The Nexus Between Agricultural Aid and Poverty Alleviation in Sub-Saharan Africa

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Abstract

The primary objective of this study is to examine the effectiveness of foreign public aid in reducing poverty in sub-Saharan African countries. Employing a methodological framework that encompasses linear panel and simultaneous equations models, we aim to assess the hypothesis that such aid contributes to poverty reduction by enhancing agricultural productivity. Our analysis yields evidence indicating a positive and statistically significant effect of international aid allocated to the agricultural sector on agricultural productivity. A 1% increase in aid per worker is associated with a 0.198% increase in agricultural productivity, holding other factors constant. Furthermore, our findings elucidate that increases in agricultural productivity exert a mitigating influence on poverty levels within the sub-Saharan African context. A 1% increase in agricultural productivity is associated with a 0.02 percentage point decrease in the poverty headcount ratio, on average, all else being equal. The results indicate that foreign aid affects poverty and agricultural productivity in the selected countries. Therefore, it is suggested that international donors increase their aid to foreign agriculture, focusing on methods that boost productivity. Consequently, our results highlight the imperative of maximizing the productivity-oriented outcomes of agricultural aid, thereby enhancing its effectiveness in efforts to reduce poverty.

Keywords: agriculture, official development assistance, poverty reduction

JEL codes *:* F35, O13, Q14

1. Introduction

The number of people living in poverty in the sub-Saharan region of Africa grew from 278 million in 1990 to 433 million in 2018 (World Bank, 2020). In 2018, most of the global poor lived in sub-Saharan Africa, and the situation is only likely to worsen with the impact of COVID-19, the levels of over-indebtedness in some countries, and the prevalence of corruption. Moreover, extreme poverty remains mainly rural: about 80% of the extremely poor live in rural areas (Castañeda et al., 2018), owing both to large rural populations and a higher poverty incidence in these areas. For instance, in Côte d'Ivoire, poverty incidence is estimated at 56.8% in rural areas and 35.9% in urban areas (African Development Bank, 2018). Incomes of the rural poor depend greatly on agricultural activities, either from work on their farms or from agricultural wage employment.

The first two Sustainable Development Goals (SDGs) of the United Nations are to end hunger and poverty. Achieving that entails the realization of food security and improved nutrition through sustainable agriculture by 2030, and will require a doubling of agricultural productivity and the incomes of small-scale food producers, especially women, indigenous peoples, and family farmers. Over the 30 years to 2014, the agricultural labor force expanded in Africa, but productivity per agricultural worker improved by a factor of only 1.6, compared with 2.5 in Asia (NEPAD, 2014). Value added per worker also remains very low in agriculture compared with other sectors. Data from the World Bank (WDI, 2020) shows that the value added per worker in agriculture increased from 6.27% to 8.61% between 2010 and 2019, while in the same period, the value added per worker in services rose from 33.37% to 36.52% and in industry decreased from 60.36% to 54.87%.

Numerous factors have been proffered as explanations for the diminished agricultural productivity in sub-Saharan Africa, with one significant factor being the reduction in public investment in agriculture, thereby detrimentally impacting its growth and overall performance (Islam, 2011). This decline in investment can be attributed to two primary sources: foreign agricultural aid and domestic agricultural expenditures. Foreign aid assumes various forms, encompassing financial support, technical expertise, or the provision of food through projects or programs, often materializing in the guise of grants or concessional loans. The term "official development assistance" (ODA) pertains to formal financial flows from one nation to another, constituting a minimum of 25% in the form of grants and directed towards economic development or enhancements in welfare. Additionally, non-official aid streams are extended by non-governmental organizations. As asserted by Kalibata (2010), foreign aid holds the potential to fulfill the essential requirements of African farmers, encompassing enhanced inputs such as seeds and soils, establishment of connecting roadways to facilitate market access, agribusiness credit, private sector investments to stimulate growth, and training coupled with technology to address the challenges posed by climate change.

Through these channels, it is hoped that foreign aid can boost agricultural productivity and thus accelerate economic growth and raise incomes for communities and countries in sub-Saharan Africa. However, aid effectiveness is one of the hotly debated topics in development economics. In Africa, the contrast between the volume of international aid and the limited results on the ground remains of great concern to governments, international organizations, and policymakers. Indeed, the Organization of Economic Co-operation and Development (OECD, 2023) reported that in the 2020–2021 period, the sub-Saharan Africa region received the largest portion of the world's ODA[1] (40.1%), followed by South and Central Asian countries (19.3%) (cf. table 1). However, the region's Human Development Index (HDI) in 2021 was 0.54, compared with a world average of 0.71 (UNDP, 2023). The United Nations Development Programme (UNDP) data presented in Table 2 show that sub-Saharan Africa is the world's least developed region and has the lowest life expectancy. Thus, the a need to assess the effectiveness of aid in this specific region.

[1] In this paper, "foreign aid" and "international aid" are equivalent to ODA.

Table 1: Regional Distribution of ODA by Individual Development Assistance Committee Donors and Multilateral Agencies

Region	2010–2011	2015–2016	2020–2021
Sub-Saharan Africa	40.7	37.2	40.1
South and Central Asia	19.2	19.7	19.3
Other Asia and Oceania	13.1	11.2	10.4
Middle East and North Africa	10.6	14.3	14.8
Europe	7.0	8.0	7.0
Latin America and Caribbean	9.4	9.5	8.4

Source: OECD (2023)

Notes: Data are in percentage of total gross disbursements and are cross-country averages

Table 2: Comparison of Human Development Index (HDI) by Region (2021)

Regions	HDI	Life expectancy at birth (years)	Expected years of schooling (years)	Mean years of schooling (years)	Gross national income (GNI) per capita (2017 PPP in USD)
Arab States	0.708	70.9	12.4	8.0	13,501
East Asia and the Pacific	0.749	75.6	13.8	7.8	15,580
Europe and Central Asia	0.796	72.9	15.4	10.6	19,352

