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Impact of Labour Migration on Paddy Farm Productivity and Efficiency

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Abstract- This research studied the effect of labor migration on paddy farm labor efficiency in the Kandy District, using primary data collected from 150 households across three agrarian services divisions. The Cobb-Douglas production function with a two-stage least squares (2SLS) technique was employed to address the issue of endogeneity arising of non-randomness in the migrant sample. The results indicate there is a significant impact of labor migration on paddy farm labor efficiency. Farmers do not efficiently reallocate the remaining labor in paddy production, which is a significant issue that needs to be addressed. Land, labor, fertilizer, and seed quantity significantly influence paddy yields in both migrant and non-migrant households. Labor was observed to have a significant positive impact on efficiency in both non-migrant and migrant households. Although labor input was crucial, the study suggests that there is no significant difference in labor efficiency between migrant and non-migrant households.

Keywords: Cobb-Douglas production function, Farm efficiency, Labor Migration, Two stage least square

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1. Introduction

Labour migration has become increasingly prevalent in many developing countries, significantly affecting the agricultural sector, particularly paddy farming. Migration is shift from a place of residence to another place for some length of time or permanently including different types of voluntary movements (Kaur et al., 2011). It often results in labor shortages in agriculture, threatening local economies and crop production (Das et al., 2024). Labour migration between urban and rural areas is inevitable in economic development globally, influencing agricultural development and social life in rural areas of developing countries (Nonthakot and Villano, 2009). In Sri Lanka, almost all internal migration has been from rural areas to urban cities (Ranathunga, 2011). The movement of rural laborers to urban areas or abroad in search of better employment opportunities leads to a reduction in the available workforce for agricultural activities (Ekanayake and Amirthalingam, 2019). Several studies highlight that rural-urban migration leads to labor shortages in farming communities, which can reduce crop yields and disrupt food supply chains ultimately leading to changes in the labor productivity and efficiency.

A. Factors Leading to Migration

Different economic, social and psychological factors are led people to leave the place of origin. People migrate to improve their economic status (Ukwatta, 2010). Low wages in their native area are a significant economic factor driving migration, along with factors like rain-fed agriculture, small landholdings, landlessness, debt, crop failures, and unemployment. In Bangladesh, higher wage rates in non-agricultural jobs significantly influence migration decisions (Rahman et al., 2022). Economic challenges, often accompanied by poverty. Social factors also play a prominent role in migration. Poverty and inadequate civic amenities are major social drivers, while strained social relations and political pressures can prompt long-term migration (Kangmennaang et al., 2017; Kaur et al., 2011). Lack of technical training and education limits opportunities within agriculture, pushing workers towards migration for better prospects. Larger family sizes and the need for financial support also motivate migration, as families seek to maximize income through diverse employment opportunities (Rahman et al., 2022; Chhom et al., 2023). Psychological factors, such as a desire for a better life, high aspirations, and the influence of others, also influence migration (Kaur et al., 2011).

B. Migration and Farm Labour

In numerous research studies, the impact of migration on farm households and their communities is vigorously highlighted. Migration can decrease farm labor and potentially reduce agricultural production, and also solve the problem of under-employment without necessarily reducing farm labor input. Additionally, remittances from migrants can be invested in both labour and non-labour farming inputs to compensate for any labor shortages (Maharjan et al., 2013). An increase in migrant workers can diversify rural household incomes and reduce their reliance on land. Migrant workers, typically younger and more educated, are less likely to engage in family agriculture. This leaves out the aged, disabled, women, and children, reducing the family's agricultural productivity and labour intensity (Chen et al., 2021). Migration may have a negative net impact on farm production, particularly in subsistence-based farming with low returns on investment (Islam and Guha, 2020). Migration results in a significant reduction in available labor, leading to abandoned arable land and decreased productivity in paddy farming. In Nepal, farmers with migrated family members reported lower livestock rearing and tree planting, indicating a decline in agricultural engagement and

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productivity (Magar et al., 2024). Some research studies highlighted that, outmigration of labour from agriculture might reduce crop production and endanger food security. Emigration leads to a reduced workforce, and if not balanced by remittances, it usually leads to greater food insecurity and poverty (Salvador, 2017). Remittances may facilitate on-farm investment or relieve credit constraints that impeded farmers from buying fertilizer or other key inputs. The unresolved question concerning migration and agricultural production is whether remittance incomes enhance production enough to compensate for the reduced availability of male or female labour in any specific setting and improve intra household welfare (Paris et al., 2009 and Maharjan et al., 2013). Labour migration is an effective approach to alleviate the limits on family capital liquidity (Chen et al., 2021).

