

**Impact of Human Development Indices on Agricultural Output in Nigeria**

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**Abstract.** The study examined the impact of human development indices on agricultural output in Nigeria between the periods of 1990 and 2021. Specifically, this research estimated the impact of gross national income per capita (GNI), life expectancy at birth (LEB), death rate (DRT), government expenditure on health (GEH) on the agricultural subsector's outputs proxied by the value of crop output (CRP), the value of livestock output (LIV), and the value of fisheries output (FIS). The times series data were sourced from the World Development Indicators, Central Bank of Nigeria (CBN) Statistical Bulletin, and the Human Development Report of the United Nations Development Programme. The study used Autoregressive distributed lag (ARDL) method in the estimation of the models. The result from the ARDL analysis disclosed that at 5 percent level, GNI, LEB, and GEH all significantly influenced agricultural outputs in Nigeria in the short run. DRT on the other hand, had significant effect on LIV alone in the short run. The long run result indicated that at 5 percent level while LEB and DRT significantly determined changes in the level of agricultural outputs in Nigeria, GNI and GEH only had long run influence on FIS under the evaluation period. The study however recommended that government's investment in human development should match that of physical development in Nigeria because indices of human development have been shown to have an impact on economic production.

**Keywords:** HDI, human development, agricultural outputs, human capital, economic growth and development, Nigeria

**Introduction**

Most African economies continue to be reliant on the food and agriculture sectors for their growth and development (Agbugba & Binaebi, 2018). Technology has advanced, but production is still quite low and falls short of expectations. Global Harvest Initiative (2014) in their research emphasized that by 2030, Sub-Saharan Africa will only be able to meet 8% of the world's food demand, in contrast to other regions. Given that it falls by about 50% of the estimated value in 2014, this is really concerning. This will consequently result in higher food costs, food imports, food assistance, and more deforestation for agricultural purposes. Poor rural families and landless households will bear the brunt of all these impacts (Ewala *et al.*, 2018). Nigeria's agriculture sector has experienced several setbacks over the years, which have led to a shortage of staple foods that can be produced on the country's soil in less than a year (Udemezue *et al.*, 2024), and a steady rise in food imports that has caused foreign exchange to

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be lost. For example, the third quarter of the 2010 fiscal year saw expenditures of \$1.23 billion on food imports (CBN, 2010; Isukul *et al.*, 2019). To prevent extreme hunger, which is characterized by poverty and a lack of sufficient nutrients, Adetiloye (2012) claims that the Nigerian agricultural system has numerous issues that need to be addressed immediately. According to the Federal Ministry of Agriculture and Rural Development (2008), their main agricultural practice is subsistence farming, which has a stagnating output and limited capacity for production.

Jacobsen *et al.* (2013) mentioned that there are several factors that contribute to the challenge of feeding the world's growing population despite increased food production. These include declining arable land, rising farm implement costs due to inflation, limited credit availability for farmers, competition for land between food and biofuel production, and rural-urban migration. By 2030, the UN wants to support sustainable agriculture, increase nutrition for all people, and ensure food security on all fronts. This has resulted in a vigorous and continuous discourse over the optimal methods for expediting the world's population expansion and augmenting food supply. To boost food production, a variety of initiatives have been put forth by governments and stakeholders at various levels (Oteh *et al.*, 2021). While some of these tactics focus on diversifying the agricultural sector, others place more emphasis on giving farmers more access to loans for agriculture to increase production (Osabohien *et al.*, 2020; Osabohien *et al.*, 2019). Put another way, efforts to increase agricultural output in Nigeria have focused primarily on agricultural finance, even though human development is essential to both the process of production and the overall economic growth of a society (Adelakun, 2011). Clearly, neither the government nor researchers have given adequate thought to the relationship between human development and agricultural production.

Human development is seen as both a necessary component of development and a driver of economic growth. Furthermore, human resource development is a key component in Nigeria's economic development. To encourage steady and sustained growth, the government should boost the amount of money given to the health and education sectors of the economy (Bloom *et al.*, 2004; Owolabi & Okwu, 2010). There are three major aspects of human development - living a long and healthy life, possessing knowledge, and enjoying a respectable standard of living are indicators of average performance of human development. If the human resources as farmers and members of the farming households are healthy, they continue or extend their performance on more cultivated areas. If the knowledge is wider for the farmers' they also can extend their agricultural performance for more areas accompanying with other agricultural branches. If the standard of living for farmers is satisfactorily good, their purchasing power parity increases, they will be able to buy or rent larger expanse of farm lands and cultivate more crops or raise more livestock (Shaqiri, 2019).

Healthier workers for example are intellectually and physically active, strong, and vibrant. Their health and education directly impact their productivity, making them more productive and well-off. In general, being ill puts a strain on a person (Cole & Neumayer, 2007) since it makes it difficult for them to fulfil scheduled obligations and affects them differently for each farm family member. For the leader of a home, for instance, it means less hours worked that could have been produced in addition to lower output. This has an impact on his anticipated benefits and those under him who depend on him for a steady source of food and income. For other family members involved in food production, this means fewer hours worked and lower output for those who can recover and continue producing (Ewala *et al.*, 2018). Health is a strategy for raising people's economic value and income levels because it is believed to be a form of human capital. In poor economies, the productivity of agricultural labour is adversely affected by poor health and low life expectancy. The reasons for the low production in the agricultural sector are related to the rise in diseases, the mortality of workers, and a lack of proper knowledge (World Bank, 2018; Anowor *et al.*, 2019).