Latin America and the Caribbean	0.754	72.1	14.8	9.0	14,521
South Asia	0.632	67.9	11.6	6.7	6,481
Sub-Saharan Africa	0.547	60.1	10.3	6.0	3,699

Source: UNDP (2023)

There is no consensus over the effectiveness of foreign aid. There is a micro–macro paradox regarding the impact of aid on economic development (Radelet, Clemens, & Bhavnani, 2004; Ndikumana, 2012), in that positive effects have been found at the micro level, but it is difficult to identify the impact of foreign aid at the macro level. This difficulty has led to a growing body of work highlighting the importance of focusing the analysis of aid effectiveness at the sectoral level (Lee & Izama, 2015; Michaelowa & Weber, 2006; Ndikumana, 2012). The evidence from a number of studies of the effects of aid on sector-specific outcomes suggests that targeted aid interventions can achieve positive results at the micro level (Dreher, Nunnenkamp, & Thiele, 2008; Gyimah-Brempong, 2015; Pickbourn & Ndikumana, 2016; Yogo & Mallaye, 2015).

Although there is a substantial body of literature on the effects of aid on economic growth, there have been relatively few studies that have investigated the impact of agricultural aid on agricultural outcomes, along with the alleviation of poverty. Norton, Ortiz, and Pardey (1992) conducted a study on the topic; however, their investigation was limited to examining the impact of aggregate aid on agricultural growth. The present study fits into the new strand of the literature on aid and development that focuses on sectoral-level analysis, moving more recently towards micro-level analysis. Specifically, it investigates the effect of agricultural aid on poverty reduction through an improvement in agricultural productivity. The study uses OECD aid data that are disaggregated by sector, and the econometric analysis uses panel data techniques that enable us to control for country-specific effects using fixed-effects estimations. To address the potential endogeneity caused by reverse

causation between aid and poverty variables, a simultaneous equations model was also estimated for robustness.
The remainder of the paper is structured as follows: Section 2 presents a brief review of the literature, Section 3 describes the data and the econometric estimation methodology, Section 4 presents the results, and the final section provides some concluding remarks.

2. Literature Review

Agricultural growth can contribute to overall national growth and, through this, to poverty reduction. The dual-economy models of Lewis (1954) and his followers (Fei & Ranis, 1961) argue that an increase in agricultural productivity can release labor from agriculture to other sectors without a reduction in agricultural output. Agricultural growth can reduce poverty levels by increasing farm incomes, providing farm employment, and adjusting food prices.
However, this is achievable only under certain conditions: first, a significant proportion of the poor must be engaged in farming; second, higher output must raise incomes to a sufficient extent. In cases in which the increase in output drives down product prices or the costs of production rise as the demand for inputs increases, there may only be a small rise in gross margins. Indeed, if input prices rise proportionately more than output, this may offset any higher gross earnings. Moreover, in cases in which the increase in output is achieved through technical innovations, benefits to poor farmers for whom farming provides the majority of their income may be limited. The adoption of innovative techniques by the poor can be limited by market imperfections that restrict the access of small farmers to key inputs, including credit, and by constraints on their knowledge of the relevant technology (Hazell & Haddad, 2001). Poor farmers may also be more risk-averse than wealthier ones and therefore unlikely to adopt productivity-enhancing techniques.
The other contribution that agricultural output can make to poverty reduction is through the labor market. Although this effect depends in part on the degree to which the rural poor are dependent on wage labor, higher levels of agricultural production are likely to boost the demand for farm labor. There might also be gains to welfare and rural human capital as increased food production and farming incomes improve rural workers' nutrition and allow

for investments in health and education (Timmer, 1997). Another impact on the rural economy may be that of reducing food prices. It has been argued that an increase in output tends to drive down the price of food, hence benefiting consumers and all net purchasers of food. The strength of this effect depends a great deal on the degree to which farm production is tradable and the associated price elasticity of demand. The poverty-reducing effects of enhancing production in the farm sector depend on the net marketing position of the poor and the price elasticity of food demand. Poor net-food-buying households benefit from lower food prices as long as the gain from reduced spending on food exceeds the loss from reduced wage income. Poor net-food-selling producers, by contrast, gain only if productivity grows faster than prices fall (World Bank, 2008). A final linkage may run from a more dynamic farm sector to social capital formation, as increased interactions between farmers, input suppliers, processors, and banks generate the confidence and trust needed to mount new non-agricultural businesses.

The importance of the agricultural sector for the promotion of economic development is supported by evidence from empirical studies. Analyses of the relationship between economic growth and poverty reduction have revealed that general GDP growth has less impact on poverty reduction than growth in the agricultural sector, mainly because of the high level of poverty in the rural areas of developing countries (Ravallion & Datt, 1996; Timmer, 1997). Moreover, in most developing countries, the agricultural sector is an important source of employment and export earnings (Lucas & Timmer, 2005; Thirtle et al., 2001). Gallup et al. (1997) found that every 1% increase in per capita agricultural output led to a 1.61% increase in the income of the poorest 20% of the population. A cross-country analysis conducted by Thirtle et al. (2001) found that on average, every 1% increase in agricultural yields reduced the number of people living on less than US$1 a day by 0.83%. Agricultural productivity growth is crucial for developing countries as it can contribute to development in many ways: increasing income, increasing food security, and reducing poverty.

