

Research Article

Investigating Annual Household Food Budget Shares in Ghana: A Micro-Level Empirical Update

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Abstract

This study examines Ghana's annual household food expenditures and their Engel food curve using the latest data from the 2017-2018 seventh round of the Ghana Living Standards Survey, which covered 14,009 household and lasted for one-year. Household demographics and specific variables influencing annual household food budget decisions in Ghana were examined, including income, household size, educational status of household head, household location, and household connectivity to electricity. The study establishes an inverse relationship between the share of the household food budget and the increase in household income, and a high annual household food expenditure elasticity with 0.49 pesewas out of every one cedi serving as annual household marginal food budget share in Ghana, on average and *ceteris paribus*. The study provides additional evidence that characterizes food as a necessity in Ghana and placed the country in the medium food insecurity zone. Economic development in Ghana means achieving food security at all times, which calls on the country to redouble its efforts to meet Goal 2 and the AU Agenda 2063 household food security targets.

Keywords

Ghana, Household, Food Budget Share, Engel Food Curve, Food Security

1. Introduction

Food insecurity and malnutrition are considered by many analysts and policymakers to be important and widespread problems in developing countries, especially in sub-Saharan Africa (SSA). For instance, [5, 18] identified conflict, climate variability and extremes, and economic slowdowns and downturns as affecting affordable food demand and worsening SSA countries' effort in ensuring affordable household food security, as 282 million people representing, 21.0 percent of the population in Africa are facing moderate to severe food insecurity [11, 18]. The Government of Ghana since the country's independence in 1957, in its economic develop-

mental drive, have focused much attention on the need to produce and ensure affordable food so that Ghanaians do not expend so much of their incomes on food, which is a characteristic of a developing economy. To achieve this, various policies and interventions aimed at increasing the supply of food for household consumption are implemented through its agency, the Ministry Food and Agriculture. Despite such remarkable progress, food insecurity remains a huge challenge for Ghanaian families, [11, 19, 21].

Using the international forecasting system, the AU Agenda

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2063, predicts that the proportion of malnourished Africans will fall from about 17 percent in 2015 to about 12 percent in 2025. With only a few years left to achieve the AU Agenda 2063 goal, it is necessary to examine Ghanaian household budgets to food needs many years after the seminal work of [16], which examined the link between income and expenditure of German households for food, at a time when the COVID-19 pandemic is still on-going. This study aims to examine empirical estimates of the of household annual food budgets in Ghana, to obtain the monthly Engel food coefficient and curve, marginal food budget share, and the food expenditure elasticity and how these estimates affect household food consumption behaviour in Ghana. These estimates are expected to provide useful insights into many aspects of household food demand with policy implications based on existing up-to-date national household data, as Ghana's economic development drive has pushed households to source their food demand from the open market rather than their gardens and farmyards.

The analyses of household food budget shares and expenditure investigations in developing countries, [1, 2, 4, 6-11, 13, 15] particularly Ghana, is a relatively new field of study. This study adds to the very few existing studies [12, 14, 31, 17,

19, 23, 24, 27-29] on household food budget share and expenditure analyses in developing countries.

The structure of the paper is predetermined. The next section deals with the empirical modelling and data source, followed by the penultimate empirical results and analysis section. A final section provides the conclusion and study implications.

2. Empirical Modelling and Data

This section presents the empirical model for the study and the data, including definitions of the variables used and their summary statistics.

2.1. Description and Summary Statistics of Variables

The descriptions and summary statistics of demographic and specific household variables used for the study are presented in Table 1.

Table 1. Definitions and summary statistics of demographic and household specific variables used.

