Migration and agricultural intensification at origin: Evidence from farm households in Central Africa

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Abstract

Migration and remittances has potential to improve development in rural areas but in Rwanda and Eastern Democratic Republic of Congo empirical work is still limited. We used New Economics of Labour Migration (NELM) as analytical framework to explain the role of migration and remittances on crop intensification. A randomly selected sample of 480 farm households was interviewed. We found that out-migration negatively influence input use while remittance does not affect their use either. We recommend smart input subsidies and policy on their distribution system to create higher incomes thus discouraging massive rural out-migration. In addition, creation of an enabling investment environment in the sending areas through improving basic infrastructure and efficiently channelling extension messages to farmers would increase intensification and crop yields.

Key words: Rural out-migration; improved varieties; remittances; fertilizers; Central Africa
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1 Introduction

Many agricultural production systems in Africa are characterized by little use of external inputs, making farmers to rely heavily on family labour input. In presence of imperfect markets, international and domestic migration is likely to have impact on labor productivity and labor choices during farm production decision making process. Migration has been proposed by policy makers as a pillar of post-2015 development agenda after the expiry of Millennium Development Goals (IOM, 2013). This is because for poor rural household's migration has become one of the adaptation strategies to escape poverty and seek out opportunities provided that migration costs are lower (Mendola, 2008; Dey, 2015).

Moreover, the role of rural out-migration and remittances in agricultural development is highly debated because on one hand it implies a loss of labour force for the household and the region of origin while on the other hand, remittances may contribute to livelihood security and provide a source for investment. The net effect of migration on agricultural development depends on the ability of households to overcome the loss of labour effects by willingness to invest remittances on yield enhancing inputs. Migration can still be welfare enhancing for remaining household members even in the absence of remittances because the family left behind have fewer individuals to support. If the labor lost by rural households cannot be replaced by hired labor then migration would impact negatively on local production especially when imperfect labor markets exist, as for example, in the Eastern parts of Rwanda and Eastern DRC. In addition, if migrants leave in response to inadequate investment opportunities in the rural economy, then remittances alone is not able to transform agricultural production (Wouterse, 2010). However, remittance income from both domestic as well as international sources have found to lower the incidence of poverty among rural households with international remittances having a stronger poverty alleviating effect yet very few rural households can access them (Dey, 2015).

Migration and remittaces could play an important role in Central Africa where more than 80% of the population in the region practices smallholder agriculture in less than one acre of land and bananas and legumes are the major staple crops. The inputs such as fertilizers, crop chemicals, hired labour and improved crop varieties are important for increasing banana and legume yields. The widely grown legumes are groundnuts, common beans and soya beans which are principal source of protein and calories. Bananas and legumes are cultivated by 80-96% of the rural population in Rwanda (Ansoms and Mckay, 2010) and more than 80% in the Eastern DRC (Ouma *et al.,* 2012). The increased use of fertilizer for increasing agricultural

productivity is associated with adoption of capital and act as a progress in the adoption of yield-enhancing technologies (Rusike *et al.*, 1997). However, previous empirical work show that migration and remittances mainly lead to either intensification defined as use of more inputs per unit area or disintensification often regarded as use of fewer inputs per unit area and can potentially results into land abandonment (Rudel *et al.*, 2005). Migration is often associated with decline in agricultural production in the short run but increases production in the long run if the remittances are well invested into yield enhancement activities (Taylor *et al.*, 2003). However, latest empirical studies by Lihua *et al.*, (2013) in China and Maharjan *et al.*, (2012) in Nepal reported a negative effect of migration and remittances on crop production. This happens because of fungibility nature of remittances since some households may use it for other purposes with limited investment in agricultural technologies.

In Central Africa, Eastern Rwanda and the DRC witnessed a high level of rural out-migration during and after civil conflicts in late 1990's and little studies have investigated its influence on agricultural intensification. This is motivated by the fact that in Africa data on migration are often missing, out of date or inconsistent with definitions used in other countries (Ratha *et al.*, 2011) making this paper an important contributor to the debate on effects of migration and remittances on development of rural areas. We adopted New Economics of Labour Migration (NELM) which considers migration as a household's strategy to raise income and reduce risks by overcoming market failures such as credit and insurance markets (Stark and Levhari 1982; Stark, 1991). It considers migration as a household decision and not individuals'. The household members can even finance migration with an expectation of receiving remittances later (Wouterse, 2010). This is true in Central African context where family ties are strong and important decisions are taken jointly after mutual consultation with all the members. Remittances can only partially compensate for lost-labor and lost-capital effects (Taylor and Fletcher, 2007) hence, remittances may help to acquire new technologies and farm inputs crop production.

