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Article

On the empirical nexus of agricultural credit facility scheme and agricultural output dynamics in Uganda

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Abstract: The role of the agricultural sector in economic growth cannot be overemphasized. Agriculture is basically one of the key sub-sectors that enhance economic growth in all economies of the world. Since no sector of the economy can grow without enough capital, agricultural credit is considered as imperative for improved agricultural output. To contribute to knowledge in this regard, this study examined the impact of agricultural credit fund (ACF) on agricultural output in Uganda using quarterly data from 2009 to 2021. By employing the Autoregressive Distributed Lag (ARDL) framework, the results revealed that ACF has no significant effect on agricultural output in Uganda in the short run, but it significantly has positive effect on the sector in the long run. We control for economic growth, proxied by gross domestic product (GDP), interest, inflation, and exchange rates and find that exiting level of GDP, spurred agricultural output, while the rate of interest and inflation retard agricultural productivity (output), especially in the long run in Uganda. We recommend that the government of Uganda needs to increase agricultural financing through the credit facility scheme for further productivity of the sector.

Keywords: agricultural credit; agricultural output; ARDL; Uganda
JEL Classification: B23; O51; Q11; Q14

1. Introduction

Over the years, agriculture has been the fundamental mainstay for economic growth of Uganda. According to the Uganda Bureau of Statistics (UBOS), the sector contributed significantly to the National Gross Domestic Product at 24% and accounts for 34 per cent of the country's export receipt [1]. In recent times however, this sectoral contribution to economic growth has however plummeted to 24.1% in 2022 [2]. In terms of agricultural sector's growth rate, the Uganda Ministry of Finance, Planning and Development [3] asserts that the agriculture, forestry and fishing sector grew by 3.6% on account of higher output from fishing and forestry activities along with growth in food crop and livestock production.

Moreover, the sector employs a substantial number of Ugandans such that about 70 per cent of the population earns from the Agricultural value chain. This performance of the agricultural sector in Uganda is not substantially different from what is obtainable in most other developing countries, especially in Africa. For instance, among other East Africa countries, the agricultural sector has contributed about 27.57% in Burundi, 37.64% in Ethiopia, 27.32% in Guinea, 24.9% in Rwanda, and 24.27% in Tanzania in 2022 [4].

Indeed, the agricultural sector thrives with several constrains that impede its full

potential for industrialization linkage. Some of these constraints range from inadequate infrastructure, limited modern agriculture cultivation skills, limited access to global markets, climate change, and inadequate access to credit for continued investment. Given the risks involved in agriculture, credit to the sector is undoubtedly low relative to other sectors. The Government of Uganda (GoU) recognized the low credits in the sector and established the Agricultural Credit Facility (ACF) in 2009 aimed at de-risking agricultural lending and with the objective of commercializing the product value chains. This is a cost sharing scheme between the GoU and Participating Financial Institutions (PFIs).

At the inception of the scheme, loans were available to only medium and long term loan beneficiaries. However, in 2018 the government recognized the fact that the majority of farmers in Uganda are small holder farmers with limited capital to finance agriculture and to contribute to economic growth. Consequently, the government created the Block allocation strategy to be included as a short term loan to benefit the smallholder farmers. Since 2009 till 2021, the GoU, together with the PFIs has remitted up-to 624.68 billion Ugandan shillings to farmers, agricultural processors and marketers. This amount meagerly represents 0.05% of total Uganda Gross Domestic Product (GDP) for these periods.

This remitted fund was composed of 50% contribution by GoU through the Central Bank for loans processed by Commercial Banks and 70% for loans administered by Micro Deposit-Taking Institutions (MDIs), while Credit Institutions (CIs) contributed 30% of each loan [5]. The ACF Scheme is recognized for increased lending to the agricultural chain although it is still considered insufficient as the contributions of the agricultural sector to GDP decreased from 26.8% in 2009 to 21.8% in 2017 [1]. Also, Florence and Nathan [6] similarly found a high level of inequality in credit distribution where more credit is directed to processing and marketing rather than production in Uganda.

Indeed, the level of existing knowledge in the literature regarding the roles of agricultural credits on agricultural output performance is acknowledged with mixed findings. While some scholars found significant positive effects of agricultural credits on agricultural sector outputs, and hence, their contributions to economic growth in different economies [7–11], others observed significant negative effects [12,13]. Yet further, there are other studies that found no significant effects of agricultural credit on agricultural productivity [14,15]. This mixed or unsettled empirical evidence on the effects of agricultural credit on agricultural sector productivity further create empirical lacuna that needs to be filled. This is essential, because there is a dearth of empirical studies in this area of research in Uganda. The study by Florence and Nathan [6] appears to be the most prominent study in this regard. While their study covered 2008–2018 with separate models, examining credits to agriculture at various value chains such as production, and processing and marketing, this study deviates slightly from theirs by investigating the aggregate effects of ACF on the level of productivity of the agricultural sector of Uganda spanning 2009–2021. The choice of this period hinges on the fact that ACF started in 2009 and not 2008 as asserted by Florence and Nathan [6]. Again, the issue of agricultural productivity as a function of ACT as asserted by Florence and Nathan [6] did not particularly employ the ACF dataset as reported by the BoU. Therefore,

this present study contributes to knowledge by empirically examining the relationship between ACF and the level of productivity or output dynamics of the agricultural sector in Uganda between 2009 and 2021.

In assessing the effects of ACF on the level of productivity of agriculture of Uganda, the effects of other important macroeconomic indicators of Uganda such as interest rate, inflation, and exchange rate on agricultural sector' output are worth controlling for in line with other studies [6,16] as shown in the empirical model for this study. This is underscored by the fact that interest rate is a key monetary policy variable that influences credit access, overall returns on investment, and agricultural productivity [17,18].