Regarding the relationship between international aid and poverty reduction, although there have been numerous studies, there is no scholarly consensus. Burnside and Dollar (2000), Collier and Dollar (2002), and Mosley, Hudson, and Verschoor (2004) posited that aid is effective only when certain conditions are in place (e.g., sound policy-making), but others have found that when using proper estimation methods, it is difficult to reject the hypothesis that aid is effective. Mosley and Suleiman (2007) argued that, in addition to size and policy environment, two other factors are relevant for aid effectiveness: stability and inter-sectoral distribution. On the first point, researchers have pointed out that the stability of aid provision can determine its ability to influence expenditure patterns in the long run. On the second point, analyses of various dimensions of sectoral distribution have revealed that aid is effective. Wolf (2007), using a simultaneous equation model (SEM), tested such outcomes as education, health, water, and sanitation and found that the share of ODA provided for education and health seems to have a positive overall effect on outcomes in these sectors, whereas total aid seems to be negatively associated. Dreher et al. (2008) used a panel of 105 countries for the 1970–2005 period to estimate the effects of aid for the education sector (measured as a percentage of GDP) and identified an important and robust positive effect of such aid on net primary school enrolment. Furthermore, Gyimah-Brempong (2015) found a positive and significant effect of health aid on health outcomes in African countries, with a greater effect in countries that increased their domestic health expenditure and those with better governance.

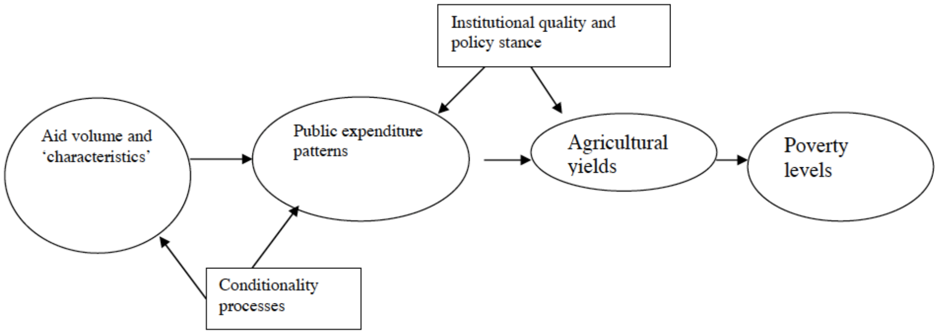
Few studies have examined the link between aid and agriculture outcomes, despite the importance of the agriculture sector in developing countries, particularly in Africa. Ssozi et al. (2017) argued that the agriculture sector received little attention from governments, donors, and foreign investors; thus, they underinvested in African agriculture even though research evidence has shown that higher agricultural productivity can boost economic growth and poverty reduction. The quality of public institutions and levels of economic freedom have also been found to enable agricultural productivity growth and to increase ODA effectiveness. Alabi's (2014) generalized method of moments (GMM) analysis of data on 47 African countries found that in sub-Saharan Africa, foreign agricultural aid has a positive and significant impact on agricultural GDP and agricultural productivity at a 10% significance level, and disaster and conflict have a positive and significant impact on aid receipts at a 5% significance level.

Mosley and Suleiman (2007) provided a conceptual framework to explain the transmission mechanism from aid to poverty alleviation through agricultural yield productivity. The distribution of agricultural aid acts as the trigger for significant transformation. When a recipient country receives financial and technical assistance, the policy stance taken by its government becomes a crucial turning point. An administration dedicated to promoting agricultural policy and environmental practices sets the foundation for success. This commitment establishes a foundation for effective public spending, allocating monies to crucial elements such as agricultural infrastructure, research, and extension services. Enhanced institutional quality promotes effective aid utilization and lays the groundwork for enduring agricultural practices. Farmers benefit from increased institutional support and specific public spending, which provide them with access to advanced technologies, better seeds, and valuable knowledge that increase agricultural productivity. Rural towns experience a significant economic transition as fields become more productive. Increased agricultural yields lead to higher revenues for farmers, which is essential for reducing poverty (Figure 1).

Kaya et al (2013) examined the direct impact of agricultural aid on poverty reduction using a panel dataset of developing countries. As a robustness check, they specified an SEM to account for a feedback relationship among the variables of interest (especially between agricultural aid and poverty). They found that aid given to the agricultural sector is effective in reducing poverty both directly and indirectly through a policy variable representing pro-poor expenditure. However, agricultural productivity was not considered in the transmission mechanism. Our study departs from theirs as we intend to empirically assess two relationships: the link between agricultural aid and agricultural productivity, and that between agricultural productivity and poverty alleviation.

Recently, Ssozi et al. (2017) used the system-GMM approach to examine whether ODA for agriculture and rural development was helping to boost agricultural productivity across 36 countries in sub-Saharan Africa, and found a positive relationship between ODA and agricultural productivity. However, they did not empirically evaluate the possible impact of agricultural productivity on poverty. Building on this literature, our research hypothesis is that aid contributes to increasing agricultural productivity, which in turn improves the population’s living conditions.

Figure 1. Transmission mechanisms from aid to poverty through agricultural yields.



Source: Mosley and Suleiman (2007)

3. Empirical Analysis

The model

This study aims to investigate empirically the effect of agricultural aid on poverty levels in countries in sub-Saharan Africa. We test the hypothesis that aid improves agricultural productivity, which in turn contributes to poverty reduction. Two econometric models are estimated. The first model is a linear panel model. The model is specified as follows:

$$poverty_{i,t} = \alpha_0 + \alpha_1 laidpwo_{i,t-1} + \alpha_2 lagriprod_{i,t} + \alpha_3 lrurpop_{\,i,t} + \alpha_4 lgovexp_{i,t} + \alpha_5\, polstab_{i,t} + \mu_{i,t} \quad (3.1)$$

where poverty is the dependent variable, measured by the headcount ratio obtained from the Povcalnet database. The explanatory variables are:

- The logarithm of agricultural aid per worker ($laidpwo$), drawn from the OECD's Creditor Reporting System (CRS) database, which covers donors' bilateral and multilateral aid and other resource flows to developing countries and countries in transition. Aid is measured in nominal terms (current prices), and divided by the number of workers in the agricultural sector. The lag of this variable is included in the model because economic shocks, like a flow of capital, may take time to play out,

- The logarithm of agricultural productivity ($lagriprod$), measured by the value added per worker in agriculture. Agriculture comprises value added from forestry, hunting, and fishing, as well as the cultivation of crops and livestock production,
- The logarithm of rural population as a percentage of total population ($lrurpop$), included as a proxy for employment in the agriculture sector (Kaya et al., 2008),
- The logarithm of government expenditures ($lgovexp$), to capture the effect of government spending in the agriculture sector, which could be an approximation of government spending on agriculture, as we were unable to obtain this data for countries in the sample, and,
- an indicator of governance level in the country, namely political stability ($polstab$).