We hypothesize that rural out-migration influence intensification of banana and legumes production in Rwanda and the DRC and that if remittances are used to purchase farm inputs (e.g fertilizers, improved varieties and hire labour) then yield would increase thereby reducing poverty and food insecurity challenges. We use descriptive methods to assess socio-economic characteristics of migrant and non-migrant households and econometric approach to analyze the effect of migration and remittances on intensification of smallholder bananas and legume production.

2 Methodology

2.1 Study region

We conducted field research in the Consortium for Improving Agricultural-based livelihood is Central Africa (CIALCA) project action sites in Eastern Rwanda and Eastern Democratic Republic of Congo (DRC). CIALCA is a consortium of the International Institute of Tropical Agriculture (IITA), Bioversity International and The International Centre for Tropical Agriculture (CIAT) and their national research and development partners, supported by the Belgian Directorate General for Development Cooperation. Action Sites as defined by CIALCA are geographical zones covering one or a limited group of communities comprising between 500 and 5,000 households in each mandate area (Ouma *et al.,* 2012)[1]. This region has just recovered from political instability which disrupted much of the economic activities including agricultural production and marketing systems. The study sites were selected based on agro-ecology, varying access levels to local and regional markets and poverty levels. The sites surveyed in the DRC include Kabare, and Walungu territories while Kirehe, Gatsibo, Kayonza, Ngoma, and Bugesera districts were visited in Rwanda. The ethnic and cultural practices as well as farming practices are similar between the two neighboring regions.

2.2 Data collection and sampling methods

We applied a multi-stage sampling technique where in the first stage; seven action sites were purposively selected from CIALCA mandate areas in the two countries. Secondly, 30 farmer groups participating in CIALCA program were selected in all the seven action sites. We selected 21 and 9 farmer groups in Eastern DRC and Rwanda respectively from the list provided by CIALCA office. We then randomly selected farm households proportionate to the size of the group from the list of farmers provided by farmer groups. The sampling design generated a total of 480 farming household heads. Of the 480 farm households in our sample 164 had migrants in the cities or abroad. Data was collected from farm households using structured questionnaire to obtain information about the household's migration history and agricultural production activities.

2.3 Estimation model

To estimate the effects of rural out-migration and remittances on banana and legume intensification, we estimated the farmer's annual expenditure on fertilizer, improved varieties and hired labour. Expenditure on these inputs which are dependent variables may have zero values as some households may not apply them at all. Therefore, to deal with corner solutions and to prevent biased as well as inconsistent estimates we employed Tobit model

(Wooldridge, 2002; Gujarati, 2004). Tobit model is a maximum likelihood estimation procedure shown in equation 1.

$$y^* = \chi_i \beta + \mu_i, \quad \mu | \chi \sim \text{Normal}(0, \sigma 2) \tag{1}$$

$y_i = 0$ *if* $y_i^* \leq 0$

$y_i = y_i^*$ *if* $y_i^* > 0$

In data censoring cases, the latent variable y^* should have hemoskedastic normal distribution with linear conditional mean; χ_i is a vector of exogenous variables that can be easily added to the model while β is a vector of unknown parameters, μ_i is the error term assumed to be independent and normally distributed as $\mu_i \sim N(0, \sigma^2)$. The outcome variables (y_i) are expenditure on fertilizer, improved varieties and hired labour. Independent variables (χ_i) include rural out-migration, remittances and other farm household characteristics that we hypothesize to be influencing crop intensification.

The parameters of this model often don't give more meaning in production systems and associating the β and i^{th} outcome is misleading (Greene, 2003). The parameters only indicates the extent a change in one unit of χ_i can affect the latent variable y^* but y_i is the outcome variable under the analysis. Therefore, we estimated the marginal effect on the dependent variable y_i due to changes in the explanatory variable given in equation 2 below.

$$\frac{\partial E(y_i)}{\partial \chi_i} = \Phi\left(\frac{\chi_i \beta}{\sigma}\right)\beta_i \tag{2}$$

Where $\Phi\left(\frac{\chi_i \beta}{\sigma}\right)\beta_i$ is the estimated probability of observing uncensored observations at values χ_i.

