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Effect of Agricultural Productivity on Economic Growth of the Democratic Republic of Congo From 1990 To 2014

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Effect of Agricultural Productivity on Economic Growth of The Democratic Republic of Congo From 1990 To 2014

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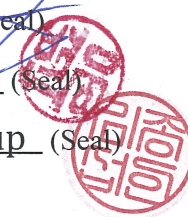Confirming the master's thesis written by

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ABSRACT

Effect of Agricultural Productivity on Economic Growth of the Democratic Republic of Congo from 1990 to 2014

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Effect of agricultural productivity on economic growth has been widely documented through the literature. However, scarce are those who dived into this correlation on DRC. This study aimed at mending that gap by responding to questions whether there is relationship between agriculture productivity and economic growth of Congo, whether agricultural technology significantly contributes to the productivity and how, whether increase in investment in the agricultural sector would positively contribute to economic growth of Congo.

This study found a significant correlation between agricultural productivity and economic growth of Congo. The results of this study revealed a significant contribution of mechanical technology but didn't find significant correlation between biochemical technology and long run economic growth. Empirical results presented in this dissertation have asserted that ODA and FDI are agricultural responsive funding channels.

The major contribution of this study is to rise public attention on the importance of agriculture as a pro-poor sector and the channel through which technology can contribute to the economic growth on the long run.

Key words: Agricultural productivity, D.R. Congo economic growth, Mechanical and biochemical technology.

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ABBREVIATION AND ACRONYMS

BCC: Central Bank of Congo

CGE: Computable General Equilibrium

COPEMECO: Confederation of Small and Medium Enterprises of Congo

DRC: Democratic Republic of the Congo

FAO: Food and Agriculture Organization

FDI: Foreign direct Investment

FEC: Federation of Congolese Enterprises

FENAPEC: National Federation of Breeders and Growers of Congo

GDP: Gross Domestic Product

HDI: Human Development Indicators

ILO: International Labor Organization

NAIP: National Agricultural Investment Plan

ODA: Official Development Aid

OLS: Ordinary Least Squares

PNSD: National Strategic Plan for Development

UNDP: Unites Nation Development Programme

US: United States

USDA: United States Department of Agriculture

WDI: World Development Indicators

WFP: World Food Programme

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CHAPTER 1: INTRODUCTION

Endowments in terms of natural resources, culture and history are diverse between nations. Defining the role agriculture should play in economic growth process depends on these endowments. However, the positive features of agriculture appear to have a significant proportion in the country's economic development process which distinguishes agriculture sector from other sectors (Johnston and Mellor, 1961)

Throughout countries, natural endowment has been the basis for the economic growth process. Yet, natural endowment can be understood in different ways, but mostly it refers to all the assets a country possesses which can be exploited for its economy to grow, say land, labor, capital, natural resources as well.

Natural resource is a relative common endowment in developing countries. Instead of being driver of economic growth, this resource turns to be the fuel to conflict and corruption with direct effect on overall economy of the country concentrating the natural wealth rent into a small class in the society. The nature of the rent from the natural resource to overall population of the country makes agriculture relatively important in terms of wealth redistribution and increase of income over the population for poverty alleviation and overall economic development. As agriculture is mainly applied in rural areas, growth therein is thus praised as a pro-poor growth given its direct benefit on the poor rural inhabitants.

Most of the population living in rural area make their living from agriculture, especially in sub-Saharan African countries. Empirical experience has shown also that low productivity in agriculture has negative effect on country's development and food security. Therefore, high dependency of the rural population on agriculture for food security makes agriculture appealing for economic growth. However, the rise of population migration towards cities is likely to impede agricultural productivity despite the increase in global population.

This global migration makes the demand and distribution for agricultural marketable products higher for consumers, stimulating development of new solutions to supply agriculture related products. These solutions will lead to poverty reduction and economic sufficiency. Moreover, in several reports the World Bank has advocated agriculture sector as an economic growth generating sector important for poverty reduction (World Bank, 1981 and 2008). Therefore, effective reasons of productivity lie in understanding the socio-economic value of farmers. Gollin argues that "growth in the overall economy depends on the development of the agricultural sector" (Gollin et al., 2002).

1.1. Statement of the problem

Like other developing countries, the Democratic Republic of Congo is a rich country with under developed economy. Though naturally endowed, the country's budget is funded at more than 34% by external partners as budgetary support. The country depends on mining as the principal source of its budgetary funding which hardly covers the overall national expenditures. GDP growth rate declined by 2,4% in 2016 from 6.5% one year before, the lowest point since 2001 due to decline of the price of minerals and shrinking of global demand of Cobalt and copper in the world market.

The UNDP 2017 report on Human Development Indicators (HDI) ranked Congo the 176th out of 187 countries with the highest rate of the population under poverty conditions. The world bank survey (2012), reveals a share of 77.1% of the population under poverty line in the country.

Surrounded by 9 countries (Rwanda, Angola, Uganda, Tanzania, South Soudan, Republic of Congo, Central African Republic, Zambia and Tanzania), Congo is the second largest African country after Algeria and the first in Sub-Sahara. The population is estimated over 83 million making it the fourth largest populated African country and the seventeenth in the world.

The country lies between latitudes 6°N and 14°S, and longitudes 12° and 32°E. It spans the Equator, with one-third to the North and two-thirds to the South and the second rainforest in the world after Amazon.

The Democratic Republic of the Congo (DRC), the largest country in Francophone Africa, has vast natural resources and spans a surface area of 2.3 million square kilometers. Fewer than 40% of the nearly 78 million inhabitants live in urban areas. Estimated over 80 million hectares of arable land and over 1,100 minerals and precious metals capable of supporting immense agricultural activities, Congo has the potential to become one of the richest countries on the African continent and a driver of African growth.[1]

Congo's enormous agricultural potential remains largely unrealized and could be its best source of inclusive growth. In addition, if the existing agricultural potential were being fully exploited, DRC could feed 1 billion people. However, currently, even the relatively small domestic market demand for food products is not met. So approximately one-third of all the food consumed in the country is imported. Annual imports include 200,000 tons of rice, 200,000 tons of maize, 120,000 tons of fish, 80,000 tons of sugar, 60,000 tons of vegetable oils, 50,000 tons of meat, and 30,000 tons of poultry.[2]

The challenge therefore, is to transform the unfortunate agricultural resource endowment into a potentiality that will benefit the general welfare, alleviate the overall poverty and drive the economic growth.

Conducting a comparative cross-sector analysis on developing countries (excluding DRC), Titus O. Awokuse and Ruizhi Xie concluded that agriculture should have a particular attention, thus increase in investment to make agriculture a booster of economic growth. (Awokuse and Xie, 2015).

1.2. Objective of the study

In the PNSD (Plan National Stratégique de Développent, translated, National strategic Plan for Development), the Democratic Republic of Congo is planning to nurture the agriculture sector

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[1] http://www.worldbank.org/en/country/drc/overview
[2] World Bank, Country Assistance Strategy for The Democratic Republic Of Congo, April 12, 2013

for the economic diversification and job creation as a way for food sufficiency and poverty alleviation. This study aims to contribute in enlightening local leaders and academics in:

- Showing the effect of agricultural productivity on the long run economic growth,
- Providing policy recommendation regarding funding channel effective on prompt agricultural development,
- Mend the gap in literature on regards to Congo agricultural productivity analysis.

1.3. Research questions and hypotheses

The present study aims at answering following questions:

- Whether there is relationship between agriculture productivity and economic growth of Congo,
- Whether agricultural technology significantly contributes to the productivity and how,
- Whether increase in investment in the agricultural sector would positively contribute to economic growth of Congo.

We subsequently assume that:

- Agricultural productivity is positively and significantly associated with economic development of Congo,
- Biochemical and mechanical technology are major factors for agricultural productivity, therefore should be combined with the labor and education in the sector,
- Increase investment in the agriculture sector through technology, from either within or without Congo will contribute to its economic growth.

Therefore, this study is aiming at studying whether there is a relationship between agriculture productivity and economic growth for poverty reduction and long run economic growth in the Democratic Republic of Congo.

1.4. Significance of the study

The literature on cross-country analysis in agriculture sector is abundant in the scholarship, however, a cross-sector analysis is scarce in the literature for DRC. The motivation of this research is to shed a light on cross-sector analysis and mend this gap.

In his paper on agricultural modernization, structural change and pro-poor growth, Otchia (Otchia, 2014) through CGE-microsimulation, compared models for agricultural modernization in the DRC. Our study differs from his that we are analyzing the contribution of agriculture productivity on overall economic growth by including technology as a component of this productivity.

Additionally, many studies have been conducted on aggregate cross-country basis. This study aims to provide a specific in-depth analysis on Congo agricultural development and draw related recommendations.

1.5. Organization of the study

This study is composed of six chapters as below detailed.

Chapter one presents the general introduction and significant basis to clarify the objectives of the study. We herein present our research question and hypothesis.

Chapter two describes the literature regarding the contribution of the agriculture to economic growth. This chapter ends by presenting a cross-cutting intersectoral analysis.

Chapter three introduces the agricultural pattern in DRC from colonial to present. It ends by presenting the National Strategic Plan for Development, a governmental roadmap towards development through agricultural sector improvement.

Chapter four describes the methodology adopted in data collection and corresponding sources. Therein are explained the different methods and techniques utilized in interpreting the data, variables and their significance and expected correlation.

Chapter five presents data analysis and interpretation. Data are processed herein and relevant interpretations for conclusion and recommendation are drawn.