The second model is a simultaneous equations model, expressed as follows:

$$\begin{cases} poverty_{it} = \alpha_1 laidpwo_{i,t-1} + \alpha_2 lagriprod_{i,t} + \theta' X_{it} + \varepsilon_{it} & (3.2) \\ laidpwo_{it} = \gamma_1 lagriprod_{i,t} + \gamma' X_{it} + \delta_{it} & (3.3) \\ lagriprod_{it} = \beta_1 laidpwo_{i,t-1} + \gamma' Z_{it} + \mu_{it} & (3.4) \end{cases}$$

The first Equation (3.2) explains poverty levels. The main explanatory variables in this equation are agricultural productivity, measured by the value added per worker in agriculture, and agriculture aid per worker, one year lagged. Data are in constant 2010 U.S. dollars. The control variables (X_{it}) are the real GDP per capita, to control for the level of economic development among countries in our sample, one-year lagged; the rural population as a percentage of total population, given that the majority of the poor are in rural areas; and also as a proxy of employment levels., government expenditures and political stability, as an indicator of governance. The error term of the first equation is ε_{it}.
The second Equation (3.3) attempts to explain the determinant of aid to African countries. The explanatory variables are the real GDP per capita, the

indicator of agricultural productivity, infant mortality as a measure of human development levels, and political stability. The error term is δ_{it}.
The third equation (3.4) explains agricultural productivity. We are interested in assessing the effect of agricultural aid per worker. Z_{it} is a set of control variables, including the real GDP per capita (as in the first equation), government expenditures, rainfall, to capture the effect of climate change on productivity, arable land as a percentage of territory, and political stability, as an indicator of governance. The error term in this equation is u_{it}.

Estimation strategies

The econometric analysis comprises three steps. A first specification is made through a linear panel model estimated by fixed effects techniques. A second estimation is made from a system of equations. In this specification, agricultural productivity, foreign aid, and poverty are considered endogenous. As a consistent estimation of the parameters requires an estimation method that can deal with the endogeneity problem, we use the three-stage least squares (3SLS) method, which is more efficient than a two-stage least squares (2SLS) estimation (Wooldridge, 2010). The 3SLS estimator decomposes reverse causality, controls for endogeneity, takes the disturbance between residuals in different equations into account, and provides the possibility of incorporating other transmission channels within a simultaneous framework. The first two stages of the 3SLS estimation, which are equivalent to a 2SLS estimation, correct the bias in coefficients arising from reverse causality. The third stage improves the estimated standard errors of the coefficients by controlling for the correlation of errors across equations (Kaya et al., 2013). Before considering the method of estimation, the identifiability of the model was checked because estimation methods that are used for SEM are functions of identification criteria. For an equation in a system of equations to be identified, the number of excluded exogenous variables in that equation must be at least as great as the number of included endogenous variables, less one. In our case, each equation is over-identified. In estimating the equations, we control for unobserved time-invariant variables and unobserved time effects by including N–1 country dummies and T–1 time dummies.

Furthermore, the Dumitrescu and Hurlin (2012) panel causality analysis is used to analyze the causal relationship between the three main variables, namely the poverty headcount ratio, foreign aid to agriculture, and agricultural productivity. This method is well-suited for our panel data structure as it accounts for heterogeneity in causal relationships across countries, improves statistical power by pooling cross-sectional information, and allows us to explore bidirectional causality. Indeed, countries differ in how aid is used, how productive agriculture is, and how poverty responds. The test accounts for these heterogeneous dynamics. The panel fixed effects and simultaneous equations models do not formally test the direction of causality. To complement these approaches, the Dumitrescu and Hurlin (2012) panel causality test is employed to determine whether past values of one variable help predict another. This multi-method strategy ensures robust and nuanced inference on the dynamics between aid, productivity, and poverty reduction. It helps confirm or challenge the assumed direction of causality in the simultaneous system.

The simple model (3.5) with two variables constitutes the basic framework for studying Granger causality in a panel data context

$$y_{i,t} = \alpha_i + \sum_{k=1}^{K} \gamma_i^{(k)} y_{i,t-k} + \sum_{k=1}^{K} \beta_i^{(k)} x_{i,t-k} + \varepsilon_{i,t} \qquad (3.5)$$

With $K \in N^*$ and $\beta_i = (\beta_i^1, \dots, \beta_i^K)'$. For simplicity, the individual effects α_i are supposed to be fixed in the time dimension. Initial conditions $(y_{i,-k}, \dots, y_{i,0})$ and $(x_{i,-k}, \dots, x_{i,0})$ of both individual processes $y_{i,t}$ and $x_{i,t}$ are given and observable. We assume that lag orders K are identical for all cross-section units of the panel, and the panel is balanced. Besides, Dumitrescu and Hurlin (2011) allow the autoregressive parameters $\gamma_i^{(k)}$ and the regression coefficients slopes $\beta_i^{(k)}$ to differ across groups.

