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Migrant Remittances, Agriculture Investment and Cropping Patterns

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ABSTRACT

This study investigates how the receipt and amount of domestic or international transfers influences household decisions regarding farm investment and the selection of capital and labor-intensive crops. We develop a conceptual framework to postulate that even though recipient households may have the possibility to employ the additional income to raise their agricultural investment, the investment falls in the short run if labor constraints arising from the migrant member's absence are binding and capital accumulation is suboptimal. Employing a set of endogenous treatment estimations, we empirically test this hypothesis on data on 5,636 rural households from Pakistan. Our findings show a substantial difference between recipient and non-recipient households in terms of their economic behavior. Recipient households make 99.64% less agricultural investment and obtain 82% less production compared to non-recipient households. The estimates are found to be robust when tested with alternate empirical techniques Heckman Selection and matching. The impact is stronger in case of households which receive domestic transfers, with 99.87% less farm investment and 77% less production than non-recipient households. Remittances result in a decrease in production of both capital- and labor-intensive crops, reflecting a decline in overall farm activity. Similar farm investment and cropping patterns are observed relative to the amount of remittances received. The results are robust to different model specifications and estimation procedures.

Key Words: Migration; Remittances; Agriculture Investment; Cropping Patterns; Instrumental Variable; PSM.

JEL Classification : D10; C21; F24

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1. Introduction

A common feature associated with the developing countries is the high incidence of outmigration from rural areas. Low yields, high risks due to climatic shocks, pest attacks, and tough working conditions push workers from farm households to seek employment in urban centers or to go abroad. There are an estimated 763 million internal migrants (Bell & Charles-Edwards, 2013), and approximately 272 million international migrants constituting about 3.5% of the sending countries' population (United Nations Department of Economic and Social Affairs, 2019). Money transfers by international migrants to their home countries constitute a significant source of foreign exchange for a number of developing countries. Out of the total international remittances of $719.4 billion in 2019, $539.5 billion were remitted to low and middle income countries (World Bank, 2021).

A rich literature in economics explores the relation between migration and agriculture. The focus of the initial theoretical models moved from neoclassical approach of individual decision to migrate due to income difference (Todaro, 1969) to the New Economics of Labor Migration (NELM) approach (Stark & Bloom, 1985) based on household level decisions which are meant to reduce income risks arising out of uncertainty. These models and the corresponding empirical analysis have come up with conflicting and at times contradictory evidence of the impact of migration and remittances on farm households. Several studies based on the NELM framework support the hypothesis that migration's positive income effect on migrant household finances dominates the negative labor-constraint effect. In the presence of imperfect labor market, if migration helps alleviate credit and insurance constraints, then the additional income from remittances can compensate for the loss of farm output due to lower family labor availability, as the household can invest in labor-saving technology or go for riskier or more profitable crops (Atamanov & Van den Berg, 2012; Kinnan et al., 2018; Rozelle et al., 1999; Taylor et al., 2003). Migrant households can use remittances to increase their investment in agriculture by adapting high-yield varieties, using more herbicides, and acquiring livestock (Abebaw et al., 2019; Böhme, 2015; Mendola, 2008; Quinn, 2009; Tshikala et al., 2019). Likewise, households can afford to take greater risks and grow high risk, high profitability cash crops (Kinnan et al., 2018).

Other studies suggest that the labor loss effect outweighs the income effect. Migration, according to this strand of literature, leads to either lower farm output or to the farm household switching to less labor-intensive crops or even to abandon farming altogether (De Brauw, 2010; Qian et al., 2016). International migration cannot overcome risk and credit constraints, thereby putting downward pressure on investment on own-cultivated and rented out land, labor inputs and agriculture income (Hossain et al., 2016; Miluka et al., 2010). Households choose strategies to overcome labor loss by shifting from high labor-intensive crops to less labor requiring crops (De Brauw, 2010). Households with international migrant members allocate more land to low risky and less labor intensive pasture and less land to moderately labor and capital intensive staple crops (Kinnan et al., 2018; Li et al., 2013; McCarthy et al., 2009;

Wouterse & Taylor, 2008). Yet other studies report insignificant evidence of change in agricultural investment resulting from migration and remittances, such as that on cattle ranching, production intensification and technical efficiency (Davis & Lopez-Carr, 2014; Hossain et al., 2016; Miluka et al., 2010).

Similarly, analysis of the impact of rural urban or internal migration on agricultural investment is also inconclusive. Kinnan et al. (2018) argue that rural to urban migration in China increased labor days of risky and high yielding farming activities such as livestock and fruit farming, while De Brauw and Giles (2018) report an opposite and negative impact on the number of labor days that rural subsistence farmers allocate to agriculture. Evidence from Vietnam is likewise contradictory, with Huy and Nonneman (2016) reporting a positive and Tuladhar et al. (2014) a negative impact of remittances on agriculture. Rural urban migration also results in a change in the cropping structure, with greater focus on the production of maize and rice crops (Qian et al., 2016; Rozelle et al., 1999; Shi, 2018). Other studies reported a negative impact of internal migration and remittances on rice production (De Brauw, 2010; D. L. Nguyen et al., 2019).

In this study, we attempt to make sense of the aforementioned ambiguous evidence through a theoretical model and the accompanying empirical analysis followed by a variety of estimations to check the robustness of our findings. We look for answer to the following questions: 1) Does the receipt of money from the household member raise investment in agriculture, i.e., whether the income effect of remittances dominates migration's labor loss effect? We hypothesize that if remittances income effect dominates, recipient households increase their investment in agriculture, but reduce it if the labor constraints dominate. 2) Do stay-behind members of recipient households too reduce the supply of their farm labor given a higher opportunity cost of leisure? This again would imply the preponderance of income effect. 3) Does the impact of remittances show in cropping patterns? If the income effect dominates, recipient households will focus more on the production of cash crops like cotton and sugarcane. In contrast, recipient households will move away from highly labor-intensive crops such as rice and fruits and vegetables if the labor loss effect is stronger. Previously, the study by Mendola (2008) tested agriculture investment among migrant households in six villages of Bangladesh and focused on the adoption of high-yield rice varieties. In this study, we take advantage of the availability of detailed country-wide representative household data to provide extensive margins of a more general form of agriculture investment among recipient households. We construct an agricultural investment indicator that encompasses long-duration agricultural assets and livestock. We go beyond McCarthy et al. (2009) who explore detailed information on labor and capital intensity of crops but only checked the impact of labor loss due to international migration. We examine the impact of the incidence and amount of remittances, both foreign and domestic, on the production of capital and labor-intensive crops as well as that of cash and subsistance crops. The differences in the cost, risk and distances involved in the two types of migration as well as their nature

(temporary/short-term versus permanent/long-term) can influence the investment, production and choice of crops of the recipient households.

We conduct our analysis on data for 5,636 rural households taken from the 2018-19 round of the Pakistan Social and Living standards Measurement (PSLM) survey (Pakistan Bureau of Statistics: Government of Pakistan, 2018-19). Majority of Pakistan's population (63.3%) resides in the rural areas. Agriculture absorbs about 38.5% of the country's labor force and contributes 18.5% to the country's GDP. Farm activities do not generate sufficient revenues and millions of surplus workers move to the urban centers or go abroad for work. Pakistan is among the top seven migrant-sending countries with about 3.26 million international emigrants in 2019 (IOM, 2020). Remittances from these non-resident Pakistanis constitute the biggest source of foreign exchange for the country. In the financial year 2020-21, the country received $29.4 billion in the form of migrant remittances (State Bank of Pakistan, 2021). Internal migration is estimated to be even more important, with 15% of the households reported to receive remittances from members living elsewhere in the country according to the Labor Force Survey Government of Pakistan (2018). Existing literature examines the impact of migration and remittances to Pakistan on income inequality (Mughal & Anwar, 2012), asset accumulation (Adams Jr, 1996, 1998; J. Ahmed et al., 2018; Oda, 2007), labor market (Mughal & Makhlouf, 2013), education attainment and child labor (Mansuri, 2006), and household welfare (V. Ahmed et al., 2010). However, no study yet has addressed migrant remittance effects on agriculture. In this study, we compare the investment and cropping patterns of recipient and non-recipient households to test our theoretical assertions by using a set of instrumental-variable and matching estimations. We show that agriculture investment and farm production of recipient rural households in Pakistan is lower compared to non-recipient households. Migration and subsequent transfers result in a decrease in production of not only capital-intensive crops but also of labor-intensive crops, reflecting a decline in overall farm activity. The impact is stronger and significantly negative for households which receive domestic remittances.

The study is structured as follows: We begin by presenting our stylized model in Section 2. Section 3 overviews relevant literature on migration, remittances, farm investment, and production. Section 4 describes the data, the empirical methodology and the identification strategy followed by key findings in Section 5. Section 6 discusses some robustness checks. The final section concludes and underscores possible policy implications.

Stylized model

Consider an economy with one sector, agriculture, in which household's common behavior is to maximize total income per head, Y. This income, Y, depends on the household's capital per head, K. It also depends on the proportion of members who stay at the farm (i.e., do not migrate), $L \in [0,1]$. Migrants send remittances to their family

proportional to $(1-L)$. Total remittances (per head) are thus of the form $r(1-L)$, where $r>0$ is fixed. Households invest a fixed share per head, s, of their total income, to increase the capital stock.

The basic equations of the simplest model can thus be given as:

$$\begin{cases} Y = AK^{\propto} L^{\beta} + r(1-L) \\ I = sY \end{cases}$$

where $(K,L) \mapsto AK^{\propto} L^{\beta}$, the production function (per head), is assumed to have constant returns to scale $(\propto +\beta = 1)$ and a fixed global productivity of factors, $A>0$.

Agriculture is a risky activity. Likewise, migration is a risky (Bryan et al., 2014) as well as costly process. Some households are risk averse and keep the risks to the minimum by engaging only in agriculture and avoid additional risk associated with the migration process. These households thus have no interest in sending family members away $(L=1)$, and all available resource are devoted to local farm to make it efficient. While on the other hand, given the low productivity and wages in the local agriculture sector compared to perceived migrant wages, the utility of typical risk-taking households is not maximized only by agriculture. Consequently, they select the migration level, L, to diversify and maximize the income per head, Y. Initially, resources of such households are allocated to two activities, namely agriculture and migration.

Household with no migrant $(\boldsymbol{L=1})$

When no migration takes place, then $\frac{\partial Y}{\partial L}(K,1) \geq 0$, the initial capital stock (per head) satisfies:

$$K \geq K^{\circ} := \left(\frac{r}{A\beta}\right)^{\frac{1}{\propto}}.$$

Where K° is the optimum level of household's capital per head. Household labor concentrates on the local production of the farm. Thus, the household's production and investment are, respectively, $Y = AK^{\propto}$ which is not lower than $Y^{\circ} := \frac{r}{\beta}$ - and $I = sY = AsK^{\propto}$.

A household may also be unable to send a member away due to the family situation, e.g., if it has only one breadwinner, the above condition $(K \geq K^{\circ})$ may fail.

Household with migrants $(\boldsymbol{L<1})$

Household which decides to send a member away need to finance migration in addition to spending on farm activities with existing resources. Thus $\frac{\partial Y}{\partial L}(K,1) < 0$, that is $K < K^{\circ}$. It persists until $\frac{\partial Y}{\partial L}(K,L) = 0$, that is, $L = \frac{K}{K^{\circ}}$, by first order conditions. In the short run, production and investment amongst the migrant households is lower compared

to the non-migrant households. Production (per head) amounts to $Y = \frac{rL}{\beta} + r(1 - L)$, which is lower than the $Y° = \frac{r}{\beta}$ threshold.

However, the dynamics of investment and depreciation could be simply represented by an additional equation:

$K_{t+1} = (1 - d)K_t + sY_t$,

where *d* stands for the annual rate of depreciation of capital and *t* indexes the year of reference. Provided the stock of capital increased over time (when investment dominates depreciation), this stock will tend to the threshold value *K*° where emigration stops[4]. It follows from above that migrant households, as compared to non-migrant ones, produce and invest less in the short run.

Different crop types and migrant categories

The above basic model can be modified to break down production into capital-intensive and labor-intensive crops. Based on capital intensity, crops can be divided into highly capital-intensive crops (mainly cash crops such as sugarcane and cotton) and low or moderately capital-intensive crops (chiefly subsistence crops such as wheat). Labor-intensive crops can be divided into highly labor-intensive crops such as vegetables, fruits, and rice, and low or moderately labor-intensive crops such as pulses, maize, and animal fodder. The value (per head) of long duration capital-intensive cash crops is denoted by Y_1 (occupying a portion, L_1, of the household's labor force), while the production (per head) of moderately capital-intensive wheat and subsistence crops is denoted by Y_2 (occupying a proportion, L_2, of the household's labor force). The production value (per head) of labor-intensive crops and less labor-intensive crops is denoted by Y_3 (occupying the share, L_3, of household labor).

Migrants are divided into domestic migrants, in proportion L_4 of the labor force and international migrants, in proportion L_5. In contrast to international migrant members, domestic migrants, being near their home, can participate in the production of short-duration crops. Long duration crops require continuous monitoring and thus cannot be adequately monitored by either the domestic or international migrants.

The basic equations of the model can thus be given as:

[4] This implication of the model, of a standard Solow type, cannot be confirmed on available cross-sectional data, and is left for subsequent research.

$$\begin{cases} Y_1 = A_1 K^{\propto_1} {L_1}^{\beta_1} \\ Y_2 = A_2 K^{\propto_2} {L_2}^{\beta_2} \\ Y_3 = bL_3 + cL_4 \\ \\ Y = Y_1 + Y_2 + Y_3 + (r-c)L_4 + rL_5 \\ I = sY \end{cases}$$

where all parameters are fixed and $L_1 + L_2 + L_3 + L_4 + L_5 = 1$. Domestic and international migrants are assumed to contribute equally to the household's wealth (otherwise there would only be one type of migrants). Hence, the remittances from the domestic migrants are subtracted from their contribution to the farm's production.