Variable	Description	Mean	SD	Min	Max	Obs.
AEXP	Household _i total annual real expenditure in cedis	10766.32	10409.83	86	228002	14,009
TEf	Household _i total annual food expenditure	4929.637	4116.254	15	86968	14,009
LnAEXP	Natural logarithm of AEXP in Cedis	8.957633	0.8349301	4.4	12.33	14,009
AFBS	Annual household _i food budget share in cedis	0.5086182	0.1721784	0.011	1.021	14,009
$\bar{m}$	Sample mean of AFBS	0.5086182	-	-	-	14,009
Sexhh	Male household _i head	7.969948	4.31338	0	1	14,009
Sizehh	Household _i size	7.969948	4.31338	1	15	14,009
agehh	Household _i head age	46.24056	15.91205			14,009
marhh	Married household _i head	0.5510029	0.4974097	0	1	14,009
rurhh	Household _i is in the rural area	0.570419	0.495034	0	1	14,009
Educ	Annual household _i total expenditure on education	1246	3303.899	0	141000	14,009
tert	Household head has a tertiary education qualification	0.0381184	0.191	0	1	14,009
elec	Annual household _i total expenditure on electricity	282	394	0	8000	14,009

2.2. Empirical Model

The study defines the value of total annual food consumption expenditure for a particular household as TEf_i , and its annual total real expenditure as $AEXP_i$.

Then it identifies that household food budget share ($AFBS_i$)

which is used as the dependent variable as:

$$AFBS_i = \frac{TEf_i}{AEXP_i}$$

The [25, 38] model is used to define a linear OLS frame-

work to estimate the proportion and expenditure of a sample

household annual food budget as:

$$AFBS_i = \alpha_0 + \beta_1 \text{LnAEXP}_i + \beta_2 \text{Sexhh}_i + \beta_3 \text{Sizehh}_i + \beta_4 \text{agehh}_i + \beta_5 \text{marhh}_i + \beta_6 \text{rurhh}_i + \beta_7 \text{Educ}_i + \beta_8 \text{tert}_i + \beta_9 \text{elec}_i + U_i$$

where $i = 1, \dots, 14,009$. (1)

The model has an error term with a zero mean, represented by U_i .

The household_i marginal food budget share estimate at the sampled mean value is estimated by the study as:

$$\frac{\delta \text{TEf}_i}{\delta \text{AEXP}_i} = \hat{\beta}_1 + \frac{1}{m}, \text{ ceteris paribus.} \quad (2)$$

And the study estimates household_i food expenditure elasticity at the sampled mean as:

$$\phi_i = \frac{\hat{\beta}_1}{\bar{m}} + 1, \text{ ceteris paribus.} \quad (3)$$

The $\hat{\beta}_1$ is an estimated parameter. The sampling variance for the household food expenditure elasticity as estimated in eqn. (3) is derived as:

$$\text{Var}(\hat{\phi}_i) = \left(\frac{1}{\bar{m}} \right)^2 \text{var}(\hat{\beta}_1) \quad (4)$$

The study test what type of a good food is in Ghana as:

$$H_0: \phi_i = 1$$

$$H_a: \phi_i < 1$$

In line with the established literature on the share of household budgets devoted to food spending, [4, 12, 30], for low-income economies, this study used total annual real household spending as a proxy for real household total annual income recorded. Cross-sectional data from living standards surveys in developing countries are characterized by potential heteroscedasticity, mainly due to difficulties in retrospective recall, fading of some respondents' memories, and misunderstanding of a survey item, among others [4, 30]. White heteroscedasticity consistent standard errors robust estimates [37] using STATA is implemented to deal with potential heteroscedasticity inherent in the data set, [4].

2.3. Empirical Model Expectations

Some theoretical considerations influencing annual

household food budget decisions in Ghana are explored to guide the empirical model estimated in this study. These socioeconomic variables are characteristics of the household in developing economies, [8, 22, 30]. In light of the foregoing, demographic and household specific variables are examined which, when applied in a Ghanaian context, can potentially impact annual household budget and food spending based on data availability.

Household income is an important determinant affecting household budget and food spending in the literature [8, 12, 16, 30]. Expectations are that as household income increases, the household budget's annual allocation to food spending will decrease, as in the case of Engels' Law, and that $\delta AFBS_i / \delta \text{LnAEXP}_i < 0$, *ceteris paribus*.

