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Original Article

Public Investment in Agricultural Growth in the West African Monetary Union (UEMOA)

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Abstract *- This article analyzes the impacts of public investments on agricultural growth in the West African Economic Monetary Union (WAEMU). Fixed effect panel models have been developed. The sample used covers 8 African countries over the period 1961 to 2016. The results of the estimations indicate that agricultural public investments have positive and significant elasticity's on agricultural growth and that this impact depends on the combination with the other factors of agricultural growth, as pointed out by some authors. On the other hand, the panel III model shows that other factors such as the price of cotton to producers, the volumes of rainfall, the number of tractors, and the active agricultural population also condition good agricultural growth. Nevertheless, the quantities of urea, the production, and the area of cotton do not have a significant impact on agricultural growth. For effective agricultural growth in this area, the adoption of chemical and mechanical innovations and substantial agricultural public investment becomes imperative and a necessary and sufficient condition to boost a truly green revolution. Moreover, our results suggest that the main channel for sustainable agricultural growth in the union is the combination of all factors of production.*

Keywords *- Agricultural public investment, Agricultural growth, Panel data model*

JEL: G31, L11, Q11, Q18

I. INTRODUCTION

Agriculture in the West African Economic Monetary Union (WAEMU) is an important lever for agricultural growth. This sector has received limited attention for a long time in the member countries. Technical, financial, and intangible investment factors in agriculture within the union do not facilitate diversified agricultural growth with a view to sustainable food security and rural poverty reduction (Hollinger, 2015).

The renewed focus on agricultural growth in this union has crystallized around NEPAD's Comprehensive Africa Agriculture Development Program (CAADP) implemented in West Africa by the Economic Community of African States. West Africa (ECOWAS) and its member states in the framework of the ECOWAS regional agricultural policy (ECOWAP). Recognition of the essential role of agriculture coincides with fundamental changes in the regional and global context for agricultural growth, creating unprecedented opportunities and new challenges. The combined effects of strong demand growth, higher agricultural prices macroeconomic conditions, and more favorable policies are creating the most unfavorable conditions for agricultural growth in the last 30 years.

At the same time, new challenges ranging from climate change to increased price volatility threaten agricultural growth in this West African union. Several works have served as theoretical anchors drawn from production functions, global models of agricultural growth, and especially endogenous growth models. The theoretical anchors have a general form of each family of economic thought and specify according to their own axioms. Empirical work reveals a multitude of factors influencing agricultural growth. The works of De Janvry (2010); De Janvry and Sadoulet (2010); Varlet (2015) and Rakotoarisoa (2016) focus instead on factors such as irrigation, rural agricultural infrastructure, adoption of agricultural technical innovations, agrarian reforms, agricultural policies, household education levels rural agricultural, agricultural prices, the qualities of the sown areas, the active agricultural workforce and especially in the current context the variability of climate change.

In the UEMOA zone, traditional crops, between 2000 and 2006, the overall volume of cereal production increased steadily from 10 600 000 tones to around 18 000 tones, an increase of 69% over the period. The highest agricultural growth was recorded by maize (86%), followed by rice (78%), sorghum (70%), and millet (54%). In terms of volume, the most cultivated cereal is millet, which accounts for about 36.3% of the total cultivated area, followed by maize and sorghum (23.6% and 23.7%). Rice represents only (16.3%), but benefits from the highest yields because the crop is largely irrigated. It appears

that the margin of increase in speculation is even lower than the initial volume is high. The major cereal-producing countries within the union are Niger (23% of total volume), followed by Burkina Faso and Mali (22%). The lowest productions are recorded in Togo (6%) and Guinea-Bissau (1%). In terms of speculation, Niger dominates millet production with just under half of the total volume (48.5%). Benin produces almost a quarter of total maize (24.3%). In 2010, Mali ranks first in rice production with 43.6% of the total volume. As for sorghum, Burkina Faso leads with 39.7% of the production of the union. Agricultural production is driven by demand, particularly urban demand, with a preference for rice. Despite agricultural performance recorded at the cereal level, agricultural growth is still low in the union. Need, many recent studies on agriculture in the area have drawn attention to the weakness of public agricultural investment. The results of agricultural investments in cereal crops are probably lulled into illusions in recent years about food supplies in WAEMU countries. Public agricultural investments in this union are in a context of decline.