C. Labor Participation in Rice Production

Men and women play distinct roles in paddy production, with tasks divided between them. Men are primarily responsible for land preparation, applying chemical fertilizers, spraying chemicals, and transporting farm products. Meanwhile, women undertake tasks like pulling and transplanting seedlings, weeding, and engaging in postharvest activities (Jeyaruba et al., 2013). Harvesting work is shared between genders, although more women are involved in this aspect. The use of machinery is exclusively handled by men. In instances of labour shortages, women exchange work with others of similar social standing. Additionally, female family members take charge of cooking and delivering food to farm workers. They oversee farm activities in the absence of male heads and manage material inputs procurement based on instructions from male heads. Principal females in migrant household are mainly responsible for keeping money and they have some control of disbursement for different expenditures. Thus, in cases of limited cash, they bear the burden of finding ways to borrow and repay private money lenders or friends, look for other income-generating activities and engage different cost saving activities (Paris et al.,2009; Jeyaruba et al., 2013).

D. Migration and Labour productivity and Efficiency

Labour migration significantly influences agricultural labour efficiency, with varying impacts across different regions and contexts. Migration and remittances play a pivotal role in agricultural development, impacting agricultural activities and social life in rural areas in developing countries (Attar et al., 2012). Many researchers argued that migration can enhance productivity growth by alleviating credit or risk constraints through remittances (Huber et al., 2010), fostering technological advancements and rural development. Rapid non-farm sector development prompts increased non-farm employment and wage rates, potentially causing farm labour migration from areas with lower wage rates. The urban movement of the labor force will eventually aggravate the rigid limitations on labor of rural production (Chen et al., 2021). In a study carried out in Thailand, Nonthakot and Villano, (2008) remittances have positive and significant effect on maize production and remittances, duration of migration, gender and education of migrants enhance the productive capacity of maize farmers. The impact of labor migration on paddy farm labor productivity, as analyzed through Arthur Lewis's two-sector model, reveals a complex relationship influenced by various factors. While some studies indicate that migration can enhance agricultural productivity and efficiency through remittances and improved resource allocation, others suggest a negative impact on productivity and efficiency due to labor shortages. Lewis's model posits a dual economy where labor moves from a subsistence agricultural sector to a capitalist sector, facilitating economic development (Hirota, 2002). Research conducted in Nigeria highlited that migrant households exhibited higher production efficiency compared to non-migrant households, suggesting that

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remittances can enhance agricultural productivity and labor efficiency (Odozi et al., 2020). The shift towards alternative employment due to low agricultural income exacerbates labor shortages, further impacting productivity in paddy farming (Magar et al., 2024). There is an unresolved question regarding labour migration and agricultural production is whether remittance incomes enhance production enough to compensate for the reduced availability of labour in specific setting. (01)

2. Methods

A. Sampling

A convenient sample of three Agrarian Services Divisions (ASDs) (Thalathuoya, Marassana, and Galaha) in the Pathahewaheta divisional secretariat of the Kandy District were selected as the study area. The total number of paddy farming families across these three ASDs is approximately 9,933. From this population, 150 paddy farming families were chosen as the sample using a multi-stage sampling technique. The number of farm families selected from each area is shown in Figure 01 below.

