

The Impact of off-Farm Income Sources on Agricultural Inputs and Farm Productivity in Cameroon

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ARTICLE INFO	ABSTRACT
Article History	Purpose: In a context of credit constraint faced by smallholders to invest, off-farm activities, while being a good lever for increasing agricultural productivity through the purchase of farm inputs, would also be an element of diversion of efforts from the agricultural sector towards non-agricultural activities. Hence, knowing the type of off-farm activity that can be done in parallel to agriculture without damaging it is of great interest. This article aims to identify non-agricultural activities that can be carried out alongside farming without having an adverse effect on agricultural activities.
Received 28 May 2026 Accepted 29 July 2026 <i>JEL Classifications</i> O13, Q12, Q18	Design/methodology/approach: The data were collected using a three-stage sampling technique from surveys conducted with 564 farmers in western Cameroon. We use Heckman's two-step procedure to estimate the land productivity equation and the Ordinary least squares method to estimate input demand equations.
Keywords: off-farm income, off-farm income from self-employment, off-farm wage income, remittance, agricultural inputs, farm productivity, Cameroon	Findings: The results show that off-farm income has a positive impact on the demand for farm inputs, particularly when derived from remittances or self-employment. Off-farm income also significantly increases farm productivity, particularly when it is derived from remittances.
	Research limitations/implications: The study's reliance on cross-sectional, self-reported survey data from Western Cameroon restricts causal inference and limits geographical generalisability. Furthermore, prioritising land productivity mitigates severe measurement constraints surrounding informal labour, but omitting total factor productivity prevents a comprehensive evaluation of overall input efficiency gains.
	Originality/value: This study suggests that diversifying income sources through self-employment and remittances could provide the additional capital needed to increase farm input demand and productivity in a low-income country such as Cameroon, where farmers face credit constraints.

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1. Introduction

Interest in studying the relationship between off-farm¹ income and agricultural productivity is motivated by the classical development of dual economic models formulated by Lewis (1954) and later formalized by Fbi and Ranis (1964). Although they often earn a meagre income from farming, smallholder farmers in low-income countries have managed to survive by combining farming with non-farming activities. Thus, their decisions, from the choice of increasing agricultural investment includes innovation, are often influenced by off-farm income. Innovation could be viewed in terms of the use of modern tools and equipment, machines such as tractors, combine harvesters, sprayers, backhoes, reaper-binder, field cultivators, hullers, and planters for cultivation which entails mechanization, use of

¹ In this study, when we talk about off-farm income (or activities), we are referring to both off-farm and non-farm income (or activities). For the purposes of this study, these two terms will be used interchangeably.

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chemical inputs like pesticides, insecticides, chemical fertilizer, improved seeds, irrigation, improved cultivation methods. It is known that new technologies and innovations have a positive effect on agricultural productivity (Feder *et al.*, 1985; Chen, 2025). This innovation can be supported by off-farm and on-farm income. The extent of off-farm work and its relationship with farm productivity may have important effects on farm productivity (Fernandez-Cornejo *et al.*, 2007). According to Pfeiffer *et al.* (2009), agricultural income portfolios in developing countries are shifting away from agricultural productivity. Non-farm income opportunities have been widely analysed as an important strategy for overcoming credit constraints faced by smallholders to invest, among other things, in agricultural productivity in developing countries (Reardon *et al.*, 1994; Janvry and Sadoulet, 2001; Iiyama *et al.*, 2008; Diiro, 2013; Mishra *et al.*, 2015; Dsouza *et al.*, 2020; Ma *et al.*, 2022). Based on primary survey data from four African countries, Mutsami *et al.* (2025) found that, on average, off-farm sources account for 60% of total household income in rural Africa. The share of off-farm income in the total household income of a farmer in Cameroon increased from 40% in 1995 to 79% in 2004 (Parrot *et al.*, 2010). A growing share of non-agricultural income is evident with differing agricultural production potential. Off-farm income can be an important source of cash income which can potentially improve agricultural productivity if it is used to buy agricultural inputs.

Most studies usually analyse only aggregated off-farm income. We can evoke for example Savadogo *et al.* (1998) in Burkina Faso, Holden *et al.* (2004) in Ethiopia, Kilic *et al.* (2009) in Albania, Pfeiffer *et al.* (2009) in Mexico, Diiro (2013) in Uganda, and Rashidin *et al.* (2020) in Pakistan, Anang and Apedo (2023) in Ghana, Drall and Mandal (2025) in India.

Although these aggregate approaches provide valuable baseline insights, treating off-farm income as a homogeneous entity obscures the distinct microeconomic pathways and labour-capital trade-offs. In a context of credit constraint faced by smallholders to invest, off-farm activities, while being a good lever for increasing agricultural productivity through the purchase of farm inputs, would also be an element of diversion of efforts from the agricultural sector towards non-agricultural activities (Shittu, 2014). Crucially, the net balance between the liquidity-easing and labour-diversion effects is determined by the theoretical nature of the off-farm source itself. Remittances represent an unearned transfer or migration return that provides a direct injection of liquidity without reducing local household farm labour. By relaxing cash constraints without creating an immediate labour bottleneck on the family plot, remittances can uniquely encourage the adoption of inputs. Wage employment usually involves rigid working hours and contractual time commitments, creating a stronger labour diversion effect away from farm management, despite providing a predictable, recurring cash flow for purchasing inputs. Self-employment presents a hybrid dynamic in that it allows for flexible labour allocation alongside farming. However, it demands continuous reinvestment of working capital, which could lead to direct competition for funds between the farm and the non-farm enterprise. It is therefore theoretically essential to distinguish between remittances, self-employment and wage employment in order to untangle these conflicting income and substitution dynamics. By moving beyond aggregate measures, this study advances existing empirical literature by revealing how varying liquidity profiles and labour constraints across distinct off-farm activities differentially shape input investment and agricultural productivity among smallholder farmers. Hence, in this study, we assess the contribution of aggregated and disaggregated off-farm income on agricultural productivity through inputs in West Cameroon.

