

Intra Agroecological Contribution of Food Demand System to Food Security in Africa

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ABSTRACT

The study aims to improve food security using a food demand system approach to address intra agroecological acumens. The methodology adopted is the Almost Ideal Demand System to analyze the food demand system and its implications on food security borrows the Huang(1996) method. Data employed are from Food and Agricultural Organization and African Development Indicators databases and run from 1991 to 2011. intra agroecological analyses of both Arid and Subhumid zones show that within zone food demand system presents great differences in terms of food budget share, price and income elasticities. The consequences of these gaps are significant on the agroecology nutritional outcome.

Keywords: Agroecological zone, food demand system, food security, AIDS, Africa

Mathematics Subject Classification: 91Bxx

Journal of Economic Literature (JEL) Classification: Q18, D12, C51

1. INTRODUCTION

There is an abundant literature on agroecology contribution of food demand system to food security. FAO (2014) reiterated that more contribution should be accorded to agroecology in a changing world focus on the ecosystem services in agriculture notably in food provisioning. On a different note, Wezel and David(2012) also established a strong link between food demand and agroecology in an attempts to find the best combination between economy, ecology, agronomy and social challenges to solution food security challenge. However, the valorisation of agroecology is attributed to Mette et al(2017)

who sightsee the notion of agroecological food system to discourse food security in a delineated geographical area.

The contribution of agroecology to food security is a wonderful framework of behavioural economics, which addresses the specificities of a people or a territory (Simon, 1972) by associating their ecological model (Green et al., 1996) to understand the specificities of their food demand system so as to better strategize on food security. Furthermore, the ecological model denotes the combination of natural sciences, which captures the correlations between organisms and their habitat (Green et al., 1996) as well as the behaviour of these organisms in their habitats (Wezel and David, 2012). Thus, it apprehends the agroecological influence of food demand system to food security. It goes from the idea that economic agents are not rational, rather they are greatly affected by the agroecology in which they find themselves. One of the main shortcomings attributed to food security studies was its major orientation only towards social and economic factors, and disregards natural sciences acumens such as food agroecology (Dean, 2004).

Theoretically, the correlation between food demand system and food security is established by Bentham and Mills in their utilitarianism theory. While World Food Programme (1996) defines food security by focusing on utility maximization for all consumers at all times, food demand system targets utility maximization of the consumer at a given period. By advocating for a satisfaction of all consumers at all times, utilitarianism theory also brings together natural sciences and behavioural amenities to meet the food security target through the theory of utility, which connects food demand system and food security concepts. The objectives of food demand system and food security are utility maximization for the consumer or a group of consumers for the previous and utility maximization for all consumers at all times for the latter. The food demand system captures environmental, economic and behavioural specificities of the consumer such as culture, agroecology, immediate social influences.

However, policies capitalizing on contribution of agroecology to consumer's wellbeing always assume that the whole agroecology presents the same soil, environment, aquaculture, biodiversity, behaviour, culture, and other characteristics. In this light, policies are elaborated for a homogeneous agroecology with alike specificities (FAO, 2018). Consequently, policies are designed to suit many countries within the considered agroecological zone. From the previous, we question the impact of within agroecological zone heterogeneities on the efficiency of expected outcome of policies. It is opportune to know if these differences within the agroecological zone are important enough to be address specifically or not, and if they are affecting significantly the expected outcome of the agroecology. For this, we investigate on the impact of food demand system on food security of some countries respectively within the arid and the sub-humid agroecological zones.

2. GENERATION OF THE DATA

The AIDS(Deaton and Muellbauer, 1980) model is used to analyze the food demand systems of Ghana, Ivory Coast, Guinea and Togo for the sub-humid agroecological zone and Algeria, Egypt, Morocco, and Niger for arid agroecological zone.

2.1. Theoretical model

The generalized AIDS (QUAIDS) is expressed in terms of budget shares with respect to prices and expenditures of consumers on foods (Deaton and Muellbauer, 1980).

$$W_i^* = \alpha_i + \sum_{j=1}^n y_{ij} \log p_j + \beta_i \log \frac{E_F}{a(p)} + \frac{\lambda_i}{\prod p_j^{\beta_j}} \left[\log \frac{E_F}{a(p)} \right]^2 + u_i + \Psi_i \quad (1)$$

Where Ψ_i are instruments of the endogenous factors.

