Impacts of Capital Formation and Investment Sources on Total Factor Productivity: The Example of Nigeria's Agriculture

Modupe Elizabeth Obe[1], Adewale Isaac Olutumise[2,3*], Olumide .O. Akinrinola[1], Olanrewaju Olaniyi Omosehin[1,4], Oluyede Adeleke Aturamu[5], Yiseyon Sunday Hosu[3]

[1]Department of Agricultural and Resource Economics, Federal University of Technology Akure, Ondo State, Nigeria.
[2]Department of Agricultural Economics, Adekunle Ajasin University, P.M.B. 001, Akungba-Akoko, Ondo State, Nigeria;
[3]Department of Economic Business Sciences, Faculty of Commerce and Administration, Walter Sisulu University, South Africa.
[4]Centre for Economic Policy & Development Research, Covenant University, Ota, Nigeria.
[5]Department of Agricultural Science and Technology, Bamidele Olumilua University of Education, Science and Technology, Ikere-Ekiti, Nigeria.
[*]Corresponding Author: adewale.olutumise@aaua.edu.ng

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Abstract

The study was designed to analyse the impact of capital formation and investment sources on Nigeria's agricultural productivity from the period 1980 - 2021. The time series data were analysed with Malmquist Data Envelopment Analysis (DEA) and the tobit regression models using DEA, the Total Factor Productivity Change, which quantifies the degree of productivity, was estimated at 1.022, which implies an average productivity progress of 2.2% annually. Again, since the value of technical efficiency change is less than technological change, it implies that the productivity gains are mainly attributable to technological progress instead of efficiency improvements in the periods under the study. The results of tobit regression indicate that domestic capital formation significantly influences agricultural TFP, highlighting the importance of government expenditure on agriculture (GEA) and gross fixed capital formation (GFCF) in enhancing productivity, although with minimal effects. Human capital formation (HCF) also showed positive impacts on Total Factor Productivity TFP, suggesting that improvements in workforce skills and knowledge are crucial for agricultural efficiency. However, FDI exhibited no significant correlation with TFP, implying that local investments are more beneficial than foreign aids in the context of Nigeria's agricultural sector. The findings emphasize the need for robust policy frameworks that align capital disbursements with agricultural production periods to optimize TFP. This study contributes to the discourse on agricultural productivity by providing empirical evidence on the critical role of capital investments in enhancing TFP within developing economies like Nigeria.

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Introduction

The emphasis on productivity for expansion in agriculture may make it unique (Anik *et al.*, 2017). According to Jorgenson *et al.* (2016), increases in the total productivity of factor inputs account for about one-third of global economic growth, but total factor productivity (TFP) in agriculture accounts for roughly three-fourths of global growth and almost all growth in industrialized nations (Fugile, 2015; Afzal *et* *al.*, 2021). Increased planting densities, higher crop yields, and reduced water and energy consumption are only a few of the farming outcomes associated with TFP growth that result from sources of TFP growth (Coomes *et al.*, 2019). This emphasis on productivity mirrors agriculture's dependence on land and water, which are precious natural resources and it is these resource constraints that have caused concern since the increase in the world population density (Lambin and Meyfroidt, 2011). The increase in the workforce due to a change in the demographic makeup, the accumulation of physical and human resources, and modernization are the three main elements that determine how the agriculture sector develops. Therefore, one of the most important variables in the industrial process is capital. The capital inventories for agriculture are made up of three things: physical assets, animals, and plants (Butzer *et al.*, 2012).