The total volume of ODA commitments for the agricultural sector has been halved since the mid-1980s to reach $ 6.2 billion in constant 2007. And interventions for food security and rural development, the average annual commitment is $ 12 billion over the same period. Investments in other sectors are nearly three times higher than in the agricultural sector. Studies of OXFAM (2015) show that 23% of the population of this union suffers from hunger despite agricultural and foreign public investment in agriculture. The national institutions of the union generally seem too weak to fulfill this role of steering, because of the decrease of the capacities of analysis in the various countries, the weakness of the capacities of the research and the formation, in a word of the deficit in investment in human capital (OXFAM, op. cit.). The share of agricultural aid in the union reached around 6% in 2007, compared to 17% in late 1980: this "reveals a clear relative abandonment of this sector" (OECD, 2009). Public agricultural investments remain a necessary and sufficient condition for the acquisition of mechanical, chemical, agronomic, and biological innovations. These agricultural public investments also play the role of the lever of a real agricultural policy capable of improving the living conditions of rural agricultural households. Effective public agricultural investments help achieve the goals of improving food security, reducing poverty, and modernizing agriculture (OXFAM, op. cit.).

Agricultural investments are crucial for agricultural growth, but also a key element in countering poverty and food insecurity; Poulton and al. (2006). De Janvry (2010); De Janvry and Sadoulet (2010). Agricultural growth also results from the importance of rainfall over the morphological characteristics of the areas sown Janusz andPodlesna(2011). Similarly, the work of Olawale and al.(2016) demonstrates that the rainfed agricultural system is vulnerable to the impacts of climate change. Price factors, in particular agricultural producer prices, have positive and/or negative effects on agricultural growth (Timmer, 2000, FAO, 2012). The variability of agricultural growth also results from crop yield risks caused by yield losses that are subject to drought, excess soil water, disease, rodents, hail, frost, and floods.

The strong hypothesis of this article is that of the effectiveness of public agricultural investments on agricultural growth in the WAEMU zone. Do public agricultural investments induce explosive agricultural growth in the WAEMU zone? What is the impact of the agricultural labor force on agricultural growth? Does agricultural growth in the WAEMU zone suffer the adverse effects of climate change? Do cotton prices to producers stimulate agricultural growth in the WAEMU zone? Is the adoption of agricultural technical innovations effective in this area? Specifically, it will analyze the impacts of public agricultural investments, the active agricultural population, agricultural innovations (numbers of agricultural tractors and the number of inputs), the price of cotton to producers, and especially the variability of climate change (rainfall) on agricultural growth in the WAEMU zone.

II. Theoretical and empirical approaches to the impacts of agricultural investments

The counter-Malthusian theory of the growth of primitive agriculture of Boserup (1965) is formalized in a continuous time frame which makes it possible to study the long-term properties of such a closed economy. It has been found that, from all initial conditions, there are two possible asymmetric results. The implications of the theory are extended to Polanyi's now-classic argument (1944) concerning structural transformation as an economic system making the transition from feudalism to capitalism and Walter's (1973) claims about the origins of African underdevelopment. The classical theory of land intensification describes intensification of land use as a unidirectional process in response to increasing local demands for land-based products and services. Boserup's (1965) theory and its followers argue that the long-term process of intensifying land use is driven primarily by population growth and the scarcity of land that endogenously induces innovation or use. Technologies and management strategies. Wide agrarian transitions provide a large amount of historical evidence that proves the validity of the theory. Boserup (op. cit.) was the first to assert that population pressure is pushing farmers to adopt more intensive land-use practices to increase food production. Boserup (1965) and others (Darity 1980, Robinson and Schutjer 1984) have argued that

agricultural intensification driven by population growth and scarcity of land induces technological and institutional changes to increase agricultural production through the supply of land. Be that as it may, for Boserup (op. cit.), population pressure must be present to precipitate a shift towards more intensive uses of the land (Darity, op. cit.). Some recent studies have relaxed the assumptions imposed in the Boserup scheme, revealing conditions leading to Boserupian, Malthusian, or other results (Turner and Ali, 1996, Demont and al., 2007). From the thought of the physiocrats to the writings of contemporary authors, the agricultural sector remains an important pillar on which any take-off of the economy must be based.

Historians point out that in many so-called developed countries today, the agrarian revolution was a prerequisite for the industrial revolution. In endogenous growth models, in addition to physical capital, the authors of this theory will recognize the importance of intangible capital in generating economic growth. This vision justifies the centrality of agriculture in the theory of development. The ability of public investment in agriculture to increase, reduce poverty, and improve food security has often been well documented in theory (Lewis 1955, Mellor, 2000 World Bank, 2008 and De Janvry, 2010).