Adding-up and homogeneity require $\sum \beta_i = \sum \lambda_i = 0$, $\sum_j y_{ij} = 0$, $\sum \alpha_i = 1$

Symmetry $\gamma_{ij} = \gamma_{ji}$, for $i \neq j$

Tiwang and Ningaye (2019) in their assessment of food demand system of cereals in Cameroon considered both stationarity and endogeneity effects in the estimation of the food demand system using the AIDS. However, for this study, we suppose the previous realized and use the simple AIDS.

2.2. The Methodology to assess the effects of food demand system on food security

The link from food demand to food security is appreciated by deducing changes in nutrients from consumption using demand elasticities following the Huang (1996) approach. To explore the linkage of the demand model to nutrient demand system, let k_i be the quantity of the k^{th} nutrient in a total of k nutrients obtained from a unit of the i^{th} food. The total quantity of that nutrient, say φ_k , obtained from various foods may be expressed as:

$$\varphi_k = \sum_i a_{ki} q_i \quad (6)$$

Undertake that a typical family assigns m units of income for acquiring n foods, and let q_i , defined as:

$$q_i = f_i(p_1, \dots, p_n, m), \quad i = 1, 2, \dots, n \quad (7)$$

Denotes the demand for the i^{th} food. Furthermore, e_{ij} being a price elasticity of the i^{th} food, the demand system may be expressed by applying the first-order differential approximation of the conceptual demand relationships as:

$$dq_i / q_i = \sum_j e_{ij} (dp_j / p_j) + \eta_i (dm / m) \quad (8)$$

Where, a price change of the j^{th} commodity, and η_i is expenditure (or income) elasticity showing the effect of quantity i in response to a change per capita expenditure. Huang (1996) shows that relative changes in nutrient consumption can be expressed as a function of relative changes in prices and expenditure: With φ_k known as the quantity of k^{th} nutrient in a total of k nutrients obtained from a unit of the i^{th} food (equation 6).

$$\begin{aligned} d\varphi_k / \varphi_k &= \sum_j (\sum_i e_{ij} \alpha_{ki} q_i / \varphi_k) (dp_j / p_j) + (\sum_i \eta_i \alpha_{ki} q_i / \varphi_k) (dm / m) \\ &= \sum_j \pi_{kj} (dp_j / p_j) + \rho_k (dm / m) \end{aligned} \quad (9)$$

Where $\pi_{kj} = \sum_i e_{ij} \alpha_{ki} q_i / \varphi_k$ is a price elasticity measure relating the effect of the j^{th} food price on the availability of the k^{th} nutrient, $\rho_k = \sum_i \eta_i \alpha_{ki} q_i / \varphi_k$ is an income elasticity measure relating the effect of income on the availability of that nutrient.

The measurement of π_{kj} is the weighted average of all own and cross price elasticities (e_{ij} 's) in response to the j^{th} price with each weight expressed as the share of each food's contribution to the k^{th} nutrient ($\alpha_{ki} q_i / \varphi_k$'s). Similarly, the measurement of ρ_k represents the weighted average of all income elasticities (η_i 's) with each weight again expressed as the share of each food's contribution to the k^{th} nutrient.

2.3 Databases

Data used for the study are price indices from FAOSTAT and food expenditures from world development indicators databases. The period of study is 1991-2011 and the choice of agroecological zones was guided by the need to select countries that are totally influenced by only one agroecological characteristics. The nutritive values of foods are generated using nutrition pro 10. The group nutritional value is approximated by the average value of the nutritional values of foods of the group.

2.4. Justification of the choice of the arid and sub-humid zones

Arid or dry tropical climate corresponds to the desert, characterized by a dry climate, with a structural precipitation deficit (World Bank, 2013). It shares similarities with the Sub-arid, which corresponds to hot steppe. The Sub-arid zone borders desert areas, with climatic conditions similar to those found in the desert (Denhez, 2007). The third zone is the Sub humid or tropical wet-and-dry climate, which corresponds to the Savannah, found between the tropical rainforest and desert biome, and share boundaries with the humid tropical, which corresponds to the Rainforest and the Monsoon (UNCCD, 2009). For this study, we compare the food demand system of four countries of the arid zone (Algeria, Egypt, Morocco, and Niger) to that of the subhumid zone (Guinea, Ghana, Ivory Coast, and Togo).