There is possibility of endogeneity problem in equation one because migration among rural households can also be influenced by other factors which may not necessarily influence agricultural input use. Endogeneity exists when one or more independent variables correlate with the error term and ignoring it may yield unbiased estimators (Wooldridge, 2002; Greene, 2003). Following the previous works by Taylor and Mora, (2006) and Vasco, (2011) that migration and remittances studies suffer from endogeneity problem, we assumed that migration and remittance to be endogenous and exogenous respectively. We identified mobile phone ownership and family migration network as instruments for migration and tested their validity. Mobile phones facilitate frequent communication between the migrants and family (Vasco, 2011) while family network promotes migration as family members are invited by the family members in other regions making it a good intervening variable since it does not affect input use. Generally, instrumental variables should be correlated to explanatory endogenous

variable and not with the outcome variable. In this study we argue that these instruments are good predictors of migration but not of the expenditure on fertilizers, hired labour and improved varieties.

Therefore we tested for endogeneity by regressing the instruments as regressors with the endogenous variable (migration) to estimate their explanatory power. Secondly, for exclusion criterion, the instruments were included as regressors in the original model to test if they are significantly affecting the output variable (expenditure on fertilizers, hired labour and on improved varieties). Finally, we adopted Smith –Blundell approach[2] (Smith and Blundell, 1986) to assess if the treatment variables are endogenous or not. Smith–Blundell test is sensitive to specification and we employed three different specifications with the first specification having household head characteristics. The second included household head and farm characteristics including land in hectares while the last one had all the variables in the model in including region dummy. Endogeneity exists when one or more independent variables correlate with the error term and ignoring it may yield unbiased estimators. Besides, it can be caused by omitting important variables, causality problems, measurement errors and simultaneity (Wooldridge, 2002; Greene, 2003).

The joint significance test for the explanatory power of migration resulted in F-statistic of 47.80 and p-value = 0.000 for all the models (See Annex-Table 1C). This is far above the rule of thumb of 10 for F statistic (Steiger and Stock, 1997) meaning that the instruments are valid. When the instruments are included as explanatory variables of fertilizer, hire labour and improved varieties expenditures, joint significance test also show that they are valid (Table 4). These two tests indicate that the instruments have explanatory power and do not directly influence the outcome variables making them valid and strong to be used in testing exogeneity by Smith-Blundell procedure. The Smith-Blundell test of exogeneity rejected the null hypothesis and we treated migration as endogenous variable with respect to fertilizer expenditure while the test failed to reject the null hypotheses for improved varieties and hired labour expenditure and in this case we treated migration as exogenous variable (Table 1B-Annex). Hence, we used tobit to estimate the improved varieties and hired labour expenditure models while instrumental variable approach for fertilizer expenditure model because of endogeneity. We adopted this because when regressor is indeed uncorrelated with the error term, the application of intervening variable estimation results into a loss of efficiency (Wooldridge, 2006).

3 Results and discussion

3.1 Causes and benefits of migration to farm households

The wage differentials between agricultural and non-agricultural sectors and availability of job opportunities in urban areas have been considered as encouraging factors for the poor in rural areas to migrate (Davis and Pearce, 2001). Similarly, in Eastern Rwanda and Eastern DRC, majority of household members migrated for wage employment in the cities and abroad (54.4%) followed by education (28.5%), visiting relatives (11.4%) and armed conflicts (5.7%) (Table 1). These findings are consistent with those reported by Musahara (2011) that 78.8% of people migrated to Kigali to seek employment job opportunities followed by urbanization of Kigali (15%) and lack of land (8.9%). This means that lack of economic opportunities and other constrains in rural areas play an important role in migration. Just like in Nepal (Maharjan *et al.*, 2012), armed conflicts was also a cause of migration in the DRC and Rwanda.