Also, the prevailing levels of inflation at any given point in time have a comprehensive effect on virtually all sectors of the economy. With high inflation, input cost would reduce extent of agricultural productivity [19]. In the same manner, a volatile exchange rate has the capacity of plunging the volume of importation of agro-allied inputs [20,21]. Thus, this study empirically examines the aggregate impacts of agricultural credit facilities (ACF) on agriculture sector's output in Uganda. Also, the study accounts for possible effects of interest rate charged on agricultural credit on the level of productivity of the agricultural sector of Uganda. It further investigates the effects of consumer price index (inflation) on the level of agricultural output of Uganda, and finally queries the possible relationship between exchange rate and the agricultural sector's output of Uganda.

In addition to the foregoing motivations for this study, the remaining sections of this paper are structured as follows: section 2 briefly reviews literature to ascertain the level of existing knowledge in the areas of agricultural credit and output performance of the agricultural sector. Also, as section 3 characterizes the trends and stylized facts about the performance of the agricultural sector ad ACF in Uganda, section 4 hosts the methodology of the study, while section 5 presents and discusses the results of the findings, and section 6 concludes the study with appropriate policy suggestions.

2. Brief literature review

2.1. Agricultural credit and agricultural sector output nexus

The impact of credit in capital formation and improvement of the performance of the agricultural sector in different countries of the world has been documented. Without agricultural financing, the needed funds for expansion of the productive capacity of the sector will be hindered. However, there are arrays of studies with different findings on agricultural credit-Agricultural output nexus in different countries.

In terms of global evidence from cross-country studies [22], examined the potential effects of bank credit on agricultural productivity spanning the period of 1990–2019 for Central African Economic Community using Autoregressive Distributed Lag (ARDL) model and found positive impacts of bank credit on agricultural productivity for the community members. Also, for countries in the West African Economic and Monetary Union (WAEMU), Oloukoi [23] employed a panel data econometric approach under the framework of ARDL and Panel vector

autoregressive (VAR) to examine the short-term impact of credit to agriculture and agricultural value-added and found that short term agricultural loans in WAEMU had poor impacts on agricultural value-added of the countries.

For Uganda, Kazaara and Christopher [9] employed a survey method while determining the impact of microcredit funding on agricultural output in Bundibugyo District of Western Region of Uganda and found that the level of productivity of the selected smallholders (famers) who were clients (customers) of BRAC and HOFOKAM Microfinance significantly increased with substantial reduction in their poverty level.

Also, Abubakar and Muhammad [16] investigated the impact of agricultural financing on agricultural output by considering the roles of commercial banks within the period of 1981–2020. The authors employed the analytical tool of ARDL and found that commercial bank agricultural financing has a positive and substantial impact on agricultural output. However, inflation and interest rates as control variables in their study exhibited negative effects on agricultural output as theoretically expected.

As part of the control variables in the model of agricultural finance and agricultural productivity nexus, Okafor [17] investigated the effect of banks credit on Nigerian agricultural development using the ordinary least square approach. The findings showed that banks credit and ACGSF significantly and positively affected agricultural output. However, interest rate was found having negative and insignificant effects on agricultural output. On the contrary however, Salisu and Alamu [18] found that interest rate has a positive and significant effect on agricultural output in Nigeria between 1981 and 2021 using ARDL analytical model. Unlike [17], the findings of Salisu and Alamu [18] did not satisfy the hypothesized or theoretical expectation of negative effects of interest rate on agricultural output.

Regarding inflation rate and bank credit as a predictor of agricultural output growth, Aye and Odhiambo [19] assessed the benchmark rate of inflation that is consistent with increased level of agricultural productivity in a panel of developing countries between 1970 and 2019. Using a dynamic panel threshold model, they found that bank credit significantly and positively enhanced agricultural output but inflation rate above 5.9% was detrimental for agricultural productivity. Also, Seven and Tumen [24] showed that agricultural credits had positive impact on agricultural productivity and that doubling agricultural credits generates around 4%–5% increase in agricultural productivity like Ahmad et al. [25] that tested the level of cointegration of agricultural credit with agricultural output and using a bound testing approach between 1973 and 2014 for Pakistan and found the existence of a long-run relationship between agricultural credit and agricultural GDP.

The level of exchange rate fluctuation is also considered as a determinant of agricultural output growth in the estimation of finance-agricultural output nexus. Adekunle and Ndukwe [20] found that changes in exchange rate and its volatility prominently affect aggregate level of agricultural output in Nigeria. While studies like Ogbuabor and Nwosu [26] and Udoka et al. [27] found agricultural credit with positive effects on agricultural output in Nigeria, [12] obtained negative effects of agricultural credit on the level of output of agricultural sector in Nigeria.

For Ethiopia and Nepal, Meressa [14] and Rima [28] respectively found that

commercial banks' credit to the agricultural sector was not statistically significant in predicting agricultural sector growth. But while using ordinary least squares (OLS) estimator, Chandio et al. [29] also found evidence of positive and significant impact of institutional agricultural credit on aggregate output of the agricultural sector of Pakistan between 1985 and 2015.

In other economies like South Africa, Chisasa and Makina [7] investigated the effects of bank credit on agricultural output from 1970 to 2011 and found a positive impact of credit on agricultural production and processing on agricultural output. This is also similar to Awotide et al. [30] that examined the effect of access to credit on agricultural productivity using smallholders Cassava farmers in Nigeria and found that access to credit has a significant positive impact on cassava productivity. This also support an earlier study by Ammani [31] that established a nexus between credit access and agricultural productivity, and found that formal credit had a positive influence on productivity of crops, livestock and fishing sectors in Nigeria. Notwithstanding the evidence of positive impacts of agricultural finance on the overall productivity of the sector, Oyakhilomen [13] and Nawaz [15], in different studies revealed no significant effects of agricultural credits on agricultural productivity in Nigeria.