In a patriarchal society in Ghana, male householders are expected to spend more on food for their household. The expectations are that as the number of male households increases, the annual household budget allocation for food spending will increase, and that $\delta AFBS_i / \delta \text{Sexhh}_i > 0$, *ceteris paribus*. Family size is expected to have a greater impact on household food spending. The expectations are that as the family size increases, the annual household budget allocation for food spending will increase, and that $\delta AFBS_i / \delta \text{Sizehh}_i > 0$, *ceteris paribus*. The age of the head of household has a positive impact on the annual household food budget [8, 30]. Expectations are that as heads of household grow in age, and to ensure good health in old age, the annual budget allocation for food spending will increase, and $\delta AFBS_i / \delta \text{agehh}_i > 0$, *ceteris paribus* in Ghana. Married heads of household in Ghana are very concerned about the allocation and expenditure of their family food budget and it is plausible that they have an increasing share and expenditure of the family food budget throughout the year. Therefore, expectations are that as more married householders increase, their annual household budget allocation to food spending will increase, and that $\delta AFBS_i / \delta \text{marhh}_i > 0$, *ceteris paribus*.

Rural households would spend more on food expenses than urban households due to the practice in Ghana, where all produce is transported to the urban centres for sale, leaving little food at exorbitant prices in the rural areas. It is plausible that such rural households would be willing to have a positive share of the family's annual budget for food spending. The expectations are that, $\delta AFBS_i / \delta \text{rurhh}_i > 0$, *ceteris paribus*. Educated households would have acquired skills in food preservation and conservation, and therefore would have fewer food budget allocations and expenditures per year. The

expectations are that, $\delta AFBS_i / \delta Educ_i < 0$, *ceteris paribus*.

Tertiary educated household heads happen to live in a smaller nuclear family in Ghana and therefore have fewer budget allocations and spending on food each year. The expectations are that, $\delta AFBS_i / \delta tert_i < 0$, *ceteris paribus*.

Households connected to the power supply from the national grid can preserve all kinds of food, using modern equipment and food preservation equipment to store all kinds of food all year round. Such households do not have to increase their share of the food budget and their spending every year. The expectations are that, $\delta AFBS_i / \delta elect_i < 0$, *ceteris paribus*.

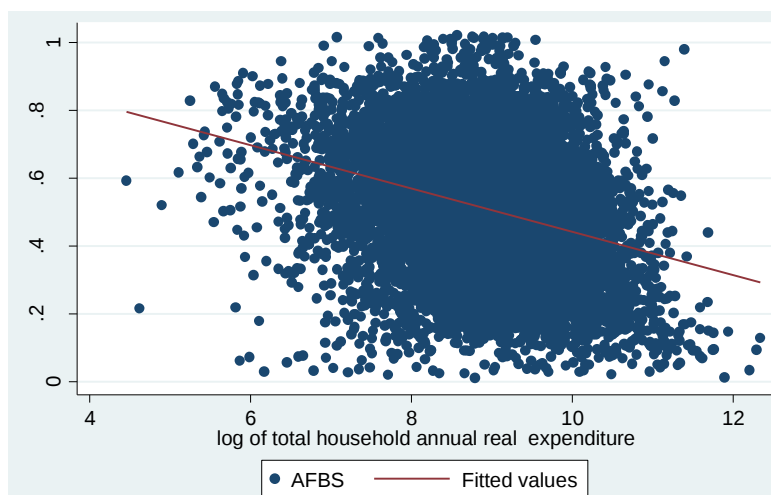
2.4. Data

The most recent data available [20], was used with permission in this study. The data is a national household survey

covering a 12-calendar month survey period with financial and technical support from the Government of Ghana and the World Bank. It contained a lot of detailed household information in Ghana. Therefore, it was considered to be of high quality and nationally representative based on a sample size of 14,009 households from 10 regions in Ghana during the 12-month data collection period.

