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Impact on agricultural productivity in Guinea of R&D Investment, Foreign Aid and Climate Change

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Abstract : The purpose of this study was to examine the role of foreign aid, climate change and investment in R&D in the agricultural productivity of Guinea. For this purpose, this study assessed the impact of two dimensions of R&D investment (i.e. R&D expenditure and R&D researches), three dimensions of foreign aid (i.e. NDA, aid effectiveness, official aid received) and three dimensions of climate change (i.e. access to electricity, CO2 emission, renewable energy consumption) on the two dimensions of agricultural productivity i.e. Agriculture Value Addition (AVA) and crop production. The 30 years' data was collected about the current variables for Guinea and the time series analysis was performed to check the relationships. The findings of the current study showed that R&D investment has a significant and negative impact on crop production but does not have a significant impact on AVA. Furthermore, the results showed that RDR has a significant positive impact on AVA, but it does not have significant impact on crop production. The impacts of ATC and REC on crop production as well as AVA are significant and positive. Furthermore, only one dimension of foreign aid (i.e. official aid received) showed a significant and positive impact on AVA however, there was no significant impact on crop production caused by any of the dimensions of foreign aid.

Keywords: Expenditure, Effectiveness, Consumption, Production, Dimensions

1. Introduction

The challenges for agricultural productivity are increasing with increased population, climate challenges and fluctuating market conditions. The farmers and agricultural industries worldwide are in need of effective tools and methods through which they can enhance their agricultural productivity. Agricultural productivity is the ratio of a country's agricultural output to its agricultural input. The agricultural productivity of any country depends on various factors that can drive the agricultural productivity in positive or negative way. The increasing challenges regarding productivity, climate change, crop production, and costs in agriculture have led the researchers to conduct studies on different issues in agriculture in order to suggest appropriate solution to related issues and challenges. The importance of agricultural productivity for a country has been suggested by several past studies because it can play an important role in competitive advantage, comparative advantage, poverty reduction, food security, economic growth and development of the country e.g. (Davis et al., 2012; K. O. Fuglie, Wang, & Ball, 2012; Matsuyama, 1992; Peterman, Quisumbing, Behrman, & Nkonya, 2011; Schneider & Gugerty, 2011). When a country is good at agricultural productivity then it can meet the domestic as well as global needs of agriculture thus enhancing the ability of the country to avail the fluctuating opportunities at domestic as well as global level. Hence, the importance of agricultural productivity suggests researcher to find different ways through which it can be potentially enhanced because the agricultural productivity depends on number of factors. In this regard, the particular studies on agricultural productivity and ways to enhance it seem to be scarce however, there are significant studies that suggest the potential role of different factors in enhancement of agricultural productivity e.g. private R&D, public R&D, foreign aid, climate change, policies and agricultural investments (K. Fuglie & Rada, 2013; Kaya, Kaya, & Gunter, 2013; Sheng, Gray, & Mullen, 2011; L. S. Wang, Ball, Fulginiti, & Plastina, 2012; S. L. Wang, Heisey, Huffman, & Fuglie, 2013). The foreign aid refers to the financial aid in a country received from foreign countries. When the foreign aid in a country increases then the country is in better position to have the needed resources in agriculture including technology, seeds, minerals etc. that can ultimately support the agricultural sector. It means that different dimensions of foreign aid can serve as important predictors of agricultural productivity which is an ultimate source for several benefits (Kaya et al., 2013; Page & Shimeles, 2015). Another important factors which contributes to the agricultural productivity is the R&D investment made in agricultural field. When a country increases its R&D investment in agricultural field then it is in better position to find new ways and latest tools and technologies to enhance the agricultural production in the country (Sheng et al., 2011; L. S. Wang et al., 2012; S. L. Wang et al., 2013). The current study aims to analyze the impact of R&D investment, foreign aid and climate change on Guinea's agricultural productivity, given the great role of R&D investment, foreign aid and climate change in agricultural productivity.

