HUMAN CAPITAL DEVELOPMENT AND AGRICULTURAL PRODUCTION IN CAMEROON

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Abstract

This study explores the influence of human capital development on agricultural production in Cameroon, while utilizing the data from 2000. to 2023. and analyzed them through quantile regression. The findings indicate that 78% of the variation in agricultural production is accounted for education expenditure, health expenditure, agricultural labor, and land use, which all exert a positive and significant influence on agricultural output. Conversely, fertilizers' use negatively and significantly affects production, likely due to inefficient or excessive application leading to soil degradation. The analysis further highlights that balanced investments in both education and health are essential for enhancing agricultural productivity, while imbalances in these expenditures can result in reduced output. The study underscores the importance of targeted investments in human capital development and sustainable farming practices to optimize agricultural production in Cameroon.

Key words: Human capital development, agricultural production, Cameroon, education, labor productivity.

JEL[2]**:** C53, Q18, O11

Introduction

Human capital development is an essential element of agricultural production, particularly in developing countries like Cameroon, where agriculture remains a significant part of the economy as a whole. It involves skills, knowledge, and experience of individuals, while it is essential in boosting productivity and advancing sustainable development within the agricultural sector. In Cameroon, where agriculture contributes around 23% to the GDP and employs nearly 70% of the labor force, the relationship between human capital development and agricultural productivity is particularly significant (WB, 2021).

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Human capital is regarded as a mix of knowledge, skills, habits, and precious experience possessed by individuals or groups, which contributes to the value of a country's organizations (Tasheva, Hillman, 2019; Gruzina et al., 2021). It has often been used worldwide as a key indicator of economic and social development (Kotsantonis, Serafeim, 2020; Gruzina et al., 2021). Throughout progress of civilization, several significant shifts and upheavals have totally transformed socio-economic relationships, shaping the concept of human capital. Mentioned changes have influenced the innovation and development of knowledge, and the formation of the global order (Hippe, 2020; Surya et al., 2020; Gruzina et al., 2021).

In addition to physical capital, human capital (including knowledge and technical expertise) is recognized as a key factor contributing to productivity growth. It is understood as the collective economic value of individuals functioning within economies, encompassing attributes as are knowledge, abilities, skills, habits, experience, health status, intelligence, training, clear judgment, and wisdom (James, 2021; Ndibe, 2022). Moreover, developing human capital can be categorized into six areas: a) medic care facilities and services, which encompass expenditures that improve life expectancy, strength, stamina, vigor, and vitality; b) on-the-job training, including traditional apprenticeships offered by companies; c) formal education through all three levels of basic education; d) adult education programs outside agriculture; e) single or family migrations in order to adapt to shifting job opportunities (factors mobility); and f) internal and external knowledge transfers, combined with technical assistance, expert opinions and recommendations (Ogunniyi, 2018; Ndibe, 2022).

It is important to recognize that human capital serves, both as driver and outcome of development of agro-economy. Developing human capital in agricultural sector is complex challenge, especially in the context of technological modernization of agricultural production. Addressing this challenge requires tackling a series of theoretical and practical issues aimed at securing the country's food independence, enhancing the competitiveness of agricultural products, improving the quality of life for rural populations, promoting innovation and innovative development of agro-industrial production, or boosting the productivity of agricultural labor (Zaika, Gridin, 2020).

Strengthening mentioned services is crucial for enhancing the capacity of farmers in Cameroon, particularly to face the challenges such as climate change, market fluctuations, or resource constraints. In Cameroon, where a substantial portion of the population depends on agriculture for their livelihoods, enhancing human capital is essential for achieving sustainable agricultural development and improving the well-being of rural communities.

Human capital development is critical driver of agricultural productivity in Cameroon. Enhancing skills and knowledge of agricultural workforce through education, training, and improved extension service can lead to significant improvements in farming output, nutritional stability, and reduction of poverty. Given the importance of agriculture to the Cameroonian economy, targeted investments in human capital are essential for achieving long-term development goals.