Following the above narrative, it becomes necessary to investigate the nexus between Nigeria's agricultural output and human development indices. The main objective of this study is to examine the effect of human development indices on agricultural output in Nigeria from the period 1990 – 2021 and the specific objectives are to:

- i. determine the effect of human development indices on the value of crop output in Nigeria;
- ii. determine the effect of human development indices on the value of livestock output; and,
- iii. determine the effect of human development indices on the value of fisheries output.

## Literature Review

### The Keynesian Theory

The Keynesian theory served as the theoretical basis for this research. The fundamental tenet of the Keynesian theory is that full production can be attained by government intervention (Keynes, 1936). Keynes viewed public spending as an external variable that might be used to promote economic growth through policy. The government can promote economic growth, according to Keynesian thinking. For this reason, multiplier effects on aggregate demand suggest that higher government consumption will also likely result in higher investment, profitability, and employment. The government's expenditures thereby raise aggregate demand, which leads to higher output, contingent on expenditure multipliers (Agbugba and Nmegbu, 2021). Since prices are relatively fixed, changes in any aspect of government, business, or consumer spending will alter output. This is the view held by Keynesians. The production will rise, for instance, if government spending rises while all other spending components stay the same (Kareem et al., 2017).

The reason for the adoption of this theory is that it envisages the importance of government intervention in boosting productivity. Funding of education and health for example could increase economic productivity and enhance economic growth.

### Empirical Review

Using the Auto Regressive Distributed Lag (ARDL) Bounds Test method of co-integration, Leshoro and Leshoro (2013) investigated the effects of the literacy rate and human development indicators on agricultural productivity. The annual data on agricultural production, the HDI, and the literacy rate index were used in this study. To evaluate the impact of the HDI and literacy index on agricultural productivity, the ARDL approach to co-integration employing bounds tests was used. It was discovered that there was a long-term correlation between the variables—literacy rate, human development indicators, and agricultural productivity (agriculture GDP). The human development index showed a positive and significant short-term effect on agricultural output, whereas the literacy rate had a significant and positive long-term influence.

Olakunle (2021) examined how Nigerian human life expectancy was affected by agricultural output between 1981 and 2019. Using the autoregressive distributed lag estimator over an extended period, agricultural output, control variables (industrial output, interest rate, inflation rate, and currency rate), and life expectancy all sustained equilibrium conditions that kept them together. The results also showed that, at the 5% level, the long-term benefits of crop production, forestry, and fishing did not statistically significantly affect life expectancy. Furthermore, the life expectancy was negatively and negligibly impacted by cattle over time. Finally, neither agricultural activity nor its components strongly affected the estimated number of years that a person will live after birth.

In Yobe State, Nigeria, Okpachu et al. (2014) investigated the impact of adult education on the agricultural productivity of small-scale female maize farmers in the Potiskum Local

Government Area. Sixty female maize volunteers and sixty randomly chosen non-participants were subjected to standardized questionnaires as part of the research. Age, education, experience, and extension contacts were linked to output in a meaningful way, according to the regression analysis. The income and production of participants and non-participants differed statistically. The results of the study showed that education improves the agricultural productivity of female small-scale maize farmers in the studied area.

In the Kumba municipality in the Southwest area of Cameroon, the impact of farmers' health on agricultural performance was examined by Ewala *et al.* (2018). They aimed to evaluate the impact of bad health on agricultural productivity. Primary data gathered from farmers surveyed in the Kumba municipality is used in this study. To increase the data's dependability, a well-structured questionnaire is given orally to farmers to gather this information. Two-staged sampling is employed to choose 60 farmers at random. Using the conventional Ordinary Least Squares (OLS) method, they modelled the impact of illness on the productivity performance of agricultural households. The study found that while 95% of farmers reported both minor and severe yield losses, only 5% of farmers' harvests were unaffected by illness. The only farmers who were spared were those who either received medical care during their illness or became ill when there wasn't much or any labour to be done on the farm. Individuals exhibiting a notable decline in yields either did not obtain aid when unwell or missed numerous workdays because of illness. According to the corrected R<sup>2</sup> value of 0.785, changes in the independent variables account for 78.5% of the variation in farmers' production performance. According to the research, a crucial and advantageous factor influencing farm productivity is the health of the farmers.

Okidim *et al.* (2022) examined the effects of human development index on Ghana's agricultural output from 2000-2019. The method employed for analyzing the time series data was the Auto Regressive Distributed Lag (ARDL) model. All the variables were found to be stationary at first difference and at level. From the results of the Error correction model (ECM), a one-unit increase in education index of the Ghanaian population, brought about a 7.1-unit increase in agricultural output, while a 1-unit increase in life expectancy at birth brought about a 150-unit increase in agricultural output.