2. Literature Review

2.1. Investment Theory

Literatures based on R&D investment usually depend upon the expenditure and economy status of the industry (van Scheppingen et al., 2016) or any company. R&D, however, has a range of characteristics from the viewpoint of investment theory that make it different from ordinary investment. R&D investment basically depends on the investment made by research and development spending or wages. It focuses on firm’s knowledge, creating relation with intangible assets and generating profits (Handley & Limao, 2015). There are many studies that effect the implications of R&D investment because they are considered the part of resource based firms to fix high adjustment costs of various industries with the help of its employees. Investment theory however (Fougère, Lecat, & Ray, 2017), gives a brief account of investment made by government sector, investment made by private sectors and investment made by foreign aids contribution or foreign funding in order to ensure agriculture industry growth which will further ensure crop productions and agriculture production of the Country. Investment theory, also explains the concept related to firm’s export investment which is often lower under trade policy uncertainty.

2.2. R&D Investment and its impact on Agricultural Productivity

Becker's (2015) studies conclude that the R&D investment cycle plays a major role in increasing the level of agricultural productivity in the agricultural industries manufacturing sector. Investment in R&D supports wages and services in the industry to improve farm and crop production. As per various studies (Gu, 2016), R&D expenditure that acts as a core dimension of R&D investment in the process of agricultural growth and agricultural production that further promotes the agricultural value addition in the GDP of the State, due to large amount of agriculture expenditure being utilized by the agriculture industry. Expenditure and investment both contributes in raising the level of GDP per capita of the agricultural sector. According to theorists (Lewis & Tan, 2016), that explain the involvement of R&D researches to briefly analyze about the R&D investment in the field of agriculture production and which will for instance, increase the value of GDP related to agricultural sector R&D expenditure realizes the value of R&D spending overtime between conception and commercialization. R&D expenditure has many unique factors that are involved in crop production. According to studies by Lucas, Knoben, and Meeus (2018), this further explains the role of research in the field of R&D which justifies initiatives such as the policy of intellectual property where government supports R&D that will further promote agricultural-related crop production. Many researches (Choi, Zahra, Yoshikawa, & Han, 2015) are based on the application of R&D investment that influences the growth rate of crop yield under the circumstances that are being explained in different researches. Thus, the following hypotheses are proposed:

H1: Investment in R&D has a significant impact on production in agriculture.

H1 (a): Expenditure on R&D has a major impact on the addition of agricultural value to GDP.

H1 (b): R&D research has a significant impact on the addition of agricultural value to GDP.

H1 (c): R&D expenditure has a significant impact on crop production.

H1 (d): Researches in R&D has a significant impact on crop production.

2.3. Foreign aid and its effect on production in agriculture

Lesk, Rowhani, and Ramankutty (2016), explain the role of foreign aid that is required by agricultural sector to enhance the agricultural production while, focusing on theoretical approaches regarding investment theory. As researches (Robinson et al., 2015), shows that foreign aid is also considered an investment made by foreign countries and states to promote the growth of crops and agricultural farming production. Usually those countries whose economy highly depends upon agriculture industries that require foreign aid to support their agricultural production, foreign aid investment determines the effective cost performance of the agriculture sector, variation in soil nutrients that can be sued by the farmers (Banga, 2016) in growing large number of crops to increase agricultural productivity that promotes labor markets, infrastructure and other facilities. Foreign aid assistance takes many forms that include: financial, technical and food security. Shiva (2016) foreign aid is divided into three certain aspects of dimensions that promotes the agriculture production, contributes in agriculture vale addition in GDP and in crop production. Foreign effectiveness, net official development assistance and aid received highly contribute to the agriculture sector. DeFries et al. (2015), believe that these foreign aid dimensions causes minimum consumption requirement and reduces domestic transport cost to promote farming and agriculture. Foreign aid generates potential economy that shows its impact on the agriculture sector, particularly on transforming the less valuable soil into valuable soil. Similarly, controlling severs agricultural pests and diseases (Gautam et al., 2019). It also involves replenishment of soil to ensure the best productivity of farms, crops and agricultural yield. Agriculture could generate positive permanent productivity (Amanor & Chichava, 2016) with the influence of investment theory that predominantly ensures welfare development assistance to receive more foreign aid. Thus, the following hypotheses are proposed:

H2: Foreign aid has a significant impact on the production of agriculture.