Chapter six includes the conclusion and policy recommendation. We therein present the answers to previous questions and hypothesis and, based on the result in chapter five, we draw relevant policy recommendation and unsolved questions for future research related to agricultural productivity.

CHAPTER 2: LITERATURE REVIEW

The relationship between agriculture productivity and economic growth is a widely debated subject. The debate ranges between scholars in demonstrating the contribution of agriculture on the economic growth in developing countries. Some are optimistic whereas others are pessimistic. Often, in developing countries, slow economic growth and low incomes are alleged as being rooted in a low and slow growth in agricultural productivity (Alston and Pardey, 2014). Gollin, however argues that there is positive relationship between increase in agricultural productivity and economic growth (Gollin, 2010).

The causal effect of agricultural productivity to economic growth however is controversially debated. The increase in agricultural productivity is on some extent highlighted as a precondition for economic growth for countries on the early stage of development as agriculture basically has an important share of the labor force. Increasing agricultural productivity positively impact a country's long run economic growth with substantial cumulative value addition effects into the economy (Gollin, 2010). However, as agricultural productivity may importantly rely on nonagricultural sectors, say technology, inputs, price and additional services, growth in the nonagricultural sector may certainly influence agricultural productivity. (Hwa, 1988).

2.1. Agricultural productivity and poverty alleviation.

The relationship between agriculture productivity and economic growth has been so widely documented. The link between agricultural growth and poverty alleviation is clearly stated and well shown in many of those literatures.

In the process of economic growth, agricultural productivity benefits the country in three ways: (i) feeding people and providing foreign currency to the economy through the exportation of the

agricultural commodities, (ii) being the workforce and fund provider for nonagricultural sectors, lastly (iii) agriculture as an outlet for products from the manufacturing sector. (Federico, 2005)

Undertaking the fact refraining the development in low income countries, Dethier and Effenberger based on Schultz's (1953) food problem theory state that low income countries are unable to develop since most people have to spend a high percentage of their income and labor to procure food. (Dethier and Effenberger, 2012). In other words, through food security, rise in income for the population, agricultural productivity appears to be a prerequisite for starting a long run economic growth process and poverty alleviation.

2.2. Agricultural and nonagricultural sector: the linkage

The relationship between agricultural and nonagricultural development has rightly to be investigated not over which sector is important than the other, rather on their relative role in economic growth and how the two sectors are intertwined. In most countries in earlier stages of development, agriculture can be a source of essential supplies for maintaining a nonagricultural population and of exports to be traded for industrial commodities. For these roles to be met, agriculture productivity must be increased. This increase is dependent on a variety of nonagricultural inputs, provision of which can be an incentive of the industrial sector.

Johnston and Mellor observed that agriculture contributes to economic growth and development through five intersectoral linkages: (i) supply of surplus labor to firms in the industrial sector; (ii) supply of food for domestic consumption; (iii) provision of market for industrial output; (iv) supply of domestic savings for industrial investment; and (v) supply of foreign exchange from agricultural export earnings to finance import of intermediate and capital goods (Johnston and Mellor, 1961)

In a growth process of populated countries, increasing rural workforce more than what would be required for agricultural sustenance can lead to a surplus of manpower in agriculture that can be absorbed in the nonagricultural sector, thus agriculture appears to be the source for manpower to nonagricultural sectors. However, this shift is likely to occur on the long run since job creation

is not rapidly formed in the earlier stage of development. Thus, growth in the two sectors interacts, each supporting and incentivizes the other.

As the largest sector in the economy of developing countries, at mainly in the earlier stages of growth, agriculture provides a high share in providing the manpower. On the structure of GDP formation in Sub-Saharan Africa, Tomšík, noted that agriculture share in population employment is relatively higher than in other sectors of the region. (Tomšík et al., 2015).

On non-agriculture sector effect on poverty and economic growth, while decomposing the Indian output sector growth, Ravallion and Datt found that output growth in primary and tertiary sector is more effective and reduced poverty both in rural and urban areas while the secondary sector growth has no effect on poverty neither in urban or rural area. (Ravallion and Datt, 1996). Additionally, Kakwani stated on the Philippines that agricultural output growth is four times effective in reducing poverty in rural area than it is in urban since growth in agriculture is more effective (1% increase reduces poverty by 1.12%) than Industry (1% increase reduces poverty by 0.25) and services (1% increase reduces poverty by 0.34). (Kakwani, 2001).

Agricultural development provides less expensive products as well as food for workers and larger markets for nonagricultural products while the latter in turns creates a market for agricultural products.

The ways agricultural productivity may influence the overall economic growth can be summarized in these assumptions: (1) Economic growth is characterized by a relative price equilibrium in which aggregate increase in the demand and supply for agricultural commodities go in pace. (2) Exporting agricultural commodities increases income and foreign currency. (3) Agriculture provides the workforce to nonagricultural sectors. (4) Being a leading sector mostly in developing economies, agriculture makes an important contribution in acquiring capital for nonagricultural sector, and lastly (5) Growing farmers' income is important as an incentive to nonagricultural sector development. (Johnston and Mellor, 1961).

2.3. Agricultural development and technology adoption

In tropical areas, virgin soils are productive for some years when converted for agricultural purposes as soils usually have good physical, chemical or biological properties. In a long run process for fertility to endure, addition properties are necessary for agricultural productivity since own soil productivity degrades.

Soil degradation is a worldwide phenomenon that has occurred in many places since the development of agriculture. Soils can be degraded in a number of ways, such as nutrient reduction, organic matter diminution, removal of topsoil by accelerated erosion, compaction and excess use of soil. On highly leached and geologically old landforms such as in much of Africa, the loss of soil's ability to provide adequate nutrition to crop plants can happen very rapidly. Hence, adoption of new technics for land productivity appears to be necessary.

New technological adoption is considered as the basis for land productivity in the modern agricultural technics. Basically, we can classify two sorts of technology. Mechanical technology in terms of tractors as a manpower substitute and biochemical technology in terms of fertilizers or additional chemicals as a land saving substitutes for higher production methods (Griliches, 1968).

Drawing from existing literature, gains from new agricultural technology have influenced the poor directly, by raising incomes of farm households, and indirectly, by raising employment, wage rates of functionally landless laborers, and by lowering the price of food staples (Pinstrup-Andersen et al., 1976; Hossain et al., 1994; Winters et al., 1998; de Janvry and Sadoulet, 1992, 2001; Irz et al., 2001).

Agricultural growth is essential for fostering economic development and feeding growing populations in most developing countries (Datt and Ravallion, 1996). Yet, since area expansion and irrigation have already become a minimal source of output growth at a world scale, agricultural growth will depend more and more on yield-increasing technological change (Hossain, 1989).

Adoption of new technology has yielded evidences in the past. Andersen argues that several Asian countries were rice importers before adopting new technologies in rice and wheat production were importers of those commodities. India and Pakistan reduced their respective imports of wheat and rice by 50% and 33% and increased domestic production in the 1966 to 1970 (Pinstrup-Andersen, 1970). Thus, agricultural productivity growth, through adoption of new technology can reduce external dependency on agricultural commodities and increase internal production, hence spread of economic growth effects on domestic population.

Similar patterns are observed in Japan and Taiwan. Through research in agriculture, increase in fertilizers application and changing in cultural practices, technological improvement in these countries was the pivotal factor responsible for the increase in rice and basic food productivity accounting for the majority of agricultural production and the most important elements leading to productivity (Pinstrup-Andersen, 1979).

Agricultural technology is necessary for agricultural productivity. To exploit this potential and make new agricultural technology contributive to economic growth, public policies in terms of incentive should accompany the introduction and adoption of the practice for the country's benefit.

2.4. Primary education and agricultural productivity

Agricultural technology adoption and education are inseparable in terms of importance and accuracy. It is widely known for technology to yield expected results, people using them should have minimum knowledge and understanding of the technics. However, documentation of the educational effect on agricultural development in Africa is mixed due mainly to lack of data or low estimation.

Education can affect agricultural productivity on different ways (Schultz 1988). Estimates have shown that the use of resources, spending on human capital is a good investment. For Africa, the returns to education were highest in Sub-Saharan Africa, the region with the lowest levels of schooling. In allocating an education budget among different levels of schooling, priority

should be given to the lower levels of (primary) education in countries that have not yet achieved universal primary (Psacharopoulos, 1994).

On Uganda, Simon Appleton and Arsene Balihuta found a significant effect of education on agricultural productively. Measured as four years of primary schooling, education rose the agricultural productivity by 7%. (Appleton and Balihuta, 1996). Thus, education benefit the rural poor people.

Though primary education would positively affect agricultural productivity to benefit the poor, relative importance should be put on the higher and tertiary education to make the whole society keep pace with the structural transformation. The world bank has advised that high level of ability is necessary as many as to benefit the poor population either directly through health, training or indirectly through research, management and administration. Therefore, the emphasis on primary education and high benefits thereof relative to secondary or advanced education should be balanced (World Bank, 1980b, p. 49)

Education and training provide the foundation for agricultural development. In developing economies, the ability and willingness of persons to apply new knowledge are the basis for increasing output of food and creating institutions required for commercial agriculture. The adoption of new, improved methods and practices by individual farmers is the manner in which traditional agriculture is transformed into a more productive system. Bringing this about is the function of adult education. An important measure of accomplishment of education for agricultural development is therefore the extent to which farmers and rural people adopt improved practices and increase their productivity. In order for developing countries to achieve the expected returns from education in agriculture, chatelain reminded "no economic growth without agricultural progress, and no agricultural progress without well-taught farmers" (Chatelain, 1963, 9 cited in Education and training for Agricultural Development by George Montgomery).

