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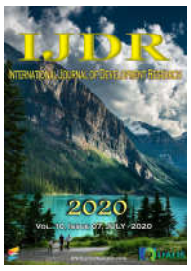

RESEARCH ARTICLE OPEN ACCESS

CROSSOVER ANALYSIS OF MAJOR CASH CROP PRODUCTION IN WEST AFRICA: POST COVID-19 PANDEMIC IN VIEW

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ABSTRACT

Food security and cash availability are some of the present major concerns of many countries of the world since the outbreak of the deadly Corona virus (COVID-19) disease. This study examines the production of major cash crops in the 16 West African countries from 1961 to 2018 using the Crossover Analysis of Variance (ANOVA) design with a view to examine the relationship between the level of production among the countries. Four variables were considered for this study namely the Area, Item, Unit and the Flag description. Six item levels comprising of major cash crops namely Cassava, Cocoa-beans, Coconuts, Groundnuts with shell, Oil Palm and Tobacco were considered. The ANOVA design shows that each of the variables is significant at different levels. Post hoc analysis of Turkey's Honestly Significant Difference (HSD) for the significant variables was also carried out. Results obtained using the official data from Food and Agriculture Organization (FAO) show that Mauritania has the lowest area count of 174 with lowest mean, 3439 and standard deviation of 2675 while Nigeria has the highest counts of 928 with highest mean of 2106649 and standard deviation of 7363172.

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INTRODUCTION

Cash crops are farm output sold on a formal agricultural market to ensure improved food security both at farm households as well as governmental levels especially in developing countries. They form an integral part of agricultural exports which immensely contribute to the economy of many African countries (FAO 2013a). However, recent outbreak of the deadly COVID-19 pandemic has posed a major challenge on the economy of many countries of the world, including West African countries and the agricultural sector, most especially cash crop production. Moreover, one of the adverse effects of the pandemic is a drastic reduction in world price oil, IEA (2020) upon which many countries rely as source of foreign exchange. Hence, there is need to examine the production of these major crops in order to ensure sustainable production and continuous cash generation amidst the effects of the pandemic. Several studies, including Negash and Swinnen (2012) on castor, and Chege *et al*. (2013) laid great emphases on the positive effect of cash crop on farmers' income with ripple effect on a nation's economy. Moreover, Fan *et al.* (2013) revealed that income generated from cash crops provides farm households with the means to save and invest in a more productive farm and accelerate a process of agricultural commercialization. They further stated that the commercialization of small-scale farmers with profit potential is an essential ingredient in ensuring future food availability and security. This enhances improved agricultural productivity which plays an important role in economic development in rural areas (Meijerink and Roza 2007; World Bank 2007). Hence, the production of cash crops plays an important role in enhancing food security. They contribute to food security at a national level through the exports of cash crops that generate foreign currency and income to import food, or invest in domestic production and their exports contribute substantially to the economy of many African countries. Although, there are limitations to such national level perspectives due to in-country restrictions to food trade. Moreover, according to (FAO 2013a), about 40% of African population live in urbanised and peri-urban areas, which are well-connected to trade routes. Many of the more remote rural areas have poor infrastructure in terms of food storage, roads and trading services. However, according to AGRA (2013) there are great prospects for further positive agricultural growth. Binswanger-Mkhize (2011) also stated that the size of Africa's

cash crop economy has significantly increased over the past decade and the rate of agricultural growth has recently speeded up, from an average of about 2.5 per cent in the 1980s and 1990s to 3.1 per cent in the 2000s and 3.7 per cent in 2007-10. In fact, analysis by International Food Policy Research Institute (IFPRI) examines what kind of agricultural growth has the greatest tendency to improve livelihoods (Diao *et al.* 2012), and finds that export crops and food staples will enhance economic growth in different and country-specific ways. They typically have higher value and growth potential than food crops, but in several countries food staples are more effective at generating economy-wide growth and reducing national poverty. Hence, this study examines the production of major cash crops in West African countries in relation to some contributing factors or variables with a view to ensure significant improvement in production.

METHODOLOGY

Crossover Design: A crossover design is a scheme such that different treatments are applied in a random order to the same patient sequentially over time. In a study for the comparison of three treatments A, B and C, for a particular patient, the treatments are applied in the order B-C-A sequentially. As many different orders of the treatments as possible are considered. The numbers of patients administered with different orders are made as equal as possible.