The model is solved as above by first order conditions. Though, in short run one would expect non-migrant households to focus more on capital-intensive production than migrant ones, while the latter would rely more on labor-intensive crops for lack of sufficient capital accumulation. However, in the long run, once capital per head reaches a certain threshold, migrant household production of capital-intensive crops and investment become positive. If labor constraint is binding and agriculture require the presence of household member to monitor the production process, the investment and production will remain negative, even with greater availability of capital per head. This can even lead to a poverty trap if the migrant households failed to save enough through time to upgrade their production. Our data confirm that migrant households produce less and invest less than non-migrant households. To solve the short-term model, we let $K^1 := \left(\frac{r}{A_1\beta_1}\right)^{\frac{1}{\propto_1}}$, $K^2 := \left(\frac{r}{A_2\beta_2}\right)^{\frac{1}{\propto_2}}$ and $K^* := \frac{K^1K^2}{K^1+K^2}$ be given capital stocks:

Household with no migrant

The basic condition for migration is when ($r > b$), if $b \geq r$ then, a rational farmer can always produce locally without bearing any cost. Even if the ($r > b$) condition is met, a risk averse household will prefer not to migrate and rather divert available resources towards agriculture and specialize in local crops ($K \geq K^*$). We assume that $b < r$ and that a risky and costly migration takes place. It follows that $L_1 + L_2 < 1$, whereas the relations $\frac{\partial Y_1}{\partial L_1}(K, L_1) = r = \frac{\partial Y_2}{\partial L_2}(K, L_2)$ hold, from the equality of the marginal productivities of labor across all types of migrants. After derivation, the latter relations yield:

$$L_1 = K\left(\frac{A_1\beta_1}{r}\right)^{\frac{1}{\propto_1}} = \frac{K}{K^1} \text{ and } L_2 = K\left(\frac{A_2\beta_2}{r}\right)^{\frac{1}{\propto_2}} = \frac{K}{K^2}.$$

This implies:

$$K < K^* = \frac{K^1K^2}{K^1+K^2}$$

from the migration condition, $L_1 + L_2 < 1$.

The above model is an idealistic simplification that shows that in the short run, labor out migration and lack of capital results in less production and investment amongst migrant households.

In the presence of the migration process, under the conditions $b < r$ and $K < K^*$, the model rules out labor-intensive production (Y_3). If the migrant households still produce labor-intensive crops (for instance for self-consumption), the reason may be that the cost of producing crops locally and their market sale price is lower than their retail price when purchased with remittances.

Household with migrants

As seen above, the relatively high income that the migrants earn ($r > b$) leads to emigration decisions by rational households. Migration is a costly process which results in a lack of capital accumulation ($K^* \geq K$) and investment ($I = sK$). Choosing to send migrants away helps the household in need to make enough savings through remittances, and to invest on the modernization of the farm. In the long run, once the accumulated capital has reached the above threshold K^*, migrants can pursue the farm's modernization through local production, generating local savings and investment. These outcomes of the model are not only sensible but also explain the paper's empirical results in the short run: Farm households which send a member away for work invest and produce less compared to non-migrant farm households.

2. Literature on Remittance, Agricultural investment, and Output

An immediate effect of outmigration on the farm household is the loss of labor due to the departure of the migrant member (Rozelle et al., 1999). The money that the migrant subsequently sends home raises family income and relaxes the financial constraints owing to credit market imperfections. This allows the household to invest in labor-compensating technologies, thereby raising farm output (McCarthy et al., 2009; Quinn, 2009; Wouterse, 2010; Zahonogo, 2011). This 'income effect' of migration should be stronger in the case of international remittances, given greater risks and higher returns. The opportunity cost for leisure of the stay-behind household member also increases as a result of additional income through migrant remittances (Atamanov & Van den Berg, 2012). This can lead to lower interest in agriculture and lower labor participation of the household in farm activities (Atamanov & Van den Berg, 2012; Miluka et al., 2010; Mughal & Makhlouf, 2013).

Empirical evidence on how agriculture investment fares among remittance recipient households, and whether the income or the labor loss effect dominates is mixed:

Abebaw et al. (2019), for instance, find that migration and remittances have a positive and significant impact on investment in livestock and herbicides use, and an insignificant effect on the adoption of improved seed varieties and fertilizers. Böhme (2015) and Chiodi et al. (2012) both study the effects of international migration from Mexico and find a positive impact on investment in productive assets. Li and Tonts (2014) report a negative impact of temporary rural urban migration and remittances on agriculture investment in China. Similarly, Castelhano et al. (2016) in Mexico estimate the effects of migration and remittances from other parts of Mexico on investment in farm and livestock and find no evidence of an increase in investment. Mendola (2008) find that in Bangladesh, domestic migration reduces agriculture investment while international remittances lead to greater adoption of high-yield varieties.

In the literature, the net impact of migration and remittances on agriculture production is ambiguous. The impact is negative if the labor loss effect dominates and positive if the remittances' income effect prevails (Atamanov & Van den Berg, 2012; Taylor & Lopez-Feldman, 2010). High disposable income, thanks to migrant remittances, allows the household to switch to high risk - high profit crops such as cash crops (Rozelle et al., 1999; Taylor & Martin, 2001). However, if the labor constraints resulting from the absence of the migrant member are binding, the household may be compelled to adopt less labor-intensive crops such as maize or fodder even though those crops might be less profitable. For many migrant households, farming becomes a secondary or part-time activity (Rigg (2005). The cultivation of crops is abandoned in favor of subsistence farming or fodder for household grains and animal feed (Davis & Lopez-Carr, 2014). However, given the symbolic value of land in the agrarian society and the absence of well-functioning farmland market in the rural areas, farm land is usually not sold (Bolganschi, 2011).

Some studies (Gibson et al., 2011; Qin & Liao, 2016) report a net positive impact of migration and remittances on agriculture, while others (e.g. Jokinen, 2018) provide evidence for a negative impact. Li et al. (2013) find that in China, migration and remittances result in a greater focus on capital-intensive and more profitable fruit orchards, and a negative impact on labor-intensive wheat production. Qian et al. (2016) report that left-behind family members of Chinese migrants turn to less labor-intensive subsistence grain production instead of more capital-intensive livestock cultivation, or even abandon their farmland.

Yet other studies fail to find evidence for any significant effect of migration on farm production. Quisumbing and McNiven (2010), for example, find no impact of migration, whether internal or international, on agriculture production in the Philippines. Similarly, Gibson et al. (2011) find that emigration from Tonga to New Zealand did not change the agriculture structure of the left behind households. De Brauw (2010) test the NELM hypothesis in the context of Vietnam and find no net impact on agriculture productivity. However, the production switches from labor-intensive rice to land-intensive maize and legumes.

The aforementioned lack of consensus on the net effect of overall migration also appears in studies on domestic and international migration. International migration and the resulting remittances is found to be linked to greater farm productivity in Mexico (Taylor & Lopez-Feldman, 2010) and a lower incidence of subsistence farming in Nepal (Maharjan et al., 2013). By contrast, Miluka et al. (2010) find no impact of international migration on crop income in Albania. Likewise, Huy and Nonneman (2016) and Rozelle et al. (1999) report a positive impact of domestic migration and remittances on agriculture production, whereas T. M. K. Nguyen et al. (2018) and Shi (2018) find a negative impact in the case of rice production in Vietnam and China, respectively.

3. Data and Methodology

Data

Data for this study come from the 2018-19 round of the Household Integrated Economic Survey (HIES) carried out along with the Pakistan Social and Living-standard Measurement (PSLM) survey (Pakistan Bureau of Statistics: Government of Pakistan, 2018-19). The HIES/PSLM 2018-19 is a nation-wide representative survey, conducted based on a two-stage stratified random sampling design. 24,809 households residing in 1,802 Primary Sampling Units (PSUs) were interviewed to collect information about demographic composition, income, education, consumption patterns, migration and remittances, agriculture, and financial situation. The survey covers all the four provinces of Pakistan with representative urban/rural breakdown. The target of this study are the households involved in agriculture regardless of whether they own or hire farmland. The corresponding sample contains 5,636 households. In this sample, households are identified based on receipt of domestic or foreign remittances. The survey provides information on whether any of the household member received income in form of internal or external remittances in the past twelve months, as well as the amount received. To highlight the difference between recipient and non-recipient households, we define remittance receipt both as a binary as well as a continuous variable based on the amount received. The binary variable is preferable on the ground that the recall data on remittance amount received over a long period (twelve months) is expected to be an approximation rather than the actual amount. This problem of inaccuracy becomes acute if the information about remittance is not collected from the same member of the household than the one who received the transfers.

Table 1 provides the overall description and definition of variables included in the study, while **Table 2** highlights the difference between recipient and non-recipient households.

Table 1. Variables' description

Variables	Definition	Obs.	Mean (St. Dev.)	Min	Max
Outcomes					
Agriculture Investment	Agriculture investment during the past year (PKR)	5636	7281 (40229)	0	1030000
Total Agriculture Output	Total value of farm output during the past year (PKR)	5632	381219 (574125)	3000	24130000
Cash Crops	Total value of cash crops (cotton and sugarcane) produced during the past year (PKR)	1781	266840 (472428)	1200	14400000
Wheat	Total value of wheat crop produced during the past year (PKR)	4815	144014 (193221)	1500	6250000
Highly Labor-Intensive Crops	Total value of labor-intensive crops (vegetables, rice and fruits) produced during the past year (PKR)	2445	186667 (261900)	400	5225000
Less/Moderately Labor-Intensive Crops	Total value of less/moderately labor-intensive Crops (maize, pulses and fodder) produced during the past year (PKR)	3570	85065 (158900)	1200	3696000
Remittances					
Domestic remittance incidence	Domestic remittances recipient HH (1 if received, 0 otherwise)	5636	0.115 (0.32)	0	1
Foreign remittance incidence	Foreign remittances recipient HH (1 if received, 0 otherwise)	5636	0.076 (0.27)	0	1
Remittance incidence	Overall remittances recipient HH (1 if received, 0 otherwise)	5636	0.183 (0.39)	0	1
Domestic remittance amount	Domestic remittances amount (PKR)	5636	20045 (70095)	0	1200000
Foreign remittance amount	Foreign remittances amount (PKR)	5636	22812 (104547)	0	3600000
Remittance amount	Overall remittances amount (PKR)	5636	42857 (127077)	0	3600000
Controls					
HHH Gender	Gender of HH head, 1=male, 0 if female.	5636	0.95 (0.21)	0	1
HHH Age	Age of HH head (Years)	5636	48.57 (14.02)	16	99
HHH Marital Dummy	Marital status of HH head, 1=married, 0 otherwise.	5636	0.93 (0.26)	0	1
HHH Education	Education of HH head (Years)	5636	3.82 (4.5)	0	16
Dependency Ratio	Number of dependents HH member/total HH size (ratio)	5636	0.43 (0.22)	0	1
Non-Agri Business Dummy	Equals 1 if HH involve in non-agri. business, 0 otherwise	5636	0.12 (0.33)	0	1
Land Own Dummy	Equals 1 if HH own agri. land, 0 otherwise	5636	0.73 (0.45)	0	1
Credit Dummy	Equals 1 if HH due a loan, 0 otherwise	5636	0.24 (0.43)	0	1
HH Income (Inc. Rem)	Total HH income including remittances (PKR)	5636	398319 (430329)	21300	12391200
HH Income (Exc. Rem)	Total HH income excluding remittances (PKR)	5636	355462 (416058)	500	12391200
Total Input Cost	Input cost (PKR)	5636	138490 (262890)	0	7792800

Authors' calculations using PSLM 2018-19.
Note: All variables measured in Pakistani Rupees (PKR) are transformed using inverse hyperbolic sine function when used in regressions.

Outcomes

Table 1 shows the outcomes used to identify the investment behavior and cropping pattern of the recipient and non-recipient farm households in the past 12 months. For regression analysis, the values of these variables are transformed using inverse hyperbolic sine function (Bellemare et al., 2020).

The agriculture investment indicator measures household investment in long run agricultural assets including land purchase and related costs, machinery, tube well, farm buildings, and livestock purchased. The indicator is calculated as the sum of values given in response to the following questions:

What was the value (in PKR[5]) of the agricultural land (including farm buildings and tube wells) purchased during the past year?
What was the cost (in PKR) of reclamations or improvements of owned land during the past year?
What was the value (in PKR) of new construction and improvements made on farm buildings, tube wells etc. during the past year?
What was the value (in PKR) of any agricultural equipment (Tube well, Tractor, Plough, Thresher, Harvester, Truck, etc.) purchased during the past year?
Livestock purchased during the past year.

On average, farm households invest PKR.7,281 (**Table 1**). Recipient households invest PKR 5,105 compared to PKR 7,768 that the non-recipient households invest (**Table 2**). In the same manner, domestic and foreign remittance recipient households invest less compared to non-recipient households. These differences are however not statistically significant in the latter case.

Farm output is measured in terms of total annual agriculture production as well as the production of four types of crops: capital intensive, subsistence, highly labor-intensive, and less/moderately labor-intensive.

Capital-intensive crops consist of cash crops such as cotton and sugarcane. Wheat is the principal subsistence crop. About 92% of cultivated farmland of the country is allocated to wheat during the winter season. Unlike cash crops, wheat is only moderately labor and capital intensive. Both wheat and cash crops need to be replanted every year, and much of the production process can be mechanized to substitute labor (Nolte & Ostermeier, 2017). Highly labor-intensive crops include vegetables and fruits, and rice. These crops require extensive manual handling.

[5] All the monetary values are reported in Pakistani Rupees (PKR). According to the State Bank of Pakistan (https://www.sbp.org.pk/ecodata) the average exchange rate of Pakistani rupees per US dollar for the survey period (August 2018-June 2019) is 137.16.

Table 2.Household profile - Recipient vs non-recipient

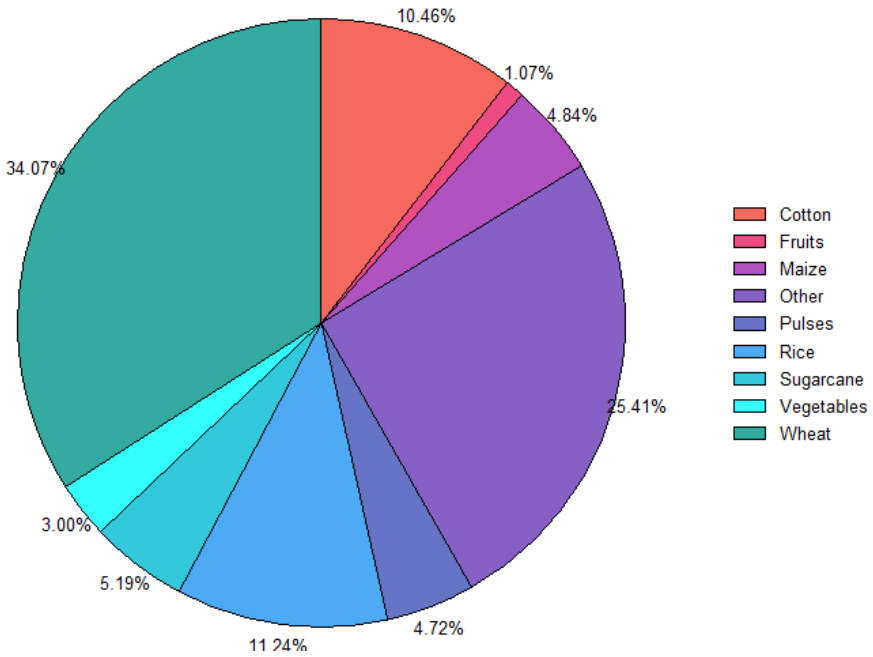
	1 Overall remittances			2 Domestic remittances			3 Foreign remittances		
Variables	**Non-recipient**	**Recipient**	**Dif.**	**Non-recipient**	**Recipient**	**Dif.**	**Non-recipient**	**Recipient**	**Dif.**
Outcomes									
Agriculture Investment	7768	5105	2663*	7647	4212	3434**	9232	6194	3038
Total Agriculture output	420080	207588	212492***	406986	165520	241466***	388303	284132	104171***
Cash crop	277767	164626	113140***	275709	119313	156397***	267845	240705	27140
Wheat	158806	78236	80570***	153022	67477	85545***	147694	95893	51801***
Highly Labor-Intensive Crops	202731	96864	105867***	199205	51818	147387***	188045	165427	22618
Less/Moderately Labor-Intensive Crops	92136	62816	29320***	90036	54896	35140***	85795	77595	8200
Remittances and Controls									
Remittances	0.000	234278	---	0.000	173989	---	0.000	296708	---
HHH Gender	0.98	0.79	0.194***	0.97	0.78	0.19***	0.96	0.81	0.15***
HHH Age	47.33	54.13	-6.8***	47.91	54.05	-6.14***	48.15	54.20	-6.04***
HHH Marital Status	0.93	0.89	0.04***	0.93	0.88	0.04***	0.93	0.91	0.01
HHH Education	3.95	3.22	0.74***	3.95	2.8	1.14***	3.82	3.85	-0.04
Dependency Ratio	0.43	0.42	0.01	0.425	0.435	-0.01	0.43	0.39	0.041***
Non-Agri. Business	0.122	0.118	0.005	0.13	0.09	0.04***	0.12	0.15	-0.04**
Land Ownership	0.69	0.87	-0.17***	0.71	0.87	-0.16***	0.72	0.87	-0.15***
Credit Dummy	0.22	0.34	-0.11***	0.23	0.37	-0.14***	0.24	0.28	-0.05**
HH Income (Inc. Rem)	378099	488630	-110531***	399996	384267	-15729	382331	616986	-234655***
HH Income (Exc. Rem)	378099	254352	123747***	372792	210278	162514***	358034	320276	37757*
Total Input Cost	151136	82004	69133***	147590	62254	85336***	140090	116599	23491*

Authors' calculations using PSLM 2018-19.