Health results and agricultural productivity in Nigeria were investigated by Anowor *et al.* (2019). A dynamic error correction model was applied in conjunction with multiple linear regression as the methodology used to estimate the structural parameters, which made use of secondary data. The econometric model constructed in this work uses dynamic error correction to treat HIV/AIDS as the dummy variable and agricultural output as the dependent variable, with death rate and life expectancy serving as proxy for health outcomes. The research results indicated that health outcomes had a major impact on Nigeria's capacity for agricultural output. It would seem from this that if the healthcare system of developing country like Nigeria is given national importance, then a significant development in the agriculture sector can be expected (Isukul *et al.*, 2020). The life expectancy coefficient (LEX) produced a positive parameter with a magnitude of 0.162133. This implied that there was a direct correlation between Nigeria's agricultural productivity and life span.

## Methodology

### Research Design/ Data Source

Quasi-experimental research design was employed in this research because the investigation relied on secondary data involving time series and dependent and independent. Further, the data for the study were obtained from the World Bank World Development Indicators, CBN Annual Statistical Bulletin (different issues), and the United Nations Development Programme (UNDP). The Annual time series data spanned from 1990 to 2021

within which the dependent variables were value of the crop output, value of livestock output, and the value of fisheries output while the independent variables consisted of gross national income per capita, life expectancy, and the control variables which were death rate and government expenditure on health.

### Model Specification

The study adopted the Auto-Regressive Distributed Lag (ARDL) econometrics regression technique (Uzah & Agbugba, 2022). The ARDL method of estimation was chosen primarily because the variables were stationarity at both the level and first difference. For ease of reference, the study refers to equations (1), (2), and (3) as the CRP model, LIV model, and FIS model, respectively as would be observed in the succeeding sections of this study.

The models associated with this study are presented in the implicit form as follows:

$$\text{CRP} = f(\text{GNI}, \text{LEB}, \text{DRT}, \text{GEH}) \quad (1)$$

$$\text{LIV} = f(\text{GNI}, \text{LEB}, \text{DRT}, \text{GEH}) \quad (2)$$

$$\text{FIS} = f(\text{GNI}, \text{LEB}, \text{DRT}, \text{GEH}) \quad (3)$$

**The linear form of the models is specified as follows:**

$$\text{CRP} = a_0 + a_1 \text{GNI} + a_2 \text{LEB} + a_3 \text{DRT} + a_4 \text{GEH} + \mu \quad (4)$$

$$\text{LIV} = b_0 + b_1 \text{GNI} + b_2 \text{LEB} + b_3 \text{DRT} + b_4 \text{GEH} + \mu \quad (5)$$

$$\text{FIS} = c_0 + c_1 \text{GNI} + c_2 \text{LEB} + c_3 \text{DRT} + c_4 \text{GEH} + \mu \quad (6)$$

**Formulating the Autoregressive Distributed Lag (ARDL) long-run model gives:**

$$\begin{aligned} \Delta(\text{CRP})_t &= a_0 + a_1(\text{CRP})_t + a_2(\text{GNI})_t + a_3(\text{LEB})_t + a_4(\text{DRT})_t + a_5(\text{GEH})_t + \\ &\sum_{i=1}^n \Delta a_1(\text{CRP})_{t-1} + \sum_{i=1}^n \Delta a_2(\text{GNI})_{t-1} + \sum_{i=1}^n \Delta a_3(\text{LEB})_{t-1} + \sum_{i=1}^n \Delta a_4(\text{DRT})_{t-1} \\ &+ \sum_{i=1}^n \Delta a_5(\text{GEH})_{t-1} + \mu_{1t} \end{aligned} \quad (7)$$

$$\begin{aligned} \Delta(\text{LIV})_t &= b_0 + b_1(\text{LIV})_t + b_2(\text{GNI})_t + b_3(\text{LEB})_t + b_4(\text{DRT})_t + b_5(\text{GEH})_t + \\ &\sum_{i=1}^n \Delta b_1(\text{LIV})_{t-1} + \sum_{i=1}^n \Delta b_2(\text{GNI})_{t-1} + \sum_{i=1}^n \Delta b_3(\text{LEB})_{t-1} + \sum_{i=1}^n \Delta b_4(\text{DRT})_{t-1} + \\ &\sum_{i=1}^n \Delta b_5(\text{GEH})_{t-1} + \mu_{2t} \end{aligned} \quad (8)$$

$$\begin{aligned} \Delta(\text{FIS})_t &= c_0 + c_1(\text{FIS})_t + c_2(\text{GNI})_t + c_3(\text{LEB})_t + c_4(\text{DRT})_t + c_5(\text{GEH})_t + \sum_{i=1}^n \Delta c_1(\text{FIS})_{t-1} + \\ &\sum_{i=1}^n \Delta c_2(\text{GNI})_{t-1} + \sum_{i=1}^n \Delta c_3(\text{LEB})_{t-1} + \sum_{i=1}^n \Delta c_4(\text{DRT})_{t-1} + \sum_{i=1}^n \Delta c_5(\text{GEH})_{t-1} + \mu_{3t} \end{aligned} \quad (9)$$