The DH test considers the HNC[2] null hypothesis, where no Granger-causal relationships are assumed to exist for any member i of the panel. The DH test is based on an aggregated Wald statistic of individual Granger causality tests defined as:

$W_{N,T}^{Hnc} = \frac{1}{N}\sum_{i=1}^{N} W_{i,T}$,

Where $W_{i,T}$ denotes the individual Wald statistics for the i^{th}cross-section unit corresponding to the individual test $H_0: \beta_i = 0$.

Using the required stationarity tests, properties like the presence of a unit root in the panel data were verified. Since the panel data contains a large number of cross-sections that are clustered together, a test of cross-sectional dependence was then carried out. When using first-generation unit root tests, an extreme assumption of cross-sectional independence is made. Consequently, a cross-dependency test was conducted using Pesaran's CD test, which is the most often used test. If a cross-section dependence is revealed, second-generation unit root tests should then be used to ascertain the stationarity levels of the variables before conducting the causality test.

Data description

The data for this study are drawn from various sources and cover the period from 2002 to 2019. The sample comprises 34 countries in sub-Saharan Africa. Although the choice of countries is governed by the availability of data, the included countries broadly cover the whole region. Table 3 shows summary statistics of the variables. The correlation matrix is found in the appendix (Table A1). The definition and measurement units can be found in the appendix (Table A2).

[2] Homogeneous Non-Causality (HNC) : The null hypothesis of HNC test is that there is no causal relation between the variables for any individual, i.e., for all i it holds that X_i does not Granger-cause Y_i

Table 3. Summary statistics

Variable	Obs.	Mean	Std. Dev.	Min	Max
Agriculture value added per worker	611	13.79	1.02	11.19	16.47
Aid per worker	612	14731.38	31424.35	10.57	375899.6
Poverty headcount ratio	612	0.45	0.215	0.0012	0.952
GDP per capita constant	612	1614.56	1845.23	248.16	10610.59
Government expenditures (% of GDP)	612	21.10	1.40	16.94	25.13
Infant mortality	612	57.644	21.99	12.5	132.9
Rural population (% of total pop.)	612	0.61	0.151	0.298	0.913
Rainfall (mm)	612	85.69	48.220	12.1	253.61
Arable land (% of territory)	612	17.06	13.99	0.321	50.40
Political stability	612	–0.45	0.84	–2.52	1.20

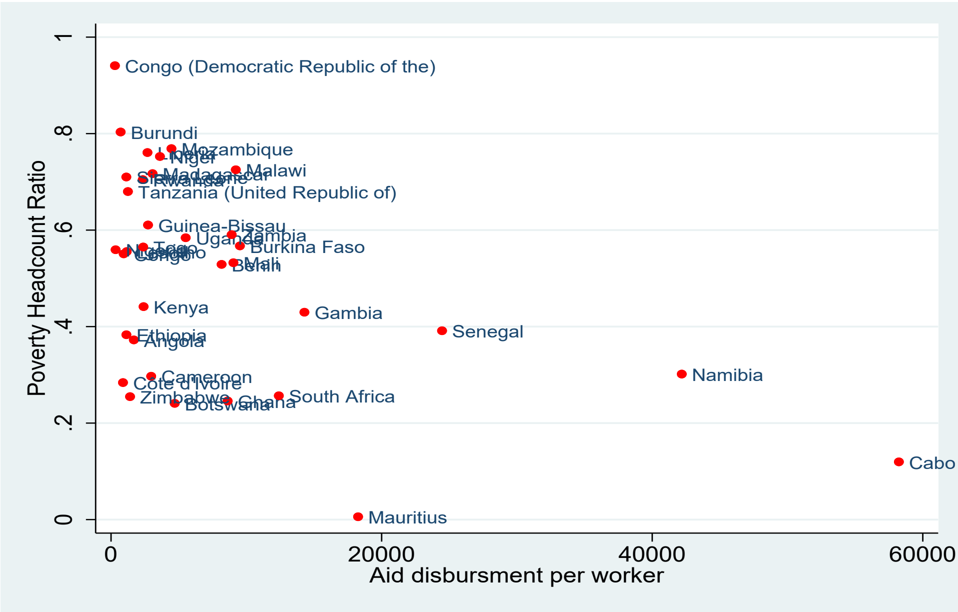
Source: Author's computation

4. Results and Discussion

Descriptive analysis

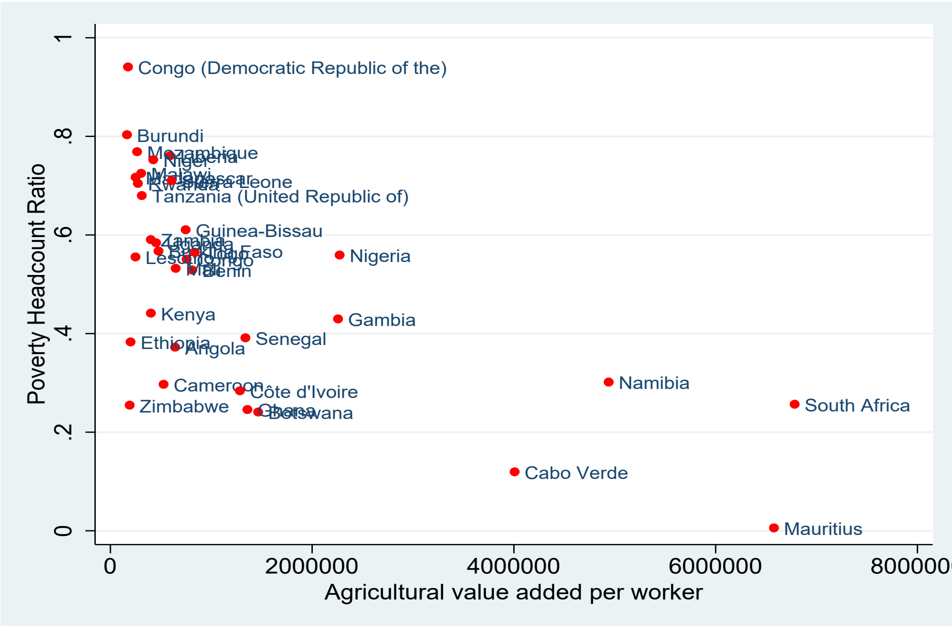
Figure 2 illustrates the relationship between agricultural aid and poverty levels in the countries included in the study. An overall negative association is evident across these variables, with significant variances observed among the selected nations. Countries like the Democratic Republic of Congo, Burundi, and Malawi have high poverty rates and receive low levels of aid per person, which may be due to their large populations. Conversely, Mauritius, Cape Verde, and Seychelles exhibit lower poverty rates. In Seychelles, there is a noticeable correlation between decreased poverty rates and increased agricultural assistance. Figure 3 shows a negative relationship between agricultural value added per worker, used as a proxy for agricultural productivity, and poverty rates. Prominent examples include the Democratic Republic of Congo and the Central African Republic, known for high poverty rates and reduced agricultural productivity. However, these observed associations remain descriptive and do not provide a basis for causal inferences. We will be able to ascertain whether there is a causal relationship between these variables through the econometric study that follows.