2.5. Agricultural productivity and commodity pricing

Agricultural commodity pricing has aroused several views: strong advocacy of support prices for important agricultural commodities or subsidies for major inputs to complete liberalization of prices and reliance upon the market mechanism to achieve efficiency and competitiveness. However, development will, in larger extent, depend on increasing in productivity. To achieve this target, important changes in systems, policies as well as institutions for agriculture need assessment. One among key government policies related to regulating agricultural sector for its growth include pricing.

In agricultural development, commodity price plays a vital role. First as a medium for transaction, and second as an incentive for farmers. The world bank contents that "Improving the productivity, profitability, and sustainability is the main pathway out of poverty in using agriculture for development". (World Development report 2008). Price incentive is advocated as a one of the main tools to achieve this productivity.

Economic openness and gain from trade is also a feature of price to benefit the farmers. A recent study by Hayami and Akino provides empirical evidence for closed and open economies: closed and open economy. In closed economies, customers gained large economic benefits while producers lost. In open economies, producers obtained substantial economic benefits and consumers surplus was left unaffected (Hayami and Akino, 1977). Simply said, farmers are better off under open economy than they would be otherwise. Therefore, policies targeting the positive outcomes from market price and liberalization are worth implementing.

2.6. Agricultural development and economic growth: a cross cutting summary

In previous sections we've discussed theoretical debates around agriculture development and its different effect on the overall economy. So far, agricultural development by the optimism side of the theory. What if the theory goes beyond debates over the positive effect of agriculture on long run economic growth?

It is clearly supported by numerous authors that higher agricultural productivity increases the rural population incomes through the rise of demand of agricultural commodities by the nonagricultural population. Via this market function, agricultural productivity contributes to economic growth. However, the leading role of agriculture in economic growth has also been criticized. Agro-pessimists view the agricultural as a low productive sector. Thus, it looks unclear that growth in agriculture would positively affect the long run economic growth (Gollin, 2010).

In the present world, globalization has a stake in agricultural development debate. Authors have advocated the developing countries, since abundant in natural resources, should exchange these commodities and import agricultural commodities to reduce domestic food production surplus and promote global agricultural trade (Byerlee et al. (2005). Byerlee argues that developing countries should depend on agricultural imports and natural resource export in the early stage of development. Schultz counter argues in terms of cost and contends that food import is expensive for low income countries (Gollin et al., 2007).

Numerous studies have revealed the impact of general economic growth and farmer income (Estudillo and Otsuka, 1999, Reardon et al. 1994). In case of Philippines, Estudillo and Otsuka argue that income of rice-farming households has risen principally due to economic growth in the nonagricultural sector. Higher incomes influenced access to new technology and modern inputs which in turn positively affect the overall agricultural productivity. Reardon contents that African farmers benefit from the reinvestment of non-farm benefits through access to credit for farming activities. The relationship between Agriculture sectors and nonagricultural sector in the economy are interdependent and complementary (Hwa, 1988). Therefore, economic growth will be a result of combined policies oriented into increasing agricultural output to benefit nonagricultural sectors.

CHAPTER 3: AGRICULTURAL PATTERN OF THE DEMOCRATIC REPUBLIC OF CONGO

In this chapter I am focusing on agricultural sector in DRC from colonial era perspective to the present status. To start, this section briefly presents the overview of the country.

Table 3. 1: DRC General Overview[3]

No	Indicator	Description
1	GDP	$68.45 billion
2	GDP composition	agriculture: 21.1% industry: 33% services: 45.9%
3	GDP Per capita	$800
4	GDP Growth rate	3.4%
5	Population	83Mn
6	Total land	2,344,858 sq km
7	Agricultural land	11% of total land

Located in central Africa, DRC is a tropical country with a variety of climate by region: from warm and humid in equatorial river basin; cooler and drier in southern plateaus. The country borders nine countries: Angola, Tanzania, Republic of Congo, Central African Republic, Rwanda, Burundi, South Sudan, Zambia and Uganda.

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[3] Based on the World Fact Book accessed on October 2018 from https://www.cia.gov/library/publications/the-world-factbook/geos/cg.html all in 2017 estimations.

Based on the recent decentralization, the country has passed to 25 provinces from 10 previously, with Kinshasa the capital as a city-province: North and South Kivu (referred to as Kivus), Maniema, Katanga, Eastern Province, Equateur, Eastern and Western Kasai, Bandundu, Bas-Congo and Kinshasa. The country, however, experience an underpopulation in terms of inhabitant per square kilometer (24 inhabitants), the higher population density being concentrated in Kinshasa with 577 inhabitants per square kilometer (UNDP).

3.1. From colony to early 1990s[4]

Most African countries experienced independence after the World War II. DRC was liberated from Belgium colony on June 30th, 1960. Before that, most of the managerial and technical positions in the country were held by expatriates and the country's economy was primarily export-led of the raw materials. After independence, the rapid departure of Belgian administrators and technicians left government and industry in the hands of low-level leaders.

The colonial administration's main purpose was to attract foreign investment in the Belgian Congo for export of agricultural products and mineral resources. To achieve this target, the government planned to establish transportation facilities. The political turmoil that followed independence caused the failure of public administration and heavily economic consequences. Important infrastructures for transport and trade were embedded. Export returns were shrink. However, the government enacted several policies aimed at the transformation of a primarily agricultural economy into a leading industrial power in the region lead by the huge mineral wealth of the country.

By launching in the 1970s a comprehensive and ambitious program consisting in the nationalization of domestic economy as done in most emerging countries at that time, Congo

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[4] Drawn from the case study presented by the Encyclopedia of Nations accessed in October 2018 accessed from http://www.country-data.com/frd/cs/zrtoc.html#zr0104. Updates added.

government intended to transform the economy to the western power model, thus realize the colonial aspirations of making Congo the breadbasket of Africa.

Zaireanization, as to name the program, was an economic nationalism promoting the ownership of the economy by citizens. For Congo (then Zaire), economic and political autonomy were perceived as dependent country's citizens. The program, however, was to be funded by external debt and based on projection of price increase of mineral commodities. Regardless of the motives for the public policies of the time, the end of the grace period led the country to economic decline given enormous debt contracted from other governments, international lending agencies as well as the collapse in world price of copper to finance its ambitious industrial development projects and the negligence of agriculture and transport infrastructures.

Congo economy began to slightly rise in in the late 1990s. But the per capita GDP rise was outpaced by the high birth rate in the country, impacting negatively the economic performance. Nevertheless, many people lived from subsistence agriculture and barter. Most of the economic activities are informal in terms of trade of goods and services that show up nowhere in official government or donor country statistics for better economic estimation.

The inattention of the elite and limited funds for investment have been advocated as the root causes of the country's agricultural decline as well as the ill-conceived Zaireanization. Nonetheless, Congo has the potential to be a net exporter of agricultural products; nevertheless, alike other economic sectors, the country hasn't yet been able to uphold its potential.

3.2. Congo Agricultural Sector Overview

Congo's economic activities, especially agriculture and related sectors, has been badly affected by the civil unrest in the country. In addition to the nationalization movement in the 1970s, the sector has experienced stagnation and degradation due to the civil war that arose in the country in the 1990s. The rural community live in poverty and daily struggle due to limit access to markets and the deterioration of related infrastructures.

Congo has a significant share of arable land in Africa, a favorable and rain-fed climate and abundant water all the yearlong. Though agriculture accounts for the largest share of employment in the economy, only 10 percent of the 80 million hectares of arable land are used. Mostly used for subsistence, agricultural development in Congo would highly depend on development of inputs, technology, finance, market access, rural infrastructure development. Main crops include, not limited to, coffee, sugar, palm oil, rubber, tea, cotton, cocoa, quinine, cassava (manioc, tapioca), bananas, plantains, peanuts (groundnuts), root crops, corn (maize), fruits; wood products.

Following tables classify Congo crops into perennial and annual crops per province based on the names prior to the decentralization.

Table 3. 2: Perennial Food Crops

Crop	Province
Hevea	Equateur, Maniema, Eastern Province, Bandundu
Cotton	Equateur, Eastern Province, Western & Eastern Kasai and Maniema
Palm oil	Equateur, Eastern Province, Kasai (Both), Maniema, Bandundu
Coffee	South & North Kivu, Eastern Province, Maniema
Cocoa	Equateur, Eastern Kasai
Tobacco	Katanga, North Kivu, Eastern Province, Bandundu, Bas-Congo

Source: UNDP

In terms of food crops, DRC provides a variety of crops production as shown in the following table :

Table 3. 3: Annual Food Crops

Produce	YEARS			PROVINCE
	1990-2000	2001-2010	2011-2016	
Beans	1634743	1155128	1470278	(Both) Kivu, Western Kasai, Eastern Province, Katanga, Bas-Congo, Bandundu
Cassava	195531620	150310420	88639275	Bandundu, Bas-Congo
Groundnuts	5178753	3682050	2469803	Bandundu, Katanga,
Maize	12272853	11568152	7039215	Eastern Province, Katanga, Kasai
Plantains	18114290	11989036	6744654	(Both) Kivu
Potatoes	860325	929378	592371	(Both) Kivu
Rice	4131801	3169409	1863145	Equateur, Eastern Province, South Kivu, Maniema
Soybeans	146193	154851	123407	Eastern Kasai, Equateur
Sugar cane	18759550	16699079	12373735	Bas-congo, South-Kivu, Eastern Province, Bandundu
Wheat	103933	86658	50920	North Kivu, Katanga

Source: FAO Stat and UNDP

All Congo provinces are appropriate for agricultural produce. Different ecological zones provide to each province comparative advantage in producing proper crops and effective for agricultural productivity.