Low/moderately labor-intensive crops include maize, pulses, and fodder. These crops usually do not require extensive human presence during cultivation.

Figure 1 shows the distribution of major crops by land allocation in Pakistan. In 2017-18, about 45% of the total cultivated land in Pakistan was allocated to wheat and rice, the country's two main cereal crops (PBS, 2018). In comparison, 16% of the land was dedicated to sugarcane and cotton. Pulses and vegetables were cultivated on 4.84% and 3% of the total cropped land respectively.

Figure 1.Figure 1. Land allocation by crop (% of total crop land)



Source: Pakistan Bureau of Statistics 2018.

Table 2 shows that farm output of recipient households is significantly lower compared to that of non-recipient households. This is the case with the recipients of both domestic and foreign remittances. The production value of cash and subsistence crops of recipient households is almost half as much as that obtained by non-recipient households (PKR 164,626 vs PKR 277,767 and PKR 78,236 vs PKR 158,806, respectively). The production of highly and less labor-intensive crops is likewise lower among recipient households compared to non-recipient households. The difference in farm output is more visible in case of domestic remittance recipients whose production of all four types of crops is around half that of non-recipient households. This pattern of low crop production is also observed among the recipients of foreign remittances, except for the cash, high, and less labor-intensive crops.

Covariates

The three variables of interest pertaining to remittances, namely, domestic remittance incidence, foreign remittance incidence, and overall remittance incidence are all binary variables which take the value of "1" if the household reports having received money from the away member during the past twelve months. We also consider the impact of the amount of domestic, foreign, and overall remittances in our analysis.

Several control variables are used to capture the impact of other factors on the outcome variables. These include household head characteristics (gender, age, marital status, and years of education), household specific economic and demographic variables (dependency ratio, borrowings, ownership of non-farm business and income), and agriculture-related controls (working on own-farm and total farm input cost). All income related variables are transformed using inverse hyperbolic sine function.

A total of 1,032 farm households (18.28% of the sample) reported to have received transfers during the past twelve months (**Table 1**). Out of these, 648 households received domestic remittances while 430 received international remittances[6]. Domestic recipient households, on average, received 173,989 Pakistani Rupees (PKR), about 53% less than the average amount of PKR 296,708 international transfers received by the recipient households (**Table 2**).

Table 2 also shows the comparison between recipient and non-recipient households by a number of household characteristics. Heads of households with non-recipient status are younger, more often married and better educated compared with heads of recipient households. 79% of the heads of recipient households are male compared to 98% of the non-recipient ones. Pakistani households usually send male adult members or household heads to work in cities or other countries, leaving women to take up their responsibilities. The difference between the marital status and education level of the heads of recipient and non-recipient households is statistically significant in case of domestic but not for international remittances. Recipient households, on average, earn lower non-remittance income and have higher debt levels compared to their non-migrant counterparts.

The difference in agriculture-related indicators between the recipient and non-recipient households is interesting: While a significantly greater proportion of domestic and international remittance recipient household's own farmland, their farm output remains substantially lower compared to non-recipient households. The input cost of remittance recipient households also lower. However, there is evidence for an increase in non-farm activities in turn, particularly in the case of international remittance recipients, suggesting that higher remittance income allows some

[6] 46 households received both internal and foreign remittances. Therefore, the total does not sum up to 1032. They are excluded while analyzing separate impact of domestic and foreign remittance.

farm households to leave agriculture. 15% recipients of international remittances are involved in non-farm businesses compared to12% non-recipient ones. A reason for this general pattern of neglect of agriculture by both domestic and international remittance recipient households appears to be due to the low quality of their farmland. This fact can be substantiated by the data reported by the Pakistan Bureau of Statistics (2020): about 84% of non-recipient households' own canal-irrigated land, whose water availability is generally better than rain-fed or tube well-watered land. In comparison, only 64% of recipient households possess canal-irrigated land. This reflects the high-risk profile of recipient households' farming activity. Migration therefore occurs as part of the household's risk-reduction or income-diversification strategy. Households decrease or even abandon their farming activities in the presence of money transfers from the away member.

4. Empirical Model and Identification Strategy

Our baseline model is given as follows :

$$Y_{ji} = \varphi_i + \lambda D_{R_i} + \beta_1 X_i + \varepsilon_{ji} \quad (1)$$

Where, Y_{ji} is the farm outcome j of the household i, D_{R_i} is remittance incidence, and X_i is the vector of control variables.

The models including domestic and international remittances are given as follows:

$$Y_{ji} = \Phi_i + \alpha_1 D_{d_i} + \alpha_2 X_i + \epsilon_{ji} \quad (2)$$

$$Y_{ji} = \beta_i + \mu_1 D_{f_i} + \mu_2 X_i + \delta_{ji} \quad (3)$$

Where, D_{d_i} is the dummy for domestic remittance incidence and D_{f_i} is the dummy for foreign remittance incidence.

The farm households' migration and agriculture decisions are subject to their appetite for risk, which, in turn, depend on the households' observable and unobservable demographic and socioeconomic characteristics. Remittances and agriculture production are therefore endogenous processes as the two may be simultaneously determined (Rozelle et al., 1999). Family wealth or farmland, for instance, can serve both as a source of financing for the migration process and thereby the remittances, and as a means to buy farm inputs and machinery needed to enhance farm output.

Similarly, an adverse weather or health shock that affects agricultural production, thereby producing a deleterious impact on household income, will also result in an increase in remittance. Reverse causality is also a possibility: higher farm production can be leveraged to fund riskier, longer-distance migration, particularly international migration, resulting in higher remittances; small-farm households, in contrast, are unable to avail these opportunities.

A number of studies (Gray & Bilsborrow, 2014; Maharjan et al., 2013; Qian et al., 2016) have employed an instrumental-variable approach to handle such sources of endogeneity. In this study, we employ this strategy by using two instruments. Following Kapri and Jha (2020) and Hanson and Woodruff (2003), we use an indicator for network effects to instrument the receipt or otherwise of migrant transfers. Existing migrant networks facilitate the migration of new migrants originating from the area or the country. The success of early migrants from a particular area provides potential migrants the motivation and know-how of the migration process. In addition to disseminating information, earlier migrants can help new arrivals from the origin community get settled in the host economy. This leads to the development of migrant communities from similar geographical or cultural background. A case in point is the Pakistani migrant community in Norway, which started developing from the migration of a few workers in early 1970s, particularly from the district of Kharian (Carling et al., 2012). Today, most of the approximately 40,000 Pakistani migrants living in Norway come from this district[7]. We assume this network or peer effect is either weak or negligible for farm production and investment decisions. We based our assumption on the fact that, although network effect plays an important role in agricultural technology adoption and crops selection, the pace of technology adoption is generally slow in case of developing countries (Krishnan & Patnam, 2014). The adoption of agricultural technology is often low among poor small holder farmers, particularly those involved in production for own consumption (see for example, Bandiera & Rasul, 2006). We assume that the network effect should be negligible in the context of Pakistan where 94% farmers are small land holders with less than 12.5 acres of land, 76% of which produce only for home consumption (Pakistan Bureau of Statistics: Government of Pakistan, 2018-19).

We define the first instrument as the proportion of recipient households in the district in 2014-15. The second instrument is defined as the proportion of households in the neighborhood, i.e., the primary sampling unit (PSU) who have received money from a member living away from home during the past twelve months. For each household, the proportion is calculated by excluding the household surveyed. This second instrument is subject to criticism for not being fully exogenous due to the cross sectional nature of the sample data (Angrist, 2014). However, the first instrument tackles this issue by using district-level proportion of recipient households taken from the previous nationwide household survey carried out in 2014-15. This instrument captures the migration trend of the district in the recent past but does not relate to the current socio-economic status of the recipient households. Furthermore, given the

[7] https://www.norway.no/en/pakistan/

random cross section nature of the two surveys, none of the households surveyed in 2014-15 are necessarily included in the 2018-19 sample. For the sake of convenience, the results of only the first instrument are discussed. The results of estimates with the second instrument are provided in the robustness section.

We take the remittance incidence ($D_{R_i}, D_{d_i}, and\ D_{f_i}$) as the treatment criterion. Household with remittance recipient status equal to 1, received the treatment, 0 otherwise. The treatment effect of receiving remittances on the outcome (Y_{ji}) is defined as:

$$Treatment\ Effect = Y_{1ji} - Y_{0ji} \tag{4}$$

Where the Y_{1ji} is the estimated outcome when the household i is receiving remittances and Y_{0ji} for the non-recipient households. As observing both outcomes for a household at same time is not possible, we obtain Average Treatment Effects (ATEs) to estimate the treatment effects.

We utilize the Probit-2SLS model to estimate the average treatment effects. The Probit-2SLS model uses a three-step procedure to consistently estimate λ, α_1, and μ_1:

Estimate the binary response models of D on the instruments and X_i using Probit
Estimate the fitted probabilities $\widehat{D}$, and
Using $\widehat{D}$ as an instrument for D in an IV regression framework, estimate λ, α_1, and μ_1.

Our definitive specification is given as follows:

$$Y_{ji} = \varphi_i + \lambda \widehat{D}_{R_i} + \beta_1 X_i + \varepsilon_{ji} \tag{5}$$

$$Y_{ji} = \Phi_i + \alpha_1 \widehat{D}_{d_i} + \alpha_2 X_i + \epsilon_{ji} \tag{6}$$

$$Y_{ji} = \beta_i + \mu_1 \widehat{D}_{f_i} + \mu_2 X_i + \delta_{ji} \tag{7}$$

First, we use the set of controls X_i along with the instruments to alternately estimate the probability of receiving overall remittances ($\widehat{D}_{R_i}$), and the probability of receiving domestic ($\widehat{D}_{d_i}$) and foreign remittances ($\widehat{D}_{f_i}$). These fitted probabilities are used to instrument the original endogenous variables (D_{R_i} , D_{d_i} and D_{f_i}) and estimate Equation (5-7) in a linear 2SLS framework.

This approach is more robust for endogenous dummy indicators compared to the commonly used 2SLS and Probit-OLS approaches (Cerulli, 2014). Unlike the standard 2SLS approach, where the bias can affect the second stage of the regression, this approach does not require the first stage to be correctly specified. The asymptotic 2SLS standard

errors and test statistics nonetheless remain valid (see e.g.Wooldridge, 2010, p.939, procedure 21.1). In the estimations where the variable of interest is the amount of remittances, we use direct 2SLS approach.

Results of first-stage estimations (given in Appendix **Table A 1**) show the coefficients of the instrument regressed on the incidence of remittance with household, household head and agriculture controls for each outcome. The coefficients of the instrument are positive and statistically significant. Post-estimation tests of exogeneity and weak instrument (First stage F-value) for level and incidence of remittances are provided at the bottom of the results tables. The test statistics show that the variables for the receipt of aggregate, domestic and international remittances are all endogenous. The p-value of exogeneity test statistics for most of the estimations is close to zero, rejecting the assumption of exogeneity of migrant remittances, while F-Stat values are invariably greater than 10, suggesting that the instruments used are valid.

We carry out a number of alternate model estimations to establish the robustness of our Probit 2SLS estimates. Firstly, we employ the selection model approach (Heckman, 1978) to estimate average treatment effects (ATEs) by including the instrumental variable to avoid the assumption of joint normality of errors. Secondly, we obtain ATEs using three matching routines: Propensity Score Matching (PSM) using nearest neighbor matching, inverse probability weighting (IPW) and augmented inverse probability weighting (AIPW). The results of these estimates are highly similar to our baseline estimates and are provided in the robustness section for comparison.

5. Results

Do the differences in agriculture investment and cropping patterns between the recipient and non-recipient households hitherto observed hold after controlling for other observable characteristics and accounting for the endogeneity of remittances? This part of the study attempts to answer this question by first exploring the impact of remittance incidence on agriculture investment. Results given in **Table 3** show that the association between the two is negative. The effect remains negative and significant using OLS (column 1) as well as instrumental estimations (column 2) with controls.

According to the IV estimates, farm investment of recipient households is 99.64%[8] lower compared to that of non-recipient households. A similar negative impact is observed for domestic (**Table 3** columns 3 and 4) and foreign remittance recipients (columns 5 and 6). The impact is strong for both the domestic (99.87%) and foreign remittance recipients (97.68%).

[8] The percentage change in inverse hyperbolic sin transformed outcome variable due to change in dummy variable can be defined as $\exp(\hat{\beta}) - 1$ and can be interpreted in the same way as log transformed variables (see for detail, Bellemare et al., 2020; Woolley, 2011). We take anti-log of the coefficients using $[e^{\beta} - 1]100$.