Figure 2. Agricultural aid disbursement per worker and poverty headcount ratio in selected countries in sub-Saharan Africa (2002–2017)



Source: World Development Indicators, 2020

Figure 3. Agriculture value added per worker and poverty headcount ratio in selected countries in sub-Saharan Africa (2002–2017)



Source: World Development Indicators, 2020

4.1. Fixed effects estimation results

Table 4 presents the results of the estimation of a poverty model using the fixed effects techniques on a panel of 32 in sub-Saharan Africa[3].

Table 4: Fixed effects estimates of the relationship between poverty, agricultural aid, and agricultural productivity , 2002–2019

Variables	(I)	(II)	(III)
Agriculture aid per worker, lagged	-0.006** (0.043)	–0.006* (0.081)	-0.008** (0.022)
Agriculture productivity	-0.039*** (0.000)	-0.0421*** (0.000)	-0.056*** (0.000)

[3]Figure 1 reveals the existence of outliers in the sample, namely Cabo Verde and Seychelles, therefore these countries were excluded from the estimations.

Rural population (as % of pop.)	0.958*** (0.000)	0.859*** (0.000)	0.976*** (0.000)
Government expenditures	-0.021** (0.006)	–0.022** (0.005)	
Political stability	-0.060*** (0.000)		
Constant	0.879*** (0.000)	1.066*** (0.000)	0.735*** (0.000)
Number of observations	544	544	544
Number of countries	32	32	32

Notes: p-values in parentheses; ***p < 0.01, **p < 0.05, *p < 0.1.
All variables except for the political stability index are in logarithm form.

In the first column, variables are all introduced into the model. The coefficients are all significant with expected signs, showing the reducing effect that aid to agriculture, agricultural productivity, government spending, and the quality of institutions could have on poverty rates. In the second column, we remove the governance variable (political stability). This variable has been eliminated from the model due to the possibility that international aid could impact poverty by bolstering recipient nations' institutional frameworks. Therefore, we eliminate it to see if there is a change in the coefficient of international aid to quantify the ceteris paribus effect of aid on poverty.
Having done this, we also observe no change in the coefficients of the variables. Similarly, the results obtained in Column 3 are without the government spending and political stability variables. Along with a small rise in the aid coefficient, we also see that the coefficients of the variables that were first introduced maintain their sign and significance. This suggests that development aid has little or no effect on poverty through budgetary contributions and institutional strengthening. This may be explained by the fact that we are using data for aid that has been earmarked for agriculture,

particularly, rather than the entire amount of aid that is distributed across all sectors.

In general, we discover that agricultural aid slightly lowers the poverty rate. According to the results, the effect of aid to agriculture on the poverty rate varies between 0.006% and 0.008 %. Specifically, a 1% increase in aid per worker is associated with an approximate 0.006 (column I and II), and 0.008 (Column III) percentage point decrease in the poverty headcount ratio, holding other factors constant. An explanation for this small effect could be that agriculture has not been a top priority for ODA spending (Eber and al. 2020). According to FAO data, since 2015, agricultural ODA has consistently comprised the smallest share of total ODA. In 2018, the relative share of ODA allocated to agriculture was 4.3%, the lowest share since 2006. Disbursements for humanitarian aid and health each amounted to more than three times the disbursements for agriculture in 2018, representing 13.9% and 13.3% of total ODA disbursements, respectively (Eber and al. 2020).

Three-stage least squares estimation results

Continuing our analysis, we address potential endogeneity concerns stemming from the reciprocal relationship between poverty levels and aid allocation within a nation. Table 5 presents the simultaneous equation model (SEM) estimates using the Three-Stage Least Squares (3SLS) approach. The expected signs are observed for the coefficients of the majority of control variables. According to the poverty equation, agricultural assistance lowers poverty levels; this relationship is statistically significant and has a tiny but negative coefficient. A 1% increase in aid per worker leads to a decline in the poverty headcount ratio by 0.007%. Agricultural productivity, measured by the value added per worker in the agricultural sector, has a negative and significant coefficient. Also, per capita income is associated with diminished poverty levels. Conversely, a rise in the rural population exacerbates poverty levels across the countries.

In the aid equation, GDP per capita is always significant, indicating a negative relationship with development aid. Aid is generally allocated to developing countries with high levels of poverty and lower GDP per capita (Mahembe & Odhiambo, 2019). Thus, as incomes appear to rise, aid volumes will have to fall. The productivity variable is positively signed and significant, indicating that the more value added per worker increases, the more aid will go to the agricultural sector.