The abundance of grassland in Congo, good for the livestock sector are less exploited. The current production of inland fishing is recorded three times less than its potential. Given the country's position, Congo is likely to be an agricultural hub and agricultural value chain in the region for both small-scale and larger agro-industrial farms should the sector develop. Regardless of the underdevelopment of the agriculture, the contribution of the sector in the national gross domestic product is relatively significant.

Figure 3. 1: Primary sector as percent of GDP
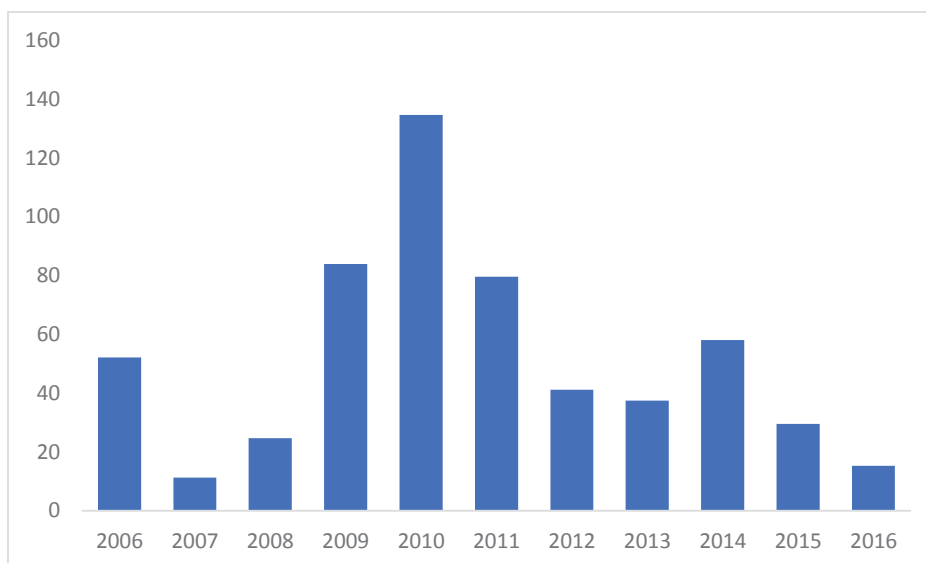
Source: Congo Central Bank

In the last decade, Congolese economy was significantly dependent on primary sector (agriculture and mining) sector. However, this dependence is not a result of agricultural development, rather the rapid decline in Mining production in the country and increase in urban migration (Otchia, 2014). Recent years witnessed an urban phenomenon especially for food security and market proximity reasons. After trade (service), agriculture is the second sector of employment in the country. Agriculture has, therefore, become an important sector for income generation given the high demand for agricultural commodities in the urban area.

3.3. Food Security

The WFP defines food security as a situation in which all members of a household have, at any given time, physical, social, and economic access to sufficient, safe and nutritious food which meets their dietary requirements and food preferences for an active and healthy life (wfp, 2015). Simply said, it is a condition of food availability and ease individual access to it.

This definition shows how population and food availability are correlated. Food sufficiency implies a thorough population growth and food production control to meet the individuals need. In the RDC, however, the last decade witnessed a population growth outpacing the food production leading to its food insecurity.

Figure 3. 2.: Agricultural Production and Population Growth
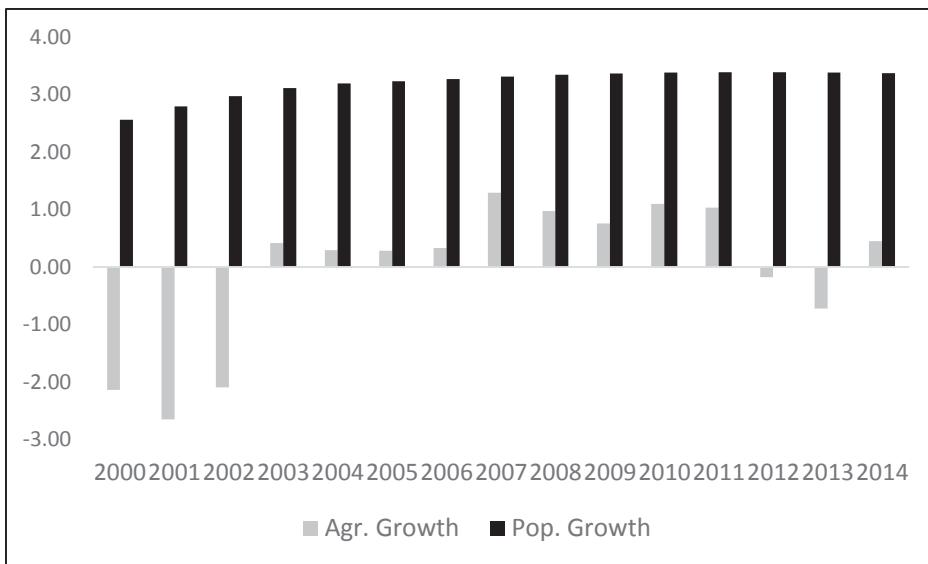
Source: Author's calculation based on FAO and WDI data

3.4. Farming Law

Land is a fundamental asset for Congo farmers given its economic, cultural and agricultural importance. Providing regulatory frame work for land governance is the primary task for the government given that the land and its contents belong to the state. Therefore, the land system in Congo is regulated under the law on agriculture N. 11/022 of December 42th, 2011 known as "farming law". The law encompasses a wide range of the activities related to agriculture, fishing and farming. It provides incentives in terms of investment in the agricultural sector as well as the limitation in farmland acquisition by foreign investment.

Congo government issued in 2013 a National Agricultural Plan encompassing the investment promotion, agro-industrial parks and investment special zones. The first special park has been established in Bukanga-Lonzo (Project on supporting investment promotion in Africa, Jica, 2016)

3.5. Structural Agriculture Organizations

In DRC economic landscape, farmer federation plays an important role in agricultural development. For small scale farmers contribution to the national economic growth, the rural structure in the country deserve a restructuration. In the past, the DRC government has sought to promote different forms of association, including mutual associations and cooperatives, but the lack of a clear vision for their organization and limited resources available in the departments concerned, have not allowed the meaningful results.

With the support of donors and different NGOs, Congo cooperative movements in the agricultural sector recently experienced a revival. These groups are mainly coordination platforms at central and provincial level aiming at defending the interests of their members and supply a better service in providing the means of production, market access and financial as well as advisory services. The FEC plays an important role as leading platform, chamber of commerce and industry. The COPEMECO and FENAPEC including various SMEs in their midst have preponderant role in agricultural cooperative movement in DRC.

3.6. National Strategic Plan for Development (PNSD)

Congo government has set up a national development plan (PNSD-Plan National Stratégique pour le Développement), a path set towards the country's economic development. To achieve this objective, the government intends to promote economic diversification and industrialization policy with focus on growth generating sectors in forms of economic zones and setting special economic zones based on comparative and competitive advantage of each zone.

Table 3. 4: Pillar of the PNSD- in regard to agriculture

PLAN	STRATEGY
Agriculture productivity improvement Promotion of financial systems decentralized and fitting the agricultural needs Technical and organizational capacity building of agricultural institutions Increasing in agricultural value addition Improvement of market access and rural development.	Improve agricultural governance Reduce vulnerability of the sector Improve agricultural competitiveness

Source: PNSD2.

Through the PNSD, DRC government intends to increase the investment in agricultural sector by reducing the conditionalities and easing the doing business climate. The country has started to revise the "farming law" and "land law" to guarantee easy access to the land for foreign investment. Congo government does believe in the importance of the agriculture as a leading sector in the country; and in the spillovers of agricultural productivity on other sectors.

Congo government intends to build infrastructures that will links production to consumption centers for a synergetic intersectoral activity, increase and value the agricultural productivity; thus, reduce the vulnerability of the sector. Through business policies improvement, Congo government is planning to increase competitivity by developing training programs, R&D as to outstand in the local, regional and international markets.

3.7. Agricultural Productivity: Initiative and Opportunity

For strategic investment in agricultural sector, the office of the Prime Minister of Congo developed a sectoral framework to foster agricultural transformation in line with the PNSD (PNUD, 2013). This program includes initiatives in supporting small scale farmers and attract

business farmers for the promotion of export crops and encouragement of young farmers to build analytical mindset with agricultural sector. This initiative includes:

1) *Small scale initiative*: provide direct support in forms of seed, agricultural tools, fertilizers to farmers as well as improve feed roads to make farmland more accessible to markets

2) *Commercial farming initiative*: to address the need for domestic food security, to accelerate efforts in food imports reduction and nutrition improvement in the country. Under this initiative, the government is providing incentives to investors in terms of public-private partnership.

3) *Young farmers initiative*: the government encourages young agri-entrepreneurs, particularly from the diaspora, to establish agribusiness in the country through financial and nonfinancial support to invest in more than 50ha of land.

4) *Analytical capacity building program*: this initiative aims at strengthening the academic institutions of the country to improve their agriculture related R&D capabilities.

