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# Environmentally sustainable socio-economic welfare and agricultural employment: evidence from ECOWAS

**C.H. Umehruo[1], O.A. Owolabi[1,2,3], B. Aderounmu[1,2,4], M.O. Rotimi[1], E.S. Osabuohien[1,2,5]**

[1]Department of Economics and Development Studies, Covenant University, Ota, Ogun State, Nigeria.
[2]Centre for Economic Policy and Development Research (CEPDeR), Covenant University, Ota, Ogun State, Nigeria.
[3]ORCID: 0000-0002-9996-3821, [4]ORCID: 0000-0002-8652-394X, [5]ORCID: 0000-0002-3258-8326,

Corresponding email: oluwarotimi.owolabi@covenantuniversity.edu.ng

**Abstract**. Environmental sustainability considerations in socio-economic welfare has been argued in recent welfare literature. With an emphasis on the role of agricultural employment, this present study explores environmentally sustainable socio-economic welfare in ECOWAS, which features countries abundant in agriculture resources, although with low levels of socio-economic welfare and low carbon emissions. The study utilises a balanced panel data set of observations in respect of all fifteen ECOWAS countries over the period of 2010 to 2019. The Human Sustainable Development Index (HSDI) was used to measure environmentally sustainable socio-economic welfare. On the other hand, agricultural employment was measured using the percentage of the employed population earning their livelihoods from agricultural employment. Panel data fixed effects estimation was used to estimate the model for the study, and the findings were that agricultural employment had a significant adverse influence on environmentally sustainable socio-economic welfare as measured by HSDI, while a further comparison of the findings with that of welfare measured using HDI indicated that agricultural employment also adversely affected HDI. The study recommends that socio-economic welfare be assessed from the view point of environmental sustainability, and the governments of ECOWAS member countries provide strong governance including strong laws and policies to ensure that socio-economic welfare that is environmentally sustainable is realised as abundant agricultural resources as well as agricultural employment are well managed.

**Keywords**: Agricultural employment, ECOWAS, Environmentally Sustainable Socio-economic welfare, HSDI, HDI, Panel data fixed effects estimation, Sub-Saharan Africa,

## 1. Introduction

Environmentally sustainable socio-economic welfare referred to an improvement in standards of living taking into consideration the cost to the planet (as measured by carbon emissions) of the development paths of countries and the apparent implications of such a path to humanity's future development, is of importance if countries are to achieve sustainable development [1].

This contrasts with the more popular socio-economic welfare, which excludes considerations regarding environmental sustainability and consequently neglects the interests of future generations unborn in an enabling environment for promoting higher levels of socio-economic welfare. However, while many factors may contribute to sustainable socio-economic welfare, the contribution of agricultural employment is of paramount significance [2-3].

Agricultural employment's significance for welfare stems from agriculture providing the bulk of employment for most African countries as highlighted by [4], and the resulting abundance of food that may result from greater agricultural employment in the presence of abundant agriculture resources as in the Economic Community of West African States (ECOWAS) member countries. The agriculture sector in Africa stands as one of the most significant sources of foreign exchange, still accounting for about 40 percent of the continent's hard currency earnings, and is the primary generator of savings and tax revenues [4]. Further, the agricultural sector adds value to the domestic economy via its linkage with other major sectors such as the manufacturing sector, to which it provides raw materials as input. In addition, in respect to providing food for Africa's vast population and contributing to food security, agriculture as a valuable occupation cannot be over-emphasised.

Agriculture as a productive activity relates to sustainable socio-economic welfare in diverse ways: environment quality, nutrition, health, education, income, and so on. For instance, the incomes of rural dwellers may be boosted where agriculture is well developed as the rural dwellers derive a sizeable share of their income from agricultural employment. In relation, socio-economic welfare indicators as nutrition, health, education may be boosted, while environmental sustainability may be encouraged as rural incomes rise high enough to enable rural dwellers to afford clean energy, and hence they cease from cutting of trees for firewood and hence this results in a decline in potential carbon emissions in the atmosphere.