In addition, 28.5% of the families sent their children to institutions of higher education in the urban centers and abroad to study; therefore no remittances are expected from such migrants. Migration for education is among the only legal ways for youth from low-income countries to enter developed countries and it provides opportunities to turn migration for education into labour migration (World Bank, 2007). Contrary to initial assumption that many would migrate due to conflicts, only 5.7% of the households indicated armed conflicts as a reason for their family member's migration. Traditional pull factors played caused rural out-migration than push factors such as conflict situations in the sending areas perhaps due to pressure on land.

Table 1: Causes and benefits of migration in farm households in Rwanda and the DRC

Causes of migration	Per cent	Benefits of migration	Per cent
Wage employment	54.4	Remittance	27.4
Armed conflicts	5.70	Goods like clothes & shoes	15.2
Further education	28.5	Less vulnerable to food insecurity	4.27
Visit relatives	11.4	No benefit from migration	53.1
Total	100		100

More than 27% of the migrant families received remittances; 15% received goods in kind such as clothes, shoes, food items and other household items. Some migrant farm households were less vulnerable to food insecurity shocks because they can request for assistance from migrant during emergencies. These households occasionally received remittances especially during food scarcity periods to prevent them from negative effect of food shortage in the short run. Study by DFID, (2007) showed that migration help rural families to increase their incomes, develop new skills, improve their social status, build up assets and improve their

quality of life. In addition, 53% of the families left behind did not derive significant benefits from migration because the migrants themselves face problems in finding stable jobs before they start to remit funds back to their families. From the survey, the remittances were mainly received quarterly (51%), occasionally in case of emergencies or at the beginning of planting seasons (30%) and monthly in cash (19%) for families who depend on remittances to survive.

3.2 Household and farm characteristics by migration status

Households, farm and community characteristics of smallholders by migration status are presented in Table 2. Migrant families had slightly more household members than non-migrant families which contradicts other findings reported by Miluka *et al.*, (2007) but confirms the findings by Vasco (2011). They also had higher number of dependents that could be propelling other members to migrate so that they can remit funds to support their families or to reduce the family burden. The migrant households' head were more married, older and appeared little more educated than the non-migrants household heads. The difference in the age of household head could be attributed to the migration of young people from rural areas as also reported by World Bank (2007). On average, most household heads had relatively less education. The household head and other members with high skills are often motivated to move away farming because higher education helps them to get employment faster in their destination.

Table 2: Household and farm characteristics of migrant and non-migrants households

Variables	Non-migrant households	Migrant households	t-test/ chi-square	Total
Household Characteristics				
Female household head (1 if yes)	21.20	17.68	0.84	20.00
Education of the head (years)	10.13	10.39	-0.73	10.22
Age of the head (years)	45.49	52.43	-5.63***	47.86
Married heads (1 if yes)	64.00	73.17	3.91**	67.29
Migration network (1 if yes)	4.43	34.15	76.54***	14.58
Received remittances (1 if received)	3.34	27.44	91.66***	9.58
Dependants (persons)	3.06	3.87	-3.44***	3.35
Active family members	2.55	3.38	-5.78***	2.83
Household size (persons)	5.61	7.24	-5.49***	6.17
House material(1 if iron sheets/tiles roof)	80.38	84.76	1.39	81.88
Transport equipment (1 if owned)	32.59	26.83	1.69	30.63
Mobile phone ownership (1 if owned)	55.75	62.80	2.87*	57.50
Farm and community characteristics				
Farm size (hectares)	1.37	1.43	-0.10	1.39
Distance to the market (km)	3.73	3.66	0.18	3.71
Livestock holdings (TLU)	1.05	1.92	-2.32**	1.35
Access to credit (1 if obtained)	25.32	29.26	0.86	26.67
Extension contacts (number)	7.00	6.35	0.71	6.78
Country (1 if in Rwanda)	49.37	27.82	22.56***	41.67
CIALCA market orientation strategies (1 if adopted)	59.81	62.80	0.41	50.83
Sample (N)	316	164		480

Notes: Note: Asterisks denote the level of significance for a t/chi-test of difference in means, *** p<0.01, ** p<0.05, * p<0.1. The variables in percentages are tested using chi-square