Figure 3. 3. Schematic PNSD Incentives Framework
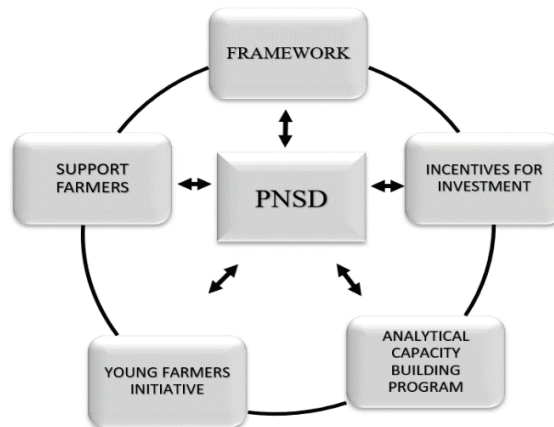
CHAPTER 4: METHODOLOGY AND DATA COLLECTION

4.1. Methodology

In order to study the relationship between the economic growth and agricultural productivity, two methods were utilized: qualitative and quantitative. The qualitative method through documentation helped to find and understand the general framework regarding effect of agricultural productivity on Congo economic growth. The quantitative method, through the time series technique was used to measure the correlation between dependent and independent variables, i.e. agricultural productivity and economic growth. In the present study, however, we are not attempting to manipulate the dependent variable (economic growth as proxied by the GDP per capita growth) and the independent variables (variables related to agricultural productivity) rather analyze the correlation between them. Our motivation is to test economic theories related to agricultural development on the long run economic growth of DRC and draw relevant policy recommendations for policy makers.

4.2 Data collection and model

This paper studies the agricultural productivity and its effect on economic growth in the DRC from 1990 to 2014. To better understand this effect, we collected the data related to agriculture from the Food and Agriculture Organization (FAO) statistics database, the Pen World Table and the US department of agriculture. Additional variables were collected from the World Bank's Development Indicators, the International Labor Organization, the International Monetary Fund, the Central Bank of Congo and the 123 surveys from the Ministry of Planning. Results from other researchers, articles and reports, were utilized as well.

Empirical studies on the field of agricultural productivity and economic growth of the DRC are scarce in the literature. Hence, the aim of this study is to mend this gap. Aforementioned

databases provided us with relevant secondary data for our research. Empirical researches have been conducted based on data provided by those sources, appraisal of which attests their reliability.

Since we are diving into the relationship between dependent and independent variables on one country, we will use time series data analysis technique. Time series analyzes data in order to extract significant lessons and determine the correlation between dependent and independent variables. We're aiming, in this study, to observe the relationship between agricultural productivity and economic growth from the estimating equation that will express whether change in GDP per capita as proxy of economic growth is function of the changes in agricultural productivity (which includes lands, livestock, technology and labor in the agriculture sector).

Many studies have sorted different variables that have impact on agriculture with likelihood to influence agricultural system in a country. For our study, we selected some of those variables and measured their relationship with GDP per capita growth as to induce relevant policies. In this section, based on data availability, the dependent and independent variables have the meaning as specified in following lines.

Dependent variables

- *Grgdp_cap*: The Gross domestic product per capita growth at annual percentage is the variable for the economic growth analysis. Time series data on Congo are collected from the World Development Indicators from 1990 to 2014. This applies as a dependent variable in our analysis collected on yearly basis.
- *prodha*: The Agricultural production per hectare. This variable relates to estimation of agricultural productivity measurement which enables the researcher to measure agricultural productivity by output over input per hectare. It is the ratio of the total crop per arable land. Annual data estimations were collected from the FAO database with the same timeframe.

Independent variables

- *manva*: is manufacture value added as percentage of GDP. It is the net output of a manufacture sector. This variable will enable to analyze the correlation between the manufacture value added and GDP per Capita growth of Congo. Data were collected from the World Development Indicators for the same timeframe.

- *lnservaw*: Logarithm of Services value added per worker including value added per worker in different services in Congo. This variable will enable us to estimate the degree of correlation between services value added and growth of DGP per Capita. Data are collected from the world Development Indicators.

- *minre*: Mineral rents are the difference between the value of production for a stock of minerals at world prices and their total costs of production. Minerals included in the calculation are tin, gold, lead, zinc, iron, copper, nickel, silver, bauxite, and phosphate. The variable is expressed as percent of GDP and collected from the World Development Indicator in the same time frame to estimate the correlation between it and the growth of GDP per Capita variable.

- *macland*: this refers to Agriculture Machine per square kilometers of arable land as a variable to measure the mechanical agricultural technology. It refers to the total stock of tractors, harvesters and threshers, irrigation pumps, milking machines, hand tools, and soil machines and farm machinery measured in 40-CV tractor equivalents divided by the arable land measured on square kilometers of arable land. The correspondent data of Congo on annual basis were collected from USDA Data base (Fuglie, 2012) and the World Development indicators.

- *lnfert*: the logarithm of Fertilizer as a variable to measure the biochemical agricultural technology. It refers to metric tons of fertilizers consumption. The correspondent data were collected from USDA Database (Fuglie, 2012).

- *lnagrilab*: refers to the labor in agriculture. It includes all the economically active population in the agricultural sector expressed in logarithm. Data on Congo are collected from USDA Database (Fuglie, 2012).
- *lnaidagri*: it is composed of Official Development Assistance (ODA) flows, Other Official Flows (OOFs) and Private Grant/Flows flowing on agriculture and its related sector expressed in logarithm terms. FAO database served to collect data on Congo in the same timeframe.
- *lnfdiagri*: it is the natural logarithm of FDI flows to agriculture, forestry and fishery (AFF) and for food, beverages and tobacco (FBT) sectors. Data are collected from the FAO database.

Control variables

Basically, control variables are understood as variables that one uses with not primary interest but can serve as measures of association in the experiment. For our study, we used following variables as control variables to check their relationship on the dependent variable.

- *inflation*: Inflation as measured by the consumer price index reflects the annual percentage change in the cost of acquiring a basket of goods and services. Data at annual percent were collected from the IMF database from 1990 to 2014.
- *opIndex*: refers to the openness index as a measurement of the country's openness to trade and/or to inflows or outflows of international investments. The index is measured by the exports plus imports over GDP at current prices expressed in percentage. The higher the index (the larger the influence of trade on domestic economy), the stronger the economy. Exports and Imports for agriculture products values based (on price terms) were collected from FAO stat and GDP from the WDI.
- *lnpoltero*: the logarithm of the political terror scale measuring the political violence in a country on a particular year as reported by the US department of state on 1 to 5 scale point. High point indicates the higher prevalence of political terror (Political Terror

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Scale, 2018). This variable will enable us to observe the influence of political instability on our dependent variable. Data were obtained from the political terror scale database.

- *lneduc*: refers to the logarithm of the education index. It is measured by mean of years of schooling for adults aged more than 25 years and the expected years of schooling for children of school entering age. This variable will help us to observe the relation between education and agricultural productivity. Data on Congo were collected from the HDI database.

Table 4. 1: Variables' expected correlation sign

Variable	Variable description	Expected sign	
		grgdp_cap	*Prodha*
grgdp_cap	Growth of Gross Domestic Product per capita		+
Prodha	Agricultural production per hectare	+	
macland	Agriculture machine per km² arable land	+	
lnagriLab	Logarithm of labor in agriculture	+	
lnfert:	the logarithm of Fertilizer per arable land	+	
lnaidagri	Logarithm of ODA flow to agriculture	+	
lnfdiagri	Logarithm of FDI to Agriculture	+	
manva	Manufacture Value added	+	
lnservaw	Logarithm of Service Value Added	+	
minre	Mineral Rent	+	
inflation	Inflation (consumer price index)		-
opindex	Openness Index		+
lnpoltero	Political terror scale		-
lneduc	Education		+

4.3. Ordinary least Squares (OLS)

The OLS method is a linear regression model used in the linear regression. The approach will enable this research to analyze the relationship between dependent variable (Y) and independent variables (X). Multiple regression approach will be used in this study. Y refers to economic growth as proxied by the Growth of GDP per capita and X refers to other variables selected in this study as independent variables. Therefore, the results will be interpreted based on the following hypothesis:

1. ***Null hypothesis***: agriculture productivity has no effect on Congo economic growth. This hypothesis can be schematized as: Ho: $\beta_1 = \beta_2 = \beta_3 = \beta_n = 0$
2. ***Alternative hypothesis***: Agriculture productivity has positive and significant effect on Congo economic growth. This can be schematized as follows: H1: $\beta_1 = \beta_2 = \beta_3 = \beta_n \neq 0$.

Our first model can be mathematically represented as in below equation

$$grgdp_{-cap} = \alpha + \beta_1 prodha + \beta_2 manva + \beta_3 \ln servaw + \beta_4 minre + \mu i \qquad (1)$$

where *grdp_cap* is the GDP per Capita growth on annual percentage, *prodha* is the agricultural production per hectare, *manva* the manufacture value added, *lnservaw* is the logarithm of service value added per worker, *minre* is the mineral rent and μi the error term. This model will enable us to make a cross-sector analysis. The second model aims to observe the influence of external variables on agricultural productivity expressed through the per hectare production. Therefore, our second model can be mathematically represented as

$$prodha = \alpha + \beta_1 inflation + \beta_2 opindex + \beta_3 \ln educ + \beta_4 \ln poltero + \beta_5 \ln agrilab + \mu i \ (2)$$

where *prodha* is the agricultural production per hectare, *inflation* is the inflation represented as the consumer price index, *opindex* is the openness index, *lneduc* is the logarithm of education, *lnpoltero* is the logarithm of the political terror scale, *lnagrilab* is the logarithm of the labor in agriculture and μi represents the error term.