ECOWAS, as an essential regional economic community, features countries with sizeable agriculture growth potential such as abundant labour as in Nigeria, a large expanse of fertile land and a conducive climate for agriculture as in Nigeria, Cote D'Ivoire and Ghana. Other ECOWAS member countries, in light of their limited agricultural outputs, can likewise potentially contribute to the potential sizeable agricultural output of ECOWAS and to that effect, High levels of sustainable socio-economic welfare are realisable in ECOWAS, although at present levels of socio-economic development are low in addition to carbon emissions, thus culminating in low sustainable socio-economic welfare on the average as measured by the Human Sustainable Development Index (HSDI). However, there are variations across ECOWAS countries regarding levels of agricultural employment and sustainable socio-economic welfare, which makes it unclear the extent to which agriculture through agricultural employment may boost sustainable socio-economic welfare in ECOWAS.

Limited literature has explored agriculture and socio-economic welfare [5-10]. However, while agriculture has not been examined from the perspective of agricultural employment, welfare has not been assessed from the perspective of sustainability, taking into account the contribution of carbon emissions in socio-economic welfare pursuit as countries progress in their development. On the other hand, agricultural employment is a broad assessment of the contribution of agriculture as agricultural employment can give rise to both employment and

output for the improvement of the environment and improving socio-economic welfare. Further welfare as measured by either Human Development Index (HDI) (referred to as socio-economic welfare) or GDP per capita (referred to as economic welfare) and which is more popular as a welfare concept in the literature, has its shortcomings. For instance, HDI, while combining income, health and education into one index do not take into account carbon emissions and hence environmental sustainability, thus overstating welfare. On the other hand, GDP per capita neglects the distributional aspect of income and other essential aspects of welfare such as health, education, quality of life, and adverse effects of economic activity on society.

Hence this present study explores ECOWAS for the contribution of agricultural employment to environmentally sustainable socio-economic welfare over the period of 2010 to 2019. Environmentally Sustainable Socio-economic welfare in this study is measured using the Human Sustainable Development Index (HSDI) derived from the Human Development Index of the UNDP, which is a highly recognised index. The HSDI by design is an improvement on the HDI and takes into account in its computation the carbon footprint of countries as they proceed on their path to development. In particular, four indices compose the HSDI, namely Carbon emissions, Income, Health and Education which combined together are reflected in the HSDI as an environmentally sustainable socio-economic welfare indicator. This present study, in particular, tests the hypotheses that agricultural employment contributes significantly to environmentally sustainable socio-economic welfare in ECOWAS and the hypothesis that agricultural employment affects all selected welfare indicators – HSDI and HDI for ECOWAS member countries.

In developing this study, section 2 discusses relevant literature, while the methodology and theoretical framework are presented in section 3. Results and discussion are presented in section 4, while in section 5, the study is concluded and recommendations made.

## 2. Literature Review

There exists a dearth of research linking agriculture to improvements in social and economic indicators related to welfare- Economic growth, GDP per capita, poverty, Human Development Index, Human sustainable development index, especially over the past decade. Despite the evidence, for less developed countries, particularly sub-Saharan African (SSA) countries, embracing agriculture as the primary occupation remains central for raising living standards [11]. Concerning economic growth, [12] found in Nigeria that cheap food imports, as a result of declining agricultural output, undermines local production leading to increased poverty, while [13] suggest that farmers in Nigeria be incentivised. Infrastructural facilities should be provided in supporting agriculture to boost economic growth in Nigeria in light of the sizeable contribution of agriculture to the GDP growth of Nigeria. Consistent with the aforementioned, [10] argues that welfare improvements may result from improved agriculture productivity.