It is often repeated in international meetings on agricultural issues and tends to become a slogan. However, empirical evidence remains generally scarce and non-existent in the case of UEMOA countries, while mechanisms for linking public investment in agriculture and improving food security, both in rural areas than in urban areas, are not always well Indeed, the work of Mellor (op. cit.) explains that agricultural investments induce an increase in cereal crops that create resources for the industrial sector. He concludes that these agricultural investments encourage innovation in the production, distribution, and management of agricultural enterprises.

On the other hand, with regard to foreign investment in the agricultural sector, Rakotoarisoa (2016) reports that the growing involvement of foreign investors in the agricultural sector in the area has led to an increase in agricultural production, with a view to sustainable food with high agricultural potential. Agrarian reforms have also played a determining role in agricultural growth. Thus, the work of Ward and al. (2012) shows that in South Africa, after the first agrarian reform linked to the end of apartheid, the agricultural sector is undergoing a restructuring characterized by the appearance of agricultural investments through commercial banks, agricultural engineering companies, asset management companies, investment funds) wishing to diversify their portfolios of agricultural activities.

Reforms of political structures impose new directions for agricultural growth. Indeed, the works of De Janvry (2010), Ducastel, and Ward (2011) explain that a new paradigm of development must be imposed on the agricultural sector in Africa in the dynamics of capitalization and industrialization to ensure growth. Sustainable agriculture. In order to attract foreign investment for agricultural growth, Bella's work (2009) emphasizes the potential for profit and the creation of agricultural jobs to significantly boost agricultural productivity in order to reduce insecurity.

Food in Africa south of the Sahara. Bako's work (2011) shows the existence of a long-term positive relationship between agricultural growth and agricultural growth. For Von Braun (2008), agricultural investors are attracted to the growth and transformation of demand for food, fertilizer, and biofuels that are likely to persist if oil prices remain at historically high levels. On the other hand, these agricultural investments have led to the scarcity of farmland, which is of increasing value on the other hand. Lack of agricultural investment in other special settings is at the root of low yields and stagnant agricultural growth. For example, the work of Coonan (2008), Bristow (2007), Brochard (2015), Gabas and Ribier (2015), and Varlet (2015) note that the evolution of the funding structure has serious consequences for the dynamic In the agricultural sector, it is true that the origin of funding affects the way in which these are affected in terms of recipients, sectors, and regions.

In this same register of agricultural financing, Wampfler and al. (2014) show that the complexification of the institutional financing landscape, the multiplication of actors, and the increasing ethnicization of intervention modalities, where the states fail to channel investments towards desired targets, inevitably leads to the underfunding of various parts of agricultural policy. Similarly, the work of Ghura (1997), Samake (2008), Fedderke and al. (2006) report that agricultural public investment stimulates agriculture itself. Also all other subsectors. The work of Barro and Sala-I-Martin (1995); Aghion (1998); Zidouemba and Gérard (2015) in this context have focused on the agricultural infrastructure that is also critical for agricultural growth. They mention the lack of public investments in rural areas (or their low efficiency or even their diversion), the supply of public goods (roads, storage warehouses, irrigation, electricity, access to health and safety). Education) is insufficient to increase sustainable agricultural growth. The work of Khalil and Chin Theng Heng(2015) identified several determinants of agricultural growth in Pakistan. Over a period of 1965-2009, they show that agricultural growth is subject to chemical fertilizer with long-term and short-run elasticities of 0.16 and 0.20, respectively. Human capital is the second important determinant

with long-run and short-run elasticity of 0.14 and 0.09, respectively. Agricultural credit has relatively low short-run and long-run elasticity of 0.06 and 0.1, respectively. Cultivated areas are insignificant in the short and long term.

In contrast, in Nigeria, the work of Udah and Nwachukwu(2015) over the last thirty years has reported agricultural growth as declining by 64 percent of the gross domestic product (GDP) from 1960 to 44 percent in 2010. They concluded that the downward factors of this agricultural growth are unskilled farm labor, defective rural infrastructure, inflation rate, and the local currency exchange rate. With an approach to agricultural growth accounting, Safdari (2011) assesses the determinants of agricultural growth in Iran from 1970 to 2007. He indicates that his factors are agricultural innovations, labor, and capital factors. He suggests that the adoption of new agricultural technical innovations and necessary and indispensable to boost agricultural growth.