3. Empirical Results

To derive the household Engel food curve, the relationship between the annual household food share and the natural logarithm of the annual total household real expenditure is plotted, [26]. The curve has a negative slope and corresponds to [30] findings for Rwanda and [8] findings for Ghana. The household Engel food curve is shown in Figure 1.



Source: Graphed from the GLSS VII data

Figure 1. Ghana households food Engel curve plotted from the GLSS VII data.

OLS estimates

The estimates of [25, 38] OLS linear model annual household food budget share and expenditure is reported in Table 2.

Table 2. OLS estimates of annual household food budget expenditure.

Variable	OLS estimate	Variable	OLS estimate
LnAEXP	-0.0166*** (-3.72)	Sizehh	0.000501 (1.67)
Sexhh	0.00242 (0.74)	agehh	0.00108*** (12.19)
		marhh	-0.0252*** (-7.96)
		rurhh	0.0290*** (8.76)
		Educ	-0.0000117*** (-5.17)

Variable	OLS estimate
elec	-0.0000682*** (-8.78)
tert	-0.0773*** (-11.35)

Source: Author's estimation from STATA based on GLSS VII data-base. t statistics in parentheses.

*** denotes statistical significance at the 1 percent level

Specific household and demographic characteristics lead to a significant impact on the household's share of the food budget and spending decisions. The estimated coefficients of head of household age, educated household, household with electricity, tertiary-educated head of household, rural household variables are all significant at the 1 percent level and have the expected signs, and are similar to the results of [30]. Estimates for the age variable of the head of household are similar to those found in [8]. The OLS-estimated coefficients for male head of household, household size variables have the expected sign but are not statistically significant.

The estimated LnAEXP coefficient ($\hat{\beta}_1$) is the response of the annual proportion of the household budget devoted to food relative to the logarithm of total annual household expenditure. It shows that a 10 percent increase in annual household spending in Ghana reduces the share of the household budget allocated to food by 0.0167 of one percentage point, on average, *ceteris paribus*.

This study tested the estimated impact of the LnAEXP coefficient on the effectiveness of the Engels food law in Ghana. The Engels Food Law states that as household income increases, the household budget for food decreases. The Engels food law test in Ghana is as follows:

$$H_0: \beta_1 = 0$$

$$T_{14,002} = \frac{-0.0166 - 0}{-3.72} = 0.0045 \quad (5)$$

Since the critical value of 1.645 rejects the null hypothesis, it statistically confirms the existence of the Engels food law in Ghana. The annual marginal share of the household budget for food, estimated at the sample mean, is derived as follows:

$$\frac{\partial AFBS_i}{\partial AEXP_i} = \hat{\beta}_1 + \frac{-}{m} = -0.0166 + 0.51 = 0.49. \quad (6)$$

This shows that a one cedi increase in annual household spending results in an increase in annual food spending by 0.49 pesewas on average, *ceteris paribus*. The annual

household food expenditure elasticity is estimated as

$$\varphi_i = \frac{\hat{\beta}_1}{\frac{-}{m}} + 1 = \frac{-0.0166}{0.51} + 1 = 0.967 \quad (7)$$

It is estimated that, other things being equal, a 10 percent increase in household expenditure per annum increases Ghana's household food needs by an average of 9.7 percent per annum.

The study derives the sampling variance for the annual household food expenditure elasticity estimated in (7) to test if food being a necessary good in Ghana is plausible.

The statistical test conducted is:

$$H_0: \varphi_i = 1$$

$$H_a: \varphi_i < 1$$

$$\begin{aligned} \text{Var}(\hat{\varphi}_i) &= \left(\frac{1}{\frac{-}{m}} \right)^2 \text{var}(\hat{\beta}_1) \\ &= \left(\frac{1}{0.51} \right)^2 \times 0.0678 = 0.26. \quad (8) \end{aligned}$$

In this case, the null hypothesis is rejected, showing that food is a necessity in Ghana. This fact confirmed the findings of [8] that classified about 97 percent of the food groups in Ghana as necessary goods. [3] also argues that food is usually a necessity in developing economies.