Capital formation on a farm refers to the development of tangible assets that over time can significantly improve the effectiveness of productive endeavours (Hamsa and Umesh, 2019). Therefore, capital asset expansion must continue at the farm level. This could be helped any time there is a higher level of public investment in infrastructure amenities. Public and private investment in agriculture during the Green Revolution and afterward significantly boosted the sector's growth (Venkataramana *et al.*, 2019). The accumulation of capital is essential to the expansion of agriculture and the development process since it is a vital source of agricultural production. Agricultural growth was first primarily fueled by public investment in farm infrastructure, such as power, roads, and, irrigation, extension services; expansion of markets and warehouses, etc. More recently, the corporate sector has also gotten involved in agricultural research and development, extension, sales, crop insurance, and other related fields. These measures have significantly augmented public funding for agriculture. In areas where infrastructure has been built through public efforts, like irrigation and the emergence of new manufacturing methods, private investment has risen, increasing the profit of private investment. Farmers are becoming more and more innovative and investment-aware in such areas, specifically the creation of irrigation developments and new production methods (Shukla, 1965; Eita and Pedro, 2020). According to the aforementioned overview, agriculture requires a significant amount of basic as well as operating capital to efficiently conduct various agricultural activities, while being a relatively labour-intensive industry. Timely investment is especially important because it is influenced by climate conditions like temperature, rainfall, dry air, etc. Large and wealthy farmers, however, typically had better access to financial inputs and benefited from economies of scale. Meanwhile, struggling with severe capital shortages are impoverished farmers who fall into the "small and marginal farm" classifications, particularly in agriculturally underdeveloped regions (Venkataramana *et al.*, 2019). The availability and wise utilization of farm power by the farmers are significant to farm productivity. Farmers can use agricultural equipment and machinery to properly use resources for production goals (FAO, 2022). This is because they help farms run more efficiently and produce more work in a given amount of time, agricultural machines boost both labour and land productivity. Mechanization not only greatly aids in the diversification and multiple cropping of agriculture, but also makes it possible to use inputs like seeds, fertilizer, and irrigation water efficiently. Through efficiency, superior input management, higher work quality, and a decrease in post-harvest losses, mechanization in agriculture increases crop output and productivity (Singh and Sahni, 2019). As a result, farms must continually renew their capital base and identify sources of investment in farms to maintain expansion and further improve agricultural productivity. Regular use and some degree of obsolescence cause the capital assets on the farm to degrade drastically over time. Therefore, to increase productivity on the farm, capital formation in terms of investments is required periodically in Nigeria.

The study modeled how sources of investment and capital formation affect total factor productivity to add to the body of literature, by focusing on Nigeria's agriculture. Unlike several studies on capital formation and agriculture in the literature (Ugochukwu and Chinyere, 2013; Adegboyega and Odusanya, 2014; Eke and Effion, 2016; Ajose and Oyedokun, 2018), the study used censored tobit regression as the econometric tool of the analysis. According to Gujarati and Porter (2009), when the dependent variable exhibits a positive mass of observations at one extreme and is unbounded at the other, Tobit regressions are appropriate. As a result of this, it is expected that it would bring a plausible estimate for robust policy implications. Again, the study also makes a difference by narrowing the investigations on the agricultural sector unlike studies of (Bakare, 2011; Kanayo, 2013; Shuaib and Dania, 2015; Ajose and Oyedokun, 2018) who used the overall GDP of their countries. Eke and Effiong (2016) examined the nexus between capital formation and agriculture but it only investigated crop production and failed to consider the influence of sources of investment as done in this study. Based on the above facts, the study would be the best option in recommending to government and non-governmental agencies how to provide possible policy measures to encourage capital formation and appropriate agricultural investment to support sustainable food production, not just in Nigeria but globally. It is on this note that the study broadly analyses the impact of capital formation on productivity in Nigeria. Specifically, it examines the behaviour of the agricultural investments by both public and private sectors in Nigeria, determines the agricultural total factor productivity using the Malmquist index approach, and estimates the impacts of capital formation and sources of investment on agricultural total factor productivity (TFP) in Nigeria using the Tobit regression models, spanning the periods of 1980 to 2021.