Poverty as a further welfare indicator has been related to agriculture. [14], investigating the welfare effects of improved maize technology based on survey data in Buruku Local Government Area of Benue State, Nigeria, found that the adoption of improved maize varieties is positively and significantly related to household welfare and thus has contributed

to moving farm households out of poverty. This is consistent with [6] findings that adoptingbiofortified cassava by smallholder farmers in Nigeria based on a cross-sectional study increased farm yield, farmers' income, and welfare outcomes of adopters of biofortified cassava. However, the finding as regards the potential for agriculture to reduce poverty contrasts with that of [15], who find in the Free State Province of South Africa using a Computable General Equilibrium (CGE) approach that considering poverty, the agriculture sector is not the major sector that increases income relative to other sectors, although agriculture reduces poverty and improves income distribution. The finding was explained by more households relying on agriculture relative to other sectors of the economy. In relation, smallholder irrigation, as highlighted by [16], may reduce rural poverty in KwaZulu-Natal, South Africa, and government policies and interventions aimed at improving agricultural productivity may raise household welfare [11], [17].

GDP per capita [18-19] and Human Development Index [20] are popular alternative measures of welfare, with both having criticism. [21] argue Index of Sustainable Economic Welfare (ISEW) is the best alternative to GDP as a measure of Social Welfare or Progress relative to three other indices, including Genuine Progress Indicator (GPI), based on corrections of GDP, sustainable or green(ed) GDP, genuine savings/investments and composite indexes. The justification of ISEW is based on it being a clear improvement over GDP. However, [1] highlights the Human Sustainable Development Index (HSDI) as an amendment to the United Nations' Human Development Index (HDI) by adding an environmental dimension and suggest that it has been largely ignored as a measure of welfare.

The need to consider the role of climate via agriculture and consistent with the need for welfare that factors in social costs appear to have given rise to a limited number of studies relating climate to welfare via agriculture. [7], using a dynamic computable general equilibrium model in Ethiopia, find that CO2 emissions negatively affect agricultural productivity and household welfare. Also, [22] find a similar adverse effect of carbon emissions on agricultural output. Further, [23] find higher amounts of rainfall and moderate temperatures to be significant drivers of improved welfare for agricultural workers in northern Ghana based on survey data. The boost to agriculture productivity of climate-smart agriculture on account of essential opportunities provided for enhancing food security and incomes was further argued by [5] to raise the welfare of farmers in Zimbabwe, while in the Nyando Basin of Kenya, through household income, climate-smart agriculture was found by [24] to boost asset accumulation of smallholder farmers.

## 3. Methodology

This study employs secondary data on all fifteen ECOWAS member countries from 2010 to 2019 to test the study's hypotheses. The choice of ECOWAS as the sample countries of this study is based on the region featuring diversity in term of agriculture resource endowments of ECOWAS member countries and the level of environmentally sustainable socio-economic welfare as measured by HSDI. The ECOWAS region is arguably the most endowed in terms of agriculture resources in sub-Saharan Africa, while also having the highest concentration of SSA's population and hence need for improved welfare levels of residents of ECOWAS member countries.

The study is founded on Armatya Sen's theory of welfare, in which welfare is viewed to result as individuals' capabilities are improved. Improvements in the welfare of individuals may be appreciated where the functionings of individuals in society are enhanced. Therefore, in relation of agricultural employment to environmentally sustainable socio-economic welfare in this present study, as individuals engage in agricultural employment which ensures a livelihood for individuals, the employment results in earnings which can be used to address their socio-economic welfare needs like education, health care, security and so on. In addition, rural dwellers particularly, can reduce reliance on burning of wood and hence achieve greater sustainability which will give rise to improved environmentally sustainable socio-economic welfare.

This present study adapts the model of [25] in specifying its model for achieving its objectives as in equation (1) with HSDI measuring Environmentally Sustainable Socio-economic Welfare

HSDI =*f*(EMPAG, EMPIND, LFPR, GFCF, POPDENS, MILEXGDP, INFL RLAW) (1)

Equation (1) is specified as an econometric model in respect of the models estimated for this study as in Equations (2) and (3).