Similarly in Kenya, Owuor (2015) identifies factors such as good distribution of water supplies, rural road infrastructure, import tariff policies, and sugar as determinants of sustainable agricultural growth. The work of Uma and Mellor (2005) reports that land pressure is increasing, the need for intensification of peasant agriculture and increased productivity is urgent in many parts of Asia, Latin America, and Africa. as much as the adjustment process modifies the terms of trade for agriculture, the reduction of urban wages and employment opportunities in the public sector. Tessema (2015) analyzes the determinants of agricultural productivity and household income in Ethiopia. The results showed that the ratio of labor-to-labor, pesticide use, manure, and household size are the most significant variables affecting farm work and land productivity. On the other hand, drought is statistically significant and has a negative effect on labor and land productivity.

Increasing the owner-operator ratio is important for improving agricultural productivity and promoting labor and non-farm income. Deepack and Tiwari (2014) show that the acceleration of economic growth, the transition from an agrarian economy to an industrial or modern economy, would depend on the ability of the agricultural sector to allow this transition. The results of the authors' econometric estimates corroborate the idea that agricultural performance determines the ability to generate employment in the sector where employment is positively influenced, the terms of trade and public investment, and variables such as non-farm production and productivity have a negative relationship with work in the agricultural sector. There is a need for agricultural sectors to absorb underemployed and unemployed people in order to induce technology, investment, and favorable terms of trade. Mohammad and Joarde (2011) report that the rapid adoption of green revolution technology, electricity consumption, literacy, and credit have had a positive effect on agricultural productivity, while the real exchange rate and time have had negative effects. Price stability has contributed to agricultural growth in Bangladesh. The negative impact of agricultural labor on agricultural value-added can be mitigated through the opening of non-agricultural jobs in rural areas or through the establishment of small-scale rural industrialization across the agribusiness that will absorb the surplus workforce. Diversification of agricultural products is a necessary condition to minimize the high dependence on rice and increase agricultural value-added. Bao (2012) analyzes agricultural growth from total agricultural factor productivity. It reports an increase in total factor productivity, shifting the frontier of production opportunities.

The main source of agricultural growth is the diversification of agricultural technical efficiency. Samuel and al. (2009) reveal that the provision of various public goods and services in the agriculture, education, health, and rural roads sectors has a significant impact on agricultural productivity. They concluded that a 1% increase in government spending on agriculture is associated with a 0.15% increase in agricultural labor productivity, with a benefit-cost contribution of 16.8. Expenses on feeder roads are second (with a benefit-cost ratio of 5), followed by health (about one-hundredth of value). Formal education was negatively associated with agricultural productivity. Fouzia and Mustafa (2013) explain that agricultural productivity growth is essential to stimulate growth in all sectors of the economy. The report for sustainable agricultural growth, total cultivated area, irrigation water, agricultural credit, import of pesticides, and improved seeds are necessary and sufficient conditions to boost agricultural growth.

Chukwukere and al. (2012) show that agricultural growth is a function of farm-level marketing, fertilizer, and agricultural mechanical innovation. John (2017) shows that the performance of agricultural growth in Kenya is linked to levels of education of rural farming households, access to good quality inputs, and especially trade openness. Jawad and Siddiqui(2014) explain that improved inputs and modern machinery are important determinants of agricultural production. In Romania, Burja (2012) shows that technical efficiency and agricultural work are crucial for agricultural growth. In Nigeria, Francis and Arene (2014) demonstrate that capital flight and political instability have negative and significant impacts on agricultural growth. He concludes that only the stock of external debt has a positive and significant effect on agricultural growth. In Malaysia, Siti and al. (2017)

reveal that agricultural growth comes not only from physical capital and the effect of human capital but also from its potential and strong policy effects in support of agriculture. The use of chemical inputs is a structure of the adoption of agricultural innovations to boost agricultural growth. In Nigeria, on time series from 1980 to 2011, the work of Oyetade (2014) confirms that factors such as the fishery, food production/rents, forestry, and the livestock labor index have a positive and significant influence on productivity. Agricultural growth. In Russia, the work of Raushan and al. (2012) concluded that the technical efficiency of agriculture is the determinant of agricultural growth. In Jordan, Samia and Dhehibi (2016) confirm in their work that variables such as agricultural research, investment in irrigation capital, and water pricing have contributed significantly to the growth of agricultural productivity. In Togo, Koffi (2017) confirms that total factor productivity can provide better growth for agriculture. He concludes that research and extension policies play an important role in determining the long-term growth of TFP. In republic

In Ethiopia, Fantu and al. (2015) reveal that agricultural growth is influenced by the use of chemical fertilizers and improved seeds, land expansion, increased labor, and productivity growth. Total of factors (PTF). They concluded that high agricultural government expenditures, improved road network, higher levels of education and training of rural farm households, and incentives related to agricultural prices are also important factors for agricultural growth. In contrast, in Kenya, the work of Beth and Ruigu (2017) argues that economic factors such as inflation, the real exchange rate, and public spending have negative and significant impacts on agricultural growth. Only climate/precipitation variables led to positive and significant impacts on agricultural growth. In Ghana, the work of Patrick and Attah-Obeng(2013) shows that the main factors influencing agricultural growth are the labor force, the real exchange rate, and real GDP per capita. They concluded that agriculture should be made more attractive and more conducive to ensuring food security in Ghana.