Materials and Methods

Description of the study area

The research was conducted in Nigeria, which is found between latitudes 4^0 and 14^0N and longitudes 3^0 and 15^0E. The Gulf of Guinea borders it on the south; Benin borders it on the west; Niger borders it on the north; and Cameroon and Chad border it on the east. Nigeria's Federal Capital City, Abuja, is home to 36 states spread across six geopolitical zones. There are more than 250 different ethnic groups in the nation; the Hausa, Igbo, and Yoruba are the largest. In 1914, these areas were combined to form the Colony and Protectorate of Nigeria. Nigeria's total land area is 923,768 square kilometers, with 13,000 square kilometers of water, 4,047 kilometers of borders, and 853 kilometers of coastline (NBS, 2019). The country's climate, which has two distinct seasons i.e. the rainy and the dry is favorable for agriculture. There are roughly 71 million hectares of arable land, and the country is well-suited for the growth of cash crops and both arable and livestock crops. For example, Nigeria was the world's largest producer of cassava in 2017 with 59 million tons (roughly 20 percent of global production).

Sources of data

This research used secondary data from 1980 to 2021 with a total of 42 data points. The time frame chosen was affected by gaps and inconsistencies in the data records. The time series data were sourced from the Food and Agriculture Organization (FAOSTAT), Nigerian Bureau of Statistics (NBS), Central Bank of Nigeria (CBN), and World Bank databases. The variables analyzed included Foreign Agricultural Assistance (FAA) in million USD, Foreign Direct Investment (FDI), Credit to Agriculture, Forestry and Fisheries (CAFF) in USD million, Government Expenditure on Agriculture (GEA) in USD million, Gross Fixed Capital Formation (GFCF) in millions of naira and human capital formation (HCF) in millions of naira.

Method of data analysis

Descriptive statistics, the Malmquist Data Envelopment Analysis (DEA) model, and the tobit regression model were used to analyze the data.

Unit root test

The necessity of the unit root test results from the possibility that macroeconomic time series may not show stationarity over time, as stated by Yilmaz (2014). A time series is considered stationary if its mean and variances remain constant over time (Gujarati and Porter, 2009). The Augmented Dickey-Fuller (ADF) test, a standard method for checking unit roots, was used to confirm the order of integration. Juselius (2006) states that in a stationary series, the mean and variance do not change, in contrast to a non-stationary series where these parameters fluctuate. The null hypothesis of a unit root test tests for non-stationarity at the I(0) or first difference I(1) level. Mafimisebi (2012) explains that a finding of $\beta = 0$ would disprove the alternative hypothesis of $\beta < 0$. Following Akinrinola and Okunlola (2020), the ADF test statistics were stated as follows:

$$\Delta Yt = \propto + pYt - 1 + \sum_{i-1}^{j} Y\Delta Yt - j + \varepsilon t \quad (1)$$

Here, Yt denotes to the variables to be analysed, including Foreign Aids to Agriculture (FAA) in millions of dollars, Foreign Direct Investment (FDI), Credit to Agriculture, Forestry and Fishing (CAFF) USD in millions, Government Expenditure on Agriculture (GEA) in USD millions, Gross Fixed Capital Formation (GFCF) in millions of naira, and Human Capital Formation (HCF) in million nairas. The Schwarz Information Criterion (SIC) is employed to determine the appropriate lag lengths, i, while the lag length j of ΔYt is used to whiten the errors, represented by εt. These tests, conducted under the null hypothesis that the variable has a unit root, these tests were conducted. The null hypothesis is upheld if the t-statistic exceeds the critical value; and is otherwise rejected.

Malmquist productivity index

The Malmquist Productivity Index, developed by Sten Malmquist, is a mathematical formulation used for measuring the productivity change between two data points (Pokharel and Featherstone, 2021). It is a widely adopted method in empirical economics, especially in productivity and efficiency analysis (González, 2020; Tenaye, 2020). It is a unique mathematical linear programming model called the DEA which is used to evaluate productivity and efficiency (Ajayi and Olutumise, 2018). It splits the total factor productivity into two components, namely technical efficiency change (EFCH) and technological change (TECHCH), in contrast to other models. It is an effective instrument for analyzing production over time because of the breakdown. Technical efficiency change and technological change were the two categories into which total factor productivity (TFP) was divided using the output-oriented Malmquist productivity index technique. This made it possible to give priority to the growth of output quantity over input quantity. The TFP index is therefore a ratio of the weighted aggregate outputs to the weighted aggregate inputs using multiple outputs and inputs. (1)