Particularly for Uganda, Florence and Nathan [6] empirically found that commercial banks' credit to the agricultural sector have no instantaneous impact on agricultural output which reflects inequality in sectoral credit allocation to the agricultural sector. Moreover, Munyambonera et al. [32] found that most studies on credit effect in Uganda are mostly done at household micro level.

Our study focused on Uganda's agricultural sector. It innovatively examines the agricultural credit facility scheme of Uganda and its roles on the level of agricultural output. In addition, it investigated the relationship and the impact of commercial banks' credit to farmers and its effect on agricultural productivity. While Florence and Nathan [6] found no significant effects of the credit to the sector, we specifically cover the time span when the credit facility scheme started in Uganda. Also, while Munyambonera et al. [32] focused on microfinance to Ugandan farmers; our study fills this empirical knowledge gap in Uganda.

2.2. The framework: Linkage effects of ACF on agricultural output (productivity)

In terms of theorizing and conceptualizing the directions of possible linkage effects of agricultural finance and output or productivity of the agricultural sector, it is important to apply eclectic approach that involves production function, credit rationing, investment and capital formation, and risk management approach among others. For instance, in the production function, it is unarguable that the inputs needed for agricultural production such as labour, capital, and land among others can be purchased with the aid of credit access to famers [33]. In relation to credit rationing, it is not untrue that farmers would experience credit constraints when the lenders, especially commercial banks limit the extent of credit available to farmers due to risk, information asymmetry, or collateral constraints. This could invariably limit or reduce increased productivity as relevantly asserted by Ghosh [34],

Guirkinger and Boucher [35] and Verteramo Chiu and Khantachavana [36]. Also, through the channel of investment and capital formation, agricultural credit can enable farmers to invest in productive assets, technology, and inputs thereby increasing the probability of increasing the overall production output [37–39]. The risk management approach is applicable here because access to credit can help farmers manage risks like crop failures, price fluctuations, and weather or climate change events, thereby increasing the level of agricultural productivity [40].

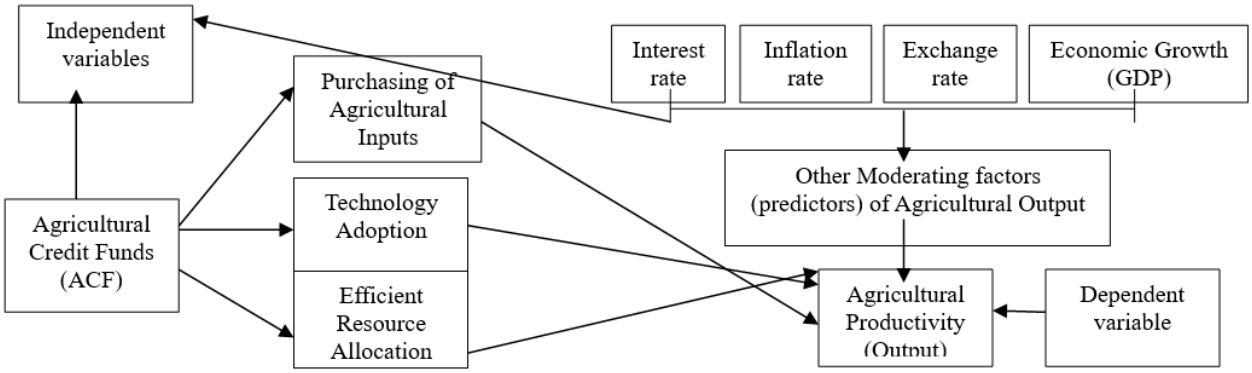

Figure 1. Theoretical and conceptual framework on agricultural credit—Agric output nexus.
Source: Authors' computation (2024).

Based on the various frameworks as shown in **Figure 1**, we hypothesize that there is an important influence of agricultural credit on agricultural output in Uganda, the level of economic growth (GDP) and other macroeconomic indicators (interest, inflation, and exchange rates) have important effects on agricultural output in Uganda.

3. Trends and stylized facts on Uganda's economy and the agricultural sector

Uganda's economy is classified as a low income country with a total population of 45.74 million in 2020 and 47.12 million in 2021 [41]. Like any many other economies, Uganda's economy is made up of the Agriculture (24.2%), Industry (25.5%) and Services (50.3%) sectors. The Agricultural sector includes Fisheries, Animal Husbandry, Dairy, and Crop sub-sectors [42]. Although agricultural sector is the ranked as 3rd in its share in Uganda's economy, but the sector plays vital role in economic growth of Uganda as it employs the highest number of employees (72.13%) unlike industry (6.51%) and service (21.36%) as at 2019 [41].

Over the years, the level of growth of the economy of Uganda has been viewed fluctuating. This is shown in **Figure 2** where the rates of GDP growth and agricultural share in GDP have experienced unstable trends especially in COVID-19 era where the pandemic has actually pounded the economy's output structures.