2. Literature Review

Off-farm income can be defined in various ways. Pfeiffer *et al.* (2009) define off-farm income as income earned from non-agricultural wage work plus remittances sent back to the household by members living outside the country. According to House (2006), off-farm or non-farm income refers to the portion of agricultural household income earned away from the farm, including wages and salaries from non-farm work, pensions, and interest income. In the United States, for example, off-farm income accounts for over 90% of farm household income on average (House, 2006). The significance of off-farm income is further emphasized by the study of Haggblade *et al.* (2005), which shows that local non-farm income makes up between 30 to 45 percent of smallholder incomes in developing countries. Chang and Boisvert (2009) demonstrate that income from off-farm sources for smallholders has continued to narrow the income gap between farm and non-farm households. The effect of off-farm income on agricultural productivity remains a topic of debate. The empirical evidence is mixed. Some studies, such as those by Holden *et al.* (2004), Pfeiffer *et al.* (2009), Mishra *et al.* (2014), Rashidin *et al.* (2020), and Li *et al.* (2022), show that agricultural production declines when access to non-farm employment improves. Therefore, access to off-farm income can reduce farm households' incentives to invest in agriculture. Additionally, Fernandez-Cornejo *et al.* (2007) analyzed the relationship between the adoption of improved corn varieties in the US and household income from either off-farm or on-farm sources. Their results indicate that adoption is not significantly influenced, suggesting that improved corn varieties may be neutral regarding off-farm and on-farm income. Conversely, the study by Reardon *et al.* (1994) in Burkina Faso revealed that when farmers face financial constraints to purchase farm inputs, access to non-farm income can provide additional liquidity needs and lead to increased agricultural intensification. Off-farm income activities might have a positive impact on productivity if smallholders have limited access to credit (Key, 2020). Furthermore, Diagana and Kelly (1994) show that with the disappearance of government subsidies in Senegal, farmers increasingly use off-farm income to buy inputs. Moreover, Egyei and Adzovor (2013) suggest that off-farm income can directly and indirectly influence agricultural productivity through credit and liquidity. It can directly impact productivity by easing

household budget constraints and indirectly by providing households with capital, security, and liquidity necessary to invest in technology or farm inputs.

In synthesising these divergent findings, we observe a general tendency: off-farm income tends to induce a labour diversion effect where credit markets are well developed. However, it acts as a substitute for liquidity financing input adoption where credit is fragmented and state agricultural support is limited. However, this pattern admits notable exceptions. In the United States, for example, despite a well-developed financial system, off-farm income relaxed binding credit constraints for small, credit-constrained farms (Key, 2020). In Pakistan, meanwhile, off-farm income reduced farm income despite comparable credit scarcity because formal credit was disproportionately channelled towards non-farm rather than farm households (Rashidin et al., 2020). Ethiopia represents a further, different kind of exception: in the fragile highland agroecology studied by Holden et al. (2004), characterised by soil fragility, low agricultural productivity, high land fragmentation and frequent droughts, the expansion of non-farm employment opportunities does not neatly fit into either the labour-diversion or liquidity-relaxation channels. Instead, it creates a trade-off between short-term poverty reduction and long-term land degradation as labour and attention are drawn away from soil and water conservation investments needed to sustain the resource base. As most existing literature treats off-farm income as a monolithic aggregate, it obscures the different ways in which distinct non-farm channels - remittances, wage employment and self-employment - interact with credit, labour market and agroecological conditions. By evaluating both aggregated and disaggregated off-farm income streams in Cameroon's specific institutional context, this study moves beyond existing literature to explain how differing liquidity profiles and labour allocations shape smallholder agricultural productivity.

3. Data and Methods

The data for this study were collected through a cross-sectional survey of 564 farming households in western Cameroon. The West Region of Cameroon is heavily reliant on agriculture, which constitutes one of the region's main economic activities and employs more than 60% of its economically active population (National Institute of Statistics [INS], 2024). In the absence of an up-to-date national agricultural census, which would provide accurate information on the size of the farming population in the region, the sample size was determined using Cochran's formula (1977), which is commonly used for large or poorly documented populations. Farmers were selected using a three-stage sampling plan. In the first stage, subdivisions with the highest agricultural production density were selected from among the four divisions in western Cameroon with the highest agricultural production density, known as the 'Barn of Cameroon', bringing the total number of subdivisions to seven. In the second stage, 42 enumeration areas² (ZDs) were randomly selected from BUCREP³ cartographic maps, proportional to population size. This comprised 25 urban and 17 rural zones. To ensure balanced representation between sectors, the final stage involved randomly selecting 11 farmers from each urban ZD and 17 from each rural ZD. This resulted in a sample of 564 farmers. The survey covered in detail crop outputs, inputs, farm income, off-farm income, and other socio-economic characteristics of the farmers and their farms.

The agricultural household model is our framework. Like in many agricultural studies as Yu sheng et al. (2019), we assume that a representative farm production function takes the Cobb-Douglas form:

$$Y = AL^\alpha K^\beta N^\gamma \quad (1)$$

Where α , β , and γ are parameters, all < 1 . A is production technology. L , K , and N are respectively labour, capital, and land.