Table 3. Remittance incidence and Agricultural investment – OLS and IV estimates

	(1)	(2)	(3)	(4)	(5)	(6)
	Overall remittance		**Domestic remittance**		**Foreign remittance**	
Remittance incidence	**-0.91*** **	**-5.52*** **	**-0.76*** **	**-6.54*** **	**-0.73*** **	**-3.68*** **
	(0.12)	(0.48)	(0.13)	(0.76)	(0.17)	(0.68)
HHH Gender	0.21	-2.63***	0.48**	-1.78***	0.64***	0.06
	(0.22)	(0.39)	(0.22)	(0.43)	(0.21)	(0.27)
HHH Age	-0.004	0.02***	-0.01	0.01***	-0.01**	-0.004
	(0.004)	(0.01)	(0.004)	(0.01)	(0.004)	(0.004)
HHH Marital Status	0.05	0.49**	-0.003	0.30	0.002	0.11
	(0.19)	(0.22)	(0.19)	(0.23)	(0.19)	(0.2)
HHH Education	-0.03**	-0.041***	-0.03**	-.029**	-0.03**	-0.03**
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Dependency Ratio	0.26	0.25	0.28	0.42*	0.19	0.12
	(0.21)	(0.24)	(0.21)	(0.25)	(0.21)	(0.22)
Non-Agri. Business	-0.57***	-0.73***	-0.56***	-0.76***	-0.54***	-0.58***
	(0.14)	(0.16)	(0.14)	(0.16)	(0.14)	(0.14)
Land Ownership	0.84***	1.11***	0.82***	1.06***	0.80***	0.82***
	(0.09)	(0.12)	(0.09)	(0.12)	(0.09)	(0.1)
Credit Dummy	-0.59***	-0.34***	-0.61***	-0.32**	-0.64***	-0.61***
	(0.1)	(0.12)	(0.1)	(0.12)	(0.1)	(0.1)
HH Income (Inc. Rem)	0.71***	1.07***	0.63***	0.55***	0.72***	0.95***
	(0.1)	(0.11)	(0.1)	(0.11)	(0.1)	(0.11)
Const.	-8.52***	-11.44***	-7.62***	-5.38***	-8.92***	-11.48***
	(1.23)	(1.42)	(1.22)	(1.38)	(1.26)	(1.42)
R-squared	0.039	0.00	0.03	0.00	0.03	0.00
Observations	5636	5462	5636	5462	5636	5462
Exogeneity: F-value		170.32***		111.23***		27.32***
First-stage (F-value)		362.67		147.96		164.60
Controls	Yes	Yes	Yes	Yes	Yes	Yes

Authors' calculations using PSLM 2018-19.

Note: Standard errors clustered at household level are shown in parentheses. Outcome variable is agricultural investment during the previous year. Variable of interest is the remittance incidence. Columns 1 and 2 show OLS and IV estimates with controls for overall remittances, column 3 and 4 for domestic and column 5 and 6 show estimates for foreign remittance . Proportion of recipient households at district level in 2014-15 is used as an instrument to estimate overall remittance (column 2). Similarly, the proportion of domestic and foreign remittance recipient households at district level in 2014-15 is used to instrument domestic (column 4) and foreign (column 6) remittances. Controls include household head controls (gender, age, education, marital status), household income, dependency ratio, non-agricultural business, credit, and a dummy for land ownership. All regressions include sample weights. Significant coefficients are marked with stars as *** p<0.01, ** p<0.05, * p<0.

These findings are also substantiated from the estimates for remittances amount (**Table 4**), where a 1% increase in the amount of remittances received is found to reduce agriculture investment of the recipient household by 0.51% (column 2). This reduction in investment is more obvious for domestic remittances (0.88%) compared to international remittances (0.41%). These results reflect the domination of migration's labour loss effect over the income effect. Remittances, that result from the household member's migration, do improve the recipient household's income but do not appear to fully compensate for the loss of labour that the absence of the migrant member causes. These estimates are in line with those in case of international migration (Li & Tonts, 2014) and domestic migration (Mendola, 2008) but differ with the findings from Abebaw et al. (2019) who found a positive association in Africa.

Table 4. Remittance amount and Agricultural investment – OLS and IV estimates

	(1)	(2)	(3)	(4)	(5)	(6)
	Overall remittance		**Domestic remittance**		**Foreign remittance**	
Remittance amount	**-0.03*** **	**-0.51*** **	**-0.03*** **	**-0.88*** **	**-0.02**	**-0.41*** **
	(0.01)	(0.04)	(0.01)	(0.08)	(0.01)	(0.05)
HHH Gender	-0.003	-3.39***	0.09	-3.38***	0.15	-0.91***
	(0.22)	(0.42)	(0.22)	(0.56)	(0.21)	(0.31)
HHH Age	-0.003	0.004***	-0.004	0.04***	-0.01	0.01
	(0.004)	(0.01)	(0.003)	(0.01)	(0.003)	(0.004)
HHH Marital Status	0.08	0.74***	0.06	0.62**	0.07	0.32
	(0.19)	(0.24)	(0.19)	(0.28)	(0.19)	(0.21)
HHH Education	-0.03**	0.02	-0.03**	0.02	-0.03**	-0.01
	(0.01)	(0.02)	(0.01)	(0.02)	(0.01)	(0.01)
Dependency Ratio	0.25	0.01	0.27	0.37	0.21	-0.02
	(0.21)	(0.26)	(0.21)	(0.30)	(0.21)	(0.23)
Non-Agri. Business	-0.55***	-0.32*	-0.57***	-0.56***	-0.57***	-0.44***
	(0.14)	(0.17)	(0.14)	(0.18)	(0.13)	(0.15)
Land Ownership	0.86***	1.39***	0.85***	1.4***	0.85***	0.97***
	(0.09)	(0.13)	(0.09)	(0.15)	(0.09)	(0.1)
Credit Dummy	-0.63***	-0.32**	-0.63***	-0.13	-0.64***	-0.6***
	(0.1)	(0.13)	(0.1)	(0.16)	(0.1)	(0.11)
HH Income (Inc. Rem)	1.62***	-0.36***	0.64***	-0.66***	0.7***	0.52***
	(0.1)	(0.12)	(0.1)	(0.17)	(0.08)	(0.09)
Const.	-7.19***	6.78***	-7.45***	10.62***	-8.26***	-5.46***
	(1.01)	(1.62)	(0.98)	(2.31)	(0.95)	(1.14)
R-squared	0.04	0.00	0.04	0.00	0.04	0.00
Observations	5636	5462	5636	5462	5636	5462
Exogeneity: F-value		250.12***		220***		98.35***
First-stage (F-value)		481.86		164		203
Controls	Yes	Yes	Yes	Yes	Yes	Yes

Authors' calculations using PSLM 2018-19.

Note: Standard errors clustered at household level are shown in parentheses. Outcome variable is agricultural investment during the previous year. Variable of interest is the remittance amount. Columns 1 and 2 show OLS and IV estimates with controls for overall remittances, column 3 and 4 for domestic and column 5 and 6 show estimates for foreign remittance . Proportion of recipient households at district level in 2014-15 is used as an instrument to estimate overall remittance (column 2). Similarly, the proportion of domestic and foreign remittance recipient households at district level in 2014-15 is used to instrument domestic (column 4) and foreign (column 6) remittances. Controls include household head controls (gender, age, education, marital status), household income, dependency ratio, non-agricultural business, credit, and a dummy for land ownership. All regressions include sample weights. Significant coefficients are marked with stars as *** p<0.01, ** p<0.05, * p<0.1.

Next, we study how does remittances affect farm output. The hypothesis, as before, is that recipient households' agriculture production should be higher if remittances' income effect prevails and lower if the labour loss effect dominates. Results shown in **Table 5** and **Table 6** again indicate that the impact of labour loss due to household member's migration on the household's farm production dominates the improvement that additional income from remittances procures. The farm output of households receiving remittances 82% lower than that of non-recipient households (**Table 5**, column 2). Similarly, for a 1% rise in the amount of remittances, the production falls by 0.31% (**Table 6**, column 2). This negative impact is visible both among domestic and foreign remittance recipient households. However, the decrease in farm output is larger for domestic remittance recipient household (77%) (**Table 5**, column 4) than for foreign (45%) (**Table 5**, column 6).

Table 5. Remittance incidence and farm output

	(1)	(2)	(3)	(4)	(5)	(6)
	Overall remittance		**Domestic remittance**		**Foreign remittance**	
Remittance incidence	**-0.28*** **	**-1.69*** **	**-0.24*** **	**-1.44*** **	**-0.14** **	**-0.58** **
	(0.05)	(0.24)	(0.05)	(0.25)	(0.06)	(0.23)
HHH Gender	0.22***	-0.54***	0.29***	-0.13	0.35***	0.28***
	(0.07)	(0.15)	(0.07)	(0.11)	(0.07)	(0.08)
HHH Age	-0.001	0.01***	-0.001	0.003***	-0.002**	-0.001*
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
HHH Marital Status	-0.06	0.06	-0.07*	-0.01	-0.07*	-0.06
	(0.04)	(0.05)	(0.04)	(0.05)	(0.04)	(0.04)
HHH Education	-9***	-.01***	-0.004**	-0.01**	-0.004**	-0.01***
	(0.002)	(0.003)	(0.002)	(0.002)	(0.002)	(0.001)
Dependency Ratio	0.001	-0.02	0.01	0.03	-0.001	-0.01
	(0.05)	(0.06)	(0.05)	(0.05)	(0.05)	(0.05)
Non-Agri. Business	-0.32***	-0.43***	-0.31***	-0.38***	-0.3***	-0.32***
	(.03883)	(.05303)	(.03867)	(.04583)	(.03766)	(0.04)
Land Ownership	-0.51***	-0.42***	-0.51***	-0.46***	-0.52***	-0.52***
	(0.02)	(0.03)	(0.02)	(0.03)	(0.02)	(0.02)
Credit Dummy	-0.15***	-0.11***	-0.15***	-0.1***	-0.16***	-0.15***
	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)
HH Income (Inc. Rem)	0.26***	0.44***	0.23***	0.25***	0.24***	0.29***
	(0.03)	(0.05)	(0.03)	(0.03)	(0.03)	(0.04)
Total Input Cost	0.57***	0.47***	0.58***	0.53***	0.58***	0.56***
	(0.05)	(0.05)	(0.05)	(0.05)	(0.04)	(0.05)
Const.	3.18***	2.57***	3.43***	4.02***	3.21***	2.84***
	(0.29)	(0.31)	(0.31)	(0.39)	(0.29)	(0.32)
R-squared	0.69	0.49	0.69	0.58	0.69	0.67
Observations	5632	5458	5632	5458	5632	5458
Exogeneity: F-value		46.54***		33.38***		4.22**
First-stage (F-value)		210.41		103.46***		143
Controls	Yes	Yes	Yes	Yes	Yes	Yes

Authors' calculations using PSLM 2018-19.

Note: Standard errors clustered at household level are shown in parentheses. Outcome variable is agricultural output during the previous year. Variable of interest is the remittance incidence. Columns 1 and 2 show OLS and IV estimates with controls for overall remittances, column 3 and 4 for domestic and column 5 and 6 show estimates for foreign remittances. The proportion of recipient households at district level in 2014-15 is used as an instrument to estimate overall remittance (column 2). Similarly, the proportion of domestic and foreign remittance recipient households at district level in 2014-15 is used to instrument domestic (column 4) and foreign (column 6) remittances. Controls include household head controls (gender, age, education, marital status), household income, dependency ratio, non-agricultural business, credit, input cost and a dummy for land ownership. All regressions include sample weights. Significant coefficients are marked with stars as *** p<0.01, ** p<0.05, * p<0.1.

Table 6. Remittance amount and farm output

	(1)	(2)	(3)	(4)	(5)	(6)
	Overall remittance		**Domestic remittance**		**Foreign remittance**	
Remittance amount	**-0.02*** **	**-0.31*** **	**-0.02*** **	**-0.47*** **	**-0.008***	**-0.31*** **
	(0.003)	(0.02)	(0.004)	(0.04)	(0.004)	(0.03)
HHH Gender	0.34***	-1.69***	0.42***	-1.43***	0.48***	-0.36**
	(0.07)	(0.19)	(0.07)	(0.26)	(0.06)	(0.16)
HHH Age	-0.001	0.02***	-0.002**	0.02***	-0.003***	0.01***
	(0.001)	(0.002)	(0.001)	(0.003)	(0.001)	(0.001)
HHH Marital Status	-0.08*	0.31***	-0.09**	0.19	-0.11**	0.09
	(0.05)	(0.1)	(0.05)	(0.12)	(0.05)	(0.08)
HHH Education	-0.003	0.02***	-0.004	0.02***	-0.005	0.01
	(.00336)	(0.01)	(0.003)	(0.01)	(0.003)	(0.01)
Dependency Ratio	-0.11*	-0.25**	-0.10*	-0.04	-0.11*	-0.29***
	(0.06)	(0.11)	(0.06)	(0.13)	(0.06)	(0.09)
Non-Agri. Business	-0.66***	-0.52***	-0.67***	-0.65***	-0.67***	-0.57***
	(0.04)	(0.07)	(0.04)	(0.08)	(0.04)	(0.06)
Land Ownership	-0.46***	-0.12**	-0.47***	-0.16**	-0.48***	-0.36***
	(0.03)	(0.05)	(0.03)	(0.06)	(0.03)	(0.04)
Credit Dummy	-0.43***	-0.22***	-0.43***	-0.14*	-0.45***	-0.4***
	(0.03)	(0.06)	(0.03)	(0.07)	(0.03)	(0.05)
HH Income (Exc. Rem)	0.58***	0.01	0.59***	-0.09	0.62***	0.49***
	(0.03)	(0.06)	(0.03)	(0.08)	(0.03)	(0.05)
Const.	5.76***	14.04***	5.55***	15.12***	5.16***	7.28***
	(0.35)	(0.75)	(0.35)	(1.08)	(0.33)	(0.58)
R-squared	0.28	0.00	0.28	0.00	0.27	0.00
Observations	5632	5458	5632	5458	5632	5458
Exogeneity: F-value		1143***		783***		593***
First-stage (F-value)		422		164		202
Controls	Yes	Yes	Yes	Yes	Yes	Yes

Authors' calculations using PSLM 2018-19.

Note: Standard errors clustered at household level are shown in parentheses. Outcome variable is agricultural output during the previous year. Variable of interest is the remittance amount. Columns 1 and 2 show OLS and IV estimates with controls for overall remittances, column 3 and 4 for domestic and column 5 and 6 show estimates for foreign remittances. The proportion of recipient households at district level in 2014-15 is used as an instrument to estimate overall remittance (column 2). Similarly, the proportion of domestic and foreign remittance recipient households at district level in 2014-15 is used to instrument domestic (column 4) and foreign (column 6) remittances. Controls include household head controls (gender, age, education, marital status), household income, dependency ratio, non-agricultural business, credit, input cost and a dummy for land ownership. All regressions include sample weights. Significant coefficients are marked with stars as *** p<0.01, ** p<0.05, * p<0.1.