Relating to human capital development, agricultural production is essential for several reasons. Firstly, agriculture remains a vital sector in many developing countries, including Cameroon, where it contributes significantly to both GDP and employment (WB, 2021). By exploring the relationship between human capital and agricultural production, studies can identify the key areas where investment in education and training can lead to substantial improvements in productivity and sustainability.

Research in this area can provide valuable insights into how targeted educational programs and extension services can bridge the information gap among farmers and encourage innovations that enhance productivity.

For countries like Cameroon, where a significant share of population relies on agriculture for their livelihood, such a research is vital for designing effective interventions that can drive sustainable development. Therefore, studies that explore the impact of human capital on agricultural production can contribute to resilience of agricultural sector in the face of global challenges.

The link between human capital development and agricultural production is critical for enhancing productivity, promoting sustainable practices, and improving the overall well-being of rural populations. By providing evidence-based insights, this research can guide investments in education and training that are necessary for the long-term growth and sustainability of the agricultural sector. This study aims to analyze the effects of human capital development on agricultural production in Cameroon.

Literature Review

Theory on human capital

The human capital theory is rooted from work of economists such as Gary Becker and Theodore Schultz, who emphasized the importance of investing in individuals' skills, knowledge, and abilities to enhance productivity. Human capital theory posits that education, training, and health are forms of capital in which individuals and societies can invest to increase economic productivity (Schultz, 1961; Becker, 1964). This theory suggests that only physical capital (like mechanization, equipment, and contents of physical infrastructure) contributes to

production, so does human capital, as a more educated and skilled workforce is more efficient, innovative, and capable of adapting to new technologies. In the context of agriculture, human capital development is critical for adopting improved agricultural practices, increasing efficiency, and responding to environmental and market changes. Farmers with better education and training are more likely to understand and implement advanced farming techniques, leading to higher yields and more sustainable agricultural practices (Evenson, Gollin, 2003). Mentioned theory underscores the need for continuous investment in education and skills development to ensure long-term economic growth and development, particularly in sectors like agriculture, where productivity gains can have significant impact on food security and poverty reduction.

Numerous empirical studies have researched the relations between human capital development and agricultural production, providing evidence to support the theoretical framework. For instance, a study by Shvakov et al. (2022) examined the components of human capital that are essential for development in modern conditions and propose a methodology to evaluate its adequacy for organizing effective agricultural production and ensuring national food security. They also provided a justification for government regulatory measures in the areas of education and labor migration, aimed at fostering the creation of human capital necessary for the efficient establishment of agricultural production and securing the food security at national level.

Similarly, Rasanjali et al. (2021) have been demonstrated that training programs led to increase in the use of high-yielding crop varieties. Additionally, their study revealed a significant difference in individuals' gross income, indicating that with proper instruction and guidance from agricultural instructors, farmers were able to achieve higher yields and consequently higher incomes.

In another study, Baiyegunhi (2024) validated the causal links between human capital (such as on-the-job training) and farmers' innovation behavior, which in turn enhances farm productivity. This highlights the importance of developing human capital to drive innovation and improve productivity in the sector of agriculture.

Osinowo et al. (2021) provided evidence that agricultural productivity increases with investments in human capital. Consequently, they recommended farmers' capacity building at the micro level, how this would advance crop, soil, and water management while also boosting the demand for and use of more efficient inputs to enhance agricultural productivity. James (2021) found that life expectancy is crucial factor influencing the growth of agriculture in Nigeria.

Karpova and Muravieva (2019) proposed methods for the effective utilization of human capital that could be adopted by agricultural companies, aiming to increase

overall production profitability through enhanced human resources, viable growth of productivity, and more efficient appliance of both, fixed and current assets.

Methodology

Data sources

Data used for this study are mainly focused on Cameroon. Annual time series from 2000. to 2023. were gotten from secondary sources. The World Bank (WB) database indicators for Education and Health expenditures were used, as well as FAO statistics for land use, and fertilizer consumption, or International Labor Organization (ILO) for agricultural labor.

Techniques of data analysis

Quantile regression was used to analyze the impact of Education and Health expenditures on agricultural production.