To measure agricultural productivity, we used only land productivity because in small-holding in West-Cameroon, it is not easy to know precisely how many hours a farmer or member of his family work on the farm a day/week/year. Land productivity, defined as output per unit of cultivated area, is a single-factor productivity indicator that can be calculated directly from a single data source, such as a farm or household survey. This is a key advantage in contexts where data is scarce, which is typical of developing countries (FAO, 2018).

Dividing N into both sides of equation (1) and taking the logarithm, we can derive farmland productivity:

$$\ln\left(\frac{Y}{N}\right) = \ln A + \alpha \ln L + \beta \ln K + (\gamma - 1) \ln N \quad (2)$$

This baseline model is used to estimate the land productivity in addition to socioeconomic characteristics of the farmers and their farms such as off-farm income, farmer's education level, farmer's gender, farmer's access to credit, household size, and farmland fertility. To identify the impact of farm input choices on land productivity, we include these socioeconomic characteristics in the baseline model:

$$\ln(y_i) = \alpha_0 + \alpha_1 \ln L_i + \alpha_2 \ln N_i + \alpha_3 \ln K_i + \alpha_4 \text{Offarm}_i + \alpha_5 \text{Offarm}_i^2 + \beta X_i + \varepsilon_i \quad (3)$$

² An enumeration area is a geographical area designed to accommodate around 200 households.

³ BUCREP stands for the Central Bureau of Census and Population Studies in Cameroon.

Here, $i = \text{farmer}$. α and β are the vector of parameters. y_i is agricultural income⁴ per are (agricultural land productivity). L_i is expenditure on labor during a year. N_i is the land in ares. K_i is the capital, these are expenditures on seed, manure, improved seeds, fertilizer, and pesticides are used as capital. $Offarm_i$ is off-farm income. X_i are a vector of other exogenous farmers/farm variables that influence agricultural productivity; these are farmer's education level, farmer's gender, farmer's access to credit, farmer's experience in farm production, farmer participation in a producer organisation, farmer-owner of land cultivated, marital status of the farmer, household size and farmland fertility. The structural agricultural conditions in Western Cameroon justify excluding distinct variables for irrigation and mechanisation, as production there is almost entirely rain-fed and relies on manual labour using traditional tools. The level of the producer's education, their gender, their experience in agricultural production, their access to credit, their ownership status of the cultivated land, their marital status, and their household size were selected as they constitute the central set of determinants of the adoption of technologies and agricultural performance at household and farm level, as identified in classic literature on the adoption of innovations in the agriculture of developing countries (Feder, Just & Zilberman, 1985). We also considered extension services and market access via a farmer's membership of a peasant organisation. Such organisations are widely documented as a major institutional mechanism through which smallholders in Sub-Saharan Africa access extension services, input supply and market information (Shiferaw et al., 2011). Therefore, including a separate variable for access to extension services would have introduced strong collinearity with participation in a producer organisation without providing additional explanatory power. Table 1 shows the summary statistics of each of the variables used in the analysis.

Table 1: Descriptive statistics by off-farm income status

Variables	Variable names (Definition and Units)	All farmers (mean) N=564	Off-farm income status		Difference
			Without off-farm income (mean) N=160	With off-farm income(mean) N=404	
farmIncome	Total annual farm income (in CFA francs)	652535	459962.3	728801.4	-268839.1***
y	Annual land productivity (in CFA francs)	7904.94	8274.28	7759.58	514.69
labor	Total annual labor for agricultural production (cost in CFA francs)	194349.3	148988.4	212358.6	-63370.17***
land	Farm size (cultivated land in ares)	107.10	89.86	113.89	-24.02**
capital	Annual Capital (expenditures on variable inputs like seed, fertilizer, manure, and pesticides, in CFA francs)	231468.1	65611.52	297153.9	-231542.3
offarm	Total annual off-farm income (in CFA francs)	236824.2	-	236824.2	-
remittance	Annual Off-farm income from transfers and others (in CFA francs)	58865.69	-	58865.69	-
wagemplcom	Annual Off-farm income from wage earnings (in CFA francs)	45554.26	-	45554.26	-
selfempl	Annual Off-farm income from self-employment (in CFA francs)	132404.3	-	132404.3	-
gender	Farmer's gender (1 if a woman and 0 otherwise)	0.82	0.89	0.80	0.09***
age	age of farmer (in years)	44.08	44.21	44.02	0.19
experience	Farmer's experience in farm production (Number of years)	23.61	25.26	22.95	2.30*
educat	Farmer's education level (0 if no education, 1 if has primary education level, and 2 if has secondary education level or higher)	1.17	1.15	1.17	-0.03

⁴ The sum of crops in value. Most smallholding farms in West-Cameroon have a large share of land in mixed cropping. In order to take into account the entire production of this mixed farming, we have opted for the sum of these different crops in value.

fertility	Evolution of the farmland fertility over the past 5 years (0 if the farmland fertility has declined, 1 if soil fertility has not changed and 2 if the farmland fertility has increased)	1.01	0.96	1.03	-0.07
credit	Farmer's access to credit (1 if access to credit, 0 otherwise)	0.34	0.26	0.37	-0.11**
Hsize	Household size (number of persons)	6.59	6.17	6.76	-0.59**
asso	Farmer participation in a producer organization (1 if a member of a producer organization, 0 otherwise)	0.69	0.69	0.69	-0.001
owner	Ownership of land cultivated (1 if owner, 0 otherwise)	0.89	0.86	0.91	-0.05*
maritalstatus	Marital status of the farmer (1 if married, 0 otherwise)	0.80	0.78	0.81	-0.03

Note: *, **, and *** indicate that difference between farmers without off-farm income and farmers with off-farm income is statistically significant at 10, 5, and 1 percent levels respectively

A square term of off-farm income ($Offfarm_i^2$) has been added to the regression to capture the potential non-linear relationship between land productivity and off-farm income ($Offfarm_i$).