III. Data sources and specification of agricultural investment model in panel

A. Data sources

The data used for this article is secondary. They come mainly from the statistical sources of the FAO and the FAO-Statistics site and extend from 1961 to 2017. These data concern agricultural growth (PIB_{ag}); public agricultural investment ($Invest_{ag}$) Invest the annual number of tractors used ($Tract_{ag}$); the amount of annual urea used ($Quatur_{ag}$); the annual precipitation volume ($Volmp_{ag}$); the area planted with cotton ($Supcot_{ag}$); cotton production ($Procot_{ag}$) the cotton producer price ($Pricot_{ag}$) and the agricultural labor force($Popact_{ag}$).

B. Specification of agricultural growth models in panel

The agricultural production model used in this paper focuses on the growth pattern of the neoclassical. This model is used to analyze the determinants of agricultural growth in the WAEMU area. A series of models is used in panel data:

Model I is the agricultural gross domestic product ($LnPIB_{ag}$)according to agricultural public investment (LnInvestagBe) and cotton production (LnPricotBe). This model 1 captures the potential effect of a public agricultural investment policy and cotton production on agricultural growth in the countries in which all countries in the zone produce cotton.

Modèle I: $LnPIBag_{it} = \beta_{it} + \beta_1 LnInvestag_{it} + +\beta_4 LnPrcot_{it} + \varepsilon_{it}$ (1)

Model II measures the influence of a public agricultural investment policy accompanied by an international cotton price policy on agricultural growth in the area. This model takes into account the agricultural gross domestic product $LnPIB_{ag}$) according to public agricultural investments (LnInvestagBe), cotton prices to producers (LnPricotBe), and areas planted with cotton (LnSupcotBe).

Modèle II: $LnPIBag_{it} = \beta_{it} + \beta_1 LnInvestag_{it} + +\beta_4 LnPrcot_{it} + \beta_7 LnSupcot_{it} + \varepsilon_{it}$(2)

Model III measures the effect of all other variables on agricultural growth except for public agricultural investment. This model confirms or denies whether the countries of the zone are in compliance with the Maputo agreements, agricultural growth is obvious?

Modèle III: $LnPIBag_{it} = \beta_{it} + +\beta_2 LnTracg_{it} + \beta_3 LnQur_{it} + \beta_4 LnPrcot_{it} + \beta_5 LnVolmP_{it} + \beta_6 LnPopact_{it} + \beta_7 LnSupcot_{it} + \varepsilon_{it}$(3)

Model IV highlights the cumulative effect of public investment policies and chemical and mechanical innovations on agricultural growth in the area. This model provides a better understanding of the degree of adoption of agricultural technical innovations in this area.

Modèle IV: $LnPIBag_{it} = \beta_{it} + \beta_1 LnInvestag_{it} + \beta_2 LnTracg_{it} + \beta_3 LnQur_{it} + \varepsilon_{it}$ (4)

Model V assesses the effects of agricultural public investment and climate change on agricultural growth in the area. This model makes it possible to better

define agricultural growth in the area and is necessarily dependent on climatic hazards.

Modèle V: $LnPIBag_{it} = \beta_{it} + \beta_1 LnInvestag_{it} + \beta_2 LnVolmP_{it} + +\varepsilon_{it}$ (5)

The endogenous variable ($LnPIBag_{it}$) is agricultural growth in volume. It takes into account all of the annual productions of each member country of the space. Agricultural development in this area is essential to maintaining a growing West African population. In the "best-case scenario", population growth is expected to be at a declining rate over the next five generations and then stabilize. Does explosive agricultural growth bring about relatively good environmental circumstances and high subsistence levels?

The agricultural investment variable ($LnInvestag_{it}$)covers public investments related to the acquisition of chemical, agronomic, mechanical, and biological inputs in each country in the sample over the period from 1961 to 2016. It is expressed in billion francs local. Increasing public investment in agriculture in this area is a major concern, but several constraints still accentuate these agricultural investments below the Maputo agreements (-10% of the national budget). Countries such as Burkina Faso, Ethiopia, Ghana, Guinea, Malawi, Mali, Niger, and Senegal have all already met or exceeded the CAADP target of 10%. They positively agricultural growth in this area?