4. Conclusions and Study Implications

Using the national representative GLSS VII data, this study estimates the relationship of the Engel food curve, which has received particular attention in examining the household budget-food preference allocation for the economy of Ghana. The results of this paper are consistent with [4, 8, 30] studies that have found an inverse relationship between the proportion of household budget devoted to food and increasing household income. The study also found high annual spending elasticity in household spending on food, as found in other developing countries by [8, 30]. This study provides additional statistical evidence characterizing food as a necessity in Ghana.

With 0.49 pesewas of each cedi serving as an annual marginal portion of the household food budget in Ghana, Ghana falls on average and all other things being equal in the [35] medium food insecurity category.

They suggested that in an economy, households that spend between 50 percent and 65 percent of total annual house-

hold expenditure on food place that economy in a medium food insecurity zone.

As a policy recommendation, more pro-poor agro-based interventions aimed at improving food production in the country through the central government's use of the latest agro-based technology in production are recommended. The construction of modern silos to store and preserve food during harvest time and thereby reduce post-harvest losses and to provide the population with this stored food during lean seasons is recommended. In view of the rapid population growth, these measures would turn Ghana's economy into a food state and enable the country to achieve the food security it had set itself. Meaningful economic development in Ghana means achieving food security at all times [30-34], which calls on the country to redouble its efforts to meet [36], SDG Goal 2 and the AU Agenda 2063 household food security targets.

Abbreviations

FAO	Food and Agriculture Organization
SDG	Sustainable Development Goals
SSA	Sub - Saharan Africa
GLSS VII	The Seventh Ghana Living Standards Survey

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Isaac Addai is the sole author, who read and approved the final manuscript.

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Data Availability Statement

Data is available at a request to the Ghana Statistical Service.

Conflicts of Interest

The author has disclosed no potential conflicts of interest related to the research data, authorship and/or publication of this article.