Off-farm income variable in the model may be correlated with the error term. Farm income can be invested in the nonfarm economy, and nonfarm income can be invested in agricultural production. To address this potential endogeneity problem, we used the forecast values of off-farm income in the land productivity equation. And Heckman's two-step procedure is used to resolve the problem of selection bias in the land productivity equation.

Table 1 shows descriptive statistics on all the variables used in our analysis for households with and without off-farm income. Households with off-farm represent 72% while households without off-farm represent 28% of the total households surveyed. In this table, 564 farmers of West-Cameroon are considered.

Table 1 presents significantly larger cultivated plots and higher expenditures on labor among farmers with off-farm income compared to those without off-farm income. The households that had off-farm income were slightly larger (6.8 vs. 6.2 members) and had a higher farm income (728 801 vs. 459 962 Fcfa). A larger proportion of farmers with off-farm income were the owner of their cultivated land and had access to credit compared to their counterparts without off-farm income. However, the number of years of experience in agricultural production is significantly higher among farmers without off-farm income. Moreover, the farmers without off-farm income had a higher proportion of female farmers.

4. Results and Discussion

In the context of credit and labour market failures, the link between off-farm and farm activities transits or passes through the effect of income from off-farm activities on input demand. Thus, we will first present the impact of off-farm income on input demand (4.1), then their effect on farm productivity (4.2).

4.1 Off-farm income and agricultural input

Table 2 shows the estimated effects of off-farm income (aggregated (I) and disaggregated (II)) and other variables on input demand. Ordinary least squares regression was used to estimate input demand. In the absence of selection bias vis-à-vis the input demand equations, we are led to estimate these latter by the OLS.

We note that off-farm income has a positive and statistically significant impact on input demand (model I), especially off-farm income from remittance and self-employment (model II). In analysing the effect of off-farm income as a whole, Key (2020) also found that it has a positive impact on agricultural inputs.

Table 2 shows that credit access has a positive and statistically significant effect on input demand. In contrast to male farmers, female farmers negatively impact the demand for inputs, probably because women farmers tend to be less well off than men (with an average annual income of 517 753 vs. 976 920 Fcfa). Indeed, women in Africa, and in Cameroon in particular, are held back by customary laws that restrict their access to land ownership. This excludes them from bank loans due to a lack of collateral. Furthermore, they are solely responsible for unpaid domestic tasks and chores, which significantly reduces the time they can devote to paid work. Soil fertility and household size have a positive effect on input use (except on capital). Indeed, this could be because high production from the fertility of cultivated plots would lead to a high demand for labor for their maintenance. Similarly, increasing the size of the household will also increase the labor force as in Pfeiffer et al. (2009). As much as being the owner of cultivated land has a positive impact on the demand for labor, being married, on the other hand, reduces this demand as well as demand for total inputs. From an economical point of view, land ownership significantly stimulates labour demand, as tenure security encourages long-term, labour-intensive plot investments. Marital status optimises the use of internal

household resources, minimising the need for external production expenditure and allowing uncompensated family labour to substitute for external hired labour.

Table 2: Estimation of the off-farm income – inputs demand relationship ^a

Variables	With aggregated off-farm income (I)			With disaggregated off-farm income (II)		
	total input	labor	capital	total input	labor	capital
offfarm	0.12***	0.06***	0.05***	-	-	-
remittance	-	-	-	0.16***	0.01	0.15***
wagemplcom	-	-	-	0.03	0.02	0.002
selfempl	-	-	-	0.13***	0.10***	0.03*
gender	-78300.00***	-67000.00***	-12700.00	-89300.00***	-64700.00***	-25800.00*
experience	961.71	940.77	-3.52	947.49	932.3	-5.33
educat	16756.41	11492.78	5522.22	21960.48	11349.44	10867.95
fertility	60226.60***	58722.81***	1418.20	59319.57***	60137.43***	-902.03
credit	83131.70***	59015.34***	24072.09*	82501.16***	54642.27***	27834.44**
hsize	18877.07***	16842.66***	2106.85	18942.63***	17260.36***	1741.65
asso	39212.15	30083.09	8522.33	41335.19*	32028.66*	8808.17
owner	50979.02	60317.66**	-8979.24	52116.17	63179.45**	-10800.00
maritalstatus	-50500.00*	-46400.00**	-5763.29	-52200.00*	-48700.00**	-4844.3
Constant	24242.04	-28900.00	55878.98*	26815.21	-35000.00	64114.57**
Nombre d'obs	561	561	562	561	561	562
F-Fisher	19.01	21.68	4.26	16.37	18.78	5.43
Prob > F	0.00	0.00	0.00	0.00	0.00	0.00
R-Squared	0.26	0.28	0.07	0.26	0.29	0.11
Adj R-squared	0.24	0.27	0.05	0.25	0.27	0.09
VIF	1.25	1.25	1.25	1.23	1.23	1.23

Note ^a: *, **, *** on the coefficients indicate statistical significance at 10%, 5%, and 1% levels, respectively.