H2 (a): Net Official Development Assistance (NDA) has a major impact on the added value of agriculture to GDP.

H2 (b): Aid effectiveness (AE) has a significant impact on agricultural value addition in GDP.

H2 (c): Aid Received (OAR) has a significant impact on agricultural value addition in GDP.

H2 (d): Net official development assistance (NDA) has a significant impact on crop production.

H2 (e): Aid effectiveness (AE) has a significant impact on crop production.

H2 (f): Aid Received (OAR) has a significant impact on crop production.

2.4. Climate change and its effect on productivity in agriculture

According to past studies by Burke and Emerick (2016), that explains the effect of climate change on the agriculture production. Climate change and farming are both known to be interrelated phenomena that occur worldwide. Pittelkow et al. (2015), elaborates the affectivity of climate change that effects agriculture in various number of ways like, average temperature, hot weather, high rainfall, continuous high heat wave and climatic extremes can results in crops burning, crops destruction and in fertile soil for crops production. However, climatic changes, changes in pesticides, increase level of diseases that affect crops directly; all these factors can cause CO_2 emission in the environment which will directly affect the agriculture production. Climate change can be divided into certain diverse dimensions which also affect the efficiency and productivity of agriculture (Costinot, Donaldson, & Smith, 2016). Access to electricity, CO_2 emission and renewable energy consumption are considered as basic dimensions that further promotes agriculture productivity, crop production and agricultural vale addition in GDP of the State. Studies by Aspinwall et al. (2015), believe that climate change is already effecting agriculture production in the negative way. Perhaps, it is reducing the crop yield by lowering nutritional quality, crop production in low altitude countries usually effect appropriate crop production because there soil lacks essential elements and minerals that are essentially required by the soil for growing crops. On the other hand, with anthropogenic emissions (Wiebe et al., 2015) agriculture leads to climate change through greenhouse gases and the conversion of non-agricultural land such as forests into agricultural land. Despite modern technologies such as enhanced varieties, genetically modified organisms and proper irrigation systems, however, environment remains a key factor in agricultural productivity as well as soil resources and natural ecosystems. Harsh and bad weather conditions can affect the crop growth and crop production along with its quality which affects its quantity of production. However studies (Grigg, 2019), suggest that agriculture is the most vulnerable to climate change in the economic sector. Farmers usually involve renewable energy consumption to decrease the affectivity of climate changes on crop and agriculture production. Agriculture's embrace of climate change requires both plant expansion and changes in farming practices. Theorists (Mottet et al., 2017), explain the theoretical background of investment theory that is associated with agriculture crop production, which however minimizes the value of spending and wages on crop production due to harsh climatic changes and emission of CO_2 in the environment. Availability of electricity can somehow increase the crop production due to functioning of tube wells, irrigation systems (Yang et al., 2015) and other harvesting tools that requires electricity to develop crop yield. Thus, the following hypotheses are proposed:

H3: Climate change has a significant impact on production in agriculture.

H3 (a): Access to electricity (ATE) has a significant impact on the contribution of agricultural value to GDP.

H3 (b): Emissions of CO2 have a significant impact on the addition of agricultural value to GDP.

H3 (c): Consumption of renewable energy (REC) has a significant impact on the contribution of agricultural value to GDP.

H3 (d): Access to electricity (ATE) affects crop production significantly.

H3 (e): CO2 emissions impact crop production significantly.

H3 (f): Consumption of renewable energy has a significant effect on crop production.