**While the short-run Error Correction Model derived from the ARDL model yields;**

$$\begin{aligned} \Delta(\text{CRP})_t &= \partial_0 + \partial_1(\text{CRP})_t + \partial_2(\text{GNI})_t + \partial_3(\text{LEB})_t + \partial_4(\text{DRT})_t + \partial_5(\text{GEH})_t + \sum_{i=1}^n \Delta \partial_1(\text{CRP})_{t-1} + \\ &\sum_{i=1}^n \Delta \partial_2(\text{GNI})_{t-1} + \sum_{i=1}^n \Delta \partial_3(\text{LEB})_{t-1} + \sum_{i=1}^n \Delta \partial_4(\text{DRT})_{t-1} + \\ &\sum_{i=1}^n \Delta \partial_5(\text{GEH})_{t-1} + \Pi \text{ECM} + \mu_{1t} \end{aligned} \quad (10)$$

$$\begin{aligned} \Delta(\text{LIV})_t &= \lambda_0 + \lambda_1(\text{LIV})_t + \lambda_2(\text{GNI})_t + \lambda_3(\text{LEB})_t + \lambda_4(\text{DRT})_t + \lambda_5(\text{GEH})_t + \sum_{i=1}^n \Delta b_1(\text{LIV})_{t-1} + \\ &\sum_{i=1}^n \Delta \lambda_2(\text{GNI})_{t-1} + \sum_{i=1}^n \Delta \lambda_3(\text{LEB})_{t-1} + \sum_{i=1}^n \Delta \lambda_4(\text{DRT})_{t-1} + \\ &\sum_{i=1}^n \Delta \lambda_5(\text{GEH})_{t-1} + \Pi \text{ECM} + \mu_{2t} \end{aligned} \quad (11)$$

$$\begin{aligned} \Delta(\text{FIS})_t &= \beta_0 + \beta_1(\text{FIS})_t + \beta_2(\text{GNI})_t + \beta_3(\text{LEB})_t + \beta_4(\text{DRT})_t + \beta_5(\text{GEH})_t + \sum_{i=1}^n \Delta b_1(\text{LIV})_{t-1} + \\ &\sum_{i=1}^n \Delta \beta_2(\text{GNI})_{t-1} + \sum_{i=1}^n \Delta \beta_3(\text{LEB})_{t-1} + \sum_{i=1}^n \Delta \beta_4(\text{DRT})_{t-1} + \\ &\sum_{i=1}^n \Delta \beta_5(\text{GEH})_{t-1} + \Pi \text{ECM} + \mu_{3t} \end{aligned} \quad (12)$$

Where CRP = value of crop output, LIV = value of livestock output, FIS = value of fisheries output, GNI = gross national income per capita, LEB = life expectancy at birth, DRT = death rate, GEH = government expenditure on health,  $a_0, b_0, c_0, \partial_0, \lambda_0, \beta_0$  = respective intercept of the models,  $a_1 - a_4; b_1 - b_4; c_1 - c_4$  = Slopes of the models respectively,  $a_1 - a_5; b_1 - b_5; c_1 - c_5$  = long-run dynamic coefficients,  $\partial_1 - \partial_5; \lambda_1 - \lambda_5; \beta_1 - \beta_5$  = short-run dynamic coefficients,  $\mu_{1t} - \mu_{3t}$  = disturbance or error term,  $\Delta$  = first difference operator,  $n$  = maximum lag length,  $\Pi$  = error correction coefficient, ECM = error correction term with one period lag, and  $f$  = Functional Notation.

**A priori Expectations:** Regarding the parameters that need to be estimated, the following are the a priori anticipated patterns of the independent variables' behaviours:

$\alpha_1 > 0$ ,  $\alpha_2 > 0$ ,  $\alpha_3 < 0$ , and  $\alpha_4 > 0$

$b_1 > 0$ ,  $b_2 > 0$ ,  $b_3 < 0$ , and  $b_4 > 0$

$c_1 > 0$ ,  $c_2 > 0$ ,  $c_3 < 0$ , and  $c_4 > 0$

## Results and Discussion

### Unit Root Test

The unit root test was conducted prior to model estimate due to its significance in uncovering the time series characteristics of the variables. The outcomes of the unit root testing are presented in Table 1.