We focus on their demand behaviour between the two zones on several food groups' notably animal products, oils, cereals, roots, tubers, fruits and vegetables. Above all, the methodological challenge is to have countries totally immersed in only one agroecological zone and that is possible only in the two considered agroecological zones.

3. RESULTS

Table 1: comparative analyses of food demand system in the arid agroecological zone

food groups		BUDGET SHARES		
	Algeria	Egypt	Morocco	Niger
cereals	0.025 (0.028)	0.023*** (0.000)	0.030*** (0.000)	0.200*** (0.010)
Roots & tubers	0.049*** (0.010)	0.006*** (0.000)	0.008*** (0.000)	0.022*** (0.002)
Fruits & vegetables	0.033 (0.018)	0.025*** (0.000)	0.009*** (0.001)	0.098*** (0.010)
oils	0.003 (0.006)	0.002*** (0.000)	0.002*** (0.000)	0.012*** (0.001)
Animal products	0.040 (0.044)	0.017*** (0.000)	0.018*** (0.000)	0.133*** (0.024)
food groups		INCOME ELASTICITIES		
	Algeria	Egypt	Morocco	Niger
cereals	0.434 (1.464)	0.104* (0.045)	0.238*** (0.056)	0.728* (0.336)
Roots & tubers	1.092 (0.965)	0.167 (0.231)	0.376*** (0.102)	0.640 (1.327)
Fruits & vegetables	0.718 (0.961)	0.239* (0.101)	-0.669 (0.434)	0.462 (0.290)
oils	0.048 (11.471)	0.021 (0.646)	0.256 (0.338)	1.332 (6.143)
Animal products	0.461 (1.270)	0.073 (0.132)	0.409*** (0.058)	0.056 (0.866)
food groups		MARSHALLIAN PRICE ELASTICITY		
	Algeria	Egypt	Morocco	Niger
cereals	-0.956 (0.712)	-0.476 (0.437)	0.345 (1.315)	-4.9*** (1.044)
Roots & tubers	-0.450 (5.921)	-0.884 (2.089)	-0.647 (2.080)	-4.975 (3.714)
Fruits & vegetables	-1.652 (1.532)	-0.669 (1.520)	15.053 (9.868)	1.434 (1.125)
oils	-3.149 (14.840)	1.243 (1.464)	1.422 (1.405)	-2.451 (15.055)
Animal products	-2.659 (2.552)	1.162 (1.439)	-1.736 (1.139)	0.791 (0.683)

An analysis of the food demand system in the arid zone (table 1) shows great differences in the budget allocation for the various food groups. Roots and tubers varies from 0.6% (Egypt) to 4.9% (Algeria). It is also the case for fruit and vegetables going from 0.9%(Morocco) to 9.8%(Niger) or still for animal products from 1,7%(Egypt) to 13.3%(Niger). Generally, the consumption of cereals and oils

in this agroecological zone are almost the same. An analysis of income elasticity shows that even though majority of the foods are normal goods, roots and tubers are luxuries while fruits and vegetables are inferior goods in Algeria, and oils are luxuries in Niger. Marshallian price elasticity analyses shows that cereals are inversely price elastic in Morocco and highly elastic in Niger where a 1% price increase leads to 4.9 fall in demand of cereals. Consumer's behaviour toward demand of fruits and vegetables, oils, and animal products when the prices change are very diverse for all the four countries under study. In addition, the behaviour of Niger is closer to that of Morocco but far from that of Egypt and Algeria in terms of price change of foods.

Table 2: comparative analyses of food demand system in the subhumid agroecological zone

food groups	budget share			
	Ivory cost	Ghana	Guinea	Togo
cereals	0.017 (2.943)	0.013 (0.011)	0.043 (0.005)	0.082 (0.009)
Roots & tubers	0.469 (108.8)	0.166 (0.180)	0.056 (0.007)	0.240 (0.028)
Fruits & vegetables	0.034 (7.703)	0.012 (0.007)	0.092 (0.010)	0.035 (0.005)
oils	0.005 (1.156)	0.002 (0.003)	0.008 (0.001)	0.011 (0.002)
Animal products	0.012 (2.747)	0.015 (0.018)	0.024 (0.003)	0.022 (0.002)