3. Methodology

3.1. Data Collection and Methods

The aim of this research is to examine the impact on Guinea's agricultural productivity of R&D investment (RDI), foreign aid and climate change. For this purpose, the time series data about the current variables was collected from databases of Guinea for last 30 years. It means that the current study has adopted the quantitative method in which the data was collected through secondary sources. The sample of the study consists of the data of last 30 years for Guinea. The database of "World Bank Group" was mainly relied to collect desired data. To analyze the secondary data, the ARMA Model was used to in order to check the relationships.

3.2. Variables Definition and Measurements

The current study includes following key variables that have been measured with different dimensions and proxies.

Dependent variable: The current study includes one dependent variable which was measured through two dimensions names as "agricultural value addition (AVA) and crop production (CP)". The AVA was measured through promotion of AVA in GDP while CP was measured as total crop output in Guinea in respective year.

Independent variables: There are three main independent variables in this study names as "R&D investment, foreign aid, and climate change". The first independent variable i.e. R&D investment has been measured through two dimensions named as "R&D expenditure (RDE) and Researches in R&D (RDR)". RDE was measured through proportion of R&D expenditure in GDP of the country while the RDR was measured by taking amount allocated to R&D. The second independent variable i.e. foreign aid has been measured through three dimensions names as, "net official development assistance (NDA), aid effectiveness (AE), and current official aid received (OAR)". The last independent variable i.e. climate change was also measured through three dimensions termed as "access to electricity (ATC), CO2 emission (CO2), and renewable energy consumption (REC)". ATC, CO2 emission and REC were measured as percentages of GDP.

Control variables: These variables were added in the model that controlled results of the study along with independent variables. In the current model called "Economic growth and Gross Net Savings (GNS)," two control variables were included. The economic growth was measured through GDP of Guinea in respective years while gross saving was measured as percentage of GDP.

3.3. Modelling and Methodological Framework

The impacts of R&D spending, foreign aid and climate change on agricultural productivity are tested in the current research by evaluating the impacts of these variables from different dimensions. For this purpose, the ARMA model was used to run regression equation of these variables. The ARMA model enables the researcher to identify the dimensions of independent variables that influenced the agricultural productivity at significant level. Following are the two econometric models that are tested in the current study.

$$AVA_t = \beta_0 + \beta_1 RDE_{t-1} + \beta_2 RDR_{t-1} + \beta_3 NDA_{t-1} + \beta_4 AE_{t-1}\ \beta_5 OAR_{t-1} + \beta_6 ATC_{t-1} + \beta_7 CO2_{t-1} + \beta_8 REC_{t-1} + \beta_9 GDP_{t-1} + \beta_{10} GNS_{t-1} + u_{it} \quad (1)$$

$$CP_t = \beta_0 + \beta_1 RDE_{t-1} + \beta_2 RDR_{t-1} + \beta_3 NDA_{t-1} + \beta_4 AE_{t-1}\ \beta_5 OAR_{t-1} + \beta_6 ATC_{t-1} + \beta_7 CO2_{t-1} + \beta_8 REC_{t-1} + \beta_9 GDP_{t-1} + \beta_{10} GNS_{t-1} + u_{it} \quad (2)$$

(a). Unit Root Test

The "unit root test" is a test through which the stationary of data is checked to confirm that the dataset of all variables is stationary. This test was applied in the current study because econometric data was the main data collected in this study and the "unit root test" becomes more essential when it comes to the macroeconomic data. This test is conducted with null hypothesis that "the data is not stationary" and the alternative hypothesis that "the data is stationary". To run this test, the methods of "ADF Fisher Chi-square (ADF Fisher) and Lin & Chu" are normally used. The current study, the "unit root test" of the current study has following mathematical explanation:

$$\Delta Y_1 = \beta_1 + \beta_2 \, \mathrm{t} + \alpha Y_{t-l} + \sum_{t=1}^{r} \rho_i \, \Delta Y_{t-i} + \mu_t \qquad (3)$$

In Equation (3), the "ΔY_{t-i}" is the "lag difference", the "β_1" is the "constant term" and "t" is the "time trend". In "unit root test", the "lag difference terms" are added sufficiently in order to make the "error term" serially independent. The null hypotheses of this test are as follow:

$$\mathrm{H}_o: \boldsymbol{\alpha = 0}$$

$$\mathrm{H}_1: \boldsymbol{\alpha \neq 0}$$

(b). Cointegration Test

This test was applied to analyze the cointegration of the data because cointegration is one of the important prerequisites of time series analysis. In this test, the null hypothesis stated that "there is no cointegration in data" while the alternative hypothesis stated that, "there is cointegration in the data".