**Determination of Environmentally Sustainable Socio-economic Welfare for ECOWAS**

The econometric specification of equation (1) is presented in equation (2)

$$\mathrm{HSDI}_{it} = \alpha_0 + \alpha_1 \mathrm{EMPAG}_{it} + \alpha_2 \mathrm{EMPIND}_{it} + \alpha_3 \mathrm{LFPR}_{it} + \alpha_4 \mathrm{Log\,GFCF}_{it} + \alpha_5 \mathrm{POPDENS}_{it} + \alpha_6 \mathrm{MILEXGDP}_{it} + \alpha_7 \mathrm{INFL}_{it} + \alpha_8 \mathrm{RLAW}_{it} + \varepsilon_t \quad (2)$$

Where, HSDI: Human Sustainable Development Index (a proxy for environmentally sustainable socio-economic welfare), EMPAG: Agricultural employment, EMPIND: Industrial employment, LFPR: Labour Force Participation Rate, GFCF: Gross Fixed Capital Formation, POPDENS: Population Density, MILEXGDP: Military expenditure as a share of GDP, INFL: Inflation, RLAW: Rule of Law, ε: error term, $\alpha_0 \ldots \alpha_8$: parameters of the model, i: 1-15, t = 2010-2019.

**Determination of Selected Alternative Measures of Welfare for ECOWAS**

Replacing HSDI in equation (2) regarding sampled countries with HDI, which in contrast to HSDI reflect only socio-economic welfare, equation (3) results.

$$\mathrm{HDI}_{it} = \beta_0 + \beta_1 \mathrm{EMPAG}_{it} + \beta_2 \mathrm{EMPIND}_{it} + \beta_3 \mathrm{LFPR}_{it} + \beta_4 \mathrm{Log\,GFCF}_{it} + \beta_5 \mathrm{POPDENS}_{it} + \beta_6 \mathrm{MILEXGDP}_{it} + \beta_7 \mathrm{INFL}_{it} + \beta_8 \mathrm{RLAW}_{it} + \varepsilon_t \quad (3)$$

HDI: Human Development Index, EMPAG: Agricultural employment, EMPIND: Industrial employment, LFPR: Labour Force Participation Rate, GFCF: Gross Fixed Capital Formation, POPDENS: Population Density, MILEXGDP: Military expenditure as a share of GDP, INFL: Inflation, RLAW: Rule of Law, ε: error term, $\beta_0 \ldots \beta_8$: parameters of the model, i: 1-15, t = 2010-2019,

HSDI was computed for this study based on HDI sourced from the United Nations Development Programme (UNDP) and like the HDI on account of its similarity in computation to the HDI ranges from zero (lowest level of sustainable socio-economic welfare) to One (highest level of sustainable socio-economic welfare). Data on agricultural employment (in percentage), Industrial employment (in percentage), Labour Force Participation Rate (in percentage),Gross fixed capital formation (in Billions of US Dollars), Population Density (in people per square kilometre of land area), Military expenditure as a share of GDP (in percentage) and Inflation rate (in percentage) were respectively sourced from the World Bank World Development Indicators (WDI). Data on Rule of Law (in decimals) was sourced from the World Bank World Governance Indicators (WGI).

HSDI in equation (2) is computed following Bravo (2014) incorporating in its computation per capita carbon ($CO_2$) emissions measured in mega tons, and by so doing differs from the HDI computation as in equation (3). In addition, the main variable of interest as regards equations (2) and (3) is Agricultural employment, while all other independent variables are control variables. The variable, GFCF, is log-transformed in the above equations to standardise the variable in line with standard econometric practice. Panel data fixed effects estimation was employed to estimate equations (2) and (3) based on the significant chi-square statistic obtained following the Hausman test.

## 4. Results

The summary statistics of variables used for this present study are as in Table 1, highlighting that while all variables exhibit some variation, there is heterogeneity in the levels of variation across the variables.