The share of migrant's households receiving remittances (27.44%) was significantly more than non-migrants (3.34%). The non-migrants households received remittances because migrants sometimes remit to distant relatives or friends who are not their household members. The migrant households owned significantly more mobile phones than non-migrant households. The mobile phones facilitate constant communication between the migrant and the family left behind. The migrant households significantly had a higher livestock holding which is consistent with the findings reported by McCarthy *et al.,* (2006) and Vasco, (2011) because in Central Africa livestock keeping is less labour intensive than crop production. Wourtese and Taylor, (2008) also found out that migrant households are likely to switch from crop to livestock production because they can afford the liquidity to purchase the animals. Livestock production is capital asset that enables farm households to meet unexpected expenditures and therefore, preferred by smallholders who do not have many other assets. The majority of migrant households were found in the DRC (72.2%) than Rwanda (27.8%) because the rural areas in the country are characterized with extremely poor infrastructure

with limited access to basic services such as health facilities, water supply, roads and employment opportunities. Still, some rural areas faced sporadic armed conflicts from rebels who stole farmers' produce and livestock.

3.3 Smallholders input use in banana and legume based systems

Almost all the farmers interviewed did not use crop chemicals such as pesticides and herbicides in crop production (Table 1A -Annex). The smallholders in Rwanda and DRC did not use crop chemicals but elsewhere in Southern Equadorian Andes rural households receiving remittances are likely to use chemical input to improve yields than those who do not (Gray, 2009). Our results also indicated that high proportion of non-migrant households used and spent more on fertilizers (US$127 per ha) compared to migrant households (US$113.7 per ha). Expenditure on improved varieties were higher among the remittance receiving than non-remittance receiving households. Expenditure on hired labour and fertilizer were not significantly different between the remittances receiving than non-remittances receiving households (Table 3). These results depict that migration and remittances have not led to abandonment of agricultural production in the region but households continue to farm in order to meet subsistence needs rather than investing in farming. The sending households in this region do not really gain from migration and the remittances received is not able to relax credit constraints. The regression analysis in section 3.4 shows if there is significant influence of migration and remittances on input use by smallholder farmers.

Table 3: Expenditure on inputs among the farming households

Variables	(a)	(b)	(c)	(d)	t-test	
	Non-migrant households	Migrant households	Non-remittance receiving households	Remittance receiving households	a≠b	c≠d
Hired labour (US$/ha)	178.9	66.5	56.50	83.81	0.73	-0.55
Fertilizer (US$/ha)	127.5	113.7	15.50	10.66	1.22	0.61
Improved varieties (US$/ha)	218.0	136.7	128.75	150.55	2.12**	-0.91
Sample size (N)	316	164	104	60		

Note: Asterisks denote the level of significance for t-test of difference in means, ** p<0.05.

3.4 Effect of migration and remittances inputs for intensification

The results of the effect of migration and remittances on fertilizers, improved varieties and hired labour use by smallholders in Rwanda and the DRC are presented in Table 4[3]. Migration had a negative and significant influence on fertilizer ($p<0.01$) and improved varieties expenditure ($p<0.05$). Remittances do not influence the input use either. This means that assumption that migration and remittances would increase intensification in banana and legume production does not hold. Similar findings have been reported among smallholders

by Miluka *et al*., (2007) in Albania, Rozelle *et al*., (1999) and Luhua *et al.,* (2013) in maize and wheat production in China and Maharjan *et al*., (2012) in Nepal among others. Similarly migration effect varies across various crop enterprises with food crops such groundnuts, millet and yam exhibiting negative relationship with migration (Afolabi, 2007).

Wourtese (2010) found that even though remittance provides households with the required liquidity and productive capital but the millet and sorghum production efficiency in Bukina Faso does not improve. Migrant households occasionally received remittances that increased household incomes substantially but they do not seem to significantly influence input use in Rwanda and the DRC. While some studies show that remittances positively influence fertilizer use among farming households (De Haas, 2006, Vasco, 2011 and Lihua *et al*., 2013), there many cases where the amount of remittances received are too small to invest on yield enhancing inputs. Besides, the small amount remittances make smallholders to spend them only to meet family daily expenditure as also reported by Gray (2009). The households mainly used remittances to meet short term family obligations such as payment of debts, purchasing food and clothes, building houses and purchasing livestock. This confirms the findings in India that households mainly spend remittances on health, education and household goods (Mohanty *et al.,* 2014). Remittances received by smallholder households in Ecuador did not significantly change crop cultivation patterns thus they still cultivated to ensure continued access to food (Jokisch, 2002).