(c). Findings

The ARMA approach was applied to analyze the time series data in the current study however, before running ARMA model, the prerequisites of time series analysis were fulfilled by applying different tests including "unit root, heteroscedasticity and co-integration tests". The analysis was performed through EViews 10 through which the hypotheses were finally checked after basis tests. The first test applied on the current data was the descriptive test through which it was ensured that the data is appropriate and normal with no extreme value or outlier in it.

(d). Unit Root Test

This test has been applied to the data to verify that its series is stationary or not. The series stationery was ensured to avoid any error in the results associated with the "fallacious regression". The table 1 presents the resulting values of statistics in both methods of “unit root test” i.e. “ADF Fisher Chi-square (ADF Fisher) and Lin & Chu”.

Table 1: Unit Root Test

Method	**Statistic**	**Prob.**
Levin, Lin & Chu t*	-11.5144	0.0000
Im, Pesaran and Shin W-stat	-11.5097	0.0000
ADF - Fisher Chi-square	150.557	0.0000
PP - Fisher Chi-square	170.188	0.0000

It can be seen in table 1 that p-value against both statistics of unit root test” i.e. “ADF Fisher Chi-square (ADF Fisher) and Lin & Chu” is < 0.05 which means that the null hypothesis of “unit root test” is rejected here based on significant results. Thus, it is found that series of the current data is stationary. In this way, the current macroeconomic data is said to be stationary so, one condition for the analysis of time series data is fulfilled through this test.

(e). Co-integration test

Another condition for the time series data is that there must be cointegration in the data because the data set is stationary. This test was also applied in EViews 10 and following results were found regarding the cointegration hypotheses.

Table 2: Co-integration Test

Variable	tau-statistic	Prob.	z-statistic	Prob.	Rho - 1	Rho S.E.	Residual variance	Long-run residual variance
AVA	-5.99394	0.0543	-25.3218	0.0940	-1.33273	0.222346	1.194757	1.194757
RDE	-5.51232	0.0474	-23.85	0.2787	-1.25527	0.227720	0.000286	0.000286
RDR	-5.42141	0.0263	-20.322	0.7617	-1.06958	0.197288	0.000723	0.000723
NDA	-5.18959	0.0217	-19.917	0.7891	-1.04827	0.201994	0.001678	0.001678
AE	-4.46441	0.0219	-17.4931	0.9425	-0.92069	0.206228	0.002083	0.002083
OAR	-4.73634	0.0489	-85.5959	0.0000	-2.40053	0.506833	0.159002	0.623950
ATC	-6.75161	0.0176	-28.4194	1.0000	-1.49576	0.221541	0.799219	0.799219
CO2	-6.85294	0.0711	-27.5284	0.9650	-1.44887	0.211423	2.48E-05	2.48E-05

REC	-6.64258	0.0268	-26.4629	0.3728	-1.39278	0.209675	0.171985	0.171985
GDP	-4.26252	0.0729	22.26468	0.0002	-3.34749	0.785331	2.255542	0.389767
GNS	-9.83184	0.0075	-31.6387	1.0000	-1.6652	0.169368	3.756873	3.756873
CP	-6.5324	0.0279	-26.9698	0.7076	-1.41946	0.217295	4.751028	4.751028

Table 2 is showing the significant presence of cointegration in the current time series data because the p-value of tau-statistics for all variables is <0.05. It means that the null hypothesis was rejected and it was found that there is cointegration in the current stationary data. Since, the statistics of "Rho-1, Rho S.E and Residual variance" are also falling within the acceptable ranges so, the second condition of time series data has also been fulfilled through this test.