The Linear model is given by;

$$Y_{ijk} = \mu + \alpha_i + \beta_{ij} + \gamma_k + \tau_{d(i,k)} + \lambda_{c(i,k-1)} + \varepsilon_{ijk} \qquad (1)$$

where

μ is the overall mean effect; i = 1, . . . , n orders or patterns or sequences; j = 1, . . . , r subjects per pattern k = 1, . . . , p; period d = 1, . . . , t treatments; c = 1, . . . , t treatment carry-over; ε_{ijk} are random errors which are identically and independently distributed following $N(0,\sigma^2)$.

We define $\lambda_{c(i,0)} = 0 \ \forall i$ (k = 1). Effects can be fixed or random as needed, and we assume random effects are independent of each other.

The test statistic for testing the null hypothesis on the treatment effects $H_0 : \tau_1 = \tau_2$ can be constructed as;

$$t_\tau = \frac{\bar{D}_1 - \bar{D}_2}{s_D}\sqrt{\frac{n}{2}} \quad \text{with 2(n-1) degree of freedom} \qquad (2)$$

where $\bar{D}_1 = \frac{1}{n}\sum_{i=1}^{n} D_{ik}$ $k = 1, 2$, and s_D is the pooled estimate of the standard deviation of the differences;

$$s_D^2 = \frac{1}{2}(s_{D_1}^2 + s_{D_2}^2)$$

If there are no carry-over effects, the equality of period effects $\pi_1 = \pi_2$ can be tested by the following test statistic;

$$t_\pi = \frac{\bar{D}_1 + \bar{D}_2}{s_D}\sqrt{\frac{n}{2}} \quad \text{with 2(n-1) degree of freedom} \qquad (3)$$

If we are willing to assume there are no carryover effects, then we can still use the Latin square or rectangle models and ANOVA tables. It should also be noted that If carry-over effects are non-zero, though they might be equal, $t\pi$ does not provide a valid test for the period effects. Moreover, analysis on treatment effect and period effect can also be done either through the ANOVA approach or the linear model approach with Latin square designs which are basically the extension of the Randomized Complete Block Design. The proper designs for crossover studies with more than two treatments are special Latin square designs with the property that each treatment follows each of others equal number of times. The analysis of q $g \times g$ Latin squares for a crossover study with g treatments and g periods are described as follows.

$$\hat{\tau}_i = \frac{(g^2 - g - 1)T_i + gR_i + F_i + P_1 - gG}{qg(g^2 - g - 2)} \qquad (4)$$

and

$$\hat{\rho}_i = \frac{gT_i + g^2R_i + gF_i + gP_1 - (g+2)G}{qg(g^2 - g - 2)} \qquad (5)$$

where:T_i: sum of all qg responses to Treatment i;

R_i: sum of all $q(g-1)$ responses in the periods immediately following Treatment i;
F_i: sum of all qg responses for those subjects who received Treatment i in the final period;
P_1: sum of all qg responses in the first period;
G: sum of all qg^2 responses in the entire study.

Let $\tau_i$and $\rho_i$be, respectively, the direct effect and carryover effect of treatment i subject to the constraints;

$$\sum \pi_i = \sum_j \tau_j = \sum_k \tau_k = 0 \quad (6)$$

The unbiased estimates of $\tau_i$and $\rho_j$are given by;

Sum of squares for carryover effects;

$$CSS = \frac{q(g^2-g-2)}{g}\sum \hat{\rho}_i^2 \quad (7)$$

Sum of squares for treatment effects (adjusted);

$$DSS = \frac{qg(g^2-g-2)}{g^2-g-1}\sum \hat{\tau}_i^2 \quad (8)$$

Residual sum of squares areusually computed from the ANOVA table I below.

Table 1. Anova table for crossover design

Source	df	Sum of Sq.
Subjects	$qg-1$	Standard
Periods	$g-1$	Standard
Treatments	$g-1$	Standard
Carryover	$g-1$	From formula
Residuals	$(qg-3(g-1)$	By Difference
Total	qg^2-1	Standard

The standard sums of squares are usually computed by using the linear model approach for repeated Latin squares, treating the squares as if they are for a non-crossover study and sum of squares for treatment is unadjusted. The term "Latin Squares" is usually as a result of the fact that Roman alphabets are used to denote assignment of the experimental units to the treatment and block levels in such a way that each treatment appears only once in each row and each column.