4.2. Off-farm income and productivity

Table 3 presents the regression for the impact of off-farm income on agricultural land productivity. Heckman's two-step procedure is used to resolve the problem of selection bias in the land productivity equation with the forecast values of off-farm income (to tackle the endogeneity problem). The estimated results are respectively with aggregated and disaggregated off-farm income.

We note in Table 3 that off-farm income is positive and statistically significant at the 5% level. Off-farm income significantly increases farm productivity. This result is consistent with some empirical results (Reardon *et al.*, 1994; Kilic *et al.*, 2009; Babatunde and Qaim 2010; Adelekan and Omotayo, 2017; Anang, 2019; Anang and Apedo, 2023). In fact, as Reardon *et al.* (1994) already said, in a context of credit market failure, as in most African countries (here in Cameroon), off-farm income would be a way for farmers to lift the financial constraint to buy the inputs necessary to boost their agricultural productivity.

The examination of the different components of off-farm income on farm productivity shows that, contrary to De Brauw and Giles (2008) and Akudugu (2016), who found that remittances did not bring productive investment in the farm, the off-farm income which impacts (here, positively) agricultural productivity comes from the remittance. This result is also confirmed in the work of Ngoura and Gankou (2024) in Cameroon. Otherwise, off-farm wage income and self-employment, even if they have a negative sign, they have no statistically significant impact on agricultural productivity. This is because wage employment and self-employment are more restrictive in terms of time. In fact, remittances have a positive and statistically significant impact on productivity. As unearned transfers, they provide direct liquidity to purchase productivity-enhancing inputs, without diverting local family labour away from the farm. By contrast, off-farm wage employment and self-employment yield negative but statistically insignificant coefficients. This reflects the competing forces of liquidity and labour: wage employment requires rigid time commitments, pulling critical labour away from farm management, while self-employment necessitates the continuous reinvestment of working capital, competing directly with the farm for scarce funds. Consequently, the structural time and resource

constraints of wage and self-employment neutralize any potential cash-flow benefits, leaving their net impact on agricultural productivity statistically indistinguishable from zero.

Table 3: Estimation of the off-farm income – land productivity relationship^a

Variables	With aggregated off-farm income (I)		With disaggregated off-farm income (II)	
	Coefficient ^b	T-statistic	Coefficient ^b	T-statistic
lnlabor	0.07	1.50	0.17**	2.10
lnland	-0.64***	-12.15	-0.64***	-7.04
lncapital	0.05	1.25	0.04	0.58
offfarmIcom_predit	1.21e-06**	2.47	-	-
remittance_predit	-	-	3.32e-06***	2.73
wagemplIcom_predit	-	-	-1.20e-06	-0.70
selfempl_predit	-	-	-8.54e-07	-0.52
gender	0.38**	2.85	-0.14	-0.42
educat	-0.10*	-1.78	0.15	0.81
fertility	0.24***	3.78	0.22**	2.04
Inverse Mills ratio	-0.88**	-2.07	-1.43*	-1.82
Constant	9.51***	16.56	9.7***	8.16
Number of obs	561		561	
Censored obs	159		159	
Uncensored obs	402		402	
Wald chi2(.)	Wald chi2(7)= 183.93		Wald chi2(9) = 75.14	
Prob > chi2	0.00		0.00	

Note^a: There is a strong correlation between the off-farm income variable and its square term, so the square term of off-farm income has been removed from the model.

^b: *, **, *** Indicate statistical significance at 10%, 5% and 1% levels, respectively.

In both models (with aggregated and disaggregated off-farm income) the variables relating to agricultural inputs have the same sign. We observe that an increase in labor expenditure of 1% makes land productivity increase by 0.175% (in model II). However, we note the inverse relationship between farm size and land productivity. An increase in the land of 1% decreases land productivity by 0.642% (in the model I) and 0.643% (in model II). This result is consistent with those of Chand et al. (2011) and Sheng et al. (2019) who found that an inverse farm size–productivity relationship persists for most small-sized farms. In fact, as farms grow in size, their increased reliance on hired labour introduces moral hazard and agency costs. This results in lower labour intensity and diluted managerial oversight per unit of land. These structural market failures consequently prevent larger farms from achieving the same level of land productivity as labour-intensive smallholders.

Unlike Palacios-López and López (2015) and Campos et al. (2016) gender has a positive effect on land productivity and is significant at the 5% level (model I). This situation is certainly because, in the study area, female farmers have fewer off-farm jobs than male farmers. They, therefore, spend more time in their plot than male farmers. In addition, being a female farmer has a positive effect on remittances⁵, which have a positive impact on farm productivity.

As with Pfeiffer et al. (2009), our analysis of models I and II reveals that greater fertility of the cultivated plot leads to a greater increase in agricultural productivity. Meanwhile, the level of education of farmers has a significantly negative impact on agricultural productivity (model I), which implies that the educated farmers decrease their involvement in agricultural production activities and move to off-farm activities, in particular, to wage off-farm employment (see Table 3A in the appendix). This result is similar to that of Rashidin et al. (2020). Economically, this finding reflects a sharp increase in the opportunity cost of farm labour: higher levels of formal education increase the value of human capital in the non-farm labour market, incentivising farmers to reallocate their time and effort towards off-farm wage employment. Consequently, farming becomes a secondary activity, suffering from reduced direct supervision and less intensive plot management by the household head, who instead relies on lower-skilled labour.

⁵ See table 3A in the appendix.