To estimate the contribution of technology and finance as agricultural productivity booster, we applied the model as presented in the mathematical formula below:

$$grgdp_{-cap} = \alpha + \beta_1 \text{macland} + \beta_2 \text{lnagrilab} + \beta_3 \text{lnfert} + \beta_4 \text{lnaidagri} + \beta_5 \text{lnfdiagri} + \mu i_t$$

(3)

in which *gdp-cap* GDP per capita growth, *macland* refers to mechanical technology used in agriculture, *agrilab* refers to the economic active labor in the agriculture, *lnfert* refers to the biochemical technology used in agriculture, *lnaidagri* relates to total ODA flows in Agriculture sector, *lnfdiagri* is the variable related to FDI flowing in Agriculture sector, and μ as the variable referring to the error term.

CHAPTER 5: DATA ANALYSIS AND INTERPRETATION.

5.1. Introduction

In this chapter we will present the result of the analysis made from the data description presented in the previous chapter. We discuss the main findings thereof through statistical computation and measurement of significance between variables.

5.2. Data Description

Primarily, our data are described in the table below

Table 5. 1: Data Description

VARIABLE	OBS	MEAN	STD. DEV.	MIN	MAX
grgdp_cap	25	-2.434	6.460	-16.783	5.896
prodha	25	.163	.003	0.157	0.167
manva	24	13.825	5.057	5.015	21.217
lnservaw	25	8.597	.234	8.167	9.052
minre	25	5.430	6.707	0.143	19.512
lnlabor	25	9.355	.135	9.113	9.573
lnaidagri	25	7.186	1.553	4.356	8.901
lnfdiagri	25	5.721	2.336	0.432	8.583
lnfert	25	8.192	.930	6.118	9.805
macland	25	.989	.064	0.924	1.127
inflation	25	1396.104	4757.931	0.9	23773.1
opindex	25	.000	.000	.000	.000
lnpoltero	25	1.524	.157	1.099	1.609
lneduc	25	-1.092	.189	-1.336	-0.761

From above table, we read 25 observations with corresponding description. This corresponds to the years from 1990 to 2014 as the period of our analysis. All the variables have been weighted on the same basis to make the analysis more reliable since it is conducted on one country.

The variable GDP per capita growth rate reads a positive variation going from -16.78% as the lowest point to 5.89% (or 5.9%) as the highest point expressing the rate to which the economy of Congo has varied during the period under study. Other variables as well have shown similar pattern.

Figure 5. 1: Congo GDP variation

In below graph we represent the pace of variation of GDP rate in the 1990-2014 timeframe.
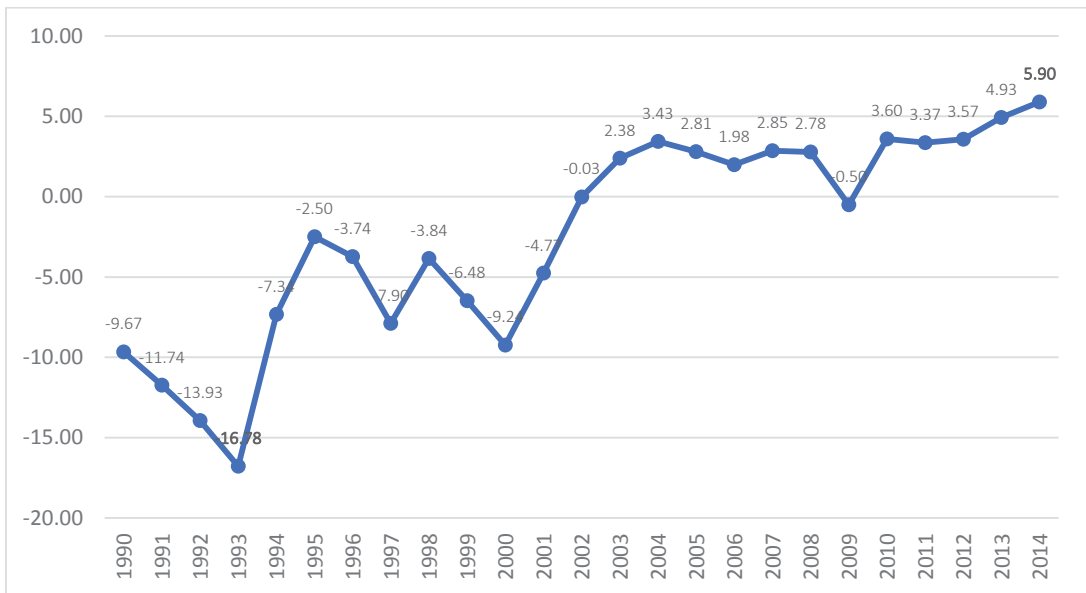
Source: WDI, World Bank

Above graph provides meaningful insights on the pace by which the rate variation of of Congo GDP occurred. Starting at -9.7% in 1990 to 5.9% in 2014, Congo GDP has varied negatively during a long period covered in this study. Negative growth rate of the GDP expresses the economic fragility of the country. Therefore, a study that investigates the possible ways of improving this situation is worth doing.

Congo's economy is heavily dependent on the primary sector (comprising minerals and agriculture) implying a high dependency on external price of these commodities. The share of agriculture in total GDP formation spans over 21.1% (2017 est.). Out of 83 million inhabitants, more than 50% live in the rural area. The number of people working in agriculture is over 60% of the total economically active population. To effectively tackle the issue regarding Congo economic fragility, policies that are directed to the primary sector improvement will positively impact the economy. This study aligns on this objective.

Table 5. 2: Data correlation matrix

	grgdp_cap	prodha	manva	lnservaw	minre	lnlabor	lnaidagri	lnfdiagri	lnfert	macland	Inflation	OpIndex	lnpoltero	lneduc
grgdp_cap	1													
prodha	0.604	1												
manva	0.545	0.583	1											
lnservaw	-0.595	-0.503	-0.686	1										
minre	0.528	-0.181	0.255	-0.435	1									
lnlabor	0.876	0.5	0.639	-0.777	0.692	1								
lnaidagri	0.884	0.443	0.563	-0.616	0.637	0.867	1							
lnfdiagri	0.871	0.616	0.648	-0.778	0.567	0.923	0.854	1						
lnfert	0	-0.49	-0.488	0.259	0.467	0.012	0.006	-0.064	1					
macland	0.735	0.152	0.458	-0.644	0.903	0.917	0.806	0.79	0.277	1				
Inflation	-0.293	-0.381	-0.428	0.282	-0.182	-0.314	-0.415	-0.283	0.273	-0.258	1			
opIndex	0.075	0.338	-0.129	0.137	-0.53	-0.261	-0.202	-0.078	-0.145	-0.446	0.098	1		
lnpoltero	0.294	0.539	0.404	-0.495	-0.061	0.45	0.082	0.418	-0.182	0.23	0.051	-0.01	1	
lneduc	0.835	0.34	0.583	-0.743	0.804	0.978	0.885	0.886	0.115	0.968	-0.31	-0.364	0.327	1

Source: Author's calculation

The result from the above table shows a significant positive correlation between *prodha, manva, minre, lnlabor, lnaidagri, lnfdiagri, macland,lneduc* and *grgdp_cap* variables. This means the growth in gross domestic product per capita (as a proxy for economic growth) is positively associated with the high output value of agricultural production productivity, manufacture value added, mineral rent, labor, aid in agriculture, foreign direct investment oriented into agriculture sector, machinery per arable land and education. The positive correlation between *macland* (as a proxy for mechanic agricultural technology) and GDP per capita growth infers that mechanical technology in agriculture is positively associated to Congo economic growth. Though statistically insignificant, there is a negative correlation between *inflation* and *grgdp_cap,* and *prodha* meaning an increase in agricultural productivity and gross domestic product per capita would reduce inflation rate in the country. On the other hand, the table reads a negative correlation between *lnservaw* and *grgdp_cap, prodha and manva.* This implies that, although service is important in any economy, for Congo case, the increase in service value addition alone may negatively impact the overall economic growth, agricultural productivity and manufacture. In the following steps of this analysis, we will look more closely to this relationship in our regression models.

It is worth mentioning the positive and high significant correlation between *macland* with *lnlabor, lnaidagri, lnfdiagri* and *lnfert*. In other words, the higher participation of labor in agriculture with mechanical and biochemical technology is positively associated with development aid and foreign direct investment, the higher the productivity. Additionally, *lneduc* is highly correlated with *lnlabor and macland.* This correlation implies that higher outcomes are expected from use of machinery by an educated population. Other variables have revealed significant correlation as well.