**Table 1: Summary Statistics of Variables**

| Variables | Observations | Mean | Std. Dev | Min | Max |
|---|---|---|---|---|---|
| **HSDI [In decimal figures]** | 150 | 0.579 | 0.0620 | 0.436 | 0.733 |
| **HDI [In decimal figures]** | 150 | 0.485 | 0.0702 | 0.331 | 0.665 |
| **EMPAG[%}** | 150 | 45.45 | 16.10 | 10.6 | 75.14 |
| **EMPIND[%}** | 150 | 13.18 | 6.060 | 5.42 | 31.55 |
| **LFPR[%}** | 150 | 65.04 | 8.205 | 47.11 | 81 |
| **GFCF [In Billions of Dollars]** | 150 | 7.86 | 18.8 | 0.066 | 114 |
| **POPDENS [people per Sq. Km of land area]** | 150 | 91.13 | 55.84 | 12.33 | 225.31 |
| **MILEXGDP[%}** | 150 | 1.289 | 0.736 | 0.381 | 3.305 |
| **INFL[%}** | 150 | 4.815 | 5.572 | -3.233 | 23.563 |
| **RLAW [In decimal figures]** | 150 | -0.642 | 0.487 | -1.586 | 0.635 |

The mean value of HSDI of 0.579, which is comparatively higher than the mean HDI of 0.485, reflects on average that ECOWAS features countries with low carbon emissions per capita. By design, both HSDI and HDI range from zero, which is the lowest level of welfare, to one, which is the highest level of welfare, as highlighted by [26]

The results of fixed effects panel data estimation in respect of HSDI and HDI and based on significant Hausman test results (significant chi-square statistic of 48.42 for equation (2) and

42.01 for equation (3)) are presented in Table 2. The diagnostics reveal that estimation results determining HSDI and HDI are absent of misspecification error based on the significant Wald statistics of the models. The models also feature high goodness of fit of approximately 0.90. Thus, interpreting the regression estimates, both equations (2) and (3) reveal that Agricultural employment has a negative and statistically significant effect on welfare- both environmentally sustainable socio-economic welfare (measured by HSDI) and Socio-economic welfare (measured by HDI).

**Table 2: Fixed Effect Panel Data Estimates for Determination of HSDI and HDI**

| **Dependent Variable** | **HSDI** | **HDI** |
|---|---|---|
| C | 0.949*** | 0.868*** |
| | (0.0535) | (0.0578) |
| EMPAG | -0.00248*** | -0.00276*** |
| | (0.000254) | (0.000275) |
| EMPIND | -0.00362*** | -0.00393*** |
| | (0.000459) | (0.000496) |
| LFPR | -0.00447*** | -0.00465*** |
| | (0.000389) | (0.000420) |
| Log GFCF | 0.00189 | 0.00239 |
| | (0.00170) | (0.00184) |
| POPDENS | 0.000577*** | 0.000655*** |
| | (0.0000825) | (0.0000891)_ |
| MILEXGDP | -0.00215 | -0.00260 |
| | (0.00140) | (0.00151) |
| INFL | -0.000454*** | -0.000511*** |
| | (0.000139) | (0.00015) |
| RLAW | 0.0111*** | 0.0130*** |
| | (0.00427) | (0.00461) |
| **R-Square** | **0.9030** | **0.9072** |
| **F-Stat** | **147.72*** ** | **155.18*** ** |
| **No. of Countries** | **15** | **15** |
| **Observations** | **150** | **150** |

Standard errors are shown in parenthesis. ** and *** denote significance at the 5 and 1% levels, respectively.