In line with Färe et al.(1994), the Malmquist productivity change index is defined as:

$$m_0\left(y_{t-1,} y_t, x_t \right) = \left[\frac{d_0^{t+1} \left(y_{t,} x_t \right)}{d_0^{t+1} \left(y_{t+1\,,} x_{t+1} \right)} \; x \; \frac{d_0^{t} \left(y_{t,} x_t \right)}{d_0^{t} \left(y_{t+1\,,} x_{t+1} \right)} \right]^{1/2} \quad (2)$$

The productivity of the production point (*xt+1, yt+1*) concerning the production point *(xt, yt)* is shown in equation (2). The technologies of period t and additional period t+1 are used in this index. The geometric mean of two output-based Malmquist-TFP indices from period t to period t+1 is known as TFP growth. Positive TFP growth from period t to period t+1 is indicated by a value greater than one, while a decline in TFP growth from the previous year is indicated by a value less than one.

Here:

M_0 = the difference in productivity between the latest production point using period (t + 1) and the previous production using period (t) technology.

d = input distance functions

y = output level

x = input level

Hence, the study employed the following model:

$y = f(x_1, x_2, x_3, x_4)$

TFP = Output/input = $y/(x_1, x_2, x_3, x_4)$

Where, y = output

x_1 = Land (ha)

x_2 = Labour (man-days)

x_3 = Fertilizer (Kg)

x_4 = Machinery (₦)

Jajri (2007) states that technological change (TECHCH) and technical efficiency change (EFCH) multiply to produce the Malmquist index of total factor productivity change (TFPCH):

TFPCH = EFCH x TECHCH (3)

The Malmquist productivity change index can be expressed as follows:

$$m_0(y_{t-1}, y_t, x_t) = \text{EFCH x TECHCH} \quad (4)$$

The change in technical efficiency (catch-up) quantifies the change in efficiency between the current (t) and the next (t+1) era, while technological change (innovation) records the shift in frontier technology.

Tobit regression model

Tobin (1958) introduced the Tobit regression model to elucidate the connection between one or more independent variables and a non-negative dependent (latent) variable in cases where the data is truncated or censored. This model typically handles data ranging from 0.0 (left-censored) to 1.0 (right-censored), which are efficiency scores obtained from Data Envelopment Analysis (DEA) models. As noted by Saglam (2017), the Tobit regression model serves as an effective method for conducting secondary-stage analyses in DEA research.
It is hereby mathematically expressed as:

Y = f (FAA, FDI, CAFF, GEA, GFCF, HCF) + e_i implicit function (5)

$Y = \beta_0 + \beta_1 FAA_i + \beta_2 FDI_i + \beta_2 CAFF_i + \beta_2 GEA_i + \beta_2 GFCF_i + \beta_2 HCF_i + e_i$ explicit function (6)

$$0_{ik} = \beta zz_{ik} + \varepsilon_{ik}, where\ \varepsilon_{ik} \sim N(\overline{0}, \sigma 2)\ and\ 0ik = \{^{\theta}_{0} ik\ if\ 0 < \theta^{*}_{ik} < 1\} \quad (7)$$

where the relationship between the latent variable (0ik∗) and the vector of independent variables (xik) is represented by the vector of unknown coefficients, β. 0ik represents the relative efficiency scores from the input-oriented CCR models, while the error term εik has an identically, independently, and normally distributed distribution.

Results and Discussion

Descriptive statistics of the capital formation and sources of investment variables

Table 1 presents descriptive statistics for selected macroeconomic variables related to capital formation and investment resources. The variables analyzed include Foreign Agricultural Assistance (FAA), Foreign Direct Investment (FDI), Agriculture, Forestry and Fisheries Credit (CAFF), Government Expenditure on Agriculture (GEA), Gross Fixed Capital Formation (GFCF), and Human Capital Formation (HCF). The average FAA value was 606.43 with a standard deviation of 674.72 and peaked at 2859.37 during the study period 1980–2021. The Jarque-Bera test with a value of 23.41 indicated a non-normal distribution at the 5% significance level. FDI values ranged significantly from 1.52E+08 to 8.84E+09, with a mean of 1.49E+09 and a standard deviation of 2.20E+09. Similarly, the CAFF values ranged from 109.00 to 3020.45 with a mean of 781.55

and a standard deviation of 746.95, which also showed a non-normal distribution according to the Jarque-Bera test value of 14.74. The GEA data ranged from 2.00 to 880.00 with a mean of 255.63 and a standard deviation of 199.61, further supporting a non-normal distribution trend among these economic variables.