Migrant households spent less on fertilizers and improved varieties than the non-migrant households which poses a challenge to policy makers because migration does not enhance investment in agriculture. It simply results into loss of labour force from the rural areas and depresses farm output since banana and legume production is labour intensive. The decline in available family labour could lead to adoption of labour saving strategies, abandonment of labour-intensive livelihood strategies and overall decrease in cropping activities (Zimmerer, 1993). In some cases, in labour intensive production systems, labour shortages occurs even without migration during peak agricultural seasons which can be compensated through joint labour exchanges common among farm households (Jokisch, 2002). The labour exchanges have also been referred in other studies as *reciprocal labour*. It is a common practice in smallholder agriculture especially where family labour is limited. In other studies it is called "*gang labour".* Nevertheless, the negative effect of migration on crop intensification clearly supports the NELM arguments that migration in the short run lead to loss of labour that reduce agricultural productivity.

Table 4: Determinants of fertilizers, improved varieties and hired labour expenditures

	Expenditure on inputs					
	Fertilizers		Improved varieties		Hired labour	
Variables	Coef.	Rob.SE	Coef.	Rob.SE	Coef.	Rob.SE
Migration	-4.843***	1.691	-0.319*	0.179	0.085	0.179
Remittances	0.349	1.103	0.261	0.336	0.810	0.615
Active family members	0.519***	0.186	0.099**	0.050	-0.096*	0.056
Dependants	0.132	0.080	0.085***	0.032	0.159	0.040
Age	-0.031	0.059	-0.019	0.038	0.090**	0.040
Age Squared	0.000	0.000	0.000	0.000	-0.001	0.000
Credit	0.503	0.364	0.184	0.168	0.011	0.196
Extension	-0.008	0.010	0.026***	0.009	0.045***	0.015
Livestock holding	0.068***	0.029	0.054***	0.007	0.030***	0.007
Female gender	0.895	0.609	0.003	0.251	-0.279	0.299
Distance to the market	-0.056	0.064	-0.028**	0.014	-0.081***	0.017
Marital status	0.819*	0.432	-0.171	0.211	-0.343	0.270
Education	-0.226	0.205	0.034	0.119	0.155	0.107
Education squared	0.012	0.010	-0.004	0.006	-0.010	0.006
CIALCA market orientation strategies	0.017	0.341	0.118	0.154	0.346	0.183
Farm size	0.034**	0.016	0.011	0.007	0.014	0.008
House material	0.463	0.540	0.427*	0.218	0.438*	0.221
Transport equipment	0.629	0.440	0.429**	0.188	0.402*	0.230
Country	0.492	0.539	-0.984***	0.216	-0.563**	0.254
Constant	2.575	1.899	2.825***	1.013	0.451	1.111
Joint sig. test (F)	3.47		2.20		0.87	
p-value	0.034		0.421		0.112	

Note: Asterisks denote the level of significance, *** p<0.01, ** p<0.05, * p<0.1.

The number of active family members positively influenced expenditure on fertilizer and improved varieties while it reduced the expenditure on hired labour. The plausible reason for this could be that as the number of active family members grows; less external labour is hired because of enough family labour to do farm activities. The households with many active members would be motivated to invest in inputs to improve yields in order to meet the needs of larger family. In addition, large families with more active members to work in the farm may have higher crop incomes and have surplus to reinvest into cultivation activities.

The number of household dependants was positive and significantly influenced improved varieties use among smallholders in this region. This was rather unexpected based on assumption that the higher the number of dependants, the lower the amount of cash available to spend on farm inputs since the household has to feed members who are not actively involved in production. The dependants are relatively consumers than producers making them a liability to the entire household. On the other hand, as the number of dependants increase, the household is forced to use the available incomes or look for other income sources to family needs. This kind of scenario can stimulate the active family members to work harder and adopt intensive production or discourage them and only focus on meeting family food requirements.

The older farmers significantly spent more on hired labour than the younger ones. This is because as the farmer advances in age their ability to command more resources increases and have a wider investment options including farm inputs. They owned relatively larger farms which motivates them to incorporate external labour in order to cultivate all the plots. Some male household heads migrated to work in the cities leaving their wives behind to manage cropping activities. The wives left behind indicated they make agricultural production decisions and constantly consult with their husbands in the cities or abroad. Extension services as expected positively influenced improved varieties and hired labour expenditures. Regular contacts with extension workers are necessary to enhance adoption of production technologies since it provides information, knowledge and skills that enable farmers to manage crops better. The extension services provided by CIALCA, other NGOs and government of Rwanda encouraged farmers to use farm inputs to enhance yields.