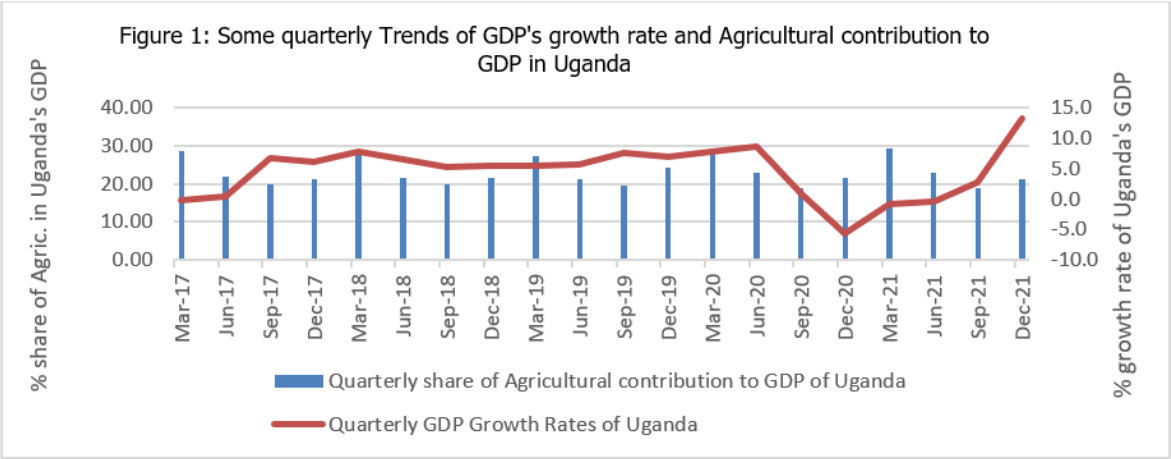

Figure 2. Some quarterly Trends of GDP's growth rate and Agricultural contribution to GDP in Uganda.
Source: Computed from the database of Bank of Uganda (2021).

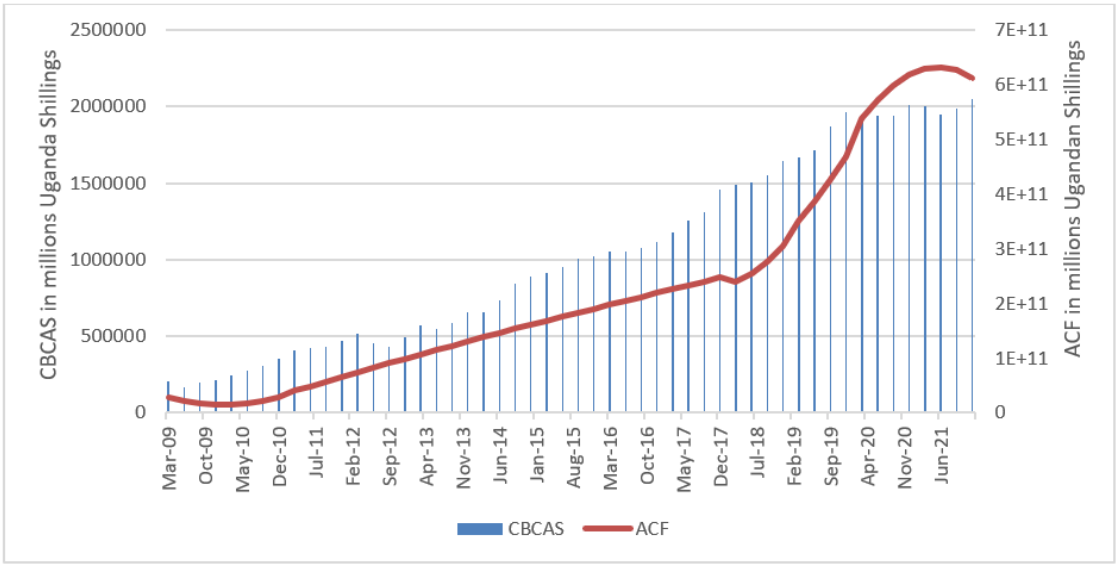

Figure 3. Quarterly trend of commercial banks' credits to the Agricultural Sector (CBCAS) and ACF disbursement in Uganda for 2009Q1–2021Q4.

Source: Computed from the database of Bank of Uganda (2021).

The agricultural sector of Uganda needs funding through agricultural financing to overcome its major binding constrains in order to be positioned well for higher contribution to Uganda's economic growth. The government of Uganda, has over the years initiated several agriculture programs such as the rural microfinance support project, microfinance deposit taking institution program, and the Plan for enhancement of sustainable financial services or microfinance outreach plan in 2003; the rural financial services program and prosperity for all in 2005 as well as the recent ACF in 2009 [6,32]. Asides ACF, there are also commercial banks' credit to the agriculture sector (CBCAS) among other private sector's credit allocations. **Figure 3** shows the level of credit allocation from the commercial banks and total disbursement on ACF. From the quarterly trends of CBCAS in **Figure 3**, it is observed that the trend of credit allocation from the commercial bank in Uganda exhibits upward trends over the years. With the exception of the second and third quarters of 2012 and Q1–Q4 of 2020 amidst COVID-19, the level of credits or loans

to agricultural sector in Uganda is encouraging with upward trends; hence, we expect that this will translate to increase in the contribution of the sector to economic growth in Uganda.

Similarly, from **Figure 3**, the disaggregated quarterly data on total disbursement of ACF exhibits a continuous upward trend but the trend however reduced in the last 2 quarters of 2021 where total quarterly disbursement reduced from 6.3 million in 2021Q2 to 6.2 and 6.1 million in 2021Q3 and 2021Q4 respectively.

4. Materials and methods

4.1. The data source and the variables

The paper utilizes quarterly data spanning a 13 year period, from 2009Q1 to 2021Q4 making a total observation of 52 data points to capture the period of ACF. Since the main concern of this study is to examine the linkage effect of ACF on the agricultural sector of Uganda, the dataset on total disbursements ACF was obtained from the progress report of Bank of England (BoU) and disaggregated quarterly. In addition to ACF, data on commercial banks' sectoral credit allocation was obtained from the same source to examine its possible differential effects on agricultural output from ACF. Other relevant data used in this study include macroeconomic variables such as Uganda's GDP, Agricultural GDP, interest rates, inflation rates, and exchange rate, and they were all obtained from the BoU.