Model specification

A major benefit of quantile regression is its robustness to outliers. Unlike ordinary least squares (OLS) regression, which minimizes the sum of squared residuals and can be heavily influenced by extreme values, quantile regression minimizes the sum of absolute residuals at each quantile. This makes it less sensitive to outliers, allowing for a more accurate representation of the underlying data distribution (Koenker, Bassett, 1978).

Quantile regression provides a more comprehensive analysis of the conditional distribution of the dependent variable by estimating the relationship between the independent variables and different points (quantiles) in the distribution of the dependent variable. This is particularly useful in time series datasets, where relationships may vary across different levels of the dependent variable, such as confrontation of periods of economic growth and recession (Cai, Stoyanov, 2014). While traditional time series models often assume a linear relationship between variables, quantile regression allows for the estimation of different slopes at different quantiles, thereby capturing the complexity of the relationship between variables over time (Koenker, 2005). Finally, quantile regression is advantageous when dealing with heteroscedasticity, situations where the variance of errors changes over time. Since it does not assume constant variance across the distribution, it can effectively model time series data where volatility, or risk is not constant, providing a more accurate picture of underlying dynamics (Koenker, Hallock, 2001). Mentioned method could be expressed by next mathematic model:

$$Qy_t = (\tau|\text{Education Expenditure}_t, \text{Fertizer Use}_t, \text{Health Expenditure}_t, \text{Agricultural Labour}_t, \text{Land Use}_t)$$
$$= \beta_0(\tau) + \beta_1(\tau)\text{Education Expenditure}_t + \beta_2(\tau)\text{Fertizer Use}_t$$
$$+ \beta_3(\tau)\text{Health Expenditure}_t + \beta_4(\tau)\text{Agricultural Labour}_t + \beta_5(\tau)\text{Land Use}_t + \varepsilon_t$$

Where, Education Expenditure is measured in FCFA, Fertilizer Use is measured in kg/ha, Health Expenditure is measured in FCFA, Agricultural Labor is measured in number of persons, Land Use is measured in hectares, $\beta_{i,\tau}$ for i = 1, 2, 3, 4, and 5 are the coefficients associated with the independent variables at quantile τ, ε_t is the error term at time t.

The impact of varying scenarios of effect of Education and Health expenditures on agricultural production was assessed. Specifically, the simulating agricultural production (Y_{it}^*) model looks like:

$$E\big(f(X_i)\big) = \theta_N^{'} = \frac{1}{N}\sum_{i=1}^{N} f(X_{it})$$

Where, X represents vector of agricultural production determinants, θ is the dependent variable (Y_{it}^*)

$$Y_{it}^* = \beta_0 + +\beta_1(\tau)(\text{Education Expenditure}_t + \vartheta_{1,it}) +$$
$$\beta_2(\tau)\text{Fertilizer Use}_t + \beta_3(\tau)\text{Land Use}_t + \beta_4(\tau)\text{Agricultural Labour}_t +$$
$$\beta_5(\tau)(\text{Health Expenditure}_t + \vartheta_{5,it}) + \varepsilon_t$$

Where, $\vartheta_{1,it}$ *and* $\vartheta_{5,it}$ represent the uncertainty in the measurement of agricultural production. Considering the structure of this model, the behavior of agricultural production across different scenarios is analyzed. The simulation scenarios include assessing the effect of changes in Education and Health expenditure on agricultural production, each by 30%. The scenario analysis did not consider the effect of changes in the input factors on agricultural production. Thereby, limiting the policy advisory on how to revamp the agricultural production in Cameroon.

Results and Discussion

Impact of changes in education and health expenditures on agricultural production

The findings linked to effects of human capital development on agricultural production is presented in Table 1. They show that the pseudo R^2 is 0.78, showing that 78% of variation in agricultural production could be explained by selected variables used in model. In addition, findings show that education expenditure, health expenditure, agricultural labor, and land use positively and significantly increase agricultural production. In contrast, fertilizer use negatively and significantly decrease agricultural

production. For instance, increased investment in education has a positive impact on agricultural production. Education enhances the skills and knowledge of farmers, leading to better decision-making, adoption of modern techniques, and ultimately higher productivity. This aligns with Ninh (2021), who was determined that education positively influences the output of rice farming households in Vietnam.