(f). Heteroscedasticity

The heteroscedasticity issue was checked in both models of this study in order to ensure that errors are constant in the current data. For this purpose, the "Breusch-Pagan-Godfrey" test was followed. This test was needed because the heteroscedasticity issue in the data creates disturbance in the accurate results because the errors show variation with the variations in independent variables therefore, this was necessary to check that errors are constant in the current data. The null hypothesis in this test stated that "there is no heteroscedasticity in the data" while the alternative hypothesis indicated that "there is heteroscedasticity in the data". Table 3 shows the results of heteroscedasticity test for both models:

Table 3: Heteroscedasticity Test

Model 1			
F-statistic	3.749786	Prob. F(10,9)	0.0296
Obs*R-squared	16.12885	Prob. Chi-Square(10)	0.0960
Scaled explained SS	4.931800	Prob. Chi-Square(10)	0.8957
Model 2			
F-statistic	1.914881	Prob. F(10,9)	0.1713
Obs*R-squared	13.60541	Prob. Chi-Square(10)	0.1918
Scaled explained SS	1.530893	Prob. Chi-Square(10)	0.9988

The p-value in heteroscedasticity test of both models is indicating that the null hypothesis is not rejected in both models because it is >0.05. Hence, it is proved that the errors in the current data are constant and they do not show variations with variation in independent variables.

(g). Regression Analysis

The fulfillment of prerequisites of time series data for analysis was followed by the main analysis in which the ARMA Model was run to check the impact of RDE, RDR, NDA, AE, OAR, ATC, CO2, REC, GDP and GNS on both dimensions of agricultural productivity i.e. AVA and Crop production. Table 4 provides the regression results of model 1.

Table 4: Regression Analysis (Dependent Variable: AVA)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
RDE	-16.78204	20.32085	-0.825853	0.4302
RDR	0.277419	10.99930	2.297966	0.0025
NDA	-5.570902	7.092534	-0.785460	0.4524
AE	5.531069	6.665410	0.829817	0.4281
OAR	0.200457	0.711781	2.281628	0.0046
ATC	0.219297	0.330486	2.663560	0.0003

CO2	1.699328	67.56102	0.025152	0.9805
REC	0.130977	0.668917	1.995804	0.0491
GDP	-0.076097	0.211462	-0.359862	0.7273
GNS	0.104319	0.121121	2.861273	0.0014
C	53.59630	136.8038	0.391775	0.7043

R-squared	0.785159	Mean dependent var	18.70666
Adjusted R-squared	0.546447	S.D. dependent var	2.437072
S.E. of regression	1.641279	Akaike info criterion	4.130322
Sum squared resid	24.24418	Schwarz criterion	4.677974
Log likelihood	-30.30322	Hannan-Quinn criter.	4.237229
F-statistic	3.289144	Durbin-Watson stat	2.645842
Prob(F-statistic)	0.043692		

The results of regression showed that only one dimension of foreign aid i.e. "current official aid received" has a significant and positive impact on AVA (p-value <0.05) while other two dimensions of foreign aid i.e. AE and NDA showed insignificant impacts on AVA (p-value >0.05). The impact of RDE on AVA is also insignificant while the impact of RDR is positive and significant on AVA. Two dimensions of climate change i.e. ATC and REC showed significant and positive impacts on AVA (p-value <0.05) while CO2 emission does not have any significant impact on AVA. The impact of GDP on AVA was also insignificant however, the GNS showed a significant and positive impact on AVA (p-value <0.05). The overall model has the good explanation because more than 50 percent variation in AVA has been explained by independent variables and control variables of this study. The results about the impact of independent variables on the crop production have been provided in table 5.