food groups	income elasticity			
	Ivory cost	Ghana	Guinea	Togo
cereals	0.310 (263.353)	0.067 (4.271)	-0.052 (0.175)	0.058 (0.326)
Roots & tubers	0.061 (211.449)	-0.068 (1.433)	-0.108 (0.112)	0.048 (0.075)
Fruits & vegetables	0.083 (251.751)	0.309 (7.321)	0.051 (0.070)	-0.088 (0.659)
oils	0.048 (678.450)	-0.480 (17.751)	-0.172 (2.628)	-0.347 (5.127)
Animal products	0.077 (459.407)	-0.069 (4.450)	-0.003 (0.326)	0.218 (1.296)

food groups	price elasticity			
	Ivory cost	Ghana	Guinea	Togo
cereals	-0.479 (42.795)	-0.839 (3.580)	0.252 (0.883)	1.679 (1.734)
Roots & tubers	-1.047 (72.646)	-1.017 (1.134)	-0.351 (1.105)	-0.036 (0.774)
Fruits & vegetables	-1.235 (114.832)	-1.546 (2.928)	0.246 (0.701)	0.725 (3.128)
oils	-1.069 (174.855)	-1.782 (6.390)	-2.162 (11.347)	2.044 (16.074)
Animal products	-0.754 (34.836)	0.466 (4.933)	0.451 (1.998)	0.007 (5.374)

*p<0.05,

**p<0.01,

***p<0.001

A similar analysis in the subhumid zone (table 2) ranges budget shares for cereals from 1.7% (Ivory Coast) to 8.2% (Togo). Also, the demand of roots and tubers, which appear to be most consumed is not homogeneous within the agroecology. It ranges from 5.6% (Guinea) to 46.9% (Ivory Coast). In

opposition to the arid zone, budget allocations present some similarities for fruits, vegetables, oils, and animal products in the subhumid. An analysis of income elasticity shows that cereals are inferior goods in Guinea, roots and tubers are inferior goods in Ghana and Guinea but generally most goods in this zone are either normal goods or inferior goods. So out of the five food groups, 4 are inferior goods in Guinea, three in Ghana, and two in Togo. These results are very different from those found in Cameroon, which is agroecologically very close to this zone (Tiwang and Ningaye, 2019).

Table 3: nutritional values of foods using Nutrition pro 10 software

NUTRIENT	energy (kcal)	Proteins	Fat	Carbo	Choles	Ca	Phos	Iron
		(g)	(g)	(g)	(mg)	(mg)	(g)	(mg)
margarine	880	0	99.5	0	0	1	0	0.2
vegetable oil	862	0	100	0	0	0	0	0
palm oil	884	0	100	0	0	0	0	0
oils	875.33	0	99.83	0	0	0.33	0	0.06
beef	211	26	11.1	0	83	19	201	1.7
chicken	293	15.8	17.7	17	44	18	210	1.1
Fish	205	18.6	13.9	0	70	12	217	1.6
mutton_~t	234	33.4	11.1	0.1	109	10	272	4.8
egg	52	10.9	0.2	0.7	0	7	15	0.1
pork	247	15.3	19.9	0.7	59	11	139	0.8
proteins	207	20	12.3	3.08	60.8	12.8	175.6	1.68
sweet potato	86	1.6	0	20.1	0	30	47	0.6
banana	89	1.1	0.3	22.8	0	5	22	0.3
yams	118	1.5	0.2	27.9	0	17	55	0.5
cassava	160	1.4	0.3	38.1	0	16	27	0.3
potato	58	2.6	0.1	12.4	0	30	38	3.2
plantain	122	1.3	0.4	31.9	0	3	34	0.6
roots and tubers	105.5	1.58	0.21	25.53	0	16.83	37.16	0.91
pineap	50	0.5	0.1	13.1	0	13	8	0.3
tomatoe	18	1	0.1	4	0	11	28	0.7
avocado	160	2	14.7	8.5	0	12	52	0.6
vegetables	64	3.3	0.5	13.5	0	25	59	1
fruits and vegetables	73	1.7	3.85	9.775	0	15.25	36.75	0.65
beans	337	22.5	1.1	61.3	0	83	406	6.7
groundnut	567	25.8	49.2	16.1	0	92	376	4.6
wheat	364	10.3	1	76.3	0	15	108	1.2
maize	86	3.2	1.2	19	0	2	89	0.5
rice	370	7.9	2.9	77.2	0	23	333	1.5
cereals	344.8	13.94	11.08	49.98	0	43	262.4	2.9
NUTRIENT	Sodium	Vita A	Thia	Ribo	Niacin	Vit C (mg)	vit B-12	Vit B-6
	(g)	(re)	(mg)	(mg)	(mg)			
margarine	4	0	0	0	0	0	0	0
vegetable oil	0	0.01	0	0	0	0	0	0