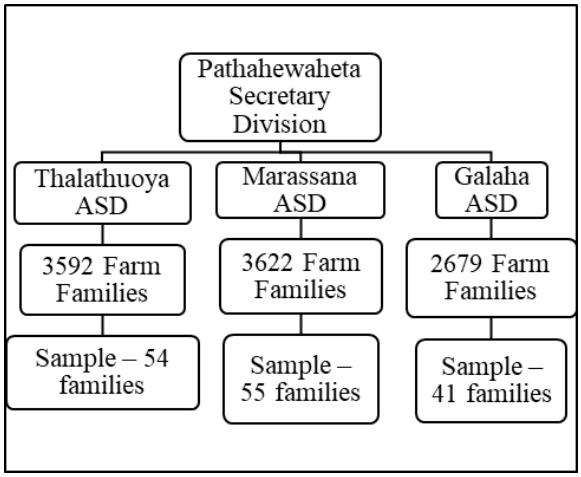

Figure 1. *Sampling Procedure*

B. Method of Analysis

Descriptive statistics were used to summarized and describe data in an abbreviated form. Characteristics of the sample such as distribution of gender, education level, type of cropping, etc. Household level data were used to estimate a model of household paddy production function, incorporating migrant elements. Specially focus on the paddy yield with respect to unit input of labour in two types of households to see whether the unit of labour input has been more efficient in-migrant households than in non-migrant households. To check this efficiency level Cobb-Douglas production function for econometric analysis were used. In its most standard form for the production of a single good with two factors, the function is,

$$Y = AK^{\alpha}L^{(1-\alpha)} \qquad (1)$$

Where: Y denotes as the real value of all goods produced in a year and L denotes as the labour input which measures by the total number of person-hours worked in a year. K denotes as the capital inputs which gives the real value of all machinery, equipment, and buildings. A denotes as total factor productivty and α, 1-α are the output elasticities.

In this empirical model labour is endogenous variable. It means unobserved factors may affect to the labour variable. If Ordinary Least Square (OLS) regression is used, these unobserved

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factors may have added for the error term. It can be subjected to simultaneous bias, where these unobserved factors in the error term might affect both labour and paddy yield. To deal with this endogenous issue, Two Stage Least Square (2SLS) regression was used instead of OLS.

In 2SLS as a first stage, we estimated a function for labour,

$$\ln L = \delta_0 + \delta_1 \ln LND + \delta_2 \ln K + \delta_3 \ln FERTI + \delta_4 \ln SEED + \delta_5 IRRI + \delta_6 MIG + \delta_7 EXP + \delta_8 EDU + \delta_9 HLTH + Ụ \quad (2)$$

Table 1
Variables in Labour Function

Notation	Variables	Remarks
L	Labour inputs	Worker days per season
LND	Land extent	Acre
K	Fixed capital input	Rupees
FERTI	Total amount of Fertilizer used per season	Kilograms per season
SEED	Quantity of seed paddy needed per season	Kilograms per season
IRRI	Land quality	Dummy variable (1=irrigated land, 0=otherwise)
MIG	Household type	Dummy variable (1=migrant household, 0=otherwise)
EXP	Experience in paddy cultivation	Years
EDU	Highest year of schooling of the farmer	Years
HLTH	Health condition of the farmer	Dummy variable (1=healthy farmer, 0=otherwise)
Ln	Natural logarithms	-
$\boldsymbol{\delta_0}$**-** $\boldsymbol{\delta_9}$	Coefficients to be estimated	-
$\boldsymbol{Ụ}$	Stochastic disturbance term	-

In labour function, there are three variables other than the exogenous variable in paddy production function. Farmer experience in paddy cultivation in years, highest year of schooling in paddy farm family as years, health condition of the farmer measured by dummy variables indicating normal health condition or unusual health condition. These three instruments correlated more with household labour inputs than paddy yield production. By using this appropriate regression method Cobb-Douglas production functions can be estimated in an unbiased way.
In the second stage we estimated the following functional form

$$lnY = \beta_0 + \beta_1 lnL + \beta_2 lnLND + \beta_3 lnK + \beta_4 lnFERTI + \beta_5 lnSEED + \beta_6 IRRI + \beta_6 MIG + \beta_7 MIGlnL + \varepsilon \quad (3)$$

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Table 2
Variables in Paddy Production Function

Notation	Variables	Remarks
Y	Total paddy production per season	Kilograms per season
L	Labour inputs	Worker days per season
LND	Land extent	Acre
K	Fixed capital input	Rupees
FERTI	Total amount of Fertilizer used per season	Kilograms per season
SEED	Quantity of seed paddy needed per season	Kilograms per season
IRRI	Land quality	Dummy variable (1=irrigated land, 0=otherwise)
MIG	Household type	Dummy variable (1=migrant household, 0=otherwise)
MIGL	Interaction term of the migrant household by labour input	-
Ln	Natural logarithms	-
β_0-β_7	Coefficients to be estimated	-
ε	Stochastic disturbance term	-