Therefore, the labour diversion effect away from core agriculture outweighs the direct managerial benefits of education, ultimately reducing overall plot productivity.

5. Conclusion and policy implications

In contexts where smallholder farmers face credit constraints when investing or dealing with agricultural risks, engaging in non-agricultural activities can be a useful means of boosting agricultural productivity by enabling the purchase of agricultural inputs. However, these activities could also divert resources away from the agricultural sector. Therefore, it is important to identify which non-agricultural activities can be carried out alongside farming without negatively impacting it. This study aimed to identify these activities. The results show that off-farm income has a positive and statistically significant impact on the demand for farm inputs, particularly when derived from remittances or self-employment. Off-farm income also significantly increases farm productivity, particularly when it is derived from remittances. Based on the findings, it is concluded that diversifying farmer income sources is important, especially with regard to remittances, and off-farm income from self-employment. Moreover, governments should create more self-employment opportunities to increase and diversify farmer income sources. Indeed, given the proven positive impact of non-agricultural self-employment on agricultural productivity and the relatively low barriers to setting up and running a small business (Nagler and Naudé, 2017), it is clear that this is an attractive option for smallholder farmers. Furthermore, given the seasonal nature of agricultural activities, self-employment in small businesses offers smallholder farmers greater flexibility in terms of working hours than most salaried jobs (Mutsani *et al.*, 2025). Consequently, governments and non-governmental organisations must implement programmes that encourage smallholder farmers to also engage in off-farm activities as self-employed workers. Whilst encouraging farmers to invest in sustainable agriculture, these programmes could include grants, advisory support, short training courses and investments in infrastructure such as roads and electricity.

In the Cameroonian context, this could be achieved by strengthening the network of Common Initiative Groups (CIGs) and cooperatives that are currently supported by the Fonds National de l'Emploi and PIAASI (Programme Intégré d'Appui aux Acteurs du Secteur Informel). These organisations provide start-up grants and short business management training to rural youth and women. Extending these schemes to farm households seeking to diversify into small-scale trade, agri-food processing or artisanal activities would operationalise the self-employment channel identified in this study.

Financial inclusion initiatives are equally important for converting off-farm earnings into productive agricultural investment. Expanding the reach of community microfinance institutions, such as the MC² network (Mutuelles Communautaires de Croissance), and village savings and loan associations (tontines), would enable farmers to save remittance and self-employment income between harvests, while also providing them with access to short-term credit for purchasing inputs. Strengthening the decentralised extension agents of the Ministry of Agriculture and Rural Development (MINADER) as relay points for advisory services would help ensure that the additional capital generated by off-farm income is actually channelled into productivity-enhancing inputs and practices, rather than into non-farm consumption.

With regard to remittance transaction costs specifically, expanding digital financial systems in rural areas via mobile money infrastructure (e.g. MTN Mobile Money and Orange Money) would reduce costs and speed up both domestic and international transfers. Furthermore, the government should reduce the transaction costs associated with remittances more broadly, including on international transfers, which remain an important source of off-farm income.

These household income sources will increase capital to acquire agricultural inputs necessary to increase agricultural productivity and help achieve the Sustainable Development Goals.

6. Study limitations

The limitations of this study should be acknowledged. First, we would like to clarify that the data used in our study is cross-sectional, meaning that no dynamic analysis was performed. Therefore, the relationships identified between off-farm income and agricultural productivity should be understood as associations rather than as strictly causal effects. Undoubtedly, an analysis using longitudinal data would provide more information; a panel-data approach, which follows the same households over several agricultural seasons, would allow these dynamics to be identified and would strengthen causal analysis.

Second, the income variables, particularly the off-farm income and remittances, were self-reported by the respondents. Such data are susceptible to recall bias and under- or over-reporting, particularly with regard to irregular or informal income sources. This can result in measurement error and bias the estimated coefficients. Future studies could address this issue by combining survey data with administrative or mobile money transaction records, when available.

Third, the regional specificity of Western Cameroon means that the findings cannot be generalised to other regions of Cameroon or to other sub-Saharan African countries. Conducting this analysis in other regions of Cameroon and other sub-Saharan African countries would help to establish whether the identified relationships here hold more generally.

Fourth, excluding total factor productivity limits our ability to measure overall efficiency gains across all productive inputs. However, given the severe measurement constraints and recall biases associated with quantifying informal labour in smallholder settings, land productivity remains the most reliable and standard metric.

These limitations naturally motivate future research using longitudinal or panel data, which should extend the analysis to other regions of Cameroon and other sub-Saharan African countries.