The change in cropping patterns seen among recipient households helps understand the strong labor loss effect thus far observed. If the remittances' income effect prevailed, we would observe greater crop production, particularly that of capital-intensive cash crops. However, we find the effect on production to be the opposite (**Table 7**). We find that the production of cash and subsistence crops is significantly lower among recipient households compared to non-recipient households, regardless of whether the estimations are carried out using OLS or Probit-2SLS. The production of the two groups of crops is lower by 97% (column 2) and 91% (column 4), respectively.

The production of cash crops and wheat also exhibits a negative trend when tested against the amount of remittance the households receive. A 1% increase in the amount of remittance received results in 0.39% lower production of cash crops and 0.19% lower production of wheat (**Table 8**, column 2 and 4).

Table 7. Remittance incidence and cropping pattern – OLS and IV estimates

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Cash crop		**Wheat production**		**Labor intensive crop production**		**Low labor-intensive crops production**	
Remittance incidence	**-0.31*** **	**-3.51*** **	**-0.26*** **	**-2.38*** **	**-0.47*** **	**-3.65*** **	**-0.19*** **	**-1.86*** **
	(0.07)	(0.64)	(0.05)	(0.28)	(0.11)	(0.41)	(0.04)	(0.28)
HHH Gender	0.53***	-0.97**	0.24***	-0.94***	0.2	-1.41***	0.29***	-0.6***
	(0.15)	(0.44)	(0.08)	(0.18)	(0.17)	(0.3)	(0.07)	(0.16)
HHH Age	-0.01***	0.01*	-0.0003	0.01***	-0.001	0.01***	-0.003***	0.004**
	(0.002)	(0.003)	(0.001)	(0.002)	(0.002)	(0.003)	(0.001)	(0.002)
HHH Marital Status	-0.17**	-0.03	-0.05	0.13**	0.01	0.26*	-0.2***	-0.04
	(0.07)	(0.13)	(0.05)	(0.07)	(0.11)	(0.15)	(0.05)	(0.07)
HHH Education	-0.01	-0.01	-0.004*	-0.01**	-0.01	-0.02**	-0.01***	-0.02***
	(0.01)	(0.01)	(0.002)	(0.003)	(0.01)	(0.01)	(0.003)	(0.01)
Dependency Ratio	0.07	-0.02	-0.04	-0.07	0.05	0.11	-0.1	-0.09
	(0.08)	(0.14)	(0.05)	(0.08)	(0.13)	(0.17)	(0.06)	(0.08)
Non-Agri. Business	-0.19***	-0.26**	-0.24***	-0.38***	-0.68***	-0.91***	-0.32***	-0.47***
	(0.07)	(0.11)	(0.04)	(0.06)	(0.11)	(0.14)	(0.05)	(0.07)
Land Ownership	-0.81***	-0.63***	-0.57***	-0.42***	-0.84***	-0.62***	-0.21***	-0.17***
	(0.04)	(0.07)	(0.03)	(0.03)	(0.06)	(0.08)	(0.04)	(0.05)
Credit Dummy	-0.03	0.09	-0.25***	-0.19***	-0.4***	-0.27***	-0.26***	-0.25***
	(0.05)	(0.08)	(0.03)	(0.04)	(0.07)	(0.09)	(0.03)	(0.04)
HH Income (Inc. Rem)	0.36***	0.62***	0.21***	0.46***	0.37***	0.75***	0.38***	0.61***
	(0.08)	(0.09)	(0.04)	(0.06)	(0.07)	(0.09)	(0.03)	(0.06)
Total Input Cost	0.5***	0.31***	0.48***	0.34***	0.39***	0.2***	0.33***	0.21***
	(0.09)	(0.09)	(0.04)	(0.05)	(0.07)	(0.07)	(0.04)	(0.04)
Const.	1.97***	2.03**	3.88***	3.12***	2.89***	1.22	3.02***	2.08***
	(0.6)	(0.89)	(0.33)	(0.42)	(0.64)	(0.89)	(0.35)	(0.42)
R-squared	0.42	0.00	0.56	0.09	0.35	0.00	0.38	0.02
Observations	1781	1770	4815	4662	2445	2383	3570	3490
Exogeneity: F-value		80.51***		80.85***		115.28***		52.4***
First-stage (F-value)		38.17		162		140.44		92.55
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Authors' calculations using PSLM 2018-19.

Note: Standard errors clustered at household level are shown in parentheses. Outcome variables are regressed on overall remittance incidence. Estimates of the production of cash crops using OLS and IV with controls are reported in column 1 and 2. Similarly, estimates of wheat production are given in column 3 and 4, estimates of labor intensive in column 5 and 6, and low labor-intensive crops in column 7 and 8, respectively. The proportion of recipient households at the district level in 2014-15 is used to instrument overall remittances. Controls include household head controls (gender, age, education, marital status), household income, dependency ratio, non-agricultural business, Credit dummy, input cost and a dummy for land ownership. All regressions include sample weights. Significant coefficients are marked with stars as *** p<0.01, ** p<0.05, * p<0.1.

Table 8. Remittance amount and cropping pattern – OLS and IV estimates

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Cash crop		**Wheat production**		**Labor intensive crop production**		**Low labor-intensive crops production**	
Remittance amount	**-0.01**	**-0.39*** **	**-0.01*** **	**-0.19*** **	**-0.02** **	**-0.36*** **	**0.005***	**-0.06*** **
	(0.01)	(0.06)	(0.003)	(0.02)	(0.01)	(0.04)	(0.003)	(0.02)
HHH Gender	0.41***	-1.74***	0.16*	-1.15***	0.09	-2.15***	0.18**	-0.23*
	(0.13)	(0.59)	(0.08)	(0.16)	(0.17)	(0.36)	(0.07)	(0.13)
HHH Age	-0.01***	0.02***	0.0001	0.02***	-0.001	0.02***	-0.003**	0.003
	(0.002)	(0.005)	(0.001)	(0.002)	(0.002)	(0.004)	(0.001)	(0.002)
HHH Marital Status	-0.16**	0.09	-0.05	0.21***	0.04	0.45**	-0.18***	-0.08
	(0.07)	(0.20)	(0.05)	(0.07)	(0.11)	(0.19)	(0.05)	(0.06)
HHH Education	-0.01	0.03***	-0.003	0.02***	-0.01	0.01	-0.01***	-0.003
	(0.004)	(0.01)	(0.002)	(0.004)	(0.006)	(0.011)	(0.003)	(0.004)
Dependency Ratio	0.08	-0.24	-0.04	-0.14*	0.06	0.06	-0.11*	-0.14*
	(0.09)	(0.21)	(0.05)	(0.08)	(0.13)	(0.2)	(0.06)	(0.07)
Non-Agri. Business	-0.19***	-0.01	-0.23***	-0.16***	-0.68***	-0.55***	-0.32***	-0.31***
	(0.07)	(0.15)	(0.04)	(0.06)	(0.11)	(0.16)	(0.05)	(0.05)
Land Ownership	-0.8***	-0.46***	-0.56***	-0.33***	-0.84***	-0.34***	-0.21***	-0.17***
	(0.05)	(0.1)	(0.03)	(0.04)	(0.06)	(0.1)	(0.04)	(0.05)
Credit Dummy	-0.04	0.07	-0.26***	-0.15***	-0.4***	-0.16	-0.28***	-0.26***
	(0.04)	(0.1)	(0.03)	(0.04)	(0.07)	(0.11)	(0.03)	(0.04)
HH Income (Exc. Rem)	0.35***	-0.25*	0.17***	-0.16***	0.36***	-0.14	0.33***	0.22***
	(0.07)	(0.14)	(0.03)	(0.04)	(0.07)	(0.09)	(0.03)	(0.04)
Total Input Cost	0.5***	0.48***	0.48***	0.43***	0.38***	0.31***	0.33***	0.31***
	(0.09)	(0.12)	(0.05)	(0.05)	(0.07)	(0.07)	(0.03)	(0.03)
Const.	2.22***	11.32***	4.34***	9.89***	3.28***	11.54***	3.73***	5.66***
	(0.58)	(1.77)	(0.35)	(0.83)	(0.66)	(1.45)	(0.40)	(0.76)
R-squared	0.43	0.00	0.56	0.004	0.35	0.00	0.38	0.30
Observations	1781	1770	4815	4662	2445	2383	3570	3490
Exogeneity: F-value		281.68***		160.6***		247.83***		14.73***
First-stage (F-value)		62.28		334.73		189		215
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Authors' calculations using PSLM 2018-19.

Note: Standard errors clustered at household level are shown in parentheses. Outcome variables are regressed on overall remittance amount. Estimates of the production of cash crops using OLS and IV with controls are reported in column 1 and 2. Similarly, estimates of wheat production are given in column 3 and 4, estimates of labor intensive in column 5 and 6, and low labor-intensive crops in column 7 and 8, respectively. The proportion of recipient households at the district level in 2014-15 is used to instrument overall remittances. Controls include household head controls (gender, age, education, marital status), household income, dependency ratio, non-agricultural business, Credit dummy, input cost and a dummy for land ownership. All regressions include sample weights. Significant coefficients are marked with stars as *** p<0.01, ** p<0.05, * p<0.1.

The production of highly and low/medium labor-intensive crops among recipient farm households is lower by 98% and 85% (**Table 7**, column 6 and 8). The trend is similar for remittance amount, with a 1% increase in the amount of remittances associated with 0.36% and 0.06% lower production of highly and medium/labor intensive crops. While the decrease is visible in the production of both high and low labor-intensive crops, the fall is stronger in case of more labor-intensive crops. The production of highly labor-intensive crops among recipient households is lower by almost PKR.100,000 which is much greater compared to low labor-intensive crops whose production drops by PKR.29,230.

One possible cause of this reduction in farm production could be that the extra income the household gains from remittances is not sufficient to acquire sufficient new farm assets in order to account for the labor requirements of labor-intensive crops (Piras et al. (2018).

Crop-wise results for domestic and foreign remittances given in Tables 9-12, shed more light on this dimension of labor constraints the recipient households face. As reported in **Table 9**, the recipients of comparatively smaller domestic remittances witness substantial reduction in the production of cash crops (column 2), subsistence crops (column 4), highly labor-intensive crops (column 6) and low/medium labor-intensive crops (column 8). The respective reduction in the production of the crops is 99%, 90%, 99% and 76% respectively. The production of various categories of crops among the recipients of foreign remittances is likewise lower (**Table 10**), even though the decrease is not as important as that seen among the recipients of domestic remittances. The production of cash crops (column 2), wheat (column 4) and low labor-intensive crops (column 8) of foreign remittances recipient households are lower than that of non-recipient households by 98%, 64% and 59%, respectively.

The production pattern of the recipients of foreign remittances, by contrast, differs in case of highly labor-intensive crops, whose production does not significantly differ from that of the non-recipient households. This may owe to the fact that the larger amounts of transfers that the recipients of international remittances receive help them hire workers or acquire labor-saving technology. According to the survey, foreign remittance recipients spent an average amount of PKR 116,599 on farm inputs such as fertilizers, pesticides and seeds compared to PKR 62,254 spent by the recipients of domestic remittances. These expenditures, those lower than what non-recipient households spend, are nonetheless much higher than those of the recipients of domestic remittances and suggest that labor constraints are more binding for the latter.

Here, the significant drop in the production of wheat by the recipients of both kinds of remittances merits our attention. Wheat production of the recipients of domestic remittances decreases by 90% while that of the recipients of foreign remittances drops by 64% compared to their non-recipient counterparts. Wheat is the chief staple food of Pakistani households. Many small farmers retain most or all of the grains to cover their home needs. Additional income, be it in the form of domestic or foreign remittances, alleviates the need for subsistence farming and allows the households to obtain their food requirements from the market. This is reflected in the fact that the food consumption expenditure of recipient households, at PKR 100,837 , is substantially higher compared to non-recipient households (PKR 86,720) (Pakistan Bureau of Statistics, 2020).

Table 9. Domestic remittance incidence and cropping pattern – OLS and IV estimates

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Cash crop		**Wheat production**		**Labor intensive crop production**		**Low labor-intensive crops production**	
Domestic remittance incidence	**-0.38*** **	**-4.91*** **	**-0.21*** **	**-2.22*** **	**-0.60*** **	**-5.02*** **	**-0.12** **	**-1.40*** **
	(0.08)	(1.31)	(0.05)	(0.34)	(0.13)	(0.73)	(0.05)	(0.33)
HHH Gender	0.58***	-0.45	0.31***	-0.38**	0.25	-1.18***	0.36***	-0.07
	(0.14)	(0.46)	(0.08)	(0.16)	(0.16)	(0.34)	(0.07)	(0.14)
HHH Age	-0.01***	0.01	-0.001	0.01***	-0.001	0.01***	-0.003***	0.001
	(0.002)	(0.004)	(0.001)	(0.001)	(0.002)	(0.003)	(0.001)	(0.002)
HHH Marital Status	-0.17**	0.03	-0.07	0.05	-0.001	0.18	-0.22***	-0.16**
	(0.07)	(0.16)	(0.05)	(0.06)	(0.12)	(0.17)	(0.05)	(0.06)
HHH Education	-0.01	-0.01	-0.004	-0.003	-0.006	-0.01	-0.01***	-0.01***
	(0.004)	(0.01)	(0.002)	(0.003)	(0.01)	(0.01)	(0.003)	(0.004)
Dependency Ratio	0.09	0.17	-0.03	-0.03	0.06	0.24	-0.1	-0.06
	(0.09)	(0.16)	(0.06)	(0.07)	(0.13)	(0.18)	(0.06)	(0.07)
Non-Agri. Business	-0.18***	-0.18	-0.23***	-0.32***	-0.67***	-0.84***	-0.31***	-0.39***
	(0.07)	(0.12)	(0.04)	(0.05)	(0.11)	(0.14)	(0.05)	(0.06)
Land Ownership	-0.8***	-0.67***	-0.58***	-0.48***	-0.85***	-0.6***	-0.22***	-0.19***
	(0.05)	(0.08)	(0.03)	(0.04)	(0.06)	(0.09)	(0.05)	(0.05)
Credit Dummy	-0.03	0.16	-0.25***	-0.18***	-0.39***	-0.17	-0.26***	-0.23***
	(0.05)	(0.1)	(0.03)	(0.04)	(0.07)	(0.11)	(0.03)	(0.04)
HH Income (Inc. Rem)	0.35***	0.44***	0.18***	0.19***	0.33***	0.39***	0.35***	0.37***
	(0.08)	(0.08)	(0.03)	(0.04)	(0.07)	(0.07)	(0.03)	(0.03)
Total Input Cost	0.51***	0.36***	0.49***	0.42***	0.39***	0.24***	0.34***	0.29***
	(0.09)	(0.07)	(0.04)	(0.05)	(0.07)	(0.07)	(0.03)	(0.04)
Const.	2.06***	3.1***	4.1***	5.17***	3.37***	5.19***	3.19***	3.78***
	(0.6)	(0.96)	(0.35)	(0.48)	(0.64)	(0.96)	(0.36)	(0.41)
R-squared	0.42	0.00	0.56	0.25	0.35	0.00	0.37	0.21
Observations	1781	1770	4815	4662	2445	2383	3570	3490
Exogeneity: F-value		43.2***		67.34***		123***		22.01***
First-stage (F-value)		17.66		86.57		68.89		58
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Authors' calculations using PSLM 2018-19.