4.2. The model specification

The collected data were operationalized using the specified econometric model below:

$$\text{Log}AGRO_t = \beta_0 + \beta_1 \text{Log}ACF_t + \beta_2 \text{Log}CBCAS_t + \beta_3 \text{Log}GDP_t + \beta_4 EXCHR_t + \beta_5 INFL_t + \beta_6 INTR_t + \varepsilon_t \quad (1)$$

where,

AGRO = Agricultural output (Agricultural GDP)
ACF = Agricultural credit fund
CBCAS = Commercial Banks' credits to agricultural sector
GDP = Gross domestic product.
EXCHR = Exchange rate of Uganda shilling to 1 USD
INFL = Inflation rate
INTR = Interest rate

While Log is the logarithmic values of the variables, other variables without log sign denote that they are in percentages, hence, they need no logarithmic transformation. Subscript t in the equation represents the time series dimensions of the data and ε stands for the error terms which captures other possible random disturbance terms. It also called white noise, thus, the larger its residual values, the less reliable the efficiency of the independent variables in measuring changes in the dependent variable.

4.3. The model estimation techniques

In addition to the descriptive or summary statistics of the data as shown in **Table 1**, the data were pre-tested using Augmented Dickey Fuller (ADF) and

Phillips-Perron tests for unit root to be able to determine the level of stationarity or stability of the data so that spurious regression could be avoided. The result of the unit root tests determines the choice of the estimation techniques. As indicated in **Table 2**, the data exhibited different levels of integration. Thus, the autoregressive Distributed Lag (ARDL) model of Pesaran et al. [43] using a bound testing approach to cointegation is used. Precisely, the ARDL model for this study using the specified stochastic model in Equation (1), in the spirit of Pesaran et al. [43]is shown in the subsequent equations.

$$\begin{aligned}\Delta \text{Log}AGRO_t = {} & \alpha_0 + \alpha_1 \text{Log}AGRO_{t-1} + \alpha_2 \text{Log}ACF_{t-1} + \alpha_3 \text{Log}CBCAS_{t-1} + \alpha_4 \text{Log}GDP_{t-1} + \alpha_5 EXCHR_{t-1} \\ & + \alpha_6 INFL_{t-1} + \alpha_7 INTR_{t-1} + \sum_{t=1}^{n} \beta_1 \Delta \text{Log}AGRO_{t-1} \\ & + \sum_{t=1}^{n} \beta_2 \Delta \text{Log}ACF_{t-1} + \sum_{t=1}^{n} \beta_3 \Delta \text{Log}CBCAS_{t-1} + \sum_{t=1}^{n} \beta_4 \Delta \text{Log}GDP_{t-1} + \sum_{t=1}^{n} \beta_5 \Delta\, EXCHR_{t-1} \\ & + \sum_{t=1}^{n} \beta_6 \Delta\, INFL_{t-1} + \sum_{t=1}^{n} \beta_7 \Delta\, INTR_{t-1} + \varepsilon_t\end{aligned} \tag{2}$$

where Δ is the differenced operator, the coefficients of the long run estimates are represented as $\alpha_1 \rightarrow \alpha_7$, while $\beta_1 \rightarrow \beta_7$ stand for the short run coefficients. The time lag is denoted as $t-1$ while the error term is denoted asε. Appropriate or optimal time lag is automatically selected by the model.

Table 1. The summary statistics.

	ACF	**AGRO**	**CBCAS**	**EXCHR**	**GDP**	**INFLA**	**INTR**
Mean	2.26×10^{11}	4816.346	1,032,537	3033.212	20,666.65	123.9231	21.47462
Median	1.79×10^{11}	3912.000	979,734	3210.500	14,030.50	113.1500	20.88500
Maximum	6.31×10^{11}	10,202.00	2,048,348	3771.700	35,021.00	168.2000	27.22000
Minimum	18.91362	2123.000	166,524.7	1889.900	9564.000	92.60000	17.87000
Std.Dev.	1.95×10^{11}	2380.193	622,379.5	628.6060	9497.211	21.76714	2.259573
Skewness	0.920254	0.622550	0.280862	−0.239711	0.218806	0.482382	0.695672
Observations	52	52	52	52	52	52	52

Source: Author's computation form BoU dataset (2021).

Table 2. The unit root test

Variables	**Augmented Dickey Fuller (ADF)**			**Phillip-Perron (PP)**		
	***T*-Statistics**	***P*-Value**	**Remark**	***T*-Statistics**	***P*-Value**	**Remark**
ACF	−3.319320	0.0751	I(0)			
AGRO	−3.386191	0.0165	I(1)	−4.442214	0.0045	I(0)
CBCAS	−5.985264	0.0000	I(1)	−6.026669	0.0000	I(1)
EXCHR	−6.048087	0.0000	I(1)	−6.009821	0.0000	I(1)
GDP	−7.770815	0.0000	I(1)	−8.075482	0.0000	I(1)
INFL	−6.868441	0.0000	I(1)	−6.868291	0.0000	I(1)
INTR	−3.521230	0.0114	I(1)	−6.277011	0.0000	I(1)

Source: Author's computation from the BoUdataset (2021).