The households closer to the market spent more on farm inputs than those who were far away because the final cost of fertilizers and improved varieties increases with the increase in distance. The distance to the market significantly influenced expenditure on improved varieties and on hired labour though it was not significant with respect to fertilizer. This

means that distance to the market could be irrelevant to fertilizer use because in most cases input sellers exist in the remote villages and in Rwanda Crop Intensification Program (CIP) delivers fertilizer and seeds to the farmers in a location that is accessible to all targeted farmers. Crop Intensification Program is a government of Rwanda (GOR) project that provide fertilizers and improved seed varieties at 50% subsidized price to farmers who voluntarily participate in land consolidation and willing to grow the priority crops (GOR, 2005). Gray (2009) also indicates that distance to the road has no effect on fertilizer use in Southern Ecuador. Although, farmers in this region faced similar market prices but poor market access for farmers residing far away from the markets in remote villages had to spend more to get inputs. These findings are consistent with other studies in Sub-Saharan Africa (Omamo *et al.,* 2002; Waithaka *et al.,* 2007; Rios *et al.,* 2009; Bekele *et al.,* 2010) where the expenditure on farm inputs increases with the decreasing farm-to-market transport costs.

Livestock production is a very important enterprise for smallholders in Rwanda and the DRC since it significantly contributed to fertilizer, improved varieties and hired labour expenditures. The households with more livestock spent on average more on farm inputs because the livestock is a sign of wealth and small ruminants such as goats, sheep and even chicken could easily be converted into cash to purchase fertilizers and improved seeds. In addition, livestock influenced hired labour expenditure because most of the workers were mainly employed to look after livestock although sometimes they participated in cropping activities. This finding is similar to results in other developing countries reported in Albania (Miluka *et al.,* 2007) and Tanzania, Guatemala and Vietnam (Rios *et al.,* 2009).

Consistent with Waithaka *et al.,* (2007) and Maharjan *et al.,* (2012) the expenditure on fertilizer increased significantly with increasing farm size. The land area under banana and legumes related positively with fertilizer use which also confirms evidences in cash crop farming in Nakuru District, Kenya (Omamo *et al.,* 2002). Banana and legumes are food crops that initially were planted for subsistence purposes but now they have taken a commercialization dimension in order to improve rural livelihoods. In the study by Omamo *et al.,* (2002) smallholders in Kenya use more chemical fertilizer on cash-crops than on food-crops. This could also imply that the smallholders in Central Africa use less fertilizer on food-crops mainly grown for home consumption. For example, in Rwanda farmers allocate more land to production of priority crops such as maize, rice, Irish potato and wheat that are under CIP program in which they get subsidized fertilizer prices. The average farms size is

shrinking due to high population pressure making crop intensification and even diversification into high valued crops, important strategies to curb food insecurity challenges.

The households with transport equipment were more likely to have high expenditures on improved varieties and hired labour than those without. Ownership of transport equipment reduces the marginal cost of movement to the markets to buy inputs or to sell farm produce. The farm households in the DRC spent more hired labour and improved varieties compared to their Rwanda counterparts. However, this result was unexpected since in Rwanda farmers obtained improved varieties at subsidized prices through CIP program. Higher investment in hired labour in the DRC could be availability of cheap farm labour drawn from larger family sizes compared to Rwanda. The possible reason as indicated earlier is that from the smallholder farmer's perspective, CIP may not have realized its goal due to top-down implementation which does not incorporate the views of the smallholders (Ansoms, 2010).

4 Conclusions and Policy Implications

This study shows that migration significantly contribute to low input use and remittances only helps to ease farm households' liquidity and capital constraints in the short run. The remittances do not influence the input use because the amounts are too small to be invested on fertilizers, improved varieties and hired labour. The families left behind often spend the cash on food, pay debts and some invest in less labour intensive activities like livestock than in crop production. The contribution of migration in securing the livelihoods of the farm households and the negative effect in terms of declining investment in inputs requires attention of policymakers. Probably, the remittances received by farm households are invested in non-farm activities and family needs such as food, medical and children education.