**Table 1: Augmented Dickey Fuller (ADF) Unit Root Test Results**

| Variable | ADF Test Stat. | 5% Critical Value | P-value | Order of Integration | Test Option       | Remark                |
|----------|----------------|-------------------|---------|----------------------|-------------------|-----------------------|
| CRP      | -4.990156      | -3.568379         | 0.0019  | I(1)                 | Trend & Intercept | Integrated of order 1 |
| LIV      | -3.045938      | -2.963972         | 0.0420  | I(1)                 | Intercept         | Integrated of order 1 |
| FIS      | -4.395984      | -3.568379         | 0.0079  | I(0)                 | Trend & Intercept | Integrated of order 0 |
| GNI      | -3.532088      | -2.963972         | 0.0139  | I(1)                 | Intercept         | Integrated of order 1 |
| LEB      | -3.000799      | -2.963972         | 0.0462  | I(1)                 | Intercept         | Integrated of order 1 |
| DRT      | -2.632977      | -1.952473         | 0.0103  | I(0)                 | None              | Integrated of order 0 |
| GEH      | -4.270403      | -3.622033         | 0.0136  | I(1)                 | Trend & Intercept | Integrated of order 1 |

Source: Author's computation from Eviews software

Table 1 presents the results of the ADF unit root tests, which shows that FIS and DRT were stationary at level. This is because the values of their respective ADF statistic (-4.395984 and -2.632977) are more negative than their respective critical values (-3.568379 and -1.952473) at 5 percent level. This result suggests that the mean and variance of the series do not vary systematically over time. Other variables, such as CRP, LIV, GNI, LEB, and GEH were not stationary at level. However, after first differencing, they became stationary, indicating that they are integrated of order one.

### Cointegration Test

The study employed the ARDL bounds cointegration test approach and the result is presented in Table 2.

**Table 2: Bounds Cointegration Test Results for CRP, LIV, and FIS Models**

| Table 2: Bounds Cointegration Test Results for CRP, LIV, and FIS Models |          |             |      |              |
|-------------------------------------------------------------------------|----------|-------------|------|--------------|
| Series                                                                  | Value    | Bounds (5%) |      | Decision     |
|                                                                         |          | I0          | I1   |              |
| <b>CRP GNI LEB DRT GEH</b>                                              |          |             |      |              |
| F-Statistics                                                            | 4.479396 | 2.86        | 4.01 | Cointegrated |
| K                                                                       | 4        |             |      |              |
| <b>LIV GNI LEB DRT GEH</b>                                              |          |             |      |              |
| F-Statistics                                                            | 4.633581 | 2.86        | 4.01 | Cointegrated |
| K                                                                       | 4        |             |      |              |
| <b>FIS GNI LEB DRT GEH</b>                                              |          |             |      |              |
| F-Statistics                                                            | 5.178286 | 2.86        | 4.01 | Cointegrated |
| K                                                                       | 4        |             |      |              |

Note: K denotes number of explanatory variables

Source: Author's computation from Eviews software

The bounds cointegration test was performed at the 5 percent significance level using the F-statistic as a guide. The result of the CRP, LIV, and FIS models in Table 2 shows that the respective F-statistic values of 4.479396, 4.633581, and 5.178286 are greater than their common upper critical bound value of 4.01 respectively. This suggests that there is long run relationship between CRP, LIV, and FIS and the independent variables of the study.

### Model Estimation

The results of the ARDL estimation for the CRP, LIV, and FIS models of the study are presented in Table 3 - 5.

**Table 3: ARDL Long and Short Run of the CRP Model**

| <b>Dependent Variable: CRP</b> |             |            |             |        |
|--------------------------------|-------------|------------|-------------|--------|
| <b>Short run results</b>       |             |            |             |        |
| Variable                       | Coefficient | Std. Error | t-Statistic | Prob.  |
| C                              | 376626.2    | 68859.55   | 5.469484    | 0.0001 |
| D(CRP(-1))                     | 0.377014    | 0.161479   | 2.334758    | 0.0377 |
| D(CRP(-2))                     | 0.215591    | 0.137187   | 1.571514    | 0.1420 |
| D(GNI)                         | -0.447062   | 0.540640   | -0.826912   | 0.4244 |
| D(GNI(-1))                     | 0.581725    | 0.466787   | 1.246233    | 0.2365 |
| D(GNI(-2))                     | -1.632317   | 0.499481   | -3.268024   | 0.0067 |
| D(LEB)                         | -7567.179   | 1359.237   | -5.567226   | 0.0001 |
| D(LEB(-1))                     | -2512.267   | 656.3167   | -3.827828   | 0.0024 |
| D(LEB(-2))                     | -2170.694   | 624.9438   | -3.473424   | 0.0046 |
| D(GEH)                         | 1.803260    | 1.763494   | 1.022549    | 0.3267 |
| D(GEH(-1))                     | 10.16558    | 2.343103   | 4.338511    | 0.0010 |
| D(GEH(-2))                     | 6.362668    | 2.164365   | 2.939739    | 0.0124 |
| CointEq(-1)*                   | -1.116168   | 0.204252   | -5.464672   | 0.0001 |
| <b>Long run results</b>        |             |            |             |        |
| GNI                            | -1.080257   | 0.604501   | -1.787023   | 0.0992 |
| LEB                            | -3877.774   | 1387.517   | -2.794758   | 0.0162 |
| DRT                            | -8238.704   | 2029.393   | -4.059688   | 0.0016 |
| GEH                            | -9.735925   | 4.912864   | -1.981721   | 0.0709 |
| R-squared                      | 0.804423    |            |             |        |
| Adjusted R-squared             | 0.657740    |            |             |        |
| Prob(F-statistic)              | 0.001066    |            |             |        |
| Durbin-Watson stat             | 2.238925    |            |             |        |