Note: Standard errors clustered at household level are shown in parentheses. Outcome variables are regressed on domestic remittance incidence. Estimates of the production of cash crops using OLS and IV with controls are reported in column 1 and 2. Similarly, estimates of wheat production are given in column 3 and 4, estimates of labor intensive in column 5 and 6, and low labor-intensive crops in column 7 and 8, respectively. The proportion of domestic remittance recipient households at district level in 2014-15 is used to instrument domestic remittances. Controls include household head controls (gender, age, education, marital status), household income, dependency ratio, non-agricultural business, Credit dummy, input cost and a dummy for land ownership. All regressions include sample weights. Significant coefficients are marked with stars as *** p<0.01, ** p<0.05, * p<0.1.

Table 10. Foreign remittance incidence and cropping pattern – OLS and IV estimates

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Cash crop		**Wheat production**		**Labor intensive crop production**		**Low labor-intensive crops production**	
Foreign remittance incidence	**-0.11**	**-3.85*** **	**-0.16*** **	**-1.02*** **	**-0.05**	**0.27**	**-0.16*** **	**-0.89*** **
	(0.13)	(1.27)	(0.06)	(0.26)	(0.14)	(0.38)	(0.06)	(0.26)
HHH Gender	0.64***	-0.29	0.35***	0.19**	0.43***	0.49***	0.37***	0.25***
	(0.17)	(0.49)	(0.08)	(0.09)	(0.16)	(0.16)	(0.07)	(0.09)
HHH Age	-0.01***	-0.002	-0.001	-0.001	-0.002	-0.003	-0.004***	-0.003***
	(0.002)	(0.002)	(0.001)	(0.001)	(0.002)	(0.002)	(0.001)	(0.001)
HHH Marital Status	-0.18**	-0.16	-0.07	-0.05	-0.02	-0.04	-0.21***	-0.18***
	(0.08)	(0.11)	(0.05)	(0.05)	(0.12)	(0.12)	(0.06)	(0.06)
HHH Education	-0.01	-0.01	-0.004	-0.01*	-0.01	-0.01	-0.01***	-0.01***
	(0.01)	(0.01)	(0.002)	(0.002)	(0.006)	(0.006)	(0.003)	(0.004)
Dependency Ratio	0.08	-0.1	-0.041	-0.07	0.04	0.05	-0.11*	-0.12*
	(0.09)	(0.15)	(0.06)	(0.06)	(0.13)	(0.13)	(0.06)	(0.06)
Non-Agri. Business	-0.18***	-0.27***	-0.22***	-0.25***	-0.65***	-0.65***	-0.31***	-0.34***
	(0.07)	(0.1)	(0.04)	(0.04)	(0.11)	(0.11)	(0.05)	(0.05)
Land Ownership	-0.82***	-0.74***	-0.58***	-0.57***	-0.88***	-0.88***	-0.22***	-0.21***
	(0.05)	(0.07)	(0.03)	(0.03)	(0.06)	(0.06)	(0.05)	(0.05)
Credit Dummy	-0.05	-0.05	-0.26***	-0.26***	-0.43***	-0.43***	-0.25***	-0.27***
	(0.05)	(0.06)	(0.03)	(0.03)	(0.07)	(0.07)	(0.03)	(0.03)
HH Income (Inc. Rem)	0.35***	0.55***	0.19***	0.28***	0.33***	0.31***	0.37***	0.45***
	(0.08)	(0.12)	(0.03)	(0.04)	(0.07)	(0.07)	(0.03)	(0.04)
Total Input Cost	0.52***	0.43***	0.49***	0.47***	0.41***	0.41***	0.34***	0.32***
	(0.09)	(0.12)	(0.05)	(0.05)	(0.07)	(0.07)	(0.03)	(0.04)
Const.	1.95***	1.29	3.86***	3.25***	3.11***	3.26***	3.01***	2.35***
	(0.61)	(0.81)	(0.34)	(0.36)	(0.63)	(0.71)	(0.36)	(0.39)
R-squared	0.42	0.00	0.56	0.52	0.34	0.33	0.37	0.34
Observations	1781	1770	4815	4662	2445	2383	3570	3490
Exogeneity: F-value		18.79***		12.9***		0.79		10.34***
First-stage (F-value)		13.93		126.45		73		106
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Authors' calculations using PSLM 2018-19.

Note: Standard errors clustered at household level are shown in parentheses. Outcome variables are regressed on foreign remittance incidence. Estimates of the production of cash crops using OLS and IV with controls are reported in column 1 and 2. Similarly, estimates of wheat production are given in column 3 and 4, estimates of labor intensive in column 5 and 6, and low labor-intensive crops in column 7 and 8, respectively. The proportion of foreign remittance recipient households at the district level in 2014-15 is used to instrument foreign remittances. Controls include household head controls (gender, age, education, marital status), household income, dependency ratio, non-agricultural business, Credit dummy, input cost and a dummy for land ownership. All regressions include sample weights. Significant coefficients are marked with stars as *** p<0.01, ** p<0.05, * p<0.1.

Table 11. Domestic remittance amount and cropping pattern – OLS and IV estimates

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Cash crop		**Wheat production**		**Labor intensive crop production**		**Low labor-intensive crops production**	
Domestic remittance amount	**-0.02****	**-0.67*****	**-0.01****	**-0.32*****	**-0.03*****	**-0.69*****	**0.006**	**-0.06****
	(0.01)	(0.12)	(.004)	(0.04)	(0.01)	(0.09)	(0.004)	(0.03)
HHH Gender	0.39***	-1.21*	0.19**	-1***	0.09	-2.37***	0.16**	-0.07
	(0.13)	(0.69)	(0.08)	(0.22)	(0.16)	(0.56)	(0.07)	(0.13)
HHH Age	-0.004***	0.02***	-0.0003	0.02***	-0.001	0.03***	-0.003**	0.001
	(0.002)	(0.01)	(0.001)	(0.003)	(0.002)	(0.01)	(0.001)	(0.002)
HHH Marital Status	-0.16**	0.22	-0.05	0.19**	0.03	0.4	-0.17***	-0.13**
	(0.07)	(0.25)	(0.05)	(0.09)	(0.11)	(0.26)	(0.05)	(0.06)
HHH Education	-0.01	0.03*	-0.004	0.02***	-0.01	0.02	-0.01**	-0.01
	(0.005)	(0.01)	(0.002)	(0.01)	(0.01)	(0.01)	(0.003)	(0.004)
Dependency Ratio	0.08	0.09	-0.03	-0.05	0.07	0.29	-0.11*	-0.11
	(0.09)	(0.25)	(0.06)	(0.1)	(0.13)	(0.26)	(0.06)	(0.07)
Non-Agri. Business	-0.19***	0.04	-0.23***	-0.23***	-0.68***	-0.55***	-0.32***	-0.32***
	(0.07)	(0.19)	(0.04)	(0.06)	(0.11)	(0.19)	(0.05)	(0.05)
Land Ownership	-0.79***	-0.51***	-0.56***	-0.34***	-0.83***	-0.22	-0.21***	-0.19***
	(0.05)	(0.12)	(0.03)	(0.05)	(0.06)	(0.14)	(0.04)	(0.05)
Credit Dummy	-0.04	0.24	-0.26***	-0.09*	-0.4***	0.09	-0.28***	-0.25***
	(0.05)	(0.16)	(0.03)	(0.06)	(0.07)	(0.17)	(0.03)	(0.04)
HH Income (Exc. Rem)	0.35***	-0.3*	0.18***	-0.27***	0.34***	-0.56***	0.33***	0.23***
	(0.07)	(0.18)	(0.03)	(0.06)	(0.07)	(0.17)	(0.03)	(0.05)
Total Input Cost	0.5***	0.47***	0.48***	0.44***	0.38***	0.29***	0.33***	0.32***
	(0.09)	(0.09)	(0.05)	(0.05)	(0.07)	(0.09)	(0.04)	(0.04)
Const.	2.34***	11.37***	4.27***	10.99***	3.52***	17.14***	3.76***	5.28***
	(0.6)	(2.14)	(0.35)	(1.09)	(0.67)	(2.52)	(0.42)	(0.91)
R-squared	0.43	0.00	0.56	0.00	0.35	0.00	0.38	0.31
Observations	1781	1770	4815	4662	2445	2383	3570	3490
Exogeneity: F-value		275.88***		155***		258.81***		5.17**
First-stage (F-value)		34.63		131.85		66.95		77.51
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Authors' calculations using PSLM 2018-19.

Note: Standard errors clustered at household level are shown in parentheses. Outcome variables are regressed on domestic remittance amount. Estimates of the production of cash crops using OLS and IV with controls are reported in column 1 and 2. Similarly, estimates of wheat production are given in column 3 and 4, estimates of labor intensive in column 5 and 6, and low labor-intensive crops in column 7 and 8, respectively. The proportion of domestic remittance recipient households at district level in 2014-15 is used to instrument domestic remittances. Controls include household head controls (gender, age, education, marital status), household income, dependency ratio, non-agricultural business, Credit dummy, input cost and a dummy for land ownership. All regressions include sample weights. Significant coefficients are marked with stars as *** p<0.01, ** p<0.05, * p<0.1.

Table 12. Foreign remittance amount and cropping pattern – OLS and IV estimates

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Cash crop		**Wheat production**		**Labor intensive crop production**		**Low labor-intensive crops production**	
Foreign remittance amount	**0.01**	**-0.38*** **	**-0.004**	**-0.14*** **	**0.007**	**-0.17*** **	**0.004**	**-0.06*** **
	(0.01)	(0.1)	(0.004)	(0.02)	(0.01)	(0.03)	(0.004)	(0.01)
HHH Gender	0.47***	-0.76	0.22***	-0.19	0.23	-0.26	0.15**	-0.03
	(0.13)	(0.61)	(0.08)	(0.12)	(0.16)	(0.22)	(0.07)	(0.08)
HHH Age	-0.01***	0.003	-0.001	0.003***	-0.002	0.003	-0.002**	-0.0002
	(0.002)	(0.003)	(0.001)	(0.001)	(0.002)	(0.003)	(0.001)	(0.001)
HHH Marital Status	-0.17**	-0.11	-0.05	0.02	0.02	0.12	-0.18***	-0.12**
	(0.07)	(0.14)	(0.05)	(0.06)	(0.11)	(0.12)	(0.05)	(0.06)
HHH Education	-0.007	0.008	-0.003	0.002	-0.008	-0.006	-0.01**	-0.005
	(0.005)	(0.01)	(0.002)	(0.003)	(0.01)	(0.01)	(0.003)	(0.003)
Dependency Ratio	0.09	-0.24	-0.04	-0.11*	0.07	-0.01	-0.11*	-0.14**
	(0.09)	(0.18)	(0.06)	(0.07)	(0.13)	(0.15)	(0.06)	(0.07)
Non-Agri. Business	-0.19***	-0.17	-0.23***	-0.21***	-0.69***	-0.67***	-0.32***	-0.31***
	(0.07)	(0.11)	(0.04)	(0.05)	(0.11)	(0.12)	(0.05)	(0.05)
Land Ownership	-0.81***	-0.67***	-0.57***	-0.51***	-0.87***	-0.79***	-0.21***	-0.19***
	(0.05)	(0.08)	(0.03)	(0.03)	(0.06)	(0.07)	(0.04)	(0.05)
Credit Dummy	-0.04	-0.09	-0.27***	-0.26***	-0.43***	-0.44***	-0.28***	-0.28***
	(0.05)	(0.08)	(0.03)	(0.04)	(0.07)	(0.08)	(0.03)	(0.04)
HH Income (Exc. Rem)	0.37***	0.16	0.19***	0.15***	0.38***	0.38***	0.32***	0.30***
	(0.07)	(0.11)	(0.04)	(0.04)	(0.07)	(0.08)	(0.03)	(0.03)
Total Input Cost	0.5***	0.51***	0.49***	0.47***	0.39***	0.37***	0.33***	0.32***
	(0.09)	(0.13)	(0.05)	(0.05)	(0.07)	(0.07)	(0.04)	(0.04)
Const.	2.02***	5.53***	4.11***	5.15***	2.84***	3.33***	3.87***	4.35***
	(0.57)	(1.42)	(0.33)	(0.46)	(0.65)	(0.77)	(0.38)	(0.45)
Exogeneity: F-value		70.55***		76.16***		46.29***		19***
First-stage (F-value)		21.84		187.39		90		156.61
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Authors' calculations using PSLM 2018-19.

Note: Standard errors clustered at household level are shown in parentheses. Outcome variables are regressed on foreign remittance amount. Estimates of the production of cash crops using OLS and IV with controls are reported in column 1 and 2. Similarly, estimates of wheat production are given in column 3 and 4, estimates of labor intensive in column 5 and 6, and low labor-intensive crops in column 7 and 8, respectively. The proportion of foreign remittance recipient households at the district level in 2014-15 is used to instrument foreign remittances. Controls include household head controls (gender, age, education, marital status), household income, dependency ratio, non-agricultural business, Credit dummy, input cost and a dummy for land ownership. All regressions include sample weights. Significant coefficients are marked with stars as *** p<0.01, ** p<0.05, * p<0.1

The negative impact of the incidence and amount of remittances observed thus far suggests the prevalence of labor loss effect. This effect can be more clearly seen by focusing on the household's migration history. However, our dataset, while providing information on the incidence, type, amount and origin of migrant remittances, does not give any information on the migrant. This is a serious limitation of the dataset. We try to overcome this difficulty in two ways:

1) Following (Bertoli & Murard, 2020), we take the household member absent at the time of the survey as a proxy for migrant member and look the impact on outcome. Although it is not perfect substitute for migration, it could nonetheless provide some suggestive evidence. The intuition for this variable is as follows: Controlling for remittances, absence of one or more household members would significantly and negatively affect farm production and investment if labor constraints are binding. Estimations reported in **Table 13** are in line with this argument. The impact of the number of absent members is negative for aggregate farm output and investment, and the production of all types of crops. However, the impact is much stronger for highly labor-intensive crops compared to less labor-intensive ones.
2) An indirect way of inferring the presence of labor loss effect could be to observe the impact of remittances on the household's labor supply. If higher household income thanks to migrant remittances leads the household away from farming activities, it should show in falling labor participation in agriculture among the stay-behind household members as well as lower farm output. The results of the impact of remittance incidence and amount on household farm labor supply (shown in **Table 14**) do not support this argument. Remittances' impact on the average number of days of farm activity per household is found to be either positive or not significantly different from zero, implying that the loss of farm activity is probably arising due to the absence of the migrant member.