In respect of HSDI, Agricultural employment in agriculture has a significant coefficient of -0.00248, indicating that Agricultural employment is important in determining HSDI, while a one percent rise in Agricultural employment gives rise to a decline in environmentally sustainable socio-economic welfare by 0.00248. On the other hand, in respect of HDI, Agricultural employment has a significant coefficient of -0.00276, indicating that Agricultural employment is important in determining HDI, while a one percent rise in Agricultural employment gives rise to a decline in socio-economic welfare by 0.00276. Hence the difference in the contribution of Agricultural employment to HSDI and HDI is only marginal at 0.0028. In other words, the overstatement of welfare using HDI rather than HSDI results in a marginal overstatement of the effect of Agricultural employmenton true welfare that is environmentally sustainable. Further, except for Log GFCF, which is insignificant, and

population density and rule of law, significant for both HSDI and HDI, all other variables are negative and significantly affect HSDI and HDI, respectively.

## 5. Conclusion and Recommendations

This study assessed the contribution of agricultural employment to environmentally sustainable socio-economic welfare in ECOWAS over the period of 2010 to 2019, based on evidence from panel data fixed effects regression estimation. Environmentally sustainable socio-economic welfare as measured by HSDI and socio-economic welfare as measured by HDI were both found to be negatively and significantly influenced by agricultural employment amongst other variables such as industrial employment, labour force participation rate, and inflation, while population density and rule of law significantly boosted environmentally sustainable socio-economic welfare. This study concludes that greater agricultural employment is unable to translate to greater welfare even where vastly improved welfare measures as HSDI and HDI are used in the analysis, while the overstatement of welfare using HDI may explain the marginally greater decline in HDI resulting from agricultural employment relative to HSDI.

This study recommends that firstly, to promote improved welfare in ECOWAS, countries should necessarily focus on environmentally sustainable socio-economic welfare as measured by HSDI given its broader considerations regarding welfare, especially that of carbon emissions that are affected as countries develop. This is further of importance as the achievement of environmentally sustainable socio-economic welfare is consistent with a global focus on countries achievement of sustainable development. Secondly, the government of ECOWAS member countries should provide strong governance including strong laws and policies to ensure that socio-economic welfare that is environmentally sustainable is realised as abundant agricultural resources as well as agricultural employment are well managed.

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## REFERENCES

[1]. Bravo, G. (2014). The Human Sustainable Development Index: New calculations and a first critical analysis. Ecological indicators, 37, 145-150.
[2]. Egbetokun, S., Osabuohien, E., Onanuga, O., Akinbobola, T., Gershon, O. and Okafor, V. (2020). Environmental Pollution, Economic Growth and Institutional Quality: Exploring the Nexus in Nigeria. Management of Environmental Quality,31 (1), 18-31.
[3]. Osabuohien, E., Oduntan, E., Gershon, O., Onanuga, O. and Ola-David, O. (2021). Handbook of Research on Institutions Development for Sustainable and Inclusive Development in Africa. Hershey, PA: IGI Global.
[4]. NEPAD. (2012). Underpinning Investments in African Agriculture and trade-related Capacities for improved Market Access: A Continental Vision. (Online). Accessed 31 July 2021 < http://www.fao.org/3/y6831e/y6831e-02.htm>