References

- Adelekan YA, Omotayo AO (2017). Linkage between rural non-farm income and agricultural productivity in Nigeria: a Tobit-two-stage least square regression approach. *The Journal of Developing Areas* 51(3):317-333. DOI: 10.1353/jda.2017.0075
- Akudugu MA (2016). Agricultural productivity, credit and farm size nexus in Africa: a case study of Ghana. *Agricultural Finance Review* 76(2):288-308. <https://doi.org/10.1108/AFR-12-2015-0058>
- Anang BT (2019). Effect of off-farm work on agricultural productivity: empirical evidence from northern Ghana. *Agricultural Science & Technology* 11(1):49-58. DOI: 10.15547/ast.2019.01.008
- Anang BT, Apedo CK (2023). The influence of off-farm work on farm income among smallholder farm households in northern Ghana. *Cogent Economics & Finance* 11(1):2196861. DOI: 10.1080/23322039.2023.2196861
- Babatunde RO, Qaim M (2010). Impact of off-farm income on food security and nutrition in Nigeria. *Food Policy* 35(4):303-311. <https://doi.org/10.1016/j.foodpol.2010.01.006>
- Campos Ana Paula de la O, Katia AC, Alberto Prieto Patron (2016). How Does the Choice of the Gender Indicator Affect the Analysis of Gender Differences in Agricultural Productivity? Evidence from Uganda. *World Development* Vol. 77, P: 17-33. <https://doi.org/10.1016/j.worlddev.2015.08.008>
- Chang HH, Boisvert RN (2009). The Conservation Reserve Program, Off-Farm Work, and Farm Household Technical Efficiencies. Working Paper No. 57034. Cornell University, Department of Applied Economics and Management. <https://ideas.repec.org/p/ags/cudawp/57034.html>
- Chen X (2025). The role of modern agricultural technologies in improving agricultural productivity and land use efficiency. *Frontiers in Plant Science* Vol. 16, P: 1675657. doi: 10.3389/fpls.2025.1675657
- Cochran, W. G. (1977). *Sampling Techniques* (3rd ed.). New York: John Wiley & Sons.
- De Brauw A, Giles J (2008). Migrant labor markets and the welfare of rural households in the developing world: Evidence from China. Policy Research Working Paper 4585. The World Bank. <https://doi.org/10.1596/1813-9450-4585>
- Diagana BN, Kelly VA (1994). Noncropping Income and · Cropping Productivity in the Senegalese Peanut Basin. Unpublished, Dept. of Agr. Econ., Michigan State University. https://scholar.google.com/scholar?hl=fr&as_sdt=0%2C5&q=Non+cropping+Income+and+%C2%B7+Cropping+Productivity++in+the+Senegalese+Peanut+Basin&btnG=. Accessed 17 May 2020
- Diirro GM (2013). Impact of Off-farm Income on Agricultural Technology Adoption Intensity and Productivity Evidence from Rural Maize Farmers in Uganda. Working Paper 11, International Food Policy Research Institute. <http://www.ifpri.org/sites/default/files/publications/usspwp11.pdf>
- Drall A, Mandal SK (2025). Does Non-Farm Income Raise Farm Productivity? New Evidence from India. *The Journal of Development Studies* 61(9):1526-1547. <https://doi.org/10.1080/00220388.2025.2467661>
- Dsouza A, Mishra AK, Sonoda T (2020). Impact of Casual and Permanent Off-Farm Activities on Food Security: The Case of India. In: Gomez y Paloma S, Riesgo L, Louhichi K (Eds.), *The Role of Smallholder Farms in Food and Nutrition Security*. Springer, Cham. https://doi.org/10.1007/978-3-030-42148-9_10
- Egyei RK, Adzovor PHY (2013). Household non-farm income: any influence on agricultural productivity in rural Ghana? *Developing Country Studies* 3(9):79-90.
- FAO (2018). *Guidelines for the measurement of productivity and efficiency in agriculture*. Rome.
- Fbi JCH, Ranis G (1964). *Development of the labor surplus economy: theory and policy*. New Haven, Conn.: Econ. Growth Center, Yale Univ. <https://www.cabdirect.org/cabdirect/abstract/19651801300>. Accessed 16 May 2020
- Feder G, Just RE, Zilberman D (1985). Adoption of Agricultural Innovations in Developing Countries: A Survey. *Economic Development and Cultural Change* 33(2):255-298. <https://doi.org/10.1086/451461>
- Fernandez-Cornejo J, Mishra AK (2007). Off-farm income, technology adoption, and farm economic performance. <https://agris.fao.org/agrissearch/search.do?recordID=US201300116774>. Accessed 17 May 2020
- Haggblade S, Reardon T, Hazell P (2005). The rural non-farm economy: Pathway out of poverty or pathway in? International Food Policy Research Institute. *The future of small farms: Proceedings of a research workshop*, Wye, UK, June 26-29, 2005. Washington, DC. https://www.researchgate.net/publication/285630998_The_rural_nonfarm_economy_Pathway_out_of_poverty_or_pathway_in. Accessed 17 May 2020
- Holden S, Bekele Shiferaw, Pender J (2004). Non-farm income, household welfare, and sustainable land management in a less-favored area in the Ethiopian highlands. *Food Policy* 29(4):369-392. <https://doi.org/10.1016/j.foodpol.2004.07.007>

