0.010	247	255
irrigation water (D)	(0.047)			(0.042)		
Speaks with irrigation	0.100**	239	203	0.089**	238	232
service provider (D)	(0.037)			(0.038)		
Agriculture Crops Management						
Sow seeds (D)	-0.119**	246	206	-0.101*	245	246
	(0.057)			(0.050)		
Sprays pesticides (D)	0.029	141	130	0.018	139	165
	(0.026)			(0.028)		
Applies fertilizers (D)	0.047*	229	191	0.031	226	224
	(0.030)			(0.033)		
Purchases agricultural	0.032	243	217	0.017	242	252
inputs (D)	(0.039)			(0.038)		
Decision on which	0.010	264	221	-0.031	263	273
crops to grow (D)	(0.049)			(0.049)		
Amount of agricultural products	0.035	187	168	0.031	187	208
to sell, consume and store (D)	(0.058)			(0.058)		
Amount of livestock to	0.020	179	151	0.016	179	204
sell and consume (D)	(0.058)			(0.058)		
Processes and	0.094*	243	210	0.102*	236	255
stores crops (D)	(0.056)			(0.053)		

Notes: Columns 1 and 4 report coefficient of PSM result Nearest Neighbor matching and Kernel matching respectively with village fixed effects excluding earnings, asset index 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. Thus, each outcome has different level of common support.Robust standard errors 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 22: Dehkan Farm: Migrant Effect on Household Gender Labor Division (ATT) by Nearest Neighbor Matching and Kernel Matching with Village Fixed Effects excluding Earnings, Asset Index and Unemployment

Dependent Variable	(1) Nearest Neighbor	(2) Migrant	(3) Non-Migrant	(4) Kernel [a]	(5) Migrant	(6) Non-Migrant
Irrigation System Management						
Cleans irrigation canal (D)	0.023 (0.023)	42	36	0.026 (0.026)	38	62
Cleans smaller irrigation ditch (D)	0.025 (0.024)	51	50	0.026 (0.027)	39	68
Sets up irrigation system (D)	0.013 (0.027)	59	54	0.024 (0.032)	46	75
Guides water flow (D)	0.010** (0.043)	58	54	0.113** (0.050)	46	73
Amount irrigation water (D)	0.035 (0.060)	58	56	0.044 (0.064)	49	69
When to apply irrigation water (D)	0.009 (0.074)	58	56	0.007 (0.081)	50	70
Speaks with irrigation service provider (D)	-0.010 (0.041)	55	45	0.002 (0.046)	48	60
Agriculture Crops Management						
Sow seeds (D)	0.114** (0.053)	52	48	0.099* (0.063)	38	54
Sprays pesticides (D)	-0.009 (0.011)	34	30	-0.023 (0.027)	12	32
Applies fertilizers (D)	0.063* (0.040)	48	37	0.040 (0.042)	32	48
Purchases agricultural inputs (D)	0.117** (0.046)	68	67	0.105** (0.046)	61	85
Decision on which crops to grow (D)	0.033 (0.075)	70	72	0.042 (0.076)	65	88
Amount of agricultural products to sell, consume and store (D)	0.041 (0.095)	62	63	0.062 (0.085)	56	79
Amount of livestock to sell and consume (D)	0.097 (0.083)	58	49	0.074 (0.080)	53	68
Processes and stores crops (D)	0.100 (0.092)	61	58	0.152* (0.091)	52	81

Notes: Columns 1 and 4 report coefficient of PSM result Nearest Neighbor matching and Kernel matching respectively with village fixed effects excluding earnings, asset index 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. Thus, each outcome has different level of common support.Robust standard errors in parentheses. D indicates dummy variable, =1 if female,=0 if male.[a]Epanechnikov kernel with 0.06 bandwidth is used. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$