Labour, land and capital are the main factors of production. Therefore, the variable named "land extent", "labour input" and "fixed capital input" have been included to the production function. Although in paddy cultivation use three types of labour inputs such as family labour, hired labour and exchange labour are used, the study employed number of workers per season. Fixed capital is another important variable and it gives the real value of all machinery, equipment etc. Total amount of fertilizer used per cultivation directly affects the yield of paddy. Land quality is measured by a dummy variable distinguishing whether it is an irrigated land or not. MIG is a dummy variable indicating the households with at least one out-migrant. The references group is the household without any out-migrants. The MIGL is the interaction term of the migration household by labour input. This interaction term is the major interest of the study. The slope of the interaction term distinguishes per unit labour efficiency of two types of households. If reallocation of labor is possible even when workers out migrate from the sector, the sign of the slope of the interaction term should be positive.

3. Results and Discussion

According to descriptive statistics, 78% are male farmers and 22% are female farmers in the sample. Most farmers in the sample are older than 40 years, with 40% belonging to the 50-59 age group. Only 2% of the sample consists of very young people under 29 years. Regarding education, 58% of the farmers in the sample are educated up to the ordinary level. Only one farmer (0.7%) has no education, 24.7% have primary education. 15.3% farmers educated up to A/L. 0.7% of farmers get technical education and 15.33% have advanced level education. Most farmers in this area have a good level of experience. Specifically, 39% have more than 30 years of experience, 40% have 10 to 30 years of experience, and only 21% have less than 10 years of experience. Farmers in this area have diversified income sources into incomes from paddy cultivation, vegetable and other crop cultivation, animal husbandry, as well as from private sector and government sector occupations. Most of the farmers in the area are engaged in small-

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scale paddy cultivation. Among them, 48% cultivate less than 1 acre of paddy, while only 1.3% farm more than 3 acres. The average productivity in this area is 1,500 kg per acre. Cultivating 1 acre of land typically requires 70 man-days. Farmers use family labour nearly 24 man-days per season, exchange labour nearly 27 man-days and hired labour nearly 19 man-days per season. In the sample, 55% of the households are migrant households, while 45% are non-migrant households. Among the migrants, 74% are males and 26% are females, with most being young people under the age of 30. There are 121 migrants in the sample, of which 81% send remittances to their households.

A. Labour Productivity and efficiency in two types of households – Results from OLS Estimation

At first, we find out the determinants of paddy production in two types of households separately. Results shows in table 3, Non migrant household (column 1) and migrant household (column 2). Result shows that output elasticity with respect to the land, labour, fertilizer and seed quantity are appear to be significant. Elasticity of land in non-migrant household is 6.72 and migrant household is 6.84 with positive relationship. It means 1% of labour input yielding 6.7% increase in paddy yield in non-migrant household and 6.8% yield increase in migrant household. Fertilizer also has positive relationship with both households. 1% increase of fertilizer amount caused to 0.29% yield increase in non-migrant household and 0.42% yield increase in migrant household. Seed quantity is significant in both household but with negative relationship. There are three seed sowing methods in this area. Broadcasting, transplanting and sowing seed in parachute method. Among these three methods for broadcasting need higher amount of seed paddy (approximately 41.74kg) but yield is comparatively lower. For seed sowing in parachute method, farmers need comparatively very low amount of seed paddy (approximately 2.6 kg) but gives higher yield than other two methods. Transplanting is in between these two methods. This is the reason behind negative relationship with seed quantity and paddy yield.

Land is significant in non-migrant household with positive relationship. When land increases 1% in non – migrant household, paddy yield will increase 0.04%. It is very less amount of increment. Reason behind this less increment is that the most of farmers in this area are not the owners of the paddy and they lend land from the owners and pay for the land from yield. Because of this reason though they increase the land with 1% they get less amount increment with respect to it. In migrant household, land is not significantly affected to the paddy yield. Because most of farmers in migrant family members not going to lend land from others. They cultivate as they have their own paddy lands only.