The variable number of an agricultural tractor ($LnTracg_{it}$) concerns the number of agricultural tractors acquired per year by each country of the union in order to mechanize its agriculture in view of better agricultural yields. Can the use of mechanized agricultural equipment boost agricultural growth in this area?

The agricultural active population variable ($LnPopcvt_{it}$) , takes into account the active agricultural population, made up of salaried and non-salaried workers having agricultural activity. In the WAEMU countries, the active agricultural population is decreasing. The rural exodus is the major cause of this situation of the agricultural labor force. What is the effect of the agricultural labor force on agricultural growth in the WAEMU zone?

The cotton price variable($LnPricotg_{it}$)) is that paid to producers in each member country. This price is a given, it is confirmed throughout the area before the agricultural campaign. This is often the international market. The price of cotton to producers is very unstable because of the great subsidy of the great European powers to their cotton growers. Cotton prices in the pats are therefore subject to many external shocks. The price must then be adjusted to balance the market. Is the price of cotton in the countries of the union currently a stimulating factor of agricultural growth?

The variable production volume of cotton ($Lnprcot_{it}$), expressed intones. The choice of this variable results from its weight in the UEMOA zone. This variable is introduced in the model in that the weight of WAEMU countries' cotton exports to the world market places this zone second among the world's exporters behind the USA. Does cotton production really have positive and significant impacts on agricultural growth in this area?

ε_{it}Represents the error term and $\beta_i$the specific effect of each country i. The variables of interest are agricultural production of food crops (maize, cassava, millet, rice, sorghum) and cash production (cotton).

IV. Analysis of statistical and econometric tests

Table 1 presents the descriptive statistics on the variables of the base model. For the years 1961 to 2016, 56 observations, the average public agricultural investment, the average agricultural Gross Domestic Product (GDP) of each UEMOA country (Benin, Burkina-Faso, Ivory Coast, Guinea- Bissau, Mali, Niger, Senegal, Togo These averages are obtained from a BPM panel with Stata11 software.

A. Results of unit root tests

Table 1 presents the unit root tests results.

Table 1. Unit Root Test (Panel All Countries[1])

	Methods			
Variables (level)	**LLC**	**IPS**	**Breitung**	**Hadri**
LnPIBagBe	-2.012*	-2.977*	22.5771	3.921*
LnInvestagBe	126.362	21.794	11.105	6.479*
LnTrasevBe	23.280	18.951	21.037	14.462*
LnQurBe	465.342	19.356	13.667	5.242*
LnVolmPBe	0.422	2.118	-3.861*	3.717*
LnSupcotBe	0.925	1.582	-5.559*	0.342
lnProcotBe	1.737	1.556	0.540	5.352*
LnPricotBe	-5.312*	-1.839*	-3.836*	7.549*
LnPopuacti	-1.168	-0.968	-1.002	2.587*
	Methods			
Variables (1st Different.)	**LLC**	**IPS**	**Breitung**	**Hadri**
LnPIBagBe	44.279*	1.596*	18.871*	2.846
LnInvestagBe	9.106*	14.716*	9.644*	3.916
LnTrasevBe	52.126*	9.746*	7.921*	7.554
LnQurBe	911.882*	20.009*	14.321*	4.572
LnVolmPBe	2.728*	-10.521*	-12.565*	2.567

[1]LLC = Levin, Lin, Chu (2002), IPS = Im, Pesaran, Shin (2003). Statistics have a standard normal asymptotic distribution with a left-side rejection zone, except for the Hadri test which is on the right side. The asterisk (*) indicates the rejection of the null hypothesis of non-stationarity (LLC, Breiting, IPS) or stationarity (Hadri) to at least 5% of significant level.

LnSupcotBe	-16.181*	-15.838*	-9.324*	-0.454
lnProcotBe	-6.846*	-8.278*	-11.673*	-0.740
LnPricotBe	-13.459*	-16.670*	-3.726*	14.542
LnPopuacti	-12.552*	-11.354*	-4.415*	2.819

Source: Results of our estimates

Table 1 presents, respectively, the results of the unit root test of the panel variables in level and in first difference. These results show that price variables from cotton to producers; Area sown with cotton, annual precipitation volume of rain are stationary in level for the Breitung test, and agricultural GDP for LLC and IPS tests. Since not all variables are stationary in level, we go to the first difference of these variables. From the results obtained at this level, all the variables are stationary. These tables also show the statistical test of Hadri-Z, which unlike the other tests mentioned, uses the null hypothesis of stationary.