In relation to the productivity equation, it is notable that agricultural aid emerges as a contributing factor to the enhancement of productivity. Additionally, there exists a positive correlation between GDP per capita and agricultural productivity, showing that when the wealth generated in the economy is equitably distributed, this fosters an improvement in producers' incomes. Consequently, these producers are more inclined to invest substantially in their endeavors, thereby augmenting their agricultural yield. Furthermore, a positive relationship is observed between the proportion of irrigated area and agricultural productivity, indicating that an increased allocation of land for irrigation is associated with higher levels of productivity in the agricultural sector.

Table 5: Three SLS estimation results from the relationship between poverty, agricultural aid, and agricultural productivity, 2002-2019

	Poverty headcount ratio	Aid per worker	Agricultural productivity
Log aid per worker, lagged	-0.007** (0.027)		0.198*** (0.000)
Log per capita GDP, lagged	-0.100*** (0.000)	-0.701*** (0.000)	0.869*** (0.000)
Log agricultural productivity	-0.020* (0.052)	0.647*** (0.000)	
Rural Population (%)	0.775*** (0.000)		

Log government expenditures	-0.010 (0.215)		-0.010 (0.608)
Political stability	-0.010 (0.135)	0.641*** (0.000)	
Infant mortality		-0.021*** (0.000)	
Log rainfall (mm)			0.089** (0.047)
Arable land (% of territory)			0.013*** (0.000)
Constant	0.987*** (0.000)	6.188*** (0.000)	5.477*** (0.000)
Number of observations	512	512	512
Number of countries	32	32	32

Notes: p-values in parentheses; *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Country and time fixed effects are included in the regressions.

An increase in gross domestic product (GDP) per capita, reflecting a higher quality of living, is associated with a rise in agricultural production. Higher income levels are linked to a rise in the availability of upgraded agricultural implements and the ability to pay for better working conditions.

The study emphasizes how agricultural production can effectively reduce poverty, albeit in tiny proportions. Many vulnerable populations in sub-Saharan Africa heavily depend on agriculture for their main source of food, which is consistent with existing academic research. The increase in agricultural production can significantly improve living conditions by increasing food supply and reducing food prices. The findings align with Gallup et al.'s (1997) finding that increased agricultural output had a beneficial effect on the income of the poorest twenty percent of the population. Thirtle et al. (2001) found that a 1% increase in agricultural output is associated with a 0.83% decrease in the population living on less than one USD per day. Thus, it can be said that boosting agricultural productivity is essential for developing countries.

Dumitrescu Hurlin Panel Causality Analysis

In the analysis process, a causality test is also conducted. The cross-section dependence tests show evidence of cross-dependence across countries in the sample (Table 6). This is expected, given that the countries in the sample are developing countries, belonging to the same economic region, whose main characteristics are high levels of poverty. Therefore, the cross-sectionally ADF (CADF) of Pesaran (2007), which is a second-generation panel unit root test, is undertaken (Table 7). The headcount poverty ratio and agricultural aid are stationary at first difference, while the agricultural productivity is stationary at level.

Table 6. Cross-section dependence test

variables	Test	Statistic	Probability.
Poverty headcount ratio	Breusch-Pagan LM	2758.512	0.000***
Aid per worker	Pesaran scaled LM	71.83484	0.000***
Agricultural value added per worker	Pesaran CD	6.135506	0.000***

Notes: ***, **, *: significance at 1% level, 5% level and 10% level
Source: Authors' compilations

Thereafter, the cross-sectionally ADF (CADF) of Pesaran (2007), which is a second-generation panel unit root test, is undertaken (Table 8). The headcount poverty ratio and agricultural aid are stationary at first difference while the agricultural productivity is stationary at level.

Table 7. Second generation Pesaran's unit root test

	PES-CADF	
	Level	First diff.
Headcount poverty ratio	0.973	0.000***
Agricultural aid per worker	0.125	0.000**
Agricultural value added per worker	0.000***	0.000***

Notes: Figures in the table are p values. ***, **, * express significance at 1% level, 5% level and 10% level
Source: Authors' computations

The Table 8 presents the results of homogeneous non causality hypothesis test between the poverty headcount ratio, foreign aid to agriculture and agricultural productivity in the sample based on three test statistics, namely, the average Wald statistic, W_{HNC} , the asymptotic standardized statistic, Z_{HNC} and the approximated standardized statistic based on finite sample moments, $\tilde{Z}_{HNC}$. The causality tests are conducted with stationary variables, and the optimal lag criteria is the Akaike information criterion (AIC).

Table 8. Homogeneous non-causality hypothesis tests results

Test statistics	**Agricultural aid does not Granger-cause poverty (lags:2)**	**Poverty does not Granger-cause Agricultural aid (lags:2)**
W_{HNC}	4.5506	1.2736
Z_{HNC}	7.2142 (0.0000***)	1.0946 (0.2737)
$\tilde{Z}_{HNC}$	3.5941 (0.0000***)	0.2691 (0.7878)
	Agricultural aid does not Granger-cause	**Agricultural productivity does not Granger-cause**

	agricultural productivity (lags: 3)	agricultural aid (lags:2)
W_{HNC}	4.1238	6.5465
Z_{HNC}	2.5952 (0.0095**)	8.1904 (0.0000***)
$\tilde{Z}_{HNC}$	-0.0770 (0.9386)	2.3704 (0.0178***)
	Agricultural productivity does not Granger-cause poverty (lags:2)	**Poverty does not Granger-cause agricultural productivity (lags:2)**
W_{HNC}	3.6371	2.0833
Z_{HNC}	10.5484 (0.0000***)	4.3333 (0.0000***)
$\tilde{Z}_{HNC}$	7.1969 (0.0000***)	2.6425 (0.0082***)

Notes: The numbers in parentheses are probability values related to the test statistic.
***, **, *: significance at 1% level, 5% level, and 10% level
Source: author's computation

A p-value of less than 1%, 5%, or 10% suggests that there is a causal relationship for at least one country in the sample, contrary to the null hypothesis of the causality test, which states that there is no causal relationship between the variables for any individual. Based on the three causality test statistics, the analysis's findings show that there is a unidirectional relationship between poverty and agricultural aid, with the relationship going in the direction from aid to poverty. This supports the outcomes from the earlier regressions. All three tests demonstrate that agricultural productivity Granger causes poverty, and two of the three indicators (W_{HNC} et Z_{HNC}) likewise, demonstrate the relationship between agricultural aid and agricultural productivity. Agricultural aid has an effect on labor productivity in the agricultural sector, which in turn has an impact on poverty.