palm oil	0	0.01	0	0	0	0	0	0
oils	1.3	0.006	0	0	0	0	0	0
beef	53	0	0.1	0.1	6.9	0	1.5	0.5
chicken	457	0	0.3	0.1	5.6	0	0.3	0
Fish	90	167	0.2	0.3	9.1	0.4	8.7	0.4
mutton_~t	5.9	0	0.1	0.3	6.5	0	0.8	0.4
egg	166	0	0	0.4	0.1	0	0.1	0
pork	1184	0	0.5	0.2	3.9	0	0.9	0.3
proteins	325.9	27.83	0.2	0.23	5.35	0.06	2.05	0.26
sweet potato	55	14.2	0.1	0.1	0.6	2.4	0	0.2
banana	1	64	0	0.1	0.7	8.7	0	0.4
yams	9	138	0.1	0	0.6	17.1	0	0.3
cassava	14	13	0.1	0	0.9	20.6	0.1	0.1
potato	10	0	0	0	1	11.4	0	0.2
plantain	4	0	0.1	0.1	0.7	18.4	0	0.3
roots and tubers	15.5	38.2	0.06	0.05	0.75	13.1	0.016	0.25
pineap	1	58	0.1	0	0.5	47.8	0	0.1
tomatoe	11	489	0	0	0.5	22.8	6.9	0.1
avocado	7	146	0.1	0.1	1.7	10	0	0.3
vegetables	47	5078	0.1	0.1	1.3	10.4	0	0.1
fruits and vegetables	16.5	1442.8	0.075	0.05	1	22.75	1.725	0.15
beans	12	0	0.6	0.2	2.1	4.5	0	0.4
groundnut	18	0	0.6	0.1	12.1	0	0	0.3
wheat	2	0	0.1	0	1.2	0	0	0
maize	15	1	0.2	0.1	1.7	6.8	0	0.8
rice	7	0	0.4	0.1	0.4	0	30.7	0.5
cereals	10.8	0.2	0.38	0.1	3.5	2.26	6.14	0.4

A check of price elasticity shows that while a price increase of cereals, fruits and vegetables will lead to a fall in demand in Ivory Coast and Ghana, it will instead provoke an increase in their demand in Guinea and Togo. In addition, while a price increase in oil drops the demand of all other countries, the one of Togo increases. The inverse situation is observed for the demand of animal products where their price increase leads to a fall in demand only in Ivory Coast and on the contrary increases the demand in all the other three countries.

Table 4: comparative analyses of a 1% increase in consumer's income on the level of nutrients derived

arid agroecological zone				
NUTRIENT	Algeria	Egypt	Morocco	Niger
energy (kcal)	454.706	104.4176	381.6409	1529.792
Proteins	18.21592	3.57992	10.9545	13.06492
Fat	18.26448	5.10187	30.72753	143.6417
Carbo	58.00841	12.0225	16.21477	57.41317
Choles	28.0288	4.4384	24.8672	3.4048
Ca	53.9065	11.86869	11.67951	50.27706

Phos	261.7984	55.09737	123.658	241.6217
Iron	3.49638	0.73282	1.29999	3.1679
Potas	946.4618	198.5765	209.7478	756.648
Sodium	183.7625	31.4732	130.9858	45.3874
Vita A	1090.562	353.2611	-939.438	692.7337
Thia	0.37649	0.082065	0.144625	0.36089
Ribo	0.23993	0.04749	0.10322	0.14078
Niacin	5.52235	1.1188	2.63415	3.7896
Vit C (mg)	31.6482	7.86437	-9.73173	20.54314
vit B-12	4.865832	1.203157	1.151761	5.39191
Vit B-6	0.67416	0.13818	0.19519	0.53506