[5]. Mujeyi, A., Mudhara, M., and Mutenje, M. (2021). The impact of climate smart agriculture on household welfare in smallholder integrated crop–livestock farming systems: evidence from Zimbabwe. Agriculture & Food Security, 10(1), 1-15.
[6]. Kolapo, A., and Kolapo, A. J. (2021). Welfare and productivity impact of adoption of biofortified cassava by smallholder farmers in Nigeria. Cogent Food & Agriculture, 7(1),
[7]. Eshete, Z. S., Mulatu, D. W., andGatiso, T. G. (2020). CO2 emissions, agricultural productivity and welfare in Ethiopia. International Journal of Climate Change Strategies and Management, 12(5), 687-704.
[8]. Darko, F. A., Palacios-Lopez, A., Kilic, T., and Ricker-Gilbert, J. (2018). Micro-level welfare impacts of agricultural productivity: Evidence from rural Malawi. The Journal of Development Studies, 54(5), 915-932.
[9]. Abdulai, A. N. (2016). Impact of conservation agriculture technology on household welfare in Zambia. Agricultural economics, 47(6), 729-741.
[10]. Dzanku, F. M. (2015). Household welfare effects of agricultural productivity: A multidimensional perspective from Ghana. The Journal of Development Studies, 51(9), 1139-1154.
[11]. Kilimani, N.,Nnyanzi, J. B., Okumu, I. M., andBbaale, E. (2020). Agricultural Productivity and Household Welfare in Uganda: Examining the Relevance of Agricultural Improvement Interventions. In The Palgrave Handbook of Agricultural and Rural Development in Africa (pp. 153-174). Palgrave Macmillan, Cham.
[12]. Omorogiuwa, O.,Zivkovic, J., andAdemoh, F. (2014). The role of agriculture in the economic development of Nigeria. European Scientific Journal, 10(4), 133 – 147.
[13]. Adenomon, M. O., andOyejola, B. A. (2013). Impact of Agriculture and Industrialization on GDP in Nigeria: Evidence from VAR and SVAR Models. International Journal of Analysis and Applications, 1(1), 40-78.
[14]. Audu, V. I., and Aye, G. C. (2014). The effects of improved maize technology on household welfare in Buruku, Benue State, Nigeria. Cogent Economics & Finance, 2(1), 960592.
[15]. Bahta, Y. T., Willemse, B. J., and Grove, B. (2014). The role of agriculture in welfare, income distribution and economic development of the Free State Province of South Africa: A CGE approach. Agrekon, 53(1), 46-74.
[16]. Sinyolo, S., Mudhara, M., and Wale, E. (2014). The impact of smallholder irrigation on household welfare: The case of Tugela Ferry irrigation scheme in KwaZulu-Natal, South Africa. Water SA, 40(1), 145-156.
[17]. Biru, W. D., Zeller, M., and Loos, T. K. (2020). The impact of agricultural technologies on poverty and vulnerability of smallholders in Ethiopia: a panel data analysis. Social Indicators Research, 147(2), 517-544.
[18]. Kamasa, K., Amponsah B. D., andForson, P. (2020). Do Crude Oil Price Changes Affect Economic Welfare? Empirical Evidence from Ghana. Ghana Mining Journal, 20(1), 51-58.
[19]. Awokuse, T. O., andXie, R. (2015). Does agriculture really matter for economic growth in developing countries? Canadian Journal of Agricultural Economics/Revue canadienned'agroeconomie, 63(1), 77-99.
[20]. Jin, H., Qian, X., Chin, T., and Zhang, H. (2020). A global assessment of sustainable development based on modification of the human development index via the entropy method. Sustainability, 12(8), 3251.
[21]. Van den Bergh, J., andAntal, M. (2014). Evaluating alternatives to GDP as measures of social welfare/progress (No. 56). WWWforEurope Working Paper.
[22]. Matthew, O., Owolabi, O. A., Osabohien, R., Urhie, E. S., Ogunbiyi, A. T., Olawande, T. I., Edafe O.D, and Daramola, P. J., (2020). Carbon emissions, agricultural output and life expectancy in West Africa. International Journal of Energy Economics and Policy, 10(3), 489-496.

[23]. Nkegbe, P. K., andKuunibe, N. (2014). Climate variability and household welfare in northern Ghana (No. 2014/027). WIDER Working Paper.
[24]. Ogada, M. J., Rao, E. J., Radeny, M., Recha, J. W., and Solomon, D. (2020). Climate-smart agriculture, household income and asset accumulation among smallholder farmers in the Nyando basin of Kenya. World Development Perspectives, 18, 100203.
[25]. Gomanee, K., Morrissey, O., Mosley, P., andVerschoor, A. (2005). Aid, government expenditure, and aggregate welfare. World Development, 33(3), 355-370.
[26]. Todaro, M. P., and Smith, S. C. (2011). Economic Development 11. Addison-Wesley, Pearson,