We test the implied null hypothesis of the ARDL model of no cointegration among the variables in Equation (2). That is, H_0: $\alpha_1 = \alpha_2 = \alpha_3 = \alpha_4 = \alpha_5 = \alpha_6 = \alpha_7 = 0$ against the alternate that there is cointegration among the variables. The alternative hypothesis is put asH_1: $\alpha_1 \neq \alpha_2 \neq \alpha_3 \neq \alpha_4 \neq \alpha_5 \neq \alpha_6 \neq \alpha_7 \neq 0$. Once the value of *F*-statistic is greater than the critical asymptotic critical values at the boundary for I(0) and I(1) as obtained by Pesaran et al. [43], it indicates that there is long run relationship (cointegration) among the variables. Once this condition is satisfied, an error correction model (ECM) that enables the estimation of the short run dynamic of the variables can be established. The ECM model is re-specified from the model in Equation (2) as:

$$\Delta \text{Log}AGRO_t = \alpha_0 + \sum_{t=1}^{n} \beta_1 \Delta \text{Log}AGRO_{t-1} + \sum_{t=1}^{n} \beta_2 \Delta \text{Log}ACF_{t-1} + \sum_{t=1}^{n} \beta_3 \Delta \text{Log}CBCAS_{t-1} + \sum_{t=1}^{n} \beta_4 \Delta \text{Log}GDP_{t-1} + \sum_{t=1}^{n} \beta_5 \Delta\, EXCHR_{t-1} + \sum_{t=1}^{n} \beta_6 \Delta\, INFL_{t-1} + \sum_{t=1}^{n} \beta_7 \Delta\, INTR_{t-1} + \beta_8 ecm_{t-1} + \varepsilon_t \quad (3)$$

where β_8 is the coefficient of the speed of adjustment of the short run shocks (disequilibrium) to the long run equilibrium.

5. The empirical results

The empirical results obtained from the study are shown in this section with summary or descriptive statistics in **Table 1** to show the overall behaviours of the variables. This is followed by another pre-estimation result using the unit root to determine the stationary level and their order of integration of the variables and the choice of the model estimation technique. The last part of this section is on the results of the bound test, and the main ARDL results for both short run and long run dimension of the effect of ACF on AGRO.

5.1. The descriptive statistics

From the descriptive statistics of the selected variables for the model, average value of GDP is the highest for the periods with a mean value of 20,666.7 billion Uganda shillings (see **Table 1**). This is followed by Agricultural output (AGRO) at 482 billion, and then agricultural credit fund (ACF) disbursement at 226 billion shillings. Commercial banks' credit to the agricultural sector (CBCAS) has the least average value at 1.03 million shillings. While average inflation rate for the study periods was 124%, average interest rate was 21.5%, and 1USD exchanged, on average to 3033.212 shillings. The observed standard deviations of the series from their mean values are significantly wide.

The asymmetric distribution of the series is measured by the values of the skewness. The skewness of a normal distribution is zero, and while all the variables are positively skewed with normal distribution, the variable on exchange rate is negatively skewed.

5.2. The unit root results

The results in **Table 2** relate to the order of integration of the variables through the unit root of ADF and PP. From the results, all the variables were found stationary

at first difference, I(1) except agricultural output that is integrated at level, I(0). This necessitates the use of the ARDL model as proposed by Pesaran et al. [43].

5.3. The ARDL bound test results

Also, since the unit root results indicate the need for ARDL, it is expected that the level of long run relationship among the variables that are integrated of different order are tested. This is done through the ARDL Bound test as shown in **Table 3**. As indicated from **Table 3**, the value of *F*-test for the bound test is 3.481 and it is greater than the respective values for the lower and upper bounds at the specified level of statistical significance. This therefore implies that there is a long run relationship among the variables, and that the included independent variables including ACF have potential capacity of influencing the level of agricultural contribution to GDP. Therefore, the results of the long run and short run effects of ACF on agricultural output of Uganda are shown in **Tables 4** and **5**.

Table 3. ARDL bound test cointegration.

Null Hypothesis: No long-run relationships exist		
Test Statistic	Value	K
F-statistic	3.480855	6
Critical Value Bounds		
Significance	**I0 Bound**	**I1 Bound**
10%	2.12	3.23
5%	2.45	3.61
2.5%	2.75	3.99
1%	3.15	4.43

Source: Author's computation from the BoU dataset (2021).

Table 4. The short run regression estimates of the estimated model.

A: Short run cointegrating result				
Variable	**Coefficient**	**Std. Error**	***t*-Statistic**	**Prob.**
DLOG(AGRO(−1))	0.133593	0.185490	0.720219	0.4783
DLOG(AGRO(−2))	−0.166716	0.123712	−1.347615	0.1904
DLOG(AGRO(−3))	−0.313038	0.077429	−4.042877	0.0005*
DLOG(ACF)	0.099210	0.211317	0.469483	0.6430
DLOG(ACF(−1))	−0.271263	0.166684	−1.627412	0.1167
DLOG(CBCA)	−0.159356	0.129867	−1.227074	0.2317
DLOG(CBCA(−1))	0.276201	0.132067	2.091375	0.0473**
D(EXCHR)	0.000052	0.000061	0.841533	0.4084
D(EXCHR(−1))	−0.000083	0.000062	−1.342227	0.1921
DLOG(GDP)	1.180558	0.062963	18.749893	0.0000*
D(INFLA)	−0.003934	0.001752	−2.245595	0.0342**
D(INFLA(−1))	0.002610	0.001028	2.538566	0.0180**
D(INFLA(−2))	−0.004303	0.001077	−3.994974	0.0005*
D(INTR)	−0.001507	0.007651	−0.196961	0.8455

Table 4. (*Continued*).