References

- [1] Abdulai, A. (2003). Economies of scale and the demand for food in Switzerland: Parametric and non-parametric analysis. *Journal of Agricultural Economics*, 54(2), 247–267. <https://doi.org/10.1111/j.1477-9552.2003.tb00062.x>
- [2] Abdulai, A., & Aubert, D. (2004). Nonparametric and parametric analysis of calorie consumption in Tanzania. *Food Policy*, 29(2), 113–129. <https://doi.org/10.1016/j.foodpol.2004.02.002>
- [3] Abdulai, A., & Kuhlitz, C. (2011). Food security policy in developing countries. *The Oxford Handbook of the Economics of Food Consumption and Policy*, 343–369. <https://doi.org/10.1093/oxfordhb/9780199569441.013.0014>
- [4] Addai, I. (2024). A Micro-Level Empirical Analysis of Annual Household Food Budget Shares in Ghana. *Social Science Research Network Electronic Journal*, Elsevier. <http://dx.doi.org/10.2139/ssrn.4717448>
- [5] African Union, 2013. 50th anniversary solemn declaration. 50th Anniversary Solemn Declaration. Available from: <https://au.int/en/documents/20130613/50th-anniversary-solemn-declaration-2013> (Accessed 15 Apr 2021).
- [6] Akparibo, R., Aryeetey, R. N., Asamane, E. A., Osei-Kwasi, H. A., Ioannou, E., Infield Solar, G., Cormie, V., Pereko, K. K., Amagloh, F. K., Caton, S. J., & Cecil, J. E. (2021). Food security in Ghanaian urban cities: A scoping review of the literature. *Nutrients*, 13(10), 3615. <https://doi.org/10.3390/nu13103615>
- [7] Annim, S. K., & Frempong, R. B. (2018). Effects of access to credit and income on dietary diversity in Ghana. *Food Security*, 10(6), 1649–1663. <https://doi.org/10.1007/s12571-018-0862-8>
- [8] Ansah, I. G., Marfo, E., & Donkoh, S. A. (2020). Food demand characteristics in Ghana: An application of the quadratic almost ideal demand systems. *Scientific African*, 8. <https://doi.org/10.1016/j.sciaf.2020.e00293>
- [9] Antwi, K. D., & Lyford, C. P. (2022). Socioeconomic determinants of rural households' food security status in northern Ghana. *Journal of Agriculture and Food Sciences*, 19(2), 86–94. <https://doi.org/10.4314/jafs.v19i2.9>
- [10] Aykac, G. (2018). Testing the Engel law for Turkey and income elasticity of food demand: Relationship of budget share of food expenditure with household profile and total expenditure (2003-2013). *Sosyoekonomi*, 105–133. <https://doi.org/10.17233/sosyoekonomi.2018.04.07>
- [11] Boero V., Cafiero, C., Gheri F., Kepple A. W., Rosero Moncayo J., Viviani S. (2021). Results of twenty national surveys using the Food Insecurity Experience Scale (FIES). <https://doi.org/10.4060/cb5623en>
- [12] Deaton, A. (2019). Introduction. *The Analysis of Household Surveys (Reissue Edition with a New Preface): A Microeconomic Approach to Development Policy*, 1–6. https://doi.org/10.1596/978-1-4648-1331-3_intro
- [13] Devereux, S., & Maxwell, S. (2001). Introduction: Food security in Sub-Saharan Africa. *Food Security in Sub-Saharan Africa*, 1–12. <https://doi.org/10.3362/9781780440170.001>
- [14] Ecker O., Fang P. (2016). Achieving A Nutrition Revolution For Africa: The Road to Healthier Diets and Optimal Nutrition. Economic Development and Nutrition Transition in Ghana: Taking Stock of Food Consumption Patterns and Trends, Regional Strategic Analysis and Knowledge Support System, Facilitated by IFPRI, Annual Trends and Outlook Report. Report number: <http://ebrary.ifpri.org/cdm/ref/collection/p15738coll2/id/130756>