5.3. Regression analysis

Figure 5. 2: GDP Sectoral Composition in Congo

The pattern of sectoral share in Congo GDP composition shows a large contribution of tertiary sector over the primary and secondary.
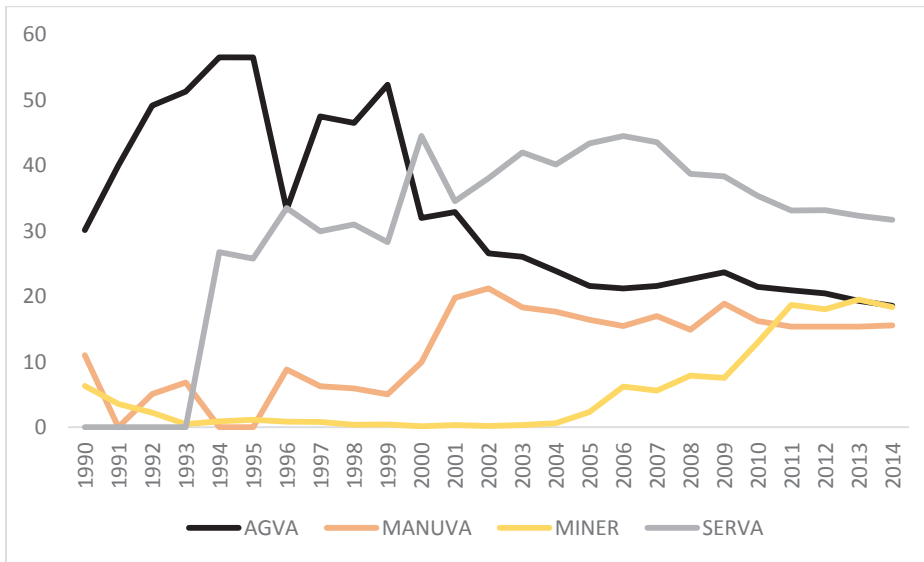
Source: WDI, World Bank

From the 2000s, service value added (as % of GDP) had the higher share followed by agriculture value addedand manufacture. However, in the early 1990s, agriculture was the main sector with higher than 50% share to the national economy. Though Congo is a resource rich country, the contribution of the mining (as % of GDP) has not been significant and is decreasing. Congo obviously is an agricultural economy given the high share of the sector in its economy (around 20%).

The objective of this analysis is to explain the importance of the agricultural sector in Congo economy. As the second sector in terms on importance, Agriculture development is vital to Congo economic growth, food security, poverty alleviation and be the takeoff booster for further development.

5.4. Economic growth regression analysis

According to our first model, we start with the economic growth analysis. By analyzing the economic growth regression, we examine whether agricultural productivity has a significant contribution pattern to Congo economic growth compared to other sectors of the economy. In other words, how much can an increase in agriculture productivity measured as production per hectare contributes to economic growth of Congo.

Table 5. 3: Economic Growth regression analysis

Dependent variable: GDP per capita Growth (*grgdp_cap*)	
Variables	Estimated coefficients
prodha	1740.08*
	(5.33)
manva	-.0636379
	(-0.32)
lnservaw	2.714879
	(0.61)
minre	.7443446*
	(5.37)
_cons	-313.1782*
	(-4.06)
	R² = 0.7946
	Adj R² = 0.7513
*t in parenthesis: * significant at 1% level, ** significant at 5% level, *** significant at 10% level*	

From this regression results, the R² is statistically significant, implying that the change in our dependent variable is significantly explained by the change in the independent variables at 79% confidence level. Differently said, the change in GDP per capita is explained by the change in *prodha, manva, lnservaw and minre.* The table reads a positive and significant correlation

between *prodha* and *grgdp_cap* inferring the significant contribution of agriculture on economic development (with a high coefficient at 1% significant level). Additionally, the coefficient of 74% being significant at 1% level implies that an increase in 1 unit of mineral rent during the period under study, all the variables being equal, would increase the GDP per capita by 74%.

It might seem misleading separating variables of primary sector in a regression model. Nevertheless, the objective in doing so was to analyze their degree of correlation with the dependent variable. We wanted to observe the contribution of each separately on the long run economic growth of Congo and induce relevant policies to help the country since it heavily relies on minerals as source of budgetary provision.

From above regression result, we observe the positive relationship between *grgdp_cap* and *prodha* explaining the high contribution of the agriculture productivity on Congo economic growth. However, we should read this result with caution because there are obviously other variables that can positively or negatively affect agriculture sector to reach its optimal level. Many reasons can be drowned, but for this study, we focus specifically on technology in agriculture and observe its effect on the long run economic growth. We additionally run a second level analysis to analyze the effect of political stability, education, price change, and openness on the agricultural productivity.

We therefore hypothesize that better agricultural technology leading to improvements in agricultural practice has a positive and significant impact on long-run economic growth. We assume that increasing in fertilizers, machinery, labor and finance to agriculture (either aid or foreign investments) will positively impact agricultural productivity with effect on the long run economic growth.

For accuracy of the results, we won't include all the variables in one model due to small sample size; therefore, variables are included separately to test the significance and robustness of the model.

5.5 Agricultural productivity analysis

In reference to our previous table of economic growth analysis (see Table 5.3), we found positive and significant correlation between *prodha* and economic growth. In this analysis, we introduce control variables as independent variables and *prodha* as dependent variable. Motivation of this analysis is to check the correlation between agriculture productivity and externalities with likelihood to influence agricultural productivity. Through this analysis we want to see whether price fluctuation (expressed through inflation rate), economic openness (expressed in agricultural production and GDP ratio), education, political instability and labor contributes either to the development or the decline of the sector.

Table 5. 4: Agriculture Productivity Regression Analysis

Dependent variable: Agricultural productivity (*prodha*)	
Variables	Estimated coefficients
Inflation	-1.60e-07*** (-2.59)
OpIndex	.4203947 (1.26)
lneduc	-.0540503* (-4.58)
lnpoltero	-.0004514*** (-0.17)
log_labor	.0836466* (4.95)
_cons	-.6787274** (-4.05)
	R-squared = 0.8442
	Adj R-squared = 0.8032
*t-value in parenthesis: * significant at 1% level, ** significant at 5% level, *** significant at 10% level*	

Referring to this table, at 84% confidence level, we can infer the relationship between the dependent and independent variables. The first result we read is the negative but significant correlation between *lnflation* and *prodha* variables, positive correlation between *opindex* and

prodha. At 1% significance level, we can conclude that agricultural productivity is influential in reducing the inflation rate in an open economy. The more open the economy with a high agricultural productivity, the less its inflation rate. The above table reads negative correlation between *lnpoltero* as a proxy for political instability and *prodha*.

Counter to our expectation, this analysis reads a negative but significant correlation between *lneduc* and *prodha* at 1% significance level on agricultural productivity.

Farmer education and productivity is praised in the literature. Most of the findings have resulted in showing positive correlation between schooling and agricultural productivity (see (Alene and Manyong, 2007) for instance); our study doesn't confirm this relationship. However, Congo case as well may confirm the general view on agriculture and education. Practical experience has shown that as higher as a person is educated, he tends to leave the agricultural sector and move to nonagricultural sector. Estudillo at al. found same pattern on farm employment in central Luzon, Philippines. They argue that higher educated people released agricultural sector and relegated to people with less or primary education (Estudillo and Otsuka, 1999). Also, our result is consistent with findings of Kenneth King at ali (2005) who also found no effect of schooling or training on improved agriculture. In order for education to be effective in improving agriculture, they said, certain crucial things need to be present for there to be a virtuous circle of influence from educational investments (King et al., 2005).

A) Technology in agriculture

We can distinguish two kinds of technologies: biochemical technology and mechanical technology. Biochemical technology refers to the application of fertilizers in the agriculture for output growth. Mechanical technology refers to the use of machineries for output improvement. We assume the more the use of technology in forms of fertilizers, and machinery, the higher the agricultural productivity. In the following regression model, we include these two variables to measure the contribution of these variables on economic growth. The variable *lnlabor* is included in the model as well since all the technologies need human force to operate.

Table 5. 5: Technology Regression Analysis

Dependent variable: GDP per capita Growth (*grgdp_cap*)	
Variables	Estimated coefficients
lnlabor	2.311993**
	(2.45)
macland	81.88194*
	(6.21)
lnfert	-1.697558
	(-1.81)
_cons	-91.17829*
	(-6.08)
	R-squared = 0.6313
	Adj R-squared = 0.5832
*t-value in parenthesis: * significant at 1% level, ** significant at 5% level, *** significant at 10% level*	

From above regression output, at 63% confidence level the change of the GDP per capita can be explained by the change in *lnlabor, macland and lnfert* as proxies for technology in the agriculture sector. Positive signs of *lnlabor, macland* in above table expresses the positive association between those variables and the dependent variable. In other words, 1 unit increase in the agricultural labor force utilizing the technology in forms of machine, other variables equal, would increase Congo GDP per capita by more than 230%. Machinery variable is statistically significant and positively correlated to the dependent variable in this model. In contrast fertilizer variable shows a negative correlation. Though Self at ali. (Self and Grabowski, 2007) praise the contribution of fertilizers in agricultural productivity, our model shows, however, no statistical significance of the biochemical technology on GDP per capita growth.

b) ODA and FDI in Agriculture

The previous analysis has provided significant results on the contribution of technology in forms of fertilizer and machinery on the long run economic growth. The following analysis aims at analyzing the relationship between finance in agriculture and Congo economic growth.

Though there exist several funding systems, for this study, we will focus mainly on two sectoral funding structures: ODA and FDI in agriculture. Analyzing the correlation between these variables and the overall economic growth will enable us to understand the agricultural friendly channel for Congo economic growth.

Table 5. 6: ODA and FDI Regression Analysis

Dependent variable: GDP per capita Growth (grgdp_cap)	
Variables	Estimated coefficients
lnaidagri	2.185345**
	(3.13)
lnfdiagri	1.171674***
	(2.52)
_cons	-24.8409*
	(-8.02)
	R-squared = 0.8388
	Adj R-squared = 0.8242
t-value in parenthesis: * significant at 1% level, ** significant at 5% level, *** significant at 10% level	

In reference to above table, at 83% confidence level, the correlation between our dependent variable and independent variables can be explained. This tables show the positive and statistically significant correlation between ODA and FDI in agriculture and the long run economic growth of Congo.