We therefore, propose policy that would increase investment in fertilizer, improved varieties and labour in because presently migration is only useful for livelihood security in the short run. The possible policy option is to encourage migrants to remit funds that can be invested in yield enhancing inputs. The government should create an enabling investment environment through improving basic infrastructure and efficiently channelling the production and marketing extension messages. This requires investment in roads, education and extension services to make farming attractive to the rural population. The governments can also give smart input subsidies[4] and enact policy on their distribution to create higher incomes to discourage massive rural out-migration. This would have greater impacts on crop intensification and subsequently increase agricultural productivity.

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Notes

1. Mandate area is political units, which are relatively large and corresponds to set of Districts in Rwanda and Territories in the DRC. The number of people living in each mandate area can vary between 300,000 and 1,200,000. Action Sites correspond to different administrative units in each of the countries ('Secteurs' in Rwanda, and 'Localités' in North and South-Kivu).
2. We used Tobexog command available in STATA 12 to run Smith and Blundell tests
3. The IV tobit results were obtained by *cmp* command in STATA as proposed by Roodman (2011) because *ivtobit* command is appropriate if the endogenous variable is continuous but in this study migration is categorical.
4. Smart subsidy is one that target households meeting certain criteria (e.g poor) and hence is more cost-effective in meeting their objectives than the universal (untargeted) subsidies used in the past.

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ANNEX

Table 1A: Share of smallholders using inputs in banana and legume production (in %)

Input	Migrant households	Non-migrant households	Non-remittance receiving households	Remittance receiving households
Fertilizers	25.6	29.43	29.8	18.3
Improved varieties	80.5	84.5	80.7	80.0
Hired labour	46.3	39.9	43.3	51.7
Crop chemicals	0.61	0.32	0.0	1.6
Sample (N)	164	316	104	60

Table 1B: Smith and Blundell tests for exogeneity for migration for the fertilizer, improved varieties and hired labour expenditure

Model	Specification 1		Specification 2		Specification 3	
	χ^2	P-value	χ^2	P-value	χ^2	P-value
Fertilizer	2.421	0.122	3.989	0.048	4.644	0.033
High yielding variety	0.345	0.558	1.732	0.189	1.727	0.190
Hired labour	0.059	0.808	0.641	0.424	0.554	0.458

Specification 1: Household head characteristics
Specification 2: Household and Farm characteristics including land in hectares, transport equipment ownership.
Specification 3: All the variables in the models in including region dummy.

Table 1C: First stage regression results for migration for expenditure on fertilizer, improved varieties and hired labour (probit)

Probit regression	Number of obs	=	480
	LR chi2(20)	=	156.07
	Prob > chi2	=	0
Log likelihood = -230.19172	Pseudo R2	=	0.2532

Variables	Coefficient	Standard Error	z	P>z
Country	-0.789	0.203	-3.900	0.000
Remittance	0.762	0.338	2.260	0.024
Active family members	0.126	0.049	2.590	0.010
Dependants	0.014	0.031	0.460	0.647
Age	0.010	0.031	0.310	0.754
Ages squared	0.000	0.000	0.400	0.692
Access to credit	0.070	0.158	0.440	0.658
Extension contacts	-0.006	0.010	-0.610	0.540
TLU	0.083	0.045	1.840	0.066
Female gender	0.346	0.218	1.590	0.112
Distance to market (km)	0.021	0.015	1.390	0.166
Marital status	0.210	0.189	1.120	0.264
Education	0.060	0.085	0.700	0.481
Education squared	-0.003	0.004	-0.760	0.448
CIALCA market orientation strategies	0.070	0.144	0.480	0.630
Land size	-0.020	0.014	-1.470	0.143
House material	0.314	0.192	1.630	0.103
Transport equipment	0.076	0.185	0.410	0.680
Mobile ownership	0.427	0.162	2.640	0.008
Migration network	1.329	0.208	6.380	0.000
_cons	-2.708	0.851	-3.180	0.001

		mobile_ownership migra_network
Joint Significance test	(1)	[migration]mobile_ownership = 0
	(2)	[migration]migra_network = 0
		chi2(2) = 47.80
		Prob > chi2 = 0.0000