subhumid agroecological zone

NUTRIENT	Ivory cost	Ghana	Guinea	Togo
energy (kcal)	177.3373	-395.957	-176.778	-239.975
Proteins	6.09888	-0.02816	-0.86882	5.09476
Fat	9.5061	-46.8494	-17.6102	-31.6457
Carbo	18.09962	4.420575	-4.86692	3.93552
Choles	4.6816	-4.1952	-0.1824	13.2544
Ca	16.62382	5.40721	-3.37105	4.63573
Phos	100.1822	14.29327	-16.3106	52.04968
Iron	1.1407	0.18855	-0.23129	0.5001
Potas	230.6867	70.2422	-55.0854	88.0092
Sodium	30.8197	-18.343	-2.5954	70.5135
Vita A	124.2878	441.3179	69.36228	-119.056
Thia	0.143085	0.030755	-0.02302	0.06192
Ribo	0.05591	0.00288	-0.00874	0.05394
Niacin	1.6257	0.12335	-0.22805	1.3173
Vit C (mg)	3.39257	6.28623	-0.37225	-1.22904
vit B-12	2.205401	0.801867	-0.23918	0.651988
Vit B-6	0.17172	0.03821	-0.04093	0.07868

The changes observed previously in food demand system within the same agroecological zone seems important, and to better appreciate their impact, let us look at their consequences on the nutrient levels of the consumers. Using nutrition pro software, we first put together the nutritional values of the various foods (table 3). Using comparative analyses, we appreciate the impact of income increase on consumer nutrient level. In addition, we also appraise the consequences of price increases in both agroecological zones.

Table 5: comparative analyses of a 1% increase in **price** on the level of nutrients derived

arid agroecological zone				
NUTRIENT	Algeria	Egypt	Morocco	Niger
energy (kcal)	-3804.53	1022.345	2034.934	-4091.4
Proteins	-70.026	14.07054	-5.34286	-57.9087
Fat	-364.118	130.3459	182.2462	-284.77
Carbo	-83.6074	-49.3195	142.5214	-355.46

Choles	-161.667	70.6496	-105.549	48.0928
Ca	-108.949	-30.2642	211.7527	-263.245
Phos	-795.208	21.70961	314.8416	-1279.03
Iron	-8.91176	-0.59295	7.36502	-16.6233
Potas	-1853.95	-418.158	3306.193	-3841.83
Sodium	-915.22	350.4304	-321.842	148.2291
Vita A	-2474.91	-966.751	21645.52	1899.949
Thia	-1.04598	-0.0517	0.874055	-1.89475
Ribo	-0.81227	0.14201	0.35552	-0.48512
Niacin	-19.5612	3.2187	6.48765	-15.2154
Vit C (mg)	-45.7981	-27.8062	334.6556	-43.5755
vit B-12	-14.1777	-1.70871	24.51557	-26.0704
Vit B-6	-1.43404	-0.20963	1.78284	-2.78299

subhumid agroecological zone				
NUTRIENT	Ivory Coast	Ghana	Guinea	Togo
energy (kcal)	-1457.58	-1972.81	-1731.29	2418.67
Proteins	-25.511	-6.61072	12.3965	24.72088
Fat	-126.274	-187.627	-206.62	225.5256
Carbo	-65.0648	-81.5741	7.42766	90.10578
Choles	-45.8432	28.3328	27.4208	0.4256
Ca	-67.0557	-71.3929	13.73951	83.41149
Phos	-342.385	-232.931	141.3177	467.1048
Iron	-4.47548	-3.68751	1.19925	5.44199
Potas	-1169.69	-1082.9	196.9547	1068.969
Sodium	-288.898	99.2191	145.5104	34.4762
Vita A	-1842.94	-2256.63	354.1094	1045.198
Thia	-0.48827	-0.40259	0.18335	0.691635
Ribo	-0.33542	-0.10487	0.12368	0.20396
Niacin	-7.73065	-2.75215	3.2776	6.61195
Vit C (mg)	-42.9397	-50.3624	1.59498	19.81711
vit B-12	-6.63389	-6.87928	2.890564	11.57346
Vit B-6	-0.83464	-0.70059	0.16721	0.77317