Table 1. Impact of human capital development on agricultural production

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Education Expenditure	0.232669	0.076414	3.044853***	0.0070
Fertilizer Use	-0.234268	0.083123	-2.818322***	0.0114
Health Expenditure	0.539680	0.084315	6.400757***	0.0000
Agricultural Labor	1.000732	0.189009	5.294629***	0.0000
Land Use	2.074484	0.676954	3.064440***	0.0067
C	-16.57927	7.699532	-2.153283	0.0451
Pseudo R-squared	0.783138	Mean dependent var		22.32137
Adjusted R-squared	0.722898	S.D. dependent var		0.627122
S.E. of regression	0.405390	Objective		1.060511
Quantile dependent var	22.33729	Restr. Objective		4.890245
Sparsity	0.059611	Quasi-LR statistic		513.9611
Prob (Quasi-LR stat)	0.000000	-		-

Source: Author's analysis.

Note: *** is significant at 1% level of probability.

Health expenditure is also positively linked to agricultural production. Healthier farmers are more productive, as good health reduces absenteeism due to illness and increases the physical and mental capacity to work effectively. As highlighted by Tenriawaru et al. (2021), the allocation of funds to the health sector appears to influence the enhancement of health outcomes, which in turn impacts the agricultural sector by contributing to consistent year-on-year growth in the production of key commodities.

The amount of land available and its efficient use directly impact agricultural production. Expanding arable land and optimizing its use through practices like crop rotation and sustainable farming leads to higher output. "Effective land use management plays a critical role in boosting agricultural yields" as has been noted by Allen and Ulimwengu (2015).

Availability of labor is crucial for agricultural production, as more labor force dedicated to farming activities generally leads to increase in productivity, especially in labor-intensive agricultural practices. According to Ursu et al. (2023), agricultural labor force plays crucial role in determining production levels.

The relationship between agricultural production and fertilizer use can be negative, particularly when fertilizers are overused or used inefficiently. Excessive fertilizers application can lead to soil degradation, reduced soil fertility over time, and environmental harm, all of which negatively affect agricultural output. "Excessive reliance on fertilizers has been associated with diminishing returns in crop yields and long-term soil health deterioration", as was observed by Zheng et al. (2022).

Impact of changes in education and health expenditures on agricultural production

The impact of changes in education and health expenditures on agricultural production were analyzed by the use of four scenarios. The figures presented (Figure 1-4.) show that when both education and health expenditures increase, agricultural production tends to rise. Investment in education equips farmers with the skills and knowledge necessary to adopt modern farming techniques, leading to higher productivity and profitability. Simultaneously, improved health services enhance the physical and mental well-being of the agricultural labor force, reducing absenteeism and increasing efficiency, as was noted by Kabiru (2020). Combined impact of increased education and health expenditures significantly enhances agricultural productivity, as farmers become better educated and healthier, allowing them to perform activities more efficiently. On the other hand, a decrease in education and health expenditures usually results in a decline in agricultural production. In developing countries, at households involved in agriculture, financial strain due to illness can severely impact their investment and production choices. Limited access to timely healthcare can further hinder production, leading to income losses that may continue over an extended period (Liu et al., 2024).

In scenario where education expenditure decreases while health expenditure increases, agricultural production may still decline. Although improved health conditions can sustain, the physical capacity of the workforce, lack of education restricts the adoption of advanced agricultural practices and technologies. Even with better health services, reduced investment in education can hinder agricultural productivity, as observed by Ninh (2021).

An increase in education expenditure combined with decrease in health expenditure presents a mixed outcome. While better education can empower farmers with advanced knowledge and skills, reduced health expenditure may lead to a decline in workforce efficiency due to increased illness and absenteeism. Increased educational investments may improve farming techniques, but without adequate health care, the productivity level in the agricultural sector is likely to decline as pointed out by Tenriawaru et al. (2021).