Table 5: Regression Analysis (Dependent Variable: CP)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
RDE	-5.132685	44.46684	-2.015068	0.0366
RDR	-1.032699	24.06907	-1.289497	0.2294
NDA	8.962430	15.52015	1.221915	0.2528

AE	-1.841083	14.58550	-0.811822	0.4378
OAR	-0.247965	1.557546	-0.159202	0.8770
ATC	1.172469	0.723182	2.621264	0.0004
CO2	-72.02421	147.8396	-0.487178	0.6378
REC	0.372315	1.463749	2.098936	0.0452
GDP	-0.080682	0.462729	-0.174362	0.8654
GNS	-0.411551	0.265042	-1.552774	0.1549
C	539.2662	299.3592	1.801402	0.1052

R-squared	0.981766	Mean dependent var	111.0820
Adjusted R-squared	0.961507	S.D. dependent var	18.30558
S.E. of regression	3.591509	Akaike info criterion	5.696514
Sum squared resid	116.0905	Schwarz criterion	6.244167
Log likelihood	-45.96514	Hannan-Quinn criter.	5.803422
F-statistic	48.45902	Durbin-Watson stat	2.471128
Prob(F-statistic)	0.000001		

The results of regression in model 2 have shown that RDE has significant but negative impact on Crop production while the RDR has no significant impact on CP. Similarly, no dimension of foreign aid showed any significant impact on CP (P-value >0.05). However, the two dimensions of climate change i.e. ATC and RED showed significant and positive impacts on CP with p-value< 0.05. There was no significant impact on CP caused by any of the two control variables. Hence, the current findings have therefore provided mixed results on the effect of foreign aid, climate change and investment in R&D on Guinea's agricultural productivity.

4. Discussion

The current study focused on the role of foreign aid, climate change and R&D expenditure in Guinea's agricultural productivity for which different aspects of these variables are examined in order to see their relationships. The secondary data collected for last 30 years about the current macroeconomic variables of Guinea was used to analyze their relationships. In response to hypothesis of the current study i.e. "R&D expenditure has a significant impact on AVA in GDP" the current findings have revealed that there is no significant impact of R&D expenditure on AVA therefore, this hypothesis is rejected. In response to the hypothesis of this study that

“Researches in R&D have a significant impact on AVA in GDP”, the current study revealed that there is significant and positive impact of RDR on AVA so, this hypothesis is accepted. Another hypothesis of this study was that “R&D expenditure has a significant impact on crop production”, the current findings revealed that there is a significant but negative impact of R&D expenditure on crop production so, this hypothesis is accepted. The hypothesis of this study i.e. “Researches in R&D have a significant impact on crop production” has been rejected through current findings because it has been found that there is no significant impact of RDR on the crop production. The current suggestions and findings about the role of R&D investment in the agricultural productivity are aligned with past findings and are supported through the results of previous studies e.g. (Becker, 2015; Choi et al., 2015; Gu, 2016; Lewis & Tan, 2016; Lucas et al., 2018).

The hypotheses of the current study regarding the impact of foreign aid have also shown mixed findings. The hypotheses in this regard about the impact of net official development assistance on the AVA as well as crop production have been rejected because the findings revealed that there is no significant impact of NDA on either crop production or AVA. The hypotheses of the current study regarding aid effectiveness i.e. “Aid effectiveness has a significant impact on AVA” and “Aid effectiveness has a significant impact on crop production” have also been rejected through findings because the results found no significant impact of aid effectiveness (AE) on any of the dimensions of agricultural productivity. Furthermore, the results of the current study have shown that the official aid received (OAR) has significant positive impact on AVA in GDP so, the hypothesis i.e. “OAR has significant impact of AVA in GDP” has been accepted in the current study However, the hypothesis about its impact on crop production was rejected because there was no significant influence on crop production caused by OAR. It means that only one dimension of foreign aid i.e. OAR has significant impact on a dimension of agricultural productivity i.e. AVA. These findings about the impact of foreign aid on the agricultural productivity are sufficiently supported by past studies e.g. (DeFries et al., 2015; Lesk et al., 2016; Robinson et al., 2015; Shiva, 2016).