Source: Author's computation from Eviews software

The short run result in Table 3 shows that in the current year and the previous year, GNI did not significantly influence growth in CRP at 5 percent level. However, GNI in two periods lag, significantly influenced changes in CRP in Nigeria. This is because, the probability value of 0.0067 in this lag period is less than 0.05. Further, the associated coefficient value of -1.632317, suggests that, for every 1 unit increase in GNI, CRP will fall by 1.632317. In another light, the long run result showed that at 5 percent level, GNI did not exert any significant influence on CRP. The result on LEB in both the long run and short run, witnessed a significant negative impact of LEB on CRP at 5 percent level. This result implies that the short-term and long-term changes in life expectancy at birth in Nigeria leads to a fall in the level of crop output. This result is not consistent with the a priori expectations. The explanation to this result is that because agriculture in Nigeria is less mechanized and is very labour intensive it requires more

energy and dedication to cultivate hectares of farmlands, thus it is expected that farmers' productivity falls as they get older; consequently, this affects agricultural performance in the economy. In the long run, DRT had a significantly negative impact on CRP as the probability value of 0.0016 fell below 0.05. This result agrees with the a priori expectations as increase in death rate is expected to lead to a decrease farmers population and a fall in crop output. Although, there was no evidence of significant impact of GEH on CRP in the long run, the short run result showed that the past values of GEH significantly determined growth in CRP. This is because in the first and second lag period, GEH yielded respective probability values of 0.0010 and 0.0124 less than 0.05.

Further, the result in Table 3 indicates that the coefficient of the error correction term labelled as CointEq(-1) is associated with a value of -1.116168 which is rightly signed and significant at 5 percent level. This result suggests that the deviation from the long run equilibrium is corrected annually at a speed of approximately 111.62 percent. In addition, the R-squared value of 0.804423 in the result indicates that about 80 percent of the variation in the CRP are explained by the variations in the independent variables. The probability value (0.001066) of the F-statistic indicates that the independent variables together had a significant impact on CRP.

**Table 4: ARDL Long and Short Run of the LIV Model**

| <b>Dependent Variable: LIV</b> |             |            |             |        |
|--------------------------------|-------------|------------|-------------|--------|
| <b>Short run results</b>       |             |            |             |        |
| Variable                       | Coefficient | Std. Error | t-Statistic | Prob.  |
| C                              | 18358.83    | 3357.434   | 5.468113    | 0.0001 |
| D(GNI)                         | 0.036094    | 0.017929   | 2.013205    | 0.0637 |
| D(GNI(-1))                     | 0.063214    | 0.016021   | 3.945672    | 0.0015 |
| D(LEB)                         | 150.3614    | 90.51495   | 1.661178    | 0.1189 |
| D(LEB(-1))                     | -35.83429   | 15.65723   | -2.288673   | 0.0382 |
| D(LEB(-2))                     | -35.14230   | 16.73979   | -2.099327   | 0.0544 |
| D(DRT)                         | 332.3577    | 138.1956   | 2.404980    | 0.0306 |
| D(GEH)                         | -0.054986   | 0.062874   | -0.874546   | 0.3966 |
| D(GEH(-1))                     | -0.083116   | 0.077048   | -1.078765   | 0.2989 |
| D(GEH(-2))                     | 0.130407    | 0.068302   | 1.909268    | 0.0769 |
| CointEq(-1)*                   | -0.271068   | 0.049666   | -5.457775   | 0.0001 |
| <b>Long run results</b>        |             |            |             |        |
| GNI                            | 0.044573    | 0.080913   | 0.550875    | 0.5904 |
| LEB                            | -920.3817   | 428.2405   | -2.149217   | 0.0496 |
| DRT                            | -1346.646   | 588.3972   | -2.288668   | 0.0382 |
| GEH                            | -1.031596   | 0.840416   | -1.227482   | 0.2399 |
| R-squared                      | 0.855243    |            |             |        |
| Adjusted R-squared             | 0.774823    |            |             |        |
| Prob(F-statistic)              | 0.000011    |            |             |        |
| Durbin-Watson stat             | 1.903418    |            |             |        |

Source: Author's computation from Eviews software

Table 4 indicates that both in the long run and short run, GNI had a positive relationship with LIV. However, at 5 percent level the only moment of significant impact in the interaction between GNI and LIV from the result was recorded in the second lag period. The coefficient (0.063214) of GNI in this period suggests that for every 1 unit increase in GNI, LIV will increase by 0.063214. Further, in the first lag period of the short run and in the long run, LEB had a significant negative impact on LIV. This result suggests that past changes in LEB one

year ago and its long-term changes significantly reduce the level of LIV in Nigeria. This result agrees with the findings of Sede and Ohemeng (2015) who submitted that life expectancy impacts economic growth. In another development, DRT in the short run and long run significantly influenced growth in LIV at 5 percent level within the evaluation period. However, there was no evidence that GEH significantly influence LIV in both the long run and in the short run at 5 percent level. The interpretation of this result is that government expenditure on health in Nigeria is inadequate both in the short term and long term to have any meaningful impact on the performance of the livestock sub-sector in Nigeria.