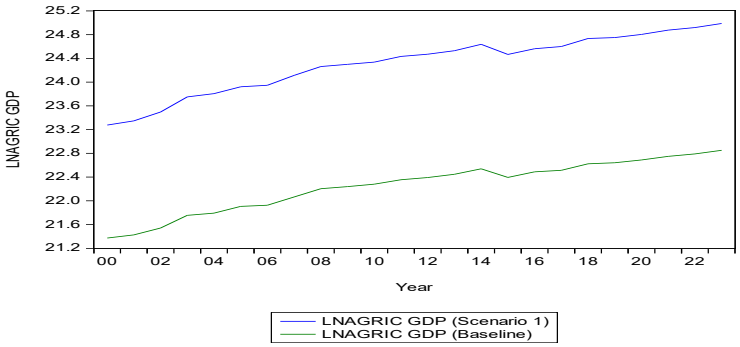

Figure 1. Impact of increases in education and health expenditures on agricultural production

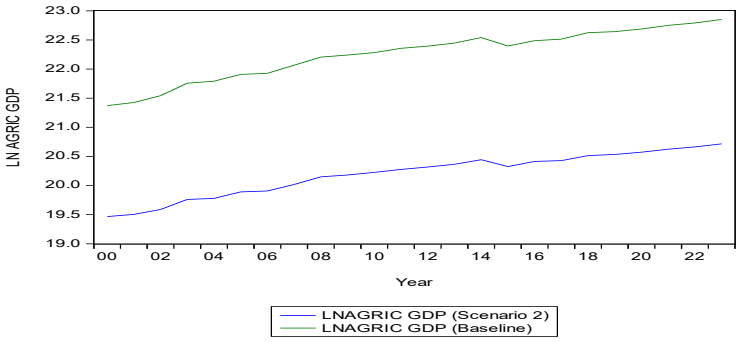

Figure 2. Impact of decreases in education and health expenditures on agricultural production

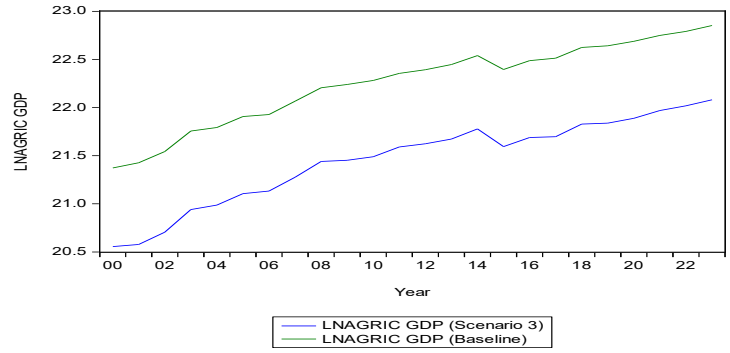

Figure 3. Impact of decrease in education expenditure and increase in health expenditure on agricultural production

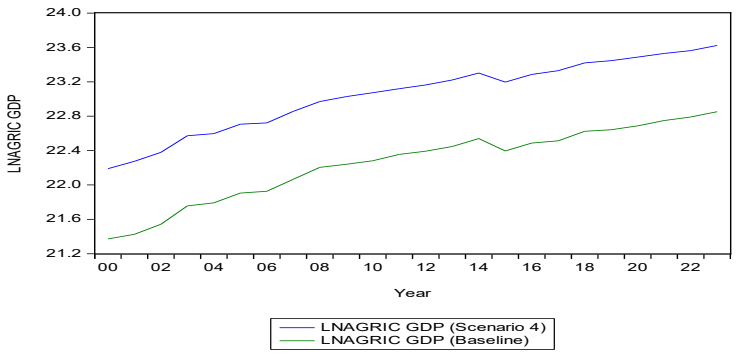

Figure 4. Impact of increase in education expenditure and decrease in health expenditure on agricultural production

The summary statistics presented in Table 2. shows that the combined increases of public health and education expenditures (Scenario 1.) ranges between 23.27 and 24.98 with the average of 24.30, as compared with the average baseline of 22.24. This shows how important are the investments in the education and health sectors for the sustainability of the agricultural sector.