In migrant household capital is significant with negative relationship. In migrant household though it has many more machinery, equipment, etc. if they have no one to operate it (if the earlier operator migrates from paddy cultivation), availability of the capital is a cost. Because of that reason 1% increases of capital in migrant household will cause a 0.05% reduction of yield. Land quality, it means whether the cultivated land is irrigated or not, is significantly not affected to the paddy production of migrant or non-migrant household. Because in this area non-irrigated lands are rich with spring water and other lands are fulfilled their water requirement by using irrigated water. So, there is no significant issue towards the paddy yield.

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Table 3
OLS of Estimates of Production Function of Two Types of Households

Variable	Non-migrant Household	Migrant Household
Intercept	-5.40***	-5.36 ***
Labour	6.72***	6.84***
Land	0.04*	0.007
Capital	0.002	-0.005**
Fertilizer	0.29***	0.42 ***
Seed quantity	-1.31***	-1.84***
Land quality	-0.02	-0.01
R^2 (%)	99.83	99.81
N	68	82

*, **, *** Significant at 10, 5 and 1 percent probability level
Source: Sample survey

B. Labour Efficiency in Two types of Households – Results from 2SLS Estimation

OLS estimates separately reveal the labour efficiency in paddy cultivation of two types of households. But it does not mention that statistically significant difference between two types of households on labour efficiency. Therefore, two sub samples were pooled together and introduced an interaction term for reveal statistically significant different. The interaction term was the household type by labour input, while holding other variables constant. The interaction term (MIGL) of the migration household by labor input in the two stage regression is the most important variable in the study and the slope of the interaction term shows the per unit labor efficiency of households. If the migration permits a reallocation of household labor remaining behind, the sign of the slope should be positive. Results can be presented in two model specifications. OLS and 2SLS regressions. Here OLS regression for whole sample is much similar to the OLS regression of separate sample. Labour, seed quality and fertilizer is the most important predictors in paddy production. Labour was very important factor, with an average of 6.78% increase in paddy production corresponding to 1% of increase in labour input. However, the coefficient of interaction term is insignificant (t =0.75). It explains that difference in labour efficiency in these two types of households is negligible. In table 4, columns 2 and 3 present estimations from a two-stage regression model where labor input is treated endogenously. Column 2 shows the first-stage results, while column 3 contains the second-stage results. The first-stage regression includes three instrumental variables: highest year of schooling, farmer's experience, and farmer's health. All other exogenous variables appear in the second-stage regression.

According to the stage 1 in 2SLS, land, seed quantity, types of households shows positive relationship towards the labour. When increase land and seed quantity needed amount of labour increases. The same point was highlighted in a study conducted by Kotir et al. (2022). An increase in land and seed quantity often leads to higher labor demands, particularly in intensive cropping systems. Though type of household does not affect the paddy production, it is significant towards the labour. 1% increase of household type yields 0.01% increase in labour input. Simply migrant household need much labour than non-migrant household. Reason behind this is that migrant household use hired labour for their cultivation. Hired laborers may not have paid satisfactory attention towards the production. When they cultivate using hired labour, the farmers have to use more hired labour than family labour. These results align with previous research conducted by Yu et al. (2022) and Ganesamoorthy (2016), which shows that both family and hired labor positively influence production outcomes. Higher land and labor

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inputs exhibited by households have been found to positively impact on their agricultural output. This result aligns with previous research conducted by Bhandari and Reddy (2015), which demonstrated that a higher workload is experienced in migrant households in the absence of male members, to manage both agricultural and non-agricultural tasks.

Use of Fertilizer have negative relationship with the labour input. 1% increases of fertilizer yield 0.18 reduction of needed labour hours. This result aligns with previous research conducted by Lei et al. (2022), which indicates that as capital input increases, labor input tends to decrease, leading to higher fertilizer usage. When fertilizer is added to the paddy land, plants will grow vigorously. Because of this vigor they can sustain towards the pest, disease and weed problem. Therefor labour need for above management practices will decrease. Two instruments are significant among three instrumental variables. Those have negative relationship with the labour. 1% increase of experience level of the farmer caused to 0.0004 % reduction of needed labour amount. Well experienced farmer can manage farm practices by using less amount of labour. 1% increment of health condition of farmer caused to 0.007 % reduction of needed labour amount. Healthy farmer can manage farm practices by using less amount of labour.