At the 5 percent significance level, the Jarque-Bera value of 16.84 indicates that the variable is not normally distributed. GFCF's standard deviation was 228095.50, and its mean was 256810.00. The variable GFCF exhibited a normal distribution, considering the coefficient (4.79, Prob. Jarque-Bera > 0.05). With a standard deviation of 150479.90, the mean HCF value for the duration was 127346.20. Over the period, HCF reached a maximum value of 444269.9. With a 5 percent significance level and a Jarque-Bera value of 5.27, the variable is not normally distributed. It was evident from the Table that every variable had a positive skewness. Kurtosis results indicated a leptokurtic peakness distribution for FAA and FDI and a platykurtic peakness distribution for CAFF, GEA, GFCF, and HCF.

Table 1. Summary of the Independent Variables Used in the Study

Statistics	FAA	FDI	CAFF	GEA	GFCF	HCF
Mean	606.43	1.49E+09	781.55	255.63	256810.00	127346.20
Median	504.94	3.48E+08	480.57	236.00	192984.40	38705.60
Maximum	2859.37	8.84E+09	3020.45	880.00	622559.30	444269.90
Minimum	0.00	1.52E+08	109.00	2.00	988.12	0.00
Std. Dev.	674.72	2.20E+09	746.95	199.61	228095.50	150479.90
Skewness	1.56	1.889242	1.44	1.26	0.17	0.82
Kurtosis	5.17	5.541920	3.89	4.99	1.32	2.28
Jarque-Bera	23.41	33.69973	14.74	16.84	4.79	5.27
Probability	0.00	0.000000	0.00	0.00	0.09	0.07
Sum	23650.89	5.81E+10	30480.59	9969.63	10015589	4966501
Sum Sq. Dev.	17299362	1.85E+20	21201442	1514021	1.98E+12	8.60E+11
Observations	42	42	42	42	42	42

Note: FAA = Foreign Aids to Agriculture in dollar million
FDI = Foreign Direct Investment, Net Flow (BoP, current USD)
CAFF = Credit to Agriculture, Forestry and Fishing USD in million
GEA = Government Expenditure on Agriculture USD million
GFCF = Gross Fixed Capital Formation in million naira
HCF = Human Capital Formation in million naira
Source: Prepared by the authors, based on Eviews 10

Summary of the total factor productivity computed variables

Table 2 provides a summary of the variables used to measure total factor productivity (TFP) in Nigeria from 1980 to 2021 using descriptive statistics. The data reveals an average performance of approximately 6,073,835.00. Inputs include 65,975.54 hectares of land, 171,450.60 kilograms of fertilizers, 29,777,104.00 man-days of labour, and machinery valued at ₦30,833.96. According to the Jarque-Bera test, the distribution of errors in output and fertilizer was found to be normal, indicating that these variables do not deviate from a normal distribution. However, the distributions for land, labor, and machinery indicated non-normality, leading to the rejection of the null hypothesis for a normal distribution of errors in these inputs. Again, output, land, and labour were negatively skewed, while fertilizer and machinery were positively skewed, which implies that investment in fertilizer and machinery rather than land and labour will enhance productivity in agriculture in the long run. In every instance, the kurtosis results revealed a platykurtic distribution. In every instance, the kurtosis results revealed a platykurtic distribution. This suggests that there is a normal distribution of the production variables.