The results about the impact of climate change on the agricultural productivity have shown that access to electricity and renewable energy consumption (REC) have caused significant positive influences on AVA as well as crop production therefore, all four hypotheses regarding the impacts of ATC and REC on crop production and AVA are accepted. However, the CO2 emission has not caused any significant impact on any of the dimension of agricultural productivity therefore, hypothesis about its impact on AVA and crop production were rejected in this research. These findings about the impact of dimensions of climate change on dimensions of agricultural productivity are supported by different past findings e.g. (Aspinwall et al., 2015; Burke & Emerick, 2016; Grigg, 2019; Pittelkow et al., 2015).

The current results are specific to Guinea that can be compared with the results of some developed countries. For instance, a study was conducted in Western Australia to see the impact of climate change and R&D on the agricultural productivity growth (APG) (Salim & Islam, 2010). The mentioned study concluded that the R&D expenditure strongly influences the APG in Western Australia because increase in R&D expenditure is followed by the improvement in the long-run prospect of APG. However, the present findings have suggested the negative impact of R&D expenditure on one dimension of agricultural productivity i.e. crop production while it has shown no significant impact on AVA. It means that the effects of the effect of R&D spending on agricultural productivity differ from developed to developing countries. Salim and Islam (2010) further found the significant relationship between climate change and AGP of Western Australia. Similar results have been found in the current study because two dimensions of climate change have shown significant effects on agricultural productivity of Guinea. Similar suggestions were provided by the review of Olesen and Bindi (2002) about the impact of climate change on the European agricultural productivity. It means that the outcomes of climate change impact on agricultural productivity between developed and developing countries are almost identical. However, the current findings regarding the impact of foreign aid on the agricultural productivity of Guinea are different from the developed countries because developed countries do not rely on foreign aid for their agricultural productivity while the current results have shown a significant impact of a dimension of foreign aid on agricultural productivity of Guinea. Hence, it can be stated that the findings regarding effects of foreign aid and R&D investment on agricultural productivity may be dissimilar between developed countries and developing countries.

5. Conclusion

The current study was about the investigation of the role of foreign aid, climate change and R&D investment in the agricultural productivity of the Guinea. To conduct this investigation, the current study examined the effects of two dimensions of R&D investment (i.e. R&D expenditure and R&D researches), three dimensions of foreign aid (i.e. NDA, aid effectiveness, official aid received) and three dimensions of climate change (i.e. access to electricity, CO2 emission, renewable energy consumption) on the two dimensions of agricultural productivity i.e. agriculture value addition (AVA) and crop production. The research has been completed by collecting the secondary data about the desired variables for last 30 years and time series analysis has been performed on the data to check the relationships. Findings of the study suggested that R&D significantly and negatively influences the crop production but it does not significantly influence the AVA. It has been further found that RDR significantly and positively influences the AVA but it does not significantly affect the crop production. The two dimensions of climate change i.e. ATC and REC have significant positive impact on crop production and AVA. Furthermore, it has been suggested by the findings of the current study that only one dimension of foreign aid (i.e. official aid received) significantly and positively influences the AVA however, there no dimension of foreign aid affects the crop production. The current study and results have important theoretical and practical implications as they will provide potential researchers with new areas of discussion and analysis on agricultural productivity and will assist Guinean policymakers to concentrate on their foreign aid, R&D spending, and climate change in order to improve agricultural productivity. However, there are some limitations of the current study regarding its approach and dimensions that need to be eliminated in future studies. For instance, the current study relied on time series data of a single country so, the future researcher should focus on panel data approach to study these relationships. Furthermore, the future researchers can used different dimensions of variables to see their impact on agricultural productivity so that, the confusion of these relationship can be eliminated with enhanced findings.

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Disclosure statement:

I hereby declare that present manuscript has not been published elsewhere in part or in entirety and is not under consideration elsewhere. We also declare that there is no conflict of interest.

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Dedication

Not mentioned.

Conflicts of Interest

There are no conflicts to declare.