Table 13. Absent household members and farm investment and output

	1	2	3	4	5	6	7	8	9	10	11	12
	Agricultural investment		**Total output**		**Cash crops**		**Wheat production**		**Labor intensive crops**		**Low labor-intensive crops**	
Absent member	**-13.88*** **	**-28.67*** **	**-11.49*** **	**-7.89*** **	**-13.36*** **	**-22.73**	**-13.63*** **	**-9.15*** **	**-13.63*** **	**-15.69** **	**-11.57** **	**0.01**
	(2.59)	(8.48)	(2.04)	(2.57)	(4.91)	(17.44)	(3.35)	(2.79)	(3.35)	(6.36)	(4.95)	(0.025)
HHH Gender		0.72		0.41		1.79		0.44		-0.59		0.75**
		(1.3)		(0.36)		(1.35)		(0.47)		(1.73)		(0.3)
HHH Age		0.01		0		0.01		0.01		0.01		0
		(0.02)		(0)		(0.02)		(0.01)		(0.02)		(0)
HHH Marital Status		-0.35		-0.17		0.69		-0.22		-1.8		-0.17
		(1.02)		(0.29)		(1.25)		(0.37)		(1.44)		(0.22)
HHH Education		0.03		0.01		0		0.02		0.02		-0.01
		(0.06)		(0.02)		(0.07)		(0.02)		(0.05)		(0.02)
Dependency Ratio		0.88		0.17		-0.56		0		0.65		0.05
		(0.84)		(0.23)		(10.08)		(0.29)		(0.81)		(0.22)
Non-Agri. Business		-1.04		-0.46**		-0.22		-0.41		-1.7**		-0.51**
		(0.71)		(0.2)		(0.85)		(0.26)		(0.73)		(0.21)
Land Ownership		2.04***		-0.17		0.08		-0.13		-0.11		-0.07
		(0.53)		(0.15)		(0.83)		(0.18)		(0.41)		(0.16)
Credit Dummy		-1.38***		-0.37***		0.29		-0.5***		-0.92**		-0.46***
		(0.5)		(0.14)		(0.72)		(0.17)		(0.46)		(0.17)
HH Income (Inc. Rem)		3.68***		1.1***		2.16		1.2***		2.19**		.96**
		(1.05)		(0.32)		(1.53)		(0.37)		(0.91)		(0.39)
Total Input Cost				0.53***		0.49**		0.46***		0.3**		0.32***
				(0.06)		(0.22)		(0.07)		(0.14)		(0.05)
Const.	2.96***	-47.11***	14.38***	-7.32*	13.95***	-22.63	13.37***	-8.56**	13.72***	-17.45*	13.06***	-4.56
	(0.3)	(13.2)	(0.22)	(3.78)	(0.47)	(20.71)	(0.22)	(4.35)	(0.37)	(9.76)	(0.65)	(4.95)
Obs.	5462	5462	5458	5458	1770	1770	4662	4662	2383	2383	3570	3490
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Source: Authors' calculations using PSLM 2018-19.

Note: Standard errors clustered at household level are shown in parentheses. Outcome variables are regressed on number of absent household members. Results of agricultural investment estimated using IV without and with controls are reported in column 1 and 2. Similarly, estimates of total output are given in column 3 and 4, cash crop production in column 5 and 6, wheat production in column 7 and 8, labor intensive crops in column 9 and 10, and low labor-intensive crops in column 11 and 12, respectively. The proportion of remittance recipient households at the district level in 2014-15 is used to instrument remittances. Controls include household head controls (gender, age, education, marital status), household income, dependency ratio, non-agricultural business, Credit dummy, input cost and a dummy for land ownership. All regressions include sample weights. Significant coefficients are marked with stars as *** p<0.01, ** p<0.05, * p<0.1.

Table 14. Remittance and households' farm labor supply

	(1)	(2)	(3)	(4)	(5)	(6)
	Overall remittance		**Domestic remittance**		**Foreign remittance**	
Remittance amount	**0.34*** **	**.037*** **	**0.70*** **	**0.76*** **	**0.23*** **	**0.15***
	(0.03)	(0.05)	(0.07)	(0.11)	(0.07)	(0.07)
HHH Gender		2.91***		3.73***		0.67
		(0.57)		(0.71)		(0.46)
HHH Age		-0.02***		-0.03***		0.01
		(0.01)		(0.01)		(0.01)
HHH Marital Status		-1.09***		-1.21***		-0.68***
		(0.26)		(0.31)		(0.24)
HHH Education		0.02		0.02		0.05***
		(0.02)		(0.02)		(0.01)
Dependency Ratio		-0.21		-0.51		-0.38
		(0.31)		(0.35)		(0.29)
Non-Agri. Business		-0.26		-0.06		-0.18
		(0.22)		(0.24)		(0.21)
Land Ownership		1.36***		1.23***		1.75***
		(0.17)		(0.19)		(0.16)
Credit Dummy		-0.52***		-0.80***		-0.37**
		(0.17)		(0.19)		(0.16)
HH Income (Exc. Rem)		1.13***		1.50***		0.4***
		(0.15)		(0.21)		(0.1)
Const.	26.58***	10.19***	26.4***	5.05*	27.21***	20.42***
	(0.10)	(2.12)	(0.12)	(2.84)	(0.08)	(1.39)
Observations	4494	4494	4494	4494	4494	4494
Controls	No	Yes	No	Yes	No	Yes

Authors' calculations using PSLM 2018-19.

Note: Standard errors clustered at household level are shown in parentheses. Outcome variable is the average of household monthly number of days of farm labor during the previous year. Columns 1 and 2 show IV estimates without and with controls for overall remittances, column 3 and 4 for domestic, while column 5 and 6 for foreign remittances. The proportion of recipient households at district level in 2014-15 is used to instrument total remittances. Similarly, the proportion of domestic and foreign remittance recipient households at district level in 2014-15 is used to instrument domestic and foreign remittances. Controls include household head controls (gender, age, education, marital status), household income, dependency ratio, non-agricultural business, Credit dummy, and a dummy for land ownership. All regressions include sample weights. Significant coefficients are marked with stars as *** p<0.01, ** p<0.05, * p<0.

Robustness Checks

We obtain our estimates with another instrument (i.e., proportion of recipient households at the PSU level excluding the household surveyed) and compare the results. The results reported in **Table 15** and **Table 16** are similar to those of our baseline estimates.

Table 15. Remittance incidence and farm investment and output: IV-2 estimates

	1	2	3	4	5	6
	Overall remittance		**Domestic remittance**		**Foreign remittance**	
	Agricultural investment	**Total output**	**Agricultural investment**	**Total output**	**Agricultural investment**	**Total output**
Remittance incidence	**-3.16*** **	**-0.98*** **	**-2.99*** **	**-0.57*** **	**-2.1*** **	**-0.74*** **
	(0.33)	(0.14)	(0.45)	(0.11)	(0.44)	(0.15)
HHH Gender	-1.2***	-0.16	-0.41	0.18**	0.35	0.24***
	(0.3)	(0.1)	(0.3)	(0.07)	(0.24)	(0.07)
HHH Age	0.01	0001**	0.001	0.001	-0.01	0.001
	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.001)
HHH Marital Status	0.26	0.0001	0.11	-0.05	0.06	-0.05
	(0.2)	(0.04)	(0.2)	(0.04)	(0.19)	(0.04)
HHH Education	-0.04***	-0.01***	-0.03**	0.0001**	-0.03**	0***
	(0.01)	(0.0001)	(0.01)	(0.0001)	(0.01)	(0.0001)
Dependency Ratio	0.27	-0.01	0.34	0.02	0.16	-0.02
	(0.22)	(0.05)	(0.22)	(0.05)	(0.21)	(0.05)
Non-Agri. Business	-0.64***	-0.37***	-0.64***	-0.33***	-0.55***	-0.31***
	(0.14)	(0.04)	(0.14)	(0.04)	(0.14)	(0.04)
Land Ownership	0.99***	-0.46***	0.92***	-0.5***	0.82***	-0.52***
	(0.1)	(0.02)	(0.1)	(0.02)	(0.09)	(0.02)
Credit Dummy	-0.46***	-0.13***	-0.48***	-0.14***	-0.63***	-0.16***
	(0.1)	(0.03)	(0.11)	(0.03)	(0.1)	(0.03)
HH Income (Inc. Rem)	0.9***	0.35***	0.61***	0.23***	0.83***	0.3***
	(0.1)	(0.04)	(0.1)	(0.03)	(0.1)	(0.04)
Total Input Cost		0.52***		0.57***		0.57***
		(0.05)		(0.05)		(0.05)
Const.	-10.07***	2.86***	-6.83***	3.59***	-10.08***	2.75***
	(1.3)	(0.28)	(1.25)	(0.32)	(1.32)	(0.26)
Obs.	5636	5632	5636	5632	5632	5632
Exogeneity: F-value	65.66***	38.52***	30***	9.3***	12.59***	16.85***
First-stage (F-value)	627	445	332	280	284	260
Controls	Yes	Yes	Yes	Yes	Yes	Yes

Source: Authors' calculations using PSLM 2018-19.

Note: Standard errors clustered at household level are shown in parentheses. Outcome variables are agricultural investment and total output. Variable of interest is the remittance incidence. Columns 1 and 2 show IV estimates with controls for overall remittances, columns 3 and 4 for domestic remittances, and columns 5 and 6 show estimates for foreign remittances. The proportion of overall recipient households at the PSU level excluding the household in question is used to instrument remittances (columns 1 and 2). Similarly, the proportion of domestic and foreign remittance recipient households at the PSU level excluding the household surveyed is used to instrument domestic (column 3 and 4) and foreign (column 5 and 6) remittances. Controls include household head controls (gender, age, education, marital status), household income, dependency ratio, non-agricultural business, Credit dummy, input cost and a dummy for land ownership. All regressions include sample weights. Significant coefficients are marked with stars as *** p<0.01, ** p<0.05, * p<0.1.

Remittances are associated with 96% lower farm investment (compared to 99% with the first instrument) and 63% lower farm output (82% with the first instrument). Farm investment and output are lower by 95% and 44% among domestic remittance receiving households and 88% and 53% lower among foreign remittance receiving households compared to their non-recipient counterparts, respectively. The trend is similar for the amount of remittances received and matches the results obtained using OLS and the baseline set of IV estimates.

Table 16. Remittance amount and farm investment and output: IV-2 estimates

	1	2	3	4	5	6
	Overall remittance		**Domestic remittance**		**Foreign remittance**	
	Agricultural investment	**Total output**	**Agricultural investment**	**Total output**	**Agricultural investment**	**Total output**
Remittance amount	**-0.29*** **	**-0.09*** **	**-0.36*** **	**-0.1*** **	**-0.2*** **	**-0.07*** **
	(0.03)	(0.01)	(0.05)	(0.01)	(0.03)	(0.01)
HHH Gender	-1.83***	-0.41***	-1.29***	-0.21**	-0.36	0.0001
	(0.33)	(0.1)	(0.33)	(0.09)	(0.25)	(0.08)
HHH Age	0.02***	0.01***	0.01***	0.0001***	0.0001	0.0001
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
HHH Marital Status	0.42**	0.06	0.27	0.01	0.19	-0.01
	(0.21)	(0.04)	(0.21)	(0.04)	(0.19)	(0.04)
HHH Education	0.001	0.001	-0.01	0.001	-0.02*	0.001
	(0.01)	(0.001)	(0.01)	(0.001)	(0.01)	(0.001)
Dependency Ratio	0.14	-0.04	0.33	0.02	0.1	-0.04
	(0.23)	(0.06)	(0.23)	(0.05)	(0.22)	(0.05)
Non-Agri. Business	-0.42***	-0.29***	-0.57***	-0.33***	-0.49***	-0.3***
	(0.15)	(0.04)	(0.14)	(0.04)	(0.14)	(0.04)
Land Ownership	1.17***	-0.41***	1.08***	-0.44***	0.92***	-0.48***
	(0.11)	(0.03)	(0.11)	(0.03)	(0.1)	(0.02)
Credit Dummy	-0.44***	-0.12***	-0.4***	-0.11***	-0.63***	-0.16***
	(0.11)	(0.03)	(0.11)	(0.03)	(0.1)	(0.03)
HH Income (Exc. Rem)	0.1	0.09***	0.13	0.11***	0.61***	0.22***
	(0.1)	(0.03)	(0.11)	(0.03)	(0.08)	(0.03)
Total Input Cost		0.54***		0.55***		0.56***
		(0.05)		(0.05)		(0.05)
Obs.	5636	5632	5636	5632	5636	5632
Exogeneity: F-value	103***	66***	72***	63***	40***	38***
First-stage (F-value)	557	523	290	278	314	310
Controls	Yes	Yes	Yes	Yes	Yes	Yes

Source: Authors' calculations using PSLM 2018-19.

Note: Standard errors clustered at household level are shown in parentheses. Outcome variables are agricultural investment and total output. Variable of interest is the remittance amount. Columns 1 and 2 show IV estimates with controls for overall remittances, columns 3 and 4 for domestic remittances, and columns 5 and 6 show estimates for foreign remittances. The proportion of overall recipient households at the PSU level excluding the household in question is used to instrument remittances (columns 1 and 2). Similarly, the proportion of domestic and foreign remittance recipient households at the PSU level excluding the household surveyed is used to instrument domestic (column 3 and 4) and foreign (column 5 and 6) remittances. Controls include household head controls (gender, age, education, marital status), household income, dependency ratio, non-agricultural business, Credit dummy, input cost and a dummy for land ownership. All regressions include sample weights. Significant coefficients are marked with stars as *** p<0.01, ** p<0.05, * p<0.1.

Next, we check for the robustness of our findings by obtaining estimates using different methodologies. Firstly, we account for sample selection through the Heckman selection method. The average treatment effect of endogenous treatment (recipient vs non-recipient) is estimated using ivtreatreg command by assigning the model type as "Heckit", which is a generalized Heckman type selection model (Cerulli, 2014). The results of the outcome and selection equations are reported in **Table 17**. Remittance recipient status is modeled in the selection equation with all the controls in the selection equation. In the second step, the outcome variable is regressed including controls for household, household head and agriculture factors, and lambda calculated from the first step. The results show that average treatment effect of being a recipient household is negative and significant. Farm investment among recipient households decreases by 99.53% compared to 99.64% estimated using Probit 2SLS, while farm output decreases by

71% compared to 82% estimated using Probit 2SLS. These results are in line with our main findings and support the conclusion that the labor loss impact of migration is dominant than the remittance income.

Secondly, we estimate the average treatment effects by matching the propensity scores. This sort of method is preferred in situations where the endogeneity arises due to selection on observables. We use nearest neighbors matching (nnmatch), inverse probability weights (IPW), and augmented probability weights (AIPW). Nearest neighbor matching and augmented probability weights are double robust methods. Average treatment effects estimated from these methods are presented in **Table 18**. The average treatment effects estimated again corroborate our main regression results. The estimates substantiate our hypothesis that the positive impact of remittance income is weak compared to the negative impact due to the labor loss of migrant member.