Stationarity (unit root) test

Table 3 presents the findings from the ADF test. Based on the integrated values at order zero, or level I[0], the results indicated that every variable under test was stationary. The purpose of the test was to confirm that, as stated by Olutumise *et al.* (2017) and Ekundayo *et al.* (2021), the time series variable under investigation was free of spurious regression results respectively. This validates the optimal use of ordinary least squares (OLS) and confirms that the regression does not accept a fictitious or absurd relationship.

Table 3. Stationarity Test using ADF

Variables	Level [I (0)]	
	Critical value at 5% level	t-Statistic
FAA	-2.943	-10.466(0) ***
FDI	-2.943	-6.272 (0) ***
CAFF	-2.943	-6.778 (0) ***
GEA	-2.964	-6.293 (7) ***
GFCF	-2.943	-3.244 (2) **
HCF	-2.943	-24.017 (0) ***
NNS	-2.943	-3.116 (0) **

NB: **, *,** means at 5% and 1% significant level respectively.
Source: Prepared by the authors, based on Eviews 10

Estimation of agricultural total factor productivity (TFP) using the Malmquist Index

Table 4 displays the findings from the Malmquist analysis of capital formation effect on agricultural total factor productivity. A productivity measure known as the total factor productivity change (TFPCH) was estimated to be at 1.022. For the duration of the study, this suggests an average annual productivity growth of 2.2%. The technical efficiency change (EFCH) measure, which is focused on the principle of constant returns to scale in technology, further suggests that productivity stagnated (1.000), whereas technological change (TECHCH) improved by 2.2 percent per year, according to the breakdown of the Malmquist index estimate. To identify the causes of inefficiency in the productivity change, the technical efficiency change (EFCH) is once more broken down into scale efficiency change (SECH) and pure technical efficiency change (PECH). The improvement in PECH and SECH was unchanged in explaining most of the efficiency changes since their coefficients are constant. Therefore, since the value of EFCH is less than TECHCH, it suggests that rather than efficiency gains during the study periods, the majority of productivity gains can be attributed to technological advancements. Similar results were found by Jajri (2007) that the negative contribution from technical efficiency meant that the TFP growth of the Malaysian economy during the whole test period was not encouraging. Moffat *et al.* (2009) found similar results to this study, indicating a decline in productivity or only a slight increase in Botswana's financial institutions due to technological regression. Again, Shen *et al.* (2011) found that the majority of the improvement was made possible by technical changes rather than efficiency improvements when evaluating road safety performance using the Malmquist productivity index.

Table 4. Malmquist Productivity Index Summary

Estimate	Value
EFCH	1.000
TECHCH	1.022
PECH	1.000

SECH	1.000
TFPCH	1.022

Note: Total Factor Productivity Change =TFPCH
Pure Technical Efficiency Change =PECH
Scale Efficiency Change =SECH
Technical Efficiency Change = EFCH
Technological Change = TECHCH
Source: Prepared by the authors, based on Eviews 10

Impact of capital formation on agricultural TFP in Nigeria

According to the diagnostic test in Table 5, a smaller standard error of regression (0.518) indicates that the model accurately predicts TFP, providing support for the model's validity. The lower values of AIC, BIC, and Hannan-Quinn indicate a better model fit and support the model structure and the inclusion of the predictors chosen. The log-likelihood value is rightly signed and provides support for the model. The dependent variable is well censored which contributes to the effectiveness of the model, suggesting that the modeling approach is appropriate. Further, Table 5 shows the findings from the censored normal Tobit regression model. The results indicate that the coefficient for Foreign Aids to Agriculture (FAA) is positive and significantly affects total factor productivity (TFP) at the 1% significance level. Specifically, a 1% increase in FAA is associated with a 0.05% increase in TFP, holding other factors constant. Additionally, the coefficient for Government Expenditure on Agriculture (GEA) is also positive and reaches statistical significance at the 10% level, indicating that each unit increase in GEA is correlated with a 0.006% increase in TFP over the study period. It can be deduced that GEA contributed to agricultural productivity over the periods. This is expected because the Nigerian government has invested in agriculture through several policies but the weak effect called for concern. This small significant impact might be due to improper implementation of the policies and lack of synchronisation of agricultural fund disbursement with the production periods. The GFCF's coefficient was positively significant in addressing variations in TFP when other things are held constant over the periods. It means that an increase in the value of GFCF by one unit will increase TFP by 0.0005%. The effect is very minimal than expected over the periods. This research supports the findings of the Adegboyega and Odusanya (2014) study which suggests a strong positive correlation between the rate of capital formation and economic growth, which serves as a proxy for overall productivity. In a study carried out by Nikolaos *et al.* (2006) in Greece, it was observed that GFCF is the major factors that affect productivity, unlike that of this study where it is a weak determinant. The probable reason might be due to the limited funds provided for capital investment in agriculture.