- House FJ (2006). *Agricultural Programs, Terms, and Laws*. Nova Publishers.
- Iiyama M, Kariuki P, Kristjanson P, Kaitibie S, Maitima J (2008). Livelihood diversification strategies, incomes and soil management strategies: a case study from Kerio Valley, Kenya. *Journal of International Development* 20(3):380-397. <https://doi.org/10.1002/jid.1419>
- Institut National de la Statistique - INS. (2024). *Annuaire statistique de la région de l'Ouest*, édition 2024. Agence Régionale de l'Ouest. <https://ins-cameroun.cm/wp-content/uploads/2025/09/ANNUAIRE-Edition-2024-Francais-Final-a-Imprimer.pdf>
- Janvry A de, Sadoulet E (2001). Income Strategies Among Rural Households in Mexico: The Role of Off-farm Activities. *World Development* 3(29):467-480. [https://doi.org/10.1016/S0305-750X\(00\)00113-3](https://doi.org/10.1016/S0305-750X(00)00113-3). Accessed 17 May 2020
- Key N (2020). Off-farm income, credit constraints, and farm investment. *Journal of Agricultural and Applied Economics* 52(4):642-663. doi:10.1017/aae.2020.25
- Kilic T, Carletto C, Miluka J, Savastano S (2009). Rural nonfarm income and its impact on agriculture: evidence from Albania. *Agricultural Economics* 40(2):139-160. <https://doi.org/10.1111/j.1574-0862.2009.00366.x>
- Lewis WA (1954). Economic Development with Unlimited Supplies of Labour. *The Manchester School* 22(2):139-191. <https://doi.org/10.1111/j.14679957.1954.tb00021.x>
- Li J, Song S, Sun G (2022). Non-Farm Employment, Farmland Renting and Farming Ability: Evidence from China. *International Journal of Environmental Research and Public Health* 19(9):5476. <https://doi.org/10.3390/ijerph19095476>
- Ma W, Vatsa P, Zheng H, Rahut DB (2022). Nonfarm employment and consumption diversification in rural China. *Economic Analysis and Policy* 76:582-598. <https://doi.org/10.1016/j.eap.2022.09.010>
- Mishra AK, Fannin JM, Joo H (2014). Off-Farm work, intensity of government payments, and farm exits: Evidence from a national survey in the United States. *Canadian Journal of Agricultural Economics/Revue canadienne d'agroéconomie* 62(2):283-306.
- Mishra AK, Mottaleb KA, Samarendu Mohanty (2015). Impact of off-farm income on food expenditures in rural Bangladesh: an unconditional quantile regression approach. *Agricultural Economics* 46(2):139-148. <https://doi.org/10.1111/agec.12146>
- Mutsami C, Parlasca MC, Qaim M (2025). Evolving Farm and Off-Farm Income Sources and Jobs in Rural Africa. *Journal of International Development* 37(6):1367-1380. <https://doi.org/10.1002/jid.70010>
- Nagler P, Naudé W (2017). Non-Farm Entrepreneurship in Rural Sub-Saharan Africa: New Empirical Evidence. *Food Policy* 67(1):175-191. <https://doi.org/10.1016/j.foodpol.2016.09.019>
- Ngoura N, Gankou JM (2024). Migration and Remittances in Cameroon: What Effects on Agricultural Growth and Household Well-Being. *African Scientific Journal* 3(27):1134-1159.
- Palacios-López A, López R (2015). The Gender Gap in Agricultural Productivity: The Role of Market Imperfections. *The Journal of Development Studies* 51(9):1175-1192. <https://doi.org/10.1080/00220388.2015.1028539>
- Parrot L, De Bon H, Malézieux E, Ganry J, Sotamenou J (2010). Peri-urban horticulture and the agricultural transformation in Africa: a case study in Cameroon. In *XXVIII International Horticultural Congress on Science and Horticulture for People (IHC2010): International Symposium on 921*. pp. 181-186.
- Pfeiffer L, López-Feldman A, Taylor JE (2009). Is off-farm income reforming the farm? Evidence from Mexico. *Agricultural Economics* 40(2):125-138. <https://doi.org/10.1111/j.1574-0862.2009.00365.x>
- Rashidin MS, Javed S, Liu B, Jian W (2020). Ramifications of Households' Nonfarm Income on Agricultural Productivity: Evidence From a Rural Area of Pakistan. *SAGE Open* 10(1):2158244020902091. <https://doi.org/10.1177/2158244020902091>
- Reardon T, Crawford E, Kelly V (1994). Links Between Nonfarm Income and Farm Investment in African Households: Adding the Capital Market Perspective. *American Journal of Agricultural Economics* 76(5):1172-1176. <https://doi.org/10.2307/1243412>
- Savadogo K, Reardon T, Pietola K (1998). Adoption of Improved Land Use Technologies to Increase Food Security in Burkina Faso: Relating Animal Traction, Productivity, and Non-Farm Income. *Agricultural Systems* 58(3):441-46. [https://doi.org/10.1016/S0308-521X\(98\)00040-7](https://doi.org/10.1016/S0308-521X(98)00040-7)
- Shiferaw, B., Hellin, J., & Muricho, G. (2011). Improving market access and agricultural productivity growth in Africa: what role for producer organizations and collective action institutions? *Food Security*, 3(4), 475-489.
- Shittu AM (2014). Off-farm labour supply and production efficiency of farm household in rural Southwest Nigeria. *Agricultural and Food Economics* 2(8):1-21. doi:10.1186/s40100-014-0008-z

Appendix

Table 3A: Tobit estimation of the off-farm income ^a

Variables	offarm	remittance	wagemplIcom	selfempl
labor	0.38***	-0.01	0.42	0.43**
land	-98.76	-68.38	-721.1	335.6
capital	0.59***	0.51***	0.05	-0.06
gender	-269777***	104884***	-1.038e+06***	-253320***
experience	-2605	-773.8	-17200	-3872
educat	58391	-58791**	576417***	76887
fertility	81241**	57062***	53520	67,654
credit	62638	-4537	40553	128238*
hsize	19105**	10065**	43208	12845
asso	27330	5.9	333031	7327
owner	164737**	116212**	-101064	58052
maritalstatus	4031	-19920	-120147	190135**
Constant	-169808	-314670***	-1.982e+06***	-565122***
Nombre d'obs	560	560	560	560
Chi-square	110.11	49.86	49.81	75.09
Prob > chi2	0.00	0.00	0.00	0.00
Pseudo r-squared	0.01	0.01	0.04	0.01
sigma	524858.2	293275.2	1242663	606114

Note ^a : *, **, *** on the coefficients indicate statistical significance at 10%, 5%, and 1% levels, respectively.

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