The results of this test confirm the presence of unit root level variables. However, all variables become stationary in the first difference. In this case, it would be wise to test the long-term relationship that might exist between these variables through a panel cointegration test. Indeed, before proceeding to the cointegration test between the variables, we judge good to verify the causal relationship between the explained variable and the explanatory variables which will be introduced in the different models of analysis.

B. Results of the Granger causality test

Table 2 presents Granger panel causality test results.

Table 2. Granger panel causality test results

Hypothesis test	F.statistic	Prob[2]*
LnInvestag Be DNGC LnPIBagBe	943.486*	0.000
LnPIBagBe DNGC LnInvestagBe	15.533*	0.003
LnTrasevBe DNGC LnPIBagBe	23.302*	0.000
LnPIBagBe DNGC LnTrasevBe	42.213*	0.000
LnQurBe DNGC LnPIBgBe	256.700*	0.002
LnPIBagBe DNGC LnQurBe	45.653*	0.000
LnVolmPBe DNGC LnPIBagBe	13.068*	0.000
LnPIBagBe DNGC LnVolmPBe	3.202*	0.041
LnSupcotBe DNGC LnPIBagBe	10.949*	0.000
LnPIBagBe DNGC LnSupcotBe	30.609*	0.000
LnProcotBe DNGC LnPIBagBe	5.626*	0.0039
LnPIBagBe DNGC LnProcotBe	2.628*	0.0073
LnPricotBe DNGC LnPIBagBe	1.107	0.331
LnPIBagBe DNGC LnPricotBe	36.990*	0.000
LnPopuacti DNGC LnPIBagBe	10.235*	0.000
LnPIBagBe DNGC LnPopuacti	0.743	0.476
Hypothesis test	F.statistic	Prob*
LnInvestagBe DNGC LnPIBagBe	943.486*	0.000
LnPIBagBe DNGC LnInvestagBe	15.533*	0.003
LnTrasevBe DNGC LnPIBagBe	23.302*	0.000
LnPIBagBe DNGC LnTrasevBe	42.213*	0.000
LnQurBe DNGC LnPIBgBe	256.700*	0.002
LnPIBagBe DNGC LnQurBe	45.653*	0.000
LnVolmPBe DNGC LnPIBagBe	13.068*	0.000
LnPIBagBe DNGC LnVolmPBe	3.202*	0.041
LnSupcotBe DNGC LnPIBagBe	10.949*	0.000
LnPIBagBe DNGC LnSupcotBe	30.609*	0.000
LnProcotBe DNGC LnPIBagBe	5.626*	0.0039
LnPIBagBe DNGC LnProcotBe	2.628*	0.0073
LnPricotBe DNGC LnPIBagBe	1.107	0.331
LnPIBagBe DNGC LnPricotBe	36.990*	0.000
LnPopuacti DNGC LnPIBagBe	10.235*	0.000
LnPIBagBe DNGC LnPopuacti	0.743	0.476

Source: Result of our estimates, 2018
NB: DNGC = Does not Granger cause

The results of the causality test reject the Granger non-causality assumption between all the explanatory variables and the explained variable with the exception of the variable PricotBe which does not have a causal effect on the GDPagBe.

C. Results of the cointegration test

Table 3 presents the cointegration test result.

Table 3. Cointegration test (Pedroni)[3]

Pedroni's method					
Paramètres	T-Statistic & Prob				
	Model I	**Model II**	**Model III**	**Model IV**	**Model V**
Panel V-Statistic	-0.251 (0.599)	9.181* (0.000)	-0.914* (0.008)	1.286* (0.00991)	5.109* (0.000)
Panel Rho-Statistic	-2.703* (0.003)	-1.451* (0.007)	0.571 (0766)	-2.920* (0.0017)	-0.238* (0.040)
Panel PP-Statistic	-2.322* (0.010)	1.107* (0.006)	-0.616 (0.268)	-3.6423* (0.0001)	1.928 (0.973)
Panel ADF-Statistic	-1.084 (0.139)	2.092 (0.982)	1.784 (0.962)	-3.20406* (0.0007)*	4.508* (0.001)
Group Rho-Statistic	-1.502* (0.006)	-0.347 (0.364)	1.626* (0.048)	-2.067* (0.0194)	0.743* (0.007)
Groupe PP-Statistic	-1.907* (0.028)	2.319* (0.008)	0.023* (0.050)	-3.611* (0.0002)	3.017* (0.008)
Groupe ADF-Statistic	-0.361 (0.358)	3.556 (0.999)	2.848* (0.009)	-3.0732* (0.001)	6.052* (0.010)