Table 2. Summary statistics

Element	Baseline	Scenario 1.	Scenario 2.	Scenario 3.	Scenario 4.
Mean	22.24985	24.30509	20.19462	21.45548	23.04423
Median	22.37444	24.44923	20.29761	21.59233	23.14192
Maximum	22.85208	24.98825	20.71592	22.08128	23.62289
Minimum	21.37268	23.27736	19.46801	20.55605	22.18932
Std. Dev.	0.435105	0.496953	0.373534	0.450227	0.420636
Skewness	-0.600761	-0.640989	-0.550394	-0.641494	-0.553934
Kurtosis	2.290415	2.388414	2.170204	2.351545	2.227074
Jarque-Bera	1.947164	2.017503	1.900297	2.066553	1.824785
Probability	0.377728	0.364674	0.386684	0.355839	0.401562
Sum	533.9965	583.3221	484.6709	514.9316	553.0614
Sum Sq. Dev.	4.354272	5.680141	3.209134	4.662192	4.069506
Observations	24	24	24	24	24

Source: Author's computation

For the decreases in public education and health expenditures, it ranges between 19.46 and 20.71 with average of 20.19, as compare with the average baseline of 22.24. This shows that limited investment in training and health transforms into drastic reduction in agricultural output. For the decrease in public education and increase in health expenditures, it ranges between 20.55 and 22.08 with average of 21.45, as compare with the average baseline of 22.24. This shows that limited investment in training could significantly impact on agricultural production. Finally, for the increase in

public education and decrease in health expenditures, it ranges between 22.18 and 23.62 with average of 23.04, as compare with the average baseline of 22.24. This shows that limited investment in health sector significantly affect labor productivity which translate into a decrease in agricultural production.

Conclusion and Recommendations

This study reveals that education expenditure, health expenditure, agricultural labor, and land use are positively and significantly associated with increased agricultural production. These factors collectively contribute to better decision-making, adoption of modern techniques, and improved labor efficiency, all of which enhance agricultural output. Conversely, fertilizer use, when applied excessively or inefficiently, has a negative and significant impact on agricultural production, leading to soil degradation and reduced productivity.

The analysis of different scenarios highlights that balanced investments in both education and health are crucial for sustaining agricultural productivity. Increases in both education and health expenditures significantly boost agricultural output, while reductions in these expenditures lead to declines in productivity. Mixed scenarios where one expenditure increases while the other decreases demonstrate the complex interplay between these factors and importance of their simultaneous enhancement to achieve optimal agricultural outcomes. According to previous, it is recommended:

I. To maximize agricultural productivity, the Cameroonian government and stakeholders should prioritize and increase investments in both education and health sectors. This dual approach will empower farmers with the necessary skills and ensure healthy workforce capable to implement modern agricultural practices effectively.

II. Agricultural policies should focus on promoting the efficient and sustainable use of fertilizers. Farmers should be educated to proper apply the fertilizers due to prevention of soil degradation and to ensure long-term productivity. Encouraging the use of organic fertilizers and integrated soil fertility management practices can also mitigate the negative effects associated with excessive fertilizers use.

III. Expanding arable land and optimizing its use through sustainable farming practices, such as crop rotation and conservation agriculture, should be encouraged. Effective land management strategies will contribute to higher agricultural yields and long-term sustainability.

IV. Given the significant role of labor in agricultural production, there should be initiatives aimed at developing agricultural labor force. This includes training

programs to improve labor skills and efforts to attract more workers into the agricultural sector, particularly in regions where mechanization is limited.

V. Policymakers should adopt a balanced approach to human capital development by ensuring that both education and health expenditures are simultaneously enhanced. This will prevent the negative effects seen in scenarios where one is increased at the expense of other, thereby sustaining and improving agricultural productivity in Cameroon.

In further research steps it could be essential to evaluate the sensitivity of input factors on agricultural production to support effective policy advocacy.

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