Generally, an increase in consumer income creates a general increase in the level of nutrients to the consuming unit. For instance, the 1% increase in consumer income will increase the level of energy intake in Algeria by 454.7 kcal, in Egypt by 104.4 kcal, in Morocco by 104.4 kcal and lastly in Niger by 1529.7 kcal. However, as this 1% income increases vitamin A by 1090.5 re for Algeria, by 353.2 for Egypt, by 692.7 for Niger, it instead drops the vitamin A level of Morocco by 939.4 re. The situation is similarly the same for vitamin C. Beside these minor surprises on the impact of policies on consumer's nutrients level in the arid agroecological zone, we realize that the impact is more serious in the subhumid agroecological zone. Under foods complementarities and substitutions effects, a 1% increase in consumer's income increases consumer energy level in Ivory Cost by 177.3 kcal, but surprisingly drops the nutrient levels of Ghana by 395.9 kcal, of Guinea by 176.7 kcal and that of Togo by 239.9 kcal. A general analysis shows that the nutrient level drops when the consumer income is

increased by 1% in Guinea for almost all the 17 nutrients considered, it drops for few nutrients in Ghana and Togo but on the opposite, it increases the level of almost all the 17 nutrients in Ivory Coast. On a different note, analyses of price increases demonstrate that a 1% increase in the price of foods in the arid agroecological zone leads to a fall in most of the nutrients in both Algeria and Niger, except for nutrients like sodium and vitamin A whose values increase by 148.2 g and 1899.9 re respectively in Niger. Still in that same agroecological zone, the same 1% price increase leads to a fall in 9/17 nutrients in Egypt and 3/17 nutrients in Morocco. In a different agroecological zone, a 1% price change of foods on the market provoke a fall in all the 17 nutrients level in Ivory coast and inversely an increase in all the 17 nutrients in Togo. Guinea results are closer to those of Togo with an increase in 15/17 nutrients increase and Ghana results are closer to that of Ivory Coast with a fall in 15/17 nutrients from the price increase.

4. DISCUSSION AND CONCLUSION

Intra agroecological zone analyses show that a policy does not necessarily generate the expected outcome between the various countries within the agroecology. From the budget allocations of foods, we observe similarities but also great differences among people who are most often analyzed as having the same consumption behaviours. In addition, income and price elasticities provide results that are not easily generalizable or identifiable as that of an agroecological zone. These heterogeneities are also found in price elasticities analyses. Results of this paper contribute immensely to both national and international policies that are generally oriented toward groups of countries with the argument that they are agroecologically similar. The severity of the outcome demonstrate clearly that the outcome of an agroecological policy may be very far from expectations with positive and negative outcome on the income level and responsiveness to pay of consumers.

For nutrients analyses, all the two agroecological zones under study provide enough evidence, which showed that there are great intra agroecological differences that the policy maker should consider when defining agroecological oriented policies. The study suggests that more consideration should be given to intra agroecological specificities in drafting food security policies. In addition, further studies should investigate the differences and elaborate better distribution policies among agroecological zones in order to help provision zones that are in need through identification of zones of abundance or commodities in abundance among zones. There is also enough results to instigate the already established agroecological nutrition characterization since the individual behaviours of countries within the same agroecological zone may be beneficial or detrimental on the health and nutrition status of the respective countries. This study also invites policy makers to reconsider Adam Smith and David Ricardo basics on cooperation and redistribution of tasks in food production and consumption satisfaction.

The objective of the study was to share light on food demand system contribution to food security with a focus on intra agroecology amenities. It compared the outcome within two agroecological zones by considering four countries for each zone. Analyses on food budget allocations, income and price

elasticities, as well as income and price nutrients demand systems provided some results. The study showed that there are differences in productivity capacities within various agroecological zones and suggest that these peculiarities should be consider in the elaboration of food and agricultural policies. These results are in light with Keynes psychological law since countries with high production like Egypt present smallest food budget shares while less productive countries like Niger allocate greater part of their budget for feeding. Since income elasticity correlates with gross domestic product of the country, we assessed the general behaviour of consumers as prices change. The study contributes also greatly to food security and nutrition since it points out the possibility of strong controversy between the natural endowment of countries and their poor nutritional status. It also argue on the need for countries within the same agroecological zone to come together, since better cooperation will help them maximize their welfare from the natural advantages of the agroecological zone. There should be more studies the drivers of the intra agroecological differences among countries of the same agroecological zone.

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