Source: Result of our estimates, 2018

In order to test the cointegration of the variables in the panel, the Pedroni test (1999) is used. This test

[2](*) Indicates the rejection of the unilateral hypothesis of no causality between the variables at the 5% threshold in the sense of bartering

[3]All reported values have a standard normal asymptotic distribution. The asterisk (*) indicates the rejection of the null hypothesis of non-cointegration to at least 5% of significance.

uses four-panel statistics and three-panel group statistics to test the null hypothesis of no cointegration against the alternative cointegration hypothesis (Pedroni 1999). From the results presented in Table 3, there is a cointegration relationship between the variables in the five models. Indeed, at least four of the seven statistical tests presented in the table reject the null hypothesis of non-cointegration at the conventional threshold of 5%.

Table 4. Results of the DOLS estimation

ESTIMATION OF MODELS					
Param	**T-Statistic & Prob**				
Explic.Varia.	**Model I**	**Model II**	**Model III**	**Model IV**	**Model V**
LnInvestagBe	0.633*** (0.000)	0.114*** (0.001)		1.286* (0.00991)	0.055** (0.028)
LnPricotBe		1.969*** (0.000)	1.239*** (0.000)	-2.920* (0.0017)	1.817*** (0.000)
LnQurBe			0.026 (0.160)	3.6423* (0.0001)	
LnVolmPBe			0.338*** (0.000)	-3.204*** (0.0007)	0.004*** (0.000)
LnSupcotBe		0.085 (0.132)	0.041389 (0.282)	2.067* (0.0194)	
lnProcotBe	1.294*** (0.000)		0.023 (0.4043)	3.611* (0.0002)	
LnTrasevBe			1.029*** (0.000)		
LnPopuacti			1.071*** (0.000)		

Source: Our estimation results (***) Significant at the 1% level; (**) significant at the 5% threshold; (*) significant at the 10% level

After verifying the stationarity and cointegration of the variables in the previous section, we estimate the long-run relationship between agricultural GDP that measures agricultural growth and agricultural public investment, the agricultural labor force, and certain variables using the dynamic least squares method or Robust Least-Squares of the panel. It should be recalled here that the estimation of the model has been done in several stages in order to capture the individual effects of the variables and the global effect when these variables interact.

D. Interpretations and economic implications

The results show that all variables are significant except the area planted with cotton in Model 2, these results reflect the role of agricultural public investment in the process of agricultural growth and the importance of cash crops in the agricultural GDP of farmers. WAEMU countries. On the other hand, the area planted has proved to be a non-influential factor of the GDP growth because its estimated parameter is not statistically significant. The evidence of this result is justified by the fact that all UEMOA countries advocate for sustainable development. So from this point of view, it is no longer a question today of seeking to increase agricultural yields by increasing areas but earlier by reducing them. Model III consists of all other suspected variables except public agricultural investments. According to the results of this model, the cotton price and agricultural labor force variables have the highest and most significant coefficients. This result stipulates that, for an effective public agricultural investment, the UEMOA Member States must constantly think of improving the living conditions of active agricultural populations through fair price policies in the context of fair trade for development sustainable.

V. CONCLUSION

The results of this article shed light on the major roles that public agricultural investments must play in the agricultural growth that is the channel for reducing food insecurity in the WAEMU zone. The results of this article show that public agricultural investments have a positive and significant impact on agricultural growth in the WAEMU zone. This estimation method allowed us to find very satisfactory results. The direct implication of these results is that the different UEMOA Member States must orient their public investment policy towards the agricultural sector to see its effect of training on the other sectors of the global economy. The study reveals that this policy must be accompanied by other policies such as investment policy in human capital, a fair price policy, financing, and the valorization of agricultural research results. Despite the fact that cotton has huge benefits from public agricultural investments, the impacts remain mixed.

The central issue of cotton today is the weakness of international prices related to support policies in the major producing countries, in particular the European Union (Greece, and Spain), the United States, and China. These support policies result in the injection of public subsidies amounting to more than $ 6 billion a year. Price factors and availability of grain products play a key role in household behavior and these factors are detrimental to local grains. Rice and wheat are widely available on the market, while the supply of millet/sorghum and other local grains remains volatile in quantity, quality and price. The WAEMU countries must now invest more in the agricultural grain sector which is the basis of the food security of the populations. The terms of trade are deficient and still lead to poor living conditions for rural agricultural households.

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