The results from the tobit regression model show that the coefficient for human capital formation (HCF) is positive and significantly affects the total factor productivity (TFP) in the controlled environment during the observed periods. Specifically, a one-unit increase in human capital is associated with a 0.0009% increase in TFP. These findings corroborate the research of Hiro and Robert (2004) who highlighted the critical role of HCF in increasing productivity. Moreover, the observations are consistent with Li and Tanna (2019), who noted that the significance of the effect of human capital on productivity decreases when institutional effects are considered. This shows that for developing countries to realize productivity gains from foreign direct investment, institutional improvement is comparatively more important than the development of human capital. The coefficient of FDI was negative and not statistically different from zero in the periods under the study. It can also be deduced that FDI had an opposite relationship with TFP over the periods. It can be deduced that greater productivity benefits in agriculture are associated with domestic aid than foreign aid in the period under the study.

Over the periods, the coefficient of CAFF was positive but statistically insignificant in its influence on TFP. It can also be deduced that CAFF had an upward relationship with TFP. The model has a good fit since it was appropriately censored and had a highly significant error distribution. The estimated model's goodness of fit was further supported by the low values of the Schwarz, Hannan-Quinn, and Akaike information criteria, which all centered around 2. The coefficient of Log-likelihood was also negatively signed (-28.59), as predicted. Except for FDI, which had a negative coefficient, every variable in the model had a positive coefficient and an upward relationship with TFP. Similarly, during the study period, every variable in the model except FDI and CAFF was statistically significant in affecting TFP.

Table 5. Results of the Impact of Capital Formation on Agricultural TFP

Variable	Coefficient	Std. Error	z-Statistic	Prob.
FAA	0.001	0.000	2.875	0.004***
FDI	-2.24E-12	5.82E-11	-0.039	0.969
CAFF	7.49E-05	0.000	0.255	0.799
GEA	0.001	0.000	1.669	0.051*
GFCF	5.55E-06	1.00E-06	5.532	0.000***
HCF	8.79E-06	1.87E-06	4.694	0.000***
Error Distribution				
SCALE:C(7)	0.505	0.057	8.832	0.000
Mean dependent var	1.052	S.D. dependent var		0.291
S.E. of regression	0.518	Akaike info criterion		1.830
Sum squared resid	8.587	Schwarz criterion		2.128
Log-likelihood	-28.681	Hannan-Quinn criteria.		1.937
Avg. log-likelihood	-0.735			
Left censored obs	0	Right censored obs		1
Uncensored obs	31	Total obs		42

Note: *, **, ***, means significant at 10%, 5%, and 1% respectively.

Source: Prepared by the authors, based on Eviews 10

Conclusions

The study concludes that the modest improvement in agricultural Total Factor Productivity (TFP) primarily stems from technological advancements, with an annual growth rate of 2.2%. Technical efficiency changes were negligible, suggesting that future productivity enhancements should focus more on adopting new technologies rather than just improving operational efficiency. It is also concluded that domestic capital inputs like government expenditure on agriculture and gross fixed capital formation, though minimally, positively impact TFP. Furthermore, human capital formation significantly boosts productivity, emphasising the value of investing in agricultural education and training. In contrast, foreign direct investment showed no significant effect on TFP, indicating that local investments are more crucial to agricultural productivity than external aids. This aligns with broader economic theories that emphasize the role of indigenous investment in driving sectoral productivity.

Conflict of interest

Regarding the publication of this manuscript, the authors declare that there are no conflicts of interest.

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