- [15] Ecker, O. (2018). Agricultural Transformation and Food and Nutrition Security in Ghana: Does farm production diversity (still) matter for household dietary diversity? *Food Policy*, 79, 271–282. <https://doi.org/10.1016/j.foodpol.2018.08.002>
- [16] Engel, J., & Kneip, A. (1996). Recent approaches to estimating Engel Curves. *Journal of Economics*, 63(2), 187–212. <https://doi.org/10.1007/bf01258672>
- [17] Essilfie, G., Sebu, J., Annim, S. K., & Asmah, E. E. (2020). Women's empowerment and household food security in Ghana. *International Journal of Social Economics*, 48(2), 279–296. <https://doi.org/10.1108/ijse-05-2020-0328>
- [18] FAO (2021). *Document card Food and Agriculture Organization of the United Nations*. Available from: <https://doi.org/10.4060/cb5623en>
- [19] Frempong, R. B., & Annim, S. K. (2017). Dietary diversity and child malnutrition in Ghana. *Heliyon*, 3(5). <https://doi.org/10.1016/j.heliyon.2017.e00298>
- [20] Ghana Statistical Service (2018): Ghana Living Standards Survey Round Seven Report. Accra, Ghana.
- [21] Ghana Statistical Service (2021). Population and Housing Census General Report Highlights. Volume 3. Accra, Ghana.
- [22] Grosh, M. E., & Glewwe, P. (1998). Data Watch: The World Bank's living standards measurement study household surveys. *Journal of Economic Perspectives*, 12(1), 187–196. <https://doi.org/10.1257/jep.12.1.187>
- [23] Jaiyeola, A., Ado, G. & Bayat, A. (2020). Assessing the health, education, food and None Food Expenditure in Nigeria: Evidence from Engel Curve Analysis of Household's expenditure in Nigeria”, <http://doi.org/10.31124/advance.12971666.v1>.
- [24] KC, K. B., Legwegoh, A. F., Therien, A., Fraser, E. D. G., & Antwi-Agyei, P. (2017). Food price, food security and dietary diversity: A comparative study of urban Cameroon and Ghana. *Journal of International Development*, 30(1), 42–60. <https://doi.org/10.1002/jid.3291>
- [25] Leser, C. E. (1963). Forms of Engel functions. *Econometrica*, 31(4), 694. <https://doi.org/10.2307/1909167>
- [26] Lewbel A. (2008). Engel Curves in S. N. Durlauf and L. E. Blume (Eds.), *The New Palgrave Dictionary of Economics*, Second Edition (London, New York, Palgrave Macmillan).
- [27] Maxwell, D. (1999). The political economy of urban food security in Sub-Saharan africa. *World Development*, 27(11), 1939–1953. [https://doi.org/10.1016/s0305-750x\(99\)00101-1](https://doi.org/10.1016/s0305-750x(99)00101-1)
- [28] Maxwell, S. (2001). The evolution of thinking about food security. *Food Security in Sub-Saharan Africa*, 13–31. <https://doi.org/10.3362/9781780440170.002>
- [29] Melo P C, Abdul-Salam Y, Roberts D, Gilbert A, Matthews R, Colen L, Mary S, Paloma SGY (2015) Income elasticities of food demand in Africa: a meta-analysis. Technical report. Institute for Prospective and Technological Studies, Joint Research.
- [30] Nsabimana, A., Bali Swain, R., Surry, Y., & Ngabitsinze, J. C. (2020). Income and food engle curves in Rwanda: A household microdata analysis. *Agricultural and Food Economics*, 8(1). <https://doi.org/10.1186/s40100-020-00154-4>
- [31] Omari, R., Frempong, G. K., & Arthur, W. (2018). Public perceptions and worry about food safety hazards and risks in Ghana. *Food Control*, 93, 76–82. <https://doi.org/10.1016/j.foodcont.2018.05.026>
- [32] Osei-Kwasi, H. A., Laar, A., Zotor, F., Pradeilles, R., Aryeetey, R., Green, M., Griffiths, P., Akparibo, R., Wanjohi, M. N., Rousham, E., Barnes, A., Booth, A., Mensah, K., Asiki, G., Kimani-Murage, E., Bricas, N., & Holdsworth, M. (2021). The African Urban Food Environment Framework for creating Healthy Nutrition Policy and Interventions in Urban Africa. *PLOS ONE*, 16(4). <https://doi.org/10.1371/journal.pone.0249621>
- [33] Otsuka, K. (2015). How promising is the Rice Green Revolution in Sub-Saharan Africa? evidence from case studies in Mozambique, Tanzania, Uganda, and Ghana, *World Food Policy*, Vol. 2 No. 1, <https://doi.org/10.18278/wfp.2.1.3>
- [34] Setsoafia, E. D., Ma, W., & Renwick, A. (2022). Effects of sustainable agricultural practices on farm income and food security in northern Ghana. *Agricultural and Food Economics*, 10(1). <https://doi.org/10.1186/s40100-022-00216-9>
- [35] Smith, L. C., & Ali, Subandoro, A. (2007). Measuring food security using household expenditure surveys. *Scribd*. Available from: <https://www.scribd.com/document/423748725/Measuring-Food-Security-Using-Household-Expenditure-Surveys-Smith-et-al> (Accessed 27 Feb 2020).
- [36] United Nations (2015). Transforming our world: The 2030 agenda for sustainable Available from: <https://digitallibrary.un.org/record/3923923> (Accessed 1 Apr 2017).
- [37] White, H. (1980). A heteroskedasticity-consistent covariance matrix estimator and a direct test for heteroskedasticity. *Econometrica*, 48(4), 817. <https://doi.org/10.2307/1912934>
- [38] Working H. (1943): Statistical laws of family expenditure. *Journal of the American Statistical Association*, 38(221), 43–56.