From the result presented in above table, ODA and FDI in agriculture appear to be agricultural friendly channels to enhance agricultural productivity for Congo economic growth. In the following sections, we aim to analyze how well those channels fits with the technology. The motivation here is the check the effect of funding directed in agriculture on the overall economic growth through technology. In other words, we want to analyze the correlation between the funding oriented to improve agricultural technology on long run economic growth.

Table 5. 7: ODA and Agricultural Technology Regression Analysis

Dependent variable: GDP per capita Growth (*grgdp_cap*)	
Variables	Estimated coefficients
macland	56.4378 *
	(3.69)
lnaidagri	1.261736*
	(2.61)
lnlabor	1.096048
	(1.14)
log_fert	-1.152946
	(-1.34)
_cons	-68.15238*
	(-4.25)
	R-squared = 0.7187
	Adj R-squared = 0.6675
*t-value in parenthesis: * significant at 1% level, ** significant at 5% level, *** significant at 10% level*	

From the regression model above, at 72% confidence level, we can infer the significance of ODA in Agriculture sector to positively impact economic growth, especially when oriented to improve technology through mechanization. Fertilizer still presents negative association with DGP per capita in our model.

Our findings are consistent with Rajan at ali. and Sheikh Ahmed. In their paper, Rajan and Subramanian (2008) found no systematic effect of aid on growth based on a traditional cross-sectional and panel analysis. Still, they suggested that moving away from the traditional cross-sectional analysis and focus on more direct evidence of the channels through which aid might help or hinder growth might be essential to improve aid effectiveness (Rajan and Subramanian, 2008). Conducting research on Sub-Saharan Africa, Zahra Sheikh Ahmed concluded no effect of aid to economic growth but suggested that aid to be effective should be brought in recipient country in forms of investment in particular sectors such as in agriculture (Sheikh Ahmed, 2014).

To test the robustness of the model, we replace *lnaidagri* by *lnfdiagri* as to verify the impact of the FDI in agriculture and its effect on the long run economic growth.

Table 5. 8: FDI and Agricultural Technology Regression Analysis

Dependent variable: GDP per capita Growth (*grgdp_cap*)		
Variables	Model (I)	Model (II)
macland	18.45046	12.0731
	(0.90)	(0.80)
lnfdiagri	1.820316**	1.952658*
	(3.63)	(4.79)
lnlabor	.4331521	
	(0.47)	
lnfert	-.1661684	.2176125
	(-0.19)	(0.75)
_cons	-33.21937	-26.73779
	(-1.66)	(-1.87)
	R-squared = 0.7695	R-squared = 0.7672
	Adj R-squared = 0.7276	Adj R-squared = 0.7368
*t-value in parenthesis: * significant at 1% level ** significant at 5% level *** significant at 10% level*		

In this regression output, the variable *lnfdiagri* shows high positive and statistical significance with the long run economic growth. This relationship can be explained at 76% confidence level.

Another result of this regression model (II) is that, despite their low statistical significance, fertilizers and machinery (as components of technology) combined with foreign direct investment in the agricultural sector show a positive correlation with the GDP per capita variable. At a significant explanatory level, mechanical technology, biochemical technology and FDI in agriculture will positively impact the long run economic development of Congo through improvement of agricultural productivity.

This result is consistent with the finding of Zahra Sheikh Ahmed (opcit) who also found positive relationship between FDI and economic growth through FDI to GDP ratio in Sub-Saharan

Africa. FDI affects economy through knowledge and technological spillovers, capital transfer and also value chain improvement especially in forms of M&A. in relation to FDI contribution to GDP through agricultural productivity, Beata notes that productivity benefits are created through partially owned corporation (Smarzynska Javorcik, 2004).

5.6. Limitation of the study

Conducting a time series analysis on one country is challenging, especially on matter related to data. Agricultural related data specifically on DRC were not available as many as wished. FAOSTAT served as the principle data source in this analysis, but data on machinery were combined with data from USDA dataset from 2009 onwards.

Secondly, data on GDP per capita growth differ depending on the reporting agency. We considered the difference between data published by the Central Bank of Congo and the World Bank through the World Development Indicators dataset. Even though secondary data are less reliable that primary data, since the latter were not available in the period from 1990 to 2014, we considered using the secondary data source which in fact is praised by other scholars as well.

Since our analysis is on one sector, we cannot conclude that developing agriculture only is the solution for economy of DRC. Other sectors should be accompanied as well for better outcomes as shown in our economic analysis result. The purpose was to analyze the interlinkage between agriculture productivity and economic growth.

Due to aforementioned impediment, our sample size was 25, based on yearly collected data. Running regressions based on small sample may be subject to some bias, reason why we don't pretend this study to be perfect.

CHAPTER 6: CONCLUSION AND POLICY RECOMMENDATION

6.1. Introduction

Effect of agricultural productivity on economic growth has been widely documented through the literature. However, scarce are those who dived into this correlation on DRC. This study aimed at mending that gap. Our study aimed at responding to the question:

- כ Whether there is relationship between agriculture productivity and economic growth of Congo,
- כ Whether agricultural technology significantly contributes to the productivity and how,
- כ Whether increase in investment in the agricultural sector would positively contribute to economic growth of Congo.

We herein present the answers to previous questions and hypothesis. Based on the result in chapter five, we draw relevant policy recommendation and sort out unsolved questions for future research related to agricultural productivity.

6.2. Summary of empirical results

Empirical results of this study have been extensively discussed in the chapter on data analysis. In this section we are responding to our research questions based on the findings.

The relationship between agricultural productivity and economic growth of Congo has been demonstrated. The economic growth regression analysis approved this relationship. Productivity per hectare as proxy for agricultural productivity read a significant correlation with GDP per capita, inferring positive correlation between these variables.

Though we observed significant correlation between agricultural productivity and economic growth, we analyzed the way to make the productivity more sustainable in the long run. Reason

why agricultural technology regression analyses were conducted. The hypothesis supposed that better agricultural technology leading to improvement in agricultural practice would have a positive and significant effect on economic growth.

Agricultural technology was understood as biochemical technology and mechanical technology in which the contribution of the manpower was considered. The findings have revealed the positive correlation between mechanical technology and economic growth. Though negatively correlated to the dependent variable, our analysis did not find a significant correlation between the biochemical technology and economic growth.

The technology regression analysis responds to the second question in showing the positive and significant correlation between technology in agriculture as independent variable and economic growth as dependent variable. The machinery per land as proxy for mechanical technology read a positive and significant correlation with GDP per capita; and negative correlation between fertilizers as proxy for biochemical technology and GDP per capita. Agricultural technology is necessary for agricultural productivity with effect on the long run economic growth. To exploit this potential and make new agricultural technology contributive to economic growth, public policies in terms of incentive should accompany the introduction and adoption of the practice for the country's benefit.

ODA and FDI regression analysis was the means through which we wanted to analyze the agricultural responsive funding channel and answer our third question. Our empirical results have shown the positive and significant correlation between ODA and FDI in agriculture on the long run economic growth. Applying these funding channels on agricultural technology to check their interlinkage, evidence have shown ODA to have positive impact on economic growth when channeled through actions leading to agricultural productivity by improving the farming practice. FDI as well showed similar pattern. However, in either case, biochemical technology still appears with negative correlation with the economic growth variable.

6.3. Policy recommendations

Growth in agriculture has been widely praised as a pro-poor growth, especially for countries in early stage of development. This definition fits well to the Democratic Republic of Congo.

Considering the result of this study, following policy recommendation can be suggested:

- Adoption of new techniques in agriculture and intensification of technological use in forms of labor and machinery to reap good fruits from agricultural productivity and provide public incentives aiming at keeping the labor into the sector,
- Increase investment in agriculture by opening up and improving investment climate through the farming and land laws
- Strengthen the national reporting, documentation and capitalization system for easing research

6.4. Final conclusion

The present study, dived into the importance of agriculture in a country's development process. The Democratic Republic of Congo is not different from other countries. This study has tested, analyzed and concluded by showing the positive correlation between agricultural productivity and the long run economic growth.

Future research oriented towards a more in-depth analysis of the correlation between the biochemical technology and economic growth in RDC is vividly encouraged.

Scientific modesty obliges us to specify that this study, though important, may not have escaped from the human nature imperfection. Therefore, we implore indulgence for any mistake, misspelling or error therein.

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ABSRACT IN KOREAN

1990 년부터 2014 년까지 콩고민주공화국의 농업생산성이 경제 성장에 미치는 영향

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농업생산성이 경제 성장에 미치는 영향은 문헌을 통해 널리 알려져 있다. 하지만, 이 문헌들 중 DRC 에 적용되는 것은 많지 않다. 이 연구는 콩고의 농업생산성과 경제 성장 간에 상관관계가 있는지, 농업 기술이 생산성에 크게 기여하는 지와 그 방법, 농업 분야의 투자 증가가 콩고의 경제 성장에 긍정적으로 기여할 것인지에 대한 질문에 응답함으로써 그 격차를 해소하고자 했다.

이 연구는 콩고의 농업생산성과 경제 성장 간에 상당한 상관관계를 발견했다. 이 연구 결과는 기계 기술의 상당한 영향력을 밝혀 냈지만, 생화학 기술과 장기 경제 성장 간의 상관관계는 발견하지 못했습니다. 이 논문에서 제시된 실증 결과는 ODA 와 FDI 가 농업에 영향을 미칠 수 있는 채널이라고 주장했다.

이 연구의 주요 공헌은 빈곤층에게 미치는 농업의 중요성과 기술이 장기적 경제 성장에 기여한다 점에 대한 대중의 관심을 높이는 데 있다.