A: Short run cointegrating result				
Variable	**Coefficient**	**Std. Error**	***t*-Statistic**	**Prob.**
D(INTR(−1))	−0.008872	0.009313	−0.952638	0.3503
D(INTR(−2))	0.024528	0.008475	2.894101	0.0080*
ECM(−1)	−1.208699	0.287992	−4.196990	0.0003*

Source: Author's computation from the BoU dataset (2021).
Note: *, **, and *** denote that the variables are significant at 1%, 5%, and 10 % level of statistical significance.

Table 5. The Long run regression estimates of the estimated model.

Variable	**Coefficient**	**Std. Error**	***t*-Statistic**	**Prob.**
B: Long Run Coefficients				
LOG(ACF)	0.170412	0.052833	3.225495	0.0036*
LOG(CBCA)	−0.307546	0.139788	−2.200086	0.0377**
EXCHR	0.000148	0.000054	2.757197	0.0110***
LOG(GDP)	0.741625	0.164321	4.513276	0.0001*
INFLA	−0.004127	0.001927	−2.142274	0.0425**
INTR	−0.012025	0.006798	−1.768958	0.0896*
C	1.204897	0.651189	1.850303	0.0766*
R-squared	0.997613	*F*-statistic	436.1019*	
Adjusted *R*-squared	0.995325	Prob(*F*-statistic)	0.000000	

Source: Author's computation from the BoU dataset (2021).
Note: *, **, and *** denote that the variables are significant at 1%, 5%, and 10% level of statistical significance.

5.4. The ARDL short run results

From the results of the short run dynamics of ARDL model in **Table 4,** a short run dynamic change in the logarithmic value of the third lag of agricultural output [DLOG(AGRO(−3)] shows a sign of negative and significant effect on the current level of agricultural output. This means a 1% increase in this lag value could reduce current level of agricultural output in Uganda by 0.134%. This is however contrary to the expectation of positive effect of the level of past agricultural output on the current level of output of the sector. This would imply that unless the existing level of agricultural sector output growth of Uganda is high enough to instigate increasing rate of agricultural growth, otherwise, the sector's output growth would be short-lived.

In terms of the effect of ACF, the short run instantaneous change in the quarterly value of ACF [DLOG(ACF)] shows no significant effect on agricultural output. This corroborates with the earlier finding of Oloukoi [23] in a panel data framework that short run agricultural loans in West Africa Economic Monetary Union (WAEMU) had poor impacts on agricultural value-added of the countries.

In terms of direct allocation of credit by the commercial bank to the agricultural sector in Uganda, the result for the short run dynamics in **Table 4** further shows that commercial banks' credit to the agricultural sector (CBCAS) played a significant positive role in agricultural output. Here, the result shows that at 5% level of statistical significance (0.0473), a 1% increase in the first lag log value of

commercial banks' loan to agricultural sector [DLOG(CBCA(−1)] significantly increased agricultural output of Uganda by 0.276%. This implies that sectoral allocations of credit by the commercial banks to the agricultural sector, which has always been before ACF in the country has significant effect on the overall level of productivity or performance of the agricultural sector of Uganda. This finding is however contrary to the position of Florence and Nathan [6] that commercial bank credit to the agricultural sector had no significant impacts on agricultural output in Uganda but is in agreement with the findings of Kazaara and Christopher [9] and Okafor [17]. that microcredit funding helped improve agricultural output in Bundibugyo District of Western Region of Uganda. Our finding is also in consonance with the empirical evidence showed by Abubakar and Muhammad [16] that commercial banks' roles in agricultural financing have positive and substantial effects on agricultural output in Nigeria.

Further evidence from **Table 4** reveals that the rate of change in economic growth, measured by the log value of GDP [DLOG(GDP)] exhibits a sign of a positive significant effect on agricultural output growth in the short run. In this case, a 1% increase in the gross domestic product (GDP) of Uganda would cause agricultural output to increase by 1.181%. By implication, the level of aggregate income growth (GDP) can be leveraged for improved productivity of the agricultural sector. This is an indication of the possibility of bi-directional causality between economic growth and agricultural productivity in the economy.

As empirically expected, the rates of inflation in the economy of Uganda are inimical to agricultural output. Here, the result from the short run dynamics in **Table 4** show that persistent increase in general prices of goods and services significantly reduce agricultural output. Based on the magnitude of the result, a 1% change in the log value of current inflation [D(INFLA)]and the second lag [D(INFLA(−2)] significantly reduced agricultural output by 0.0039% and 0.0043% respectively. These results imply that inflation is detrimental to agricultural output productivity in Uganda. When the general price level of goods and services rise, the production input needed for agricultural production may not be affordable as the amount of loans disbursed cannot afford essential equipment. Thus, the expected level of agricultural productivity will significantly reduce. This finding is also in congruence with the findings on the negative effect of inflation on the level of agricultural output by Kazaara and Christopher [9].

Interest rate is a vital determinant of the ability of the farm holders to repay loans borrowed. The rate of interest rate charge ostensibly reveals the level of efficient and inefficient use of the credits accessed. Hence, increase in interest rate has the potential to reduce the level of agricultural output. From the result in **Table 4**, change in the second lag logarithmic value of interest rate [D(INTR(−2))] shows a significant positive effects of on agricultural productivity by 0.0245%. This is however contrary to the expectation of negative effect. In the short run however, it is not uncommon that the net effect of interest rate on agricultural output could be positive as the borrowed fund is needed to instantly spur aggregate agricultural output.

The last variable in **Table 4** is the error correction model (ECM). It plays a significant role in correcting for the short run dynamic disequilibrium in the system

and reveals the speed of the adjustment by which instantaneous disequilibrium can be corrected in the long run. Based on its coefficient, it will take 12.1% for short run errors in the system that causes disequilibrium to be corrected in the long run. Thus, even if ACF has not significantly enhanced agricultural productivity in Uganda, based on the time path, its positive effects on agricultural output will improve with time.