Table 4
Labour efficiency – Results from 2SLS Estimation

Variable	OLS	Two Stage Regression	
		Stage 1	Stage 2
Intercept	-5.36***	1.56***	-5.57***
Labour	6.78***	-	6.91***
Land	0.025	0.15***	0.006
Capital	-0.002	-0.0007	-0.002
Fertilizer	0.37***	-0.19***	0.39***
Seed Quantity	-1.61***	0.85***	-1.71***
Land quality	-0.02*	0.0007	-0.02**
Type of Household	0.03*	0.01**	0.05
Interaction term (MIGL)	-0.02*	-	-0.03*
Highest year of schooling	-	0.001	-
Experience of the farmer	-	-0.0003**	-
Health condition of the farmer	-	-0.007**	-
R^2 (%)	99.82	93.91	99.82
N	150	150	150

*, **, *** *Significant at 10, 5 and 1 percent probability level*
Source: Sample survey

In 2nd stage of 2SLS, labour, fertilizer, seed quantity and land quality significant towards the paddy yield. 1% increase of fertilizer input caused to 0.39% increases of paddy production. Increment of seed quantity caused to decrease the paddy yield as was case with the OLS estimates. The land quality also has negative relationship with yield. Land quality is measured by using dummy variable. Whether it is an irrigated land or non-irrigated land. 1% increases of irrigated land causes to 0.01% reduction of yield. Irrigated paddy fields can create favorable

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conditions for pests and diseases, which can significantly reduce yields if not managed properly. On the other hand, inefficient irrigation practices, such as over-irrigation or insufficient water supply, can negatively impact crop yields. For example, downstream farmers often receive less water, leading to lower yields compared to upstream farms. Because of this reason there can be a negative relationship with land quality and paddy yield.

If the migration permits a reallocation of household labor remaining behind the sign of the slope should be positive in the interaction term. But two stage regression gives a negative estimate for the interaction term and it is significant at 10% significant level. This negative value indicates that two stage regression has offered negative evidences that paddy farmers do not allocate their labor remaining at households efficiently in paddy production. The two-stage regression model yield non-significant in interaction term. However, 1% of labour input yielded 6.91% increase in paddy production.

4. Conclusion

Among 150 sample of this area 53% are migrant household. OLS results indicated that, labour is significant in both migrant and non-migrant households. 1% increase of labour will give 6.71% yield increases in non-migrant household and 6.8% yield increases in migrant household. This result shows that there is a kind of impact of migration on paddy farm labour efficiency. Simple comparison estimates between two types of households may yield biased results due to the endogeneity arising from the sub migrant sub-sample. This biasness arises as migrants self-select into migrant sub sample. As a result, it can occur errors because of the unobserved factors in error term. To overcome this statistical issue, 2SLS regression was used. To find out the efficiency in two type of household, interaction term in between type of household and labour was used. As the interaction term significant at 10% significant level with a negative sign, it could be concluded that farmers do not reallocate the remaining labor efficiently in paddy production which is a significant matter to be considered. However, being a migrant household is significant towards the paddy labor input. It can be the reason for significant different in labour input in two types of households at OLS. Finally, we can conclude there is a significant impact of labour migration on paddy farm labour efficiency. However, the negative effect on the labor efficiency can be minimized if the paddy farmers more labor using the remittances sent by the migrants. When farmers get remittances, farmers can allocate those remittances for hired labour to reduce labour scarcity, hire or purchase new machinery and equipment, purchase high quality inputs like quality seed, high quality agrochemicals to increase the productivity and labor efficiency in paddy. Youth out-migration can leave elderly parents to manage paddy farms, often resulting in reduced productivity and efficiency due to labor shortages (Lamichhane, 2024). Migration can lead to labor shortages in agriculture affecting productivity and efficiency for small farmers. In contrast to this, the migration of labor and sending remittances to origin households may increase overall agricultural productivity by reallocating labor more efficient uses (Djuikom, 2018) and filling the gap of labor scarcity created by labor migration through hiring labor and purchasing machineries and equipment using remittances.

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