Furthermore, the results suggest a bidirectional relationship between foreign agricultural aid and agricultural productivity, as well as between poverty and agricultural productivity. Aid can provide farmers with access to modern technology, better quality seeds, improved irrigation systems, etc. This can increase their productivity and, consequently, reduce poverty by increasing farm incomes. On the other hand, poverty can also negatively affect agricultural productivity. Poor farmers may have limited access to resources such as land, water, and credit, which can hamper their ability to invest in improved farming practices. As a result, their productivity may remain low, maintaining their poverty level.

5. Conclusion

Sub-Saharan African countries mainly rely on agriculture as the foundation of their livelihoods, particularly for disadvantaged groups. To address this situation, it is crucial to base poverty reduction efforts in these countries on improving the agricultural sector. This nexus is a focus point in the objectives of this article, which aims to examine the influence of foreign agricultural aid on reducing poverty in sub-Saharan Africa. The study suggests that agricultural productivity has a crucial role in promoting national progress and alleviating poverty, as it was revealed by significant studies conducted by Lewis (1954) and Fei & Ranis (1961). An investigation using a fixed effects technique and a simultaneous equation model confirms that foreign agricultural aid improves agricultural productivity and reduces poverty levels. This article emphasizes that increasing agricultural productivity is a powerful and effective way of reducing poverty in sub-Saharan Africa. Furthermore, a causality test is conducted to analyze the causal relationship between the poverty headcount ratio, foreign aid to agriculture, and agricultural productivity. The results reveal that aid does affect agricultural productivity and poverty in the selected countries. Therefore, it can be advised that foreign agricultural aid be increased by international donors, and that priority be given to factors that improve productivity when allocating sectoral foreign agricultural aid. In addition, governments should increase and improve the effectiveness of public spending in agriculture. This would benefit the productivity of agriculture and boost Sub-Saharan Africa's economy as a whole.

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Appendix

Table A1. Correlation matrix

variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
(1) Poverty headcount ratio	1,00									
(2) Aid per worker	-0.31*	1.00								
(3) Agriculture value added per worker	-0.50*	0.34*	1.00							
(4) GDP per capita constant 2010US	-0.60*	0.23*	0.68*	1.00						
(5) Rural population (% total population)	0.51*	-0.12*	-0.50*	-0.63*	1.00					
(6) Political stability	-0.27*	0.35*	0.17*	0.36*	-0.25*	1.00				
(7) Government expenditures	-0.30*	-0.01	0.82*	0.58*	-0.36*	-0.03	1.00			
(8) Infant mortality	0.31*	-0.35*	-0.26*	-0.26*	0.01	-0.19*	-0.18*	1.00		
(9) Arable land (% of territory)	0.14*	-0.08	0.05	-0.34*	0.36*	-0.13*	-0.05	-0.05	1.00	
(10) Rainfall	0.33*	-0.31*	-0.27*	-0.36*	-0.12*	-0.24*	-0.21*	0.41*	0.11*	1.00

Notes: * indicates 5% significance level.

Table A2: Source and Definition of variables

	Definition	Source
Agricultural aid per worker	The DAC definition of aid to agriculture includes assistance to "agriculture", "forestry", and "fishing". ODA for agriculture includes agricultural sector policy, agricultural development and inputs, crop and livestock production, and agricultural credit, cooperatives, and research. These figures are divided by the number of employees in the agricultural sector, which is drawn from the ILO database.	OECD (2020)
Agricultural productivity	Agricultural productivity is measured by the agriculture value added per worker. Value added in agriculture measures the output of the agricultural sector (ISIC divisions 1-5) less the value of intermediate inputs. Agriculture comprises value added from forestry, hunting, and fishing as well as cultivation of crops and livestock production. Data are in constant 2010 U.S. dollars.	United Nations Statistics Division and ILOSTAT of the ILO
Poverty headcount ratio	Poverty headcount ration is the percentage of the population living with less than $1.90.	Povcalnet database, 2019
GDP per capita	GDP per capita is gross domestic product divided by midyear population. Data are in constant 2010 U.S. dollars.	United Nations Statistics Division
Rural population (% total population)	The proportion of the population living in rural areas (% of total population)	ILOSTAT database (2018)
Government expenditures (% GDP)	Final consumption expenditure as a percentage of GDP	United Nations Statistics Division
Political stability	Index of political stability and absence of violence/terrorism	World Governance Indicators (WGI, 2020) of the World Bank
Infant mortality	Infant mortality rate per thousand births for a given year	World Bank WDI, 2020
Arable land in % of territory	Proportion of arable land in the territory	FAOSTAT of the FAO

Rainfall (mm)	Average precipitation in depth (mm per year)	FAO (2020)

Table A3. The list of countries

Angola	Cameroon	Ghana	Malawi	Nigeria	Tanzania
Benin	Congo, Dem. Rep.	Guinea-Bissau	Mali	Rwanda	Togo
Botswana	Congo, Rep.	Kenya	Mauritius	Senegal	Uganda
Burkina Faso	Cote d'Ivoire	Lesotho	Mozambique	Sierra Leone	Zambia
Burundi	Ethiopia	Liberia	Namibia	South Africa	Zimbabwe
Cabo Verde	Gambia	Madagascar	Niger		

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