The model was found to have a good fit with an R-squared value of 0.855243. This demonstrates that variations in the independent variables explained approximately 86 percent of the variation in LIV. The probability value of the F-statistic of 0.000011 indicates that the independent variables have a joint significant influence on the dependent variable at 5 percent level. Additionally, at 5 percent level, the coefficient (-0.271068) of the error correction term is statistically significant and appropriately signed, indicating that the adjustment to long run equilibrium occurs at a speed of 27 percent annually.

**Table 5: ARDL Long and Short Run of the FIS Model**

| <b>Dependent Variable: FIS</b> |             |            |             |        |
|--------------------------------|-------------|------------|-------------|--------|
| <b>Short run results</b>       |             |            |             |        |
| Variable                       | Coefficient | Std. Error | t-Statistic | Prob.  |
| C                              | 6652.004    | 1132.463   | 5.873926    | 0.0001 |
| D(FIS(-1))                     | 0.343304    | 0.133492   | 2.571725    | 0.0245 |
| D(FIS(-2))                     | -0.222450   | 0.093459   | -2.380194   | 0.0348 |
| D(GNI)                         | 0.043248    | 0.006689   | 6.465804    | 0.0000 |
| D(GNI(-1))                     | -0.011656   | 0.005284   | -2.205825   | 0.0476 |
| D(LEB)                         | -70.25838   | 34.31133   | -2.047673   | 0.0631 |
| D(LEB(-1))                     | 101.3371    | 43.81878   | 2.312639    | 0.0393 |
| D(LEB(-2))                     | 18.14801    | 4.417931   | 4.107808    | 0.0015 |
| D(DRT)                         | -112.4367   | 54.17868   | -2.075295   | 0.0601 |
| D(DRT(-1))                     | 118.4042    | 64.53695   | 1.834673    | 0.0915 |
| D(GEH)                         | 0.077860    | 0.018819   | 4.137377    | 0.0014 |
| D(GEH(-1))                     | -0.095894   | 0.026776   | -3.581270   | 0.0038 |
| CointEq(-1)*                   | -0.475852   | 0.080989   | -5.875535   | 0.0001 |
| <b>Long run results</b>        |             |            |             |        |
| GNI                            | 0.103180    | 0.024572   | 4.199137    | 0.0012 |
| LEB                            | -208.2473   | 46.22562   | -4.505019   | 0.0007 |
| DRT                            | -249.3896   | 56.70968   | -4.397654   | 0.0009 |
| GEH                            | 0.391664    | 0.101435   | 3.861229    | 0.0023 |
| R-squared                      | 0.931396    |            |             |        |
| Adjusted R-squared             | 0.879943    |            |             |        |
| Prob(F-statistic)              | 0.000000    |            |             |        |
| Durbin-Watson stat             | 2.451509    |            |             |        |

Source: Author's computation from Eviews software

The result in Table 5 shows that at 5 percent level GNI significantly influence changes in FIS in Nigeria. Specifically, in the current period and the long run there is evidence of significant positive impact of GNI on FIS; the probability values in the said periods of 0.0000 and 0.0012 respectively are less than 0.05. This result aligns with the a priori expectations. However, GNI in one period lag had a negative on FIS within the sample period, thus

emphasises the importance of past economic developments in determining current economic outlook. In the short run, LEB had a significant negative impact on FIS in the first lag and second lag periods at 5 percent level. The corresponding coefficient values of 101.3371 and 18.14801 in these periods suggest that for every 1 unit increase in life expectancy, fishery output will increase by 101.3371 unit and 18.14801 unit respectively. Uzah and Agbugba (2023) made a similar observation in their study.

The long run coefficient value of -208.2473 suggests the existence of a negative relationship between LEB and FIS. At 5 percent level, the relationship was significant which suggests that increase in LEB leads to a fall in FIS in the long run. Further, in the short run, there was no evidence of significant impact of DRT on FIS at 5 percent, however, in the long run evidence of significant negative impact was witness on FIS. This result suggests that while short run changes in DRT is inadequate in influencing growth in FIS, the long-term increase in DRT on the other leads to a fall in FIS. This result conforms with the a priori expectations. The interpretation is that increase in Nigeria's death rate will affect the population of fish farmers in Nigeria which could lead to a decline in the performance of the fisheries sub-sector in Nigeria.

In the short run GEH had a mixed effect on FIS at 5 percent level. This can be attributed to the fluctuations in government expenditure which results in inconsistent outcomes. However, in the long run, GEH had a coefficient value of 0.391664 and a probability value of 0.0023 less than 0.05. This result implies that for every 1 unit increase in GEH, FIS will increase by 0.391664 unit. This result underscores the importance of government spending on public goods in the health sector. In a nutshell government expenditure on health affect the health of agricultural practitioners such that the healthier the farmer, the better his productivity.

The coefficient (-0.475852) of the error correction term is significant at 5 percent level; this indicates that the long-run equilibrium position can be reached by the model at a speed of 48 percent approximately. In addition, the probability value (0.000000) of the F-statistic is significant at 5 percent and it indicates that the independent variables jointly influence the dependent variable. The R-squared value of 0.931396 implies that 93 percent of the changes in FIS are explained by changes in the independent variables. Thus, this result indicates that the model is a good fit.