5.5. The ARDL long run results

Interesting findings were obtained from the long run dimensions of the impacts of ACF on agricultural productivity in Uganda. As evidenced from the results in **Table 5**, increase in ACF will, in the long run increase agricultural productivity in Uganda by 0.17% quarterly. Thus, ACF is a good policy direction for improved real sector performance of Uganda.

In relation to the commercial banks' credit to the agricultural sector (CBCAS), the long run result reveals that 1% increases in the log value such credit [LOG(CBCA)] will significantly reduce agricultural output by 0.308% approximately. This is however contrary to the short run result whereby the instant effect of CBCAS on the agricultural sector was 0.27%. This means that obtaining credit will significantly improve agricultural output as needed farm inputs could be purchased. But the indication in the long run is that, as borrowers (beneficiaries of the loan) continue to pay back, especially with high interest rate, the accumulated positive effects of the credit on farm yields and aggregate agricultural output could diminish.

In terms of exchange rate in the long run, the result reveals that exchange rate will significantly increase agricultural output by 0.00015% for a 1% increase in Uganda shillings for 1 dollar. Based on the long run, this can be possible and beneficial if the level of output productivity of the agricultural sector of Uganda is tailored towards export with the assistance of ACF. The log value of Economic growth [LOG(GDP)] shows that in the long run, a 1% increase in GDP of Uganda will increase agricultural output by 0.74%. This further shows that economic growth itself is a necessity for the expected advancement of the agricultural sector of the country.

On the part of inflation and interest rate, the results in **Table 5**indicate that in the long run, inflation and interest rate have significant negative effects on agricultural sector output by 0.004% and 0.012% respectively. These are in line with a' priori expectation that increase in inflation rate and interest rate charge on credit will worsen economic growth the growth path or performance of the agricultural sector in Uganda.

Overall, the ARDL results showcased that ACF and all the control variables (all other independent variables) in the estimated model are significant determinants of agricultural productivity in Uganda. This is revealed by the value of the coefficient of the determination of the model (*R*-square) in the last columns of **Table 5**. The value of R^2 is 0.997613 and its adjusted value is 0.995325. These figures imply that ACF and all other independent variables account for 99.8% or 99.5% of the overall changes or variations in the agricultural output in Uganda's economy. In all, ACF is

a right policy with significant positive long run effects on agriculture sector of the country.

5.6. The model diagnostics results

In order to ensure that the estimated ARDL model in this study is not spurious, the regression output is subjected to the basic test of econometrics in terms of auto-correlation problem, heteroscedasticity and model instability test. These tests were done using the Breusch-Godfrey Serial Correlation Lagrangian multiplier (LM) test, Breusch-Pagan-Godfrey Test, and the Ramsey Reset Test. These results as shown in **Table 6** reveal that there is no problem of serial correlations and heteroscedasticity problems because the probability values of the chi-square distributions are not significant. The Ramsey Reset test also indicated that the specified model is structurally stable and no misspecification problem.

These diagnostics therefore authenticate the validity of the empirical results obtained in the short and long run that ACF does not have significant effects on agricultural output in the short run but very significant in determining agricultural output in the long run in Uganda.

Table 6. Model's diagnostic tests.

Breusch-Godfrey Serial Correlation LM Test:			
F-statistic	1.770246	Prob. *F*(2, 22)	0.1937
Obs × squared Obs × *R*-squared	6.653890	Prob. Chi-Square(2)	0.0359
Heteroskedasticity Test: Breusch-Pagan-Godfrey			
F-statistic	1.047623	Prob. *F*(23, 24)	0.4544
Obs × squared	24.04757	Prob. Chi-Square(23)	0.4012
Scaled explained SS	10.01185	Prob. Chi-Square(23)	0.9912
Ramsey RESET Test			
	Value	**Df**	**Probability**
t-statistic	0.099132	23	0.9219
F-statistic	0.009827	(1, 23)	0.9219

6. Conclusion and recommendations

The importance of agricultural sector development is indispensable for aggregate output in the economy. Its role is greatly enhanced when farm input demands are met through agricultural credit funding. In Uganda, commercial banks' credit to agriculture has been on for several years. However, ACF was initiated in 2009 to further enhance the productivity of the sector. From the analysis of the short run model, ACF has not shown significant effects, however, the long run effect of the facility was significant up to 0.17%. Increase in inflation and incessant rise in interest rates charged on the credit facilities proved to be significant in reducing agricultural productivity in Uganda, especially in the long run. Indeed, our stated hypotheses have been confirmed by our empirical results such that agricultural financing through agricultural credit has an indispensible role in facilitating overall agricultural productivity in Uganda. We also confirmed the hypothesis that the levels

of economic growth, inflation, interest, and exchange have significant effects on agricultural output in Uganda, especially in the long run. Our findings negate the position of Florence and Nathan [6] who found insignificant effects of agricultural credit on the level of productivity of the sector in Uganda. Other future studies could beam the research light in the direction of unveiling the relationship among agricultural credit, climate change and agricultural output in Uganda as agricultural financing could effectively help farmers cope with the challenge of climate change.

Based on these findings among others, it is important that the government of Uganda (GoU) put more funds in the facility to enhance further improvement of the sector. Similarly, the monetary authority of Uganda is expected to have inflation targeting policy so that frequent hikes in general prices of goods and services can be curbed. Again, strict monitoring and evaluation of ACF and all the institutions that are involved in the facility is necessary to guarantee better development and equity in its allocation process to the potential beneficiaries.

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