Table 17. Remittances and farm investment and output: Heckman specification

	1		2		3		4		5		6	
	Agriculture Investment		Total output		Cash crops production		Wheat production		Labor intensive prod.		Low labor-intensive prod.	
Equation	Outcome	Selection	Outcome	Selection	Outcome	Selection	Outcome	Selection	Outcome	Selection	Outcome	Selection
Model type	Linear	Probit	Linear	Probit	Linear	Probit	Linear	Probit	Linear	Probit	Linear	Probit
Dependent	Agri. Investment	Remittance 1/0.	Total output	Remittance 1/0.	Cash crops	Remittance 1/0.	Wheat prod.	Remittance 1/0.	Labor intensive	Remittance 1/0.	Low labor intensive	Remittance 1/0.
Remittance incidence (ATE)	**-5.25*** **		**-1.20*** **		**-2.39*** **		**-1.72*** **		**-2.69*** **		**-1.20*** **	
	-0.41		-0.08		-0.27		-0.11		-0.22		-0.17	
HHH Gender dummy	-2.18***	-1.66***	-0.29***	-1.60***	-0.36	-1.46***	-0.56***	-1.58***	-0.94***	-1.52***	-0.31***	-1.64***
	-0.37	-0.11	-0.06	-0.11	-0.23	-0.29	-0.09	-0.12	-0.19	-0.17	-0.12	-0.12
HHH age	0.01**	0.02***	0.002***	0.017***	0.001	0.016***	0.005***	0.016***	0.005**	0.016***	0.001	0.02***
	-0.005	-0.002	-0.001	-0.001	-0.002	-0.004	-0.001	-0.002	-0.002	-0.003	-0.001	-0.002
HHH marital dummy	0.48**	0.37***	0.03	0.36***	-0.04	0.24	0.07	0.34***	0.21*	0.29**	-0.07	0.39***
	-0.21	-0.09	-0.04	-0.09	-0.10	-0.18	-0.05	-0.10	-0.11	-0.15	-0.06	-0.10
HHH education	-0.04***	-0.02***	-0.01***	-0.01***	-0.01	0.001	-0.001***	-0.01*	-0.02***	-0.02**	-0.015***	-0.01**
	-0.01	-0.01	0.00	-0.01	-0.01	-0.01	0.001	-0.01	-0.01	-0.01	0.004	-0.01
Dependency ratio	0.12	-0.18*	0.002	-0.20*	0.03	-0.33	-0.04	-0.16	0.05	-0.03	-0.05	-0.12
	-0.24	-0.10	-0.04	-0.11	-0.10	-0.21	-0.06	-0.11	-0.13	-0.18	-0.07	-0.12
Non-Agri business dummy	-0.82***	-0.20***	-0.36***	-0.27***	-0.23***	-0.01	-0.30***	-0.25***	-0.76***	-0.33***	-0.38***	-0.31***
	-0.16	-0.07	-0.03	-0.07	-0.08	-0.14	-0.04	-0.08	-0.09	-0.12	-0.05	-0.08
Land ownership dummy	1.43***	0.19***	-0.48***	0.22***	-0.71***	0.22*	-0.51***	0.23***	-0.72***	0.23**	-0.18***	0.07
	-0.13	-0.07	-0.02	-0.07	-0.06	-0.13	-0.03	-0.07	-0.06	-0.11	-0.04	-0.08
Credit Dummy	-0.48***	0.06	-0.13***	0.01	0.001	0.17	-0.23***	0.07	-0.35***	-0.01	-0.22***	-0.04
	-0.13	-0.05	-0.02	-0.06	-0.06	-0.11	-0.03	-0.06	-0.07	-0.09	-0.03	-0.06
HH Income	1.06***	0.27***	0.37***	0.37***	0.51***	0.29***	0.37***	0.34***	0.56***	0.39***	0.51***	0.42***
	-0.10	-0.04	-0.02	-0.04	-0.05	-0.09	-0.03	-0.05	-0.06	-0.07	-0.04	-0.05
Total input cost			0.51***	-0.13***	0.38***	-0.21***	0.40***	-0.12***	0.33***	-0.11***	0.27***	-0.17***
			-0.01	-0.02	-0.03	-0.05	-0.01	-0.02	-0.02	-0.03	-0.02	-0.02
Prop.Rec.dist15		3.43***		2.9***		3.48***		2.89***		3.54***		2.09***
		-0.16		-0.18		-0.45		-0.19		-0.27		-0.22
Const.	-11.34***	-5.02***	2.86***	-4.76***	2.25***	-2.94***	3.37***	-4.49***	2.13***	-5.76***	2.39***	-4.63***
	-1.27	-0.53	-0.21	-0.54	-0.56	-1.05	-0.30	-0.58	-0.65	-0.88	-0.37	-0.60
Hazard: lambda	0.77***		0.52***		1.19***		0.85***		1.16***		0.62***	
	(0.23)		(0.04)		(0.14)		(0.06)		(0.12)		(0.10)	
Obs.	717		5458		1770		4662		2383		3490	
Controls	Yes		Yes		Yes		Yes		Yes		Yes	

Authors' calculations using PSLM 2018-19.

Note: Robust standard errors are shown in parentheses. Column 1-6 consist of Heckman model. Each column presents Heckman's outcome equation of the dependent variable and the probit selection equation for remittance recipient and non-recipient. The Heckman model is estimated using Heckit implemented through Stata's ivtreatreg command. The selection equation includes IV-2 (proportion of recipient households at district level in 2014-15). Controls include household head controls (gender, age, education, marital status), household income, dependency ratio, non-agricultural business, Credit dummy, input cost and a dummy for land ownership. All regressions include sample weights. Significant coefficients are marked with stars as *** p<0.01, ** p<0.05, * p<0.

Table 18. Remittances and farm investment and output: Matching estimates

	1			2			3		
Dependent	**Agriculture Investment**			**Total output**			**Cash crops production**		
Model type	**NNMATCH**	**IPW**	**AIPW**	**NNMATCH**	**IPW**	**AIPW**	**NNMATCH**	**IPW**	**AIPW**
ATE	**-0.94*** **	**-0.88*** **	**-0.57*** **	**-0.83*** **	**0.83*** **	**-0.54*** **	**-0.79*** **	**-0.69*** **	**-0.37*** **
	(0.23)	(0.11)	(0.14)	(0.06)	(0.88)	(0.05)	(0.1)	(0.09)	(0.1)
Obs.	5636	5636	5636	5632	5632	5632	1781	1781	1781
Controls	Yes			Yes			Yes		

Authors' calculations using PSLM 2018-19.

Note: Robust standard errors are shown in parentheses. Column 1-6 show agricultural outcome variables. Subsequent columns report the Average Treatment Effect (ATE) estimated using Nearest Neighbor matching, Inverse Probability Weighting (IPW) and Augmented Inverse Probability Weighting (AIPW) models. Controls include household head controls (gender, age, education, marital status), household income, dependency ratio, non-agricultural business, Credit dummy, input cost and a dummy for land ownership. IPW and AIPW models are estimated using sample weights. Significant coefficients are marked with stars as *** p<0.01, ** p<0.05, * p<0.1.

Table 18. Continue.

	4			5			6		
	Wheat production			**Labor intensive crop production**			**Low labor-intensive crops production**		
Model type	**NNMATCH**	**IPW**	**AIPW**	**NNMATCH**	**IPW**	**AIPW**	**NNMATCH**	**IPW**	**AIPW**
ATE	**-0.72*** **	**-0.72*** **	**-0.52*** **	**-1.31*** **	**-1.03*** **	**-0.83*** **	**-0.38*** **	**-0.42**	**-0.12*** **
	(0.06)	(0.05)	(0.05)	(0.15)	(0.12)	(0.1)	(0.06)	(0.05)	(0.05)
Obs.	4815	4815	4815	2445	2445	2445	3570	3570	3570
Controls	Yes			Yes			Yes		

Authors' calculations using PSLM 2018-19.

Note: Robust standard errors are shown in parentheses. Column 1-6 show agricultural outcome variables. Subsequent columns report the Average Treatment Effect (ATE) estimated using Nearest Neighbor matching, Inverse Probability Weighting (IPW) and Augmented Inverse Probability Weighting (AIPW) models. Controls include household head controls (gender, age, education, marital status), household income, dependency ratio, non-agricultural business, Credit dummy, input cost and a dummy for land ownership. IPW and AIPW models are estimated using sample weights. Significant coefficients are marked with stars as *** p<0.01, ** p<0.05, * p<0.1.

6. Conclusion

A large proportion of rural population in the developing countries is directly or indirectly associated with farm activities. The growing body of literature on agriculture's association with out-migration lacks consensus on the beneficial or detrimental nature of migration's impact. In this study, we shed light on the issue by drawing a conceptual model and testing the hypotheses empirically by analyzing detailed farm household data. We hypothesized about the direction of migration's impact on farm investment and output to answer the question as to which of the two effects, the income effect and the labor-loss effect, prevails. If the remittances income effect dominates, recipient households increase their investment in agriculture, but reduce it if the labor constraints dominate. If the income effect dominates, recipient households produce more cash crops like cotton and sugarcane and decrease the production of subsistence crops such as wheat. However, if the labor-loss effect prevails, recipient households move away from highly labor-intensive crops such as rice and fruits and vegetables, and switch to less labor-intensive crops such as maize, pulses or fodder. We tested these hypotheses on data for 5,636 farm households from the 2018-19 round of Pakistan Social and Living-standards Measurement Survey. We come up with the following key findings:

a) There is a strong evidence showing that the labor-loss effect dominates the income effect. Recipient households make 99% less agricultural investment and obtain 82% less production compared to non-recipient households. Recipient households may be unable to overcome their resource constraints and come out of poverty trap in spite of the additional income through remittances, and are therefore unable to improve their farm assets (Piras et al. (2018). Our findings are line with those of Atamanov and Van den Berg (2012) and Gibson et al. (2011) who reported deleterious effects of migration on investment in production-enhancing and labor-compensating agriculture technology, (Mughal & Makhlouf, 2013) who report a higher likelihood to move out of agriculture among recipient farm households, and (Qian et al., 2016) who find a greater incidence of abandoning farm lands.
b) The negative impact on farm investment and production is observed among the recipients of both the domestic and foreign remittances. However, the impact is particularly strong in case of the domestic compared to foreign remittances. This possibly owes to the fact that domestic remittances are on average much smaller than foreign remittances, and the losses to domestic migrant households due to labor constraints are proportionally higher.
c) The labor-loss effect also manifests itself in farm households' cropping patterns. The production of all crops (including highly labor-intensive crops) among recipient households is significantly lower compared to non-recipient households.

d) The decrease in production is more visible in the recipients of domestic remittances. The fall is as much as 99% in case of capital-intensive crops. The negative trend also prevails among the foreign remittance recipient households except for the production of highly labor-intensive crops where the difference is insignificant.
e) The labor participation of stay-behind members of the recipient households does not decrease, suggesting that the loss of farm output is more likely due to the absence of the migrant member.

These findings point to a substantial role of the process of migration and the resulting financial transfers in determining the level of agriculture investment and production. About 18% of Pakistani households receive money from family members living away from home. Although these migrant remittances help improve household wellbeing through higher income, they lead to sub-optimal farm investment and low agricultural production. This could have a non-negligible impact on the food import dependency and food security of a country where undernutrition is widespread, and a large segment of the population is vulnerable to significant international food price shocks. Besides, the fact that reduction in farm output is concentrated in small-farm households which make up 94% of the country's farm households highlights the challenges of low agriculture productivity and financial constraints that these households face.

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Appendices.

Table A 1. First stage regressions

	1	2	3	4	5	6
	Overall remittance		**Domestic remittance**		**Foreign remittance**	
	Incidence	**Amount**	**Incidence**	**Amount**	**Incidence**	**Amount**
Prop.Rec.dist15	**2.71*** **	**10.31*** **				
	(0.19)	(0.52)				
Prop.Dom.Rec.dist15			**3.26*** **	**8.02*** **		
			(0.26)	(0.66)		
Prop.For.Rec.dist15					**4.34*** **	**12.24*** **
					(0.3)	(0.86)
HHH Gender	-1.54***	-5.58***	-1.14***	-3.53***	-0.7***	-1.75***
	(0.12)	(0.36)	(0.11)	(0.41)	(0.13)	(0.39)
HHH Age	0.02***	0.07***	0.02***	0.05***	0.01**	0.02***
	(0.0001)	(0.01)	(0.0001)	(0.0001)	(0.0001)	(0.0001)
HHH Marital Status	0.37***	1.2***	0.25**	0.61**	0.22	0.5**
	(0.12)	(0.29)	(0.12)	(0.24)	(0.14)	(0.21)
HHH Education	-0.02***	0.07***	-0.01	0.04***	-0.01	0.03***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Dependency Ratio	-0.18	-0.62**	0.03	0.11	-0.5***	-0.75***
	(0.11)	(0.28)	(0.12)	(0.24)	(0.14)	(0.21)
Non-Agri. Business	-0.3***	0.15	-0.31***	-0.17	-0.13	0.23
	(0.08)	(0.2)	(0.09)	(0.15)	(0.1)	(0.15)
Land Ownership	0.23***	0.33**	0.16**	0.17	0.18**	0.14
	(0.06)	(0.13)	(0.07)	(0.12)	(0.09)	(0.09)
Credit Dummy	0.001	0.03	0.17***	0.39***	-0.3***	-0.39***
	(0.06)	(0.15)	(0.06)	(0.13)	(0.08)	(0.11)
HH Income (Inc. Rem)	0.37***	-20.05***	-0.03	-10.48***	0.56***	-0.59***
	(0.05)	(0.11)	(0.05)	(0.11)	(0.06)	(0.1)
Total Input Cost	-0.14***	0.07	-0.11***	0.0001	-0.07***	0.13**
	(0.02)	(0.06)	(0.02)	(0.05)	(0.02)	(0.06)
Const.	-4.65***	27.21***	-0.36	20.02***	-8.45***	6.72***
	(0.55)	(1.24)	(0.58)	(1.27)	(0.66)	(1.23)
Observations	5462	5462	5462	5462	5462	5462
Pseudo R^2	0.26	0.32	0.19	0.21	0.25	0.15
Controls	Yes	Yes	Yes	Yes	Yes	Yes

Authors' calculations using PSLM 2018-19.

Note: Standard errors clustered at household level are shown in parentheses. First-stage regression results of endogenous overall remittance incidence estimated using probit model and overall remittance amount using linear model with household controls are alternately reported in columns 1 and 2. The instrument is the proportion of recipient households at district level in 2014-15. Similarly, domestic and foreign remittance incidences and amount are presented in column 3-6. Domestic and foreign remittances are estimated using the proportion of domestic and foreign recipient households at district level in 2014-15. Controls include household head controls (gender, age, education, marital status), household income, dependency ratio, non-agricultural business, Credit dummy, input cost and a dummy for land ownership. All regressions include sample weights. Significant coefficients are marked with stars as*** p<.01, ** p<.05, * p<.1.