### Post-estimation Tests

The post-estimation testing mostly focused on the residual's diagnostics tests. The results are shown in Table 6.

**Table 6: Post-estimation Tests Results for CRP, LIV, and FIS Models**

| CROP OUTPUT MODEL                                    |               |          |                      |        |
|------------------------------------------------------|---------------|----------|----------------------|--------|
| <b>Breusch-Godfrey serial correlation LM test</b>    | F-statistic   | 0.855239 | Prob. F(2,10)        | 0.4541 |
|                                                      | Obs*R-squared | 4.235852 | Prob. Chi-Square(2)  | 0.1203 |
| <b>Breusch-Pagan-Godfrey Heteroskedasticity test</b> | F-statistic   | 1.380298 | Prob. F(16,12)       | 0.2896 |
|                                                      | Obs*R-squared | 18.79016 | Prob. Chi-Square(16) | 0.2797 |
| <b>Ramsey RESET</b>                                  | t-statistic   | 0.817993 | Prob. Value          | 0.4307 |
|                                                      | F-statistic   | 0.669112 | Prob. Value          | 0.4307 |
| LIVESTOCK OUTPUT MODEL                               |               |          |                      |        |
| <b>Breusch-Godfrey serial correlation LM test</b>    | F-statistic   | 0.028105 | Prob. F(2,12)        | 0.9723 |
|                                                      | Obs*R-squared | 0.135209 | Prob. Chi-Square(2)  | 0.9346 |

|                                                      |               |          |                      |        |
|------------------------------------------------------|---------------|----------|----------------------|--------|
| <b>Breusch-Pagan-Godfrey Heteroskedasticity test</b> |               |          |                      |        |
|                                                      | F-statistic   | 0.607791 | Prob. F(14,14)       | 0.8187 |
|                                                      | Obs*R-squared | 10.96283 | Prob. Chi-Square(14) | 0.6890 |
| <b>Ramsey RESET</b>                                  |               |          |                      |        |
|                                                      | t-statistic   | 1.575409 | Prob. Value          | 0.1392 |
|                                                      | F-statistic   | 2.481913 | Prob. Value          | 0.1392 |
| <b>FISHERIES OUTPUT MODEL</b>                        |               |          |                      |        |
| <b>Breusch-Godfrey serial correlation LM test</b>    |               |          |                      |        |
|                                                      | F-statistic   | 0.913166 | Prob. F(2,10)        | 0.4323 |
|                                                      | Obs*R-squared | 4.478451 | Prob. Chi-Square(2)  | 0.1065 |
| <b>Breusch-Pagan-Godfrey Heteroskedasticity test</b> |               |          |                      |        |
|                                                      | F-statistic   | 0.983984 | Prob. F(16,12)       | 0.5221 |
|                                                      | Obs*R-squared | 16.45663 | Prob. Chi-Square(16) | 0.4216 |
| <b>Ramsey RESET</b>                                  |               |          |                      |        |
|                                                      | t-statistic   | 1.143983 | Prob. Value          | 0.2769 |
|                                                      | F-statistic   | 1.308696 | Prob. Value          | 0.2769 |

Source: Author's computation from Eviews software

Table 6 shows the results of the Breusch-Godfrey serial correlation LM, heteroskedasticity tests, and Ramsey RESET test. It shows that at 5 percent, the models are free from the problem of serial correlation. This is because the probability values of their respective Obs\*R-squared is greater than 0.05. Similarly, the models did not exhibit evidence of heteroscedasticity because, the probability values of their respective Obs\*R-squared are greater than 0.05. Further, the respective probability values of the F-statistic of the CRP, LIV, and FIS are less than 0.05. Therefore, it implies that these models are well specified.

## Conclusion and Recommendations

### Conclusion

The study investigated the impact of human development indices on agricultural output in Nigeria from the period of 1990 to 2021. Using ARDL estimation method, the study came with empirical findings from which the following conclusions are drawn: GNI and LEB in the short run significantly reduce CRP while increase in GEH significantly increases CRP. The study also showed that in the long run, LEB, DRT, and GEH raise the level of CRP in Nigeria. More so, growth in LIV in the short run is positively influenced by GNI but negatively influenced by LEB. The study also disclosed that while DRT reduces LIV in the short run, GEH significantly increases LIV in Nigeria. The study found that in the long run, LIV was influenced by changes in LEB and DRT respectively. Further empirical evidence from the study showed that GNI and GEH have mixed significant impact on FIS in the short run. However, LEB significantly increased FIS in the short run. In addition, GNI and GEH have been found to increase FIS in the long run; in contrast though, LEB and DRT leads to a fall in FIS.

### Recommendations

The findings of this empirical investigation serve as the foundation for the following recommendations:

- Government's investment in human development should match that of physical development in Nigeria because indices of human development have been shown to have an impact on economic production.
- Government funding of the health sector should be expedited to achieve appropriate and efficient service delivery.

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