RESULTS AND DISCUSSION

Descriptive Statistics: Tables II, III, IV and V respectively show the mean and standard deviation of the variables (Area, Item, Unit and Flag Description) that ware examined in this study. Table II shows the mean and standard deviation for the parameters determined of Area. Table III shows the mean and standard deviation for the parameters of Item. Table IV shows for the mean and standard deviation for the parameter of Unit and Table V shows the parameters of Flag Description.

Descriptive Statistics for Area: This section shows the descriptive statistics for the Areas under study. The 16 areas considered are displayed below with count, mean and standard deviation of each area. Mauritania has the lowest count, 174 with lowest mean, 3439 and standard deviation of 2675. Nigeria has the highest counts of 928 with highest mean of 2106649 and standard deviation of 7363172. The mean and the standard deviations of other countries were also reported.

Table II. Mean and standard deviation for area

S/N	Area	count	mean	sd
1	Benin	839	162037	548964
2	Burkina Faso	522	54330	101898
3	Cape Verde	466	20613	35968
4	Cote-d'Ivoire	928	308839	661819
5	Gambia	406	37551	44189
6	Ghana	928	600299	2056014
7	Guinea	928	89848	199669
8	Guinea-Bissau	511	31528	33124
9	Liberia	730	47158	102409
10	Mali	522	64141	99254
11	Mauritania	174	3439	2675
12	Niger	522	93830	144511
13	Nigeria	928	2106649	7363172
14	Senegal	638	207660	359477
15	Sierra Leone	886	68924	337855
16	Togo	928	63004	151664

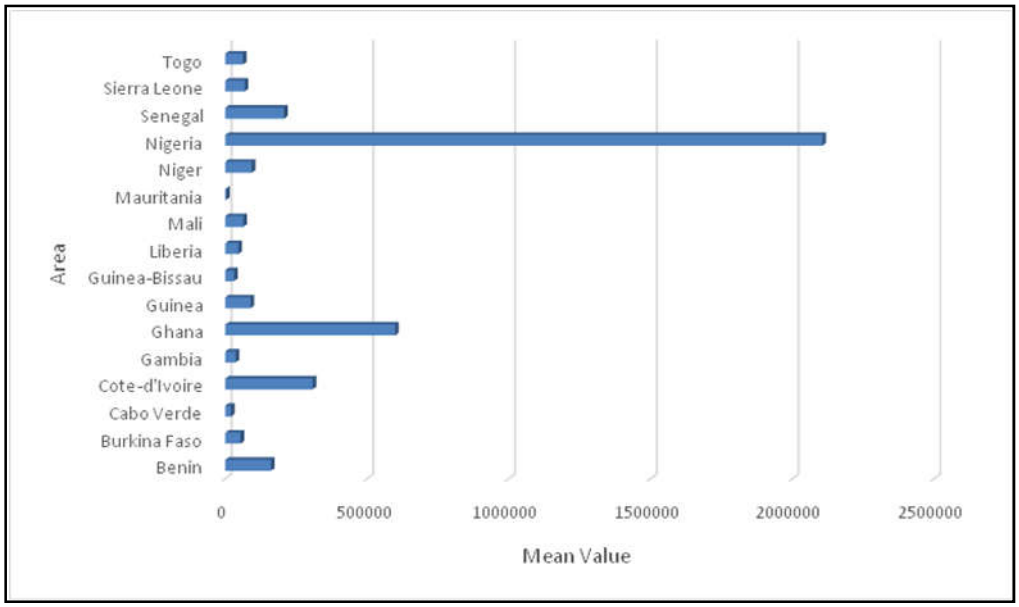

Fig 1. Mean estimate for Areas

Fig 1 shows the mean estimates for the areas under consideration. The plot shows Nigeria with the longest bar follow by Ghana and Cote-d I'voire and so on.

Descriptive statistics for Item: Table III shows the descriptive statistics for the Item. The table shows that Groundnuts with shell has the highest count with the highest mean of 181198 and standard deviation of 441454. We could also see from the table that Oil palm gives the lowest count of 638 with mean of 112511 and standard deviation of 231748. We would see from the table that Tobacco unmanufactured produces the minimum mean of 4992 and standard deviation of 6104.

Table III. Mean and standard deviation for item

S/N	Item	Count	mean	sd
1	Cassava	2538	975010	4706508
2	Cocoa beans	1303	252576	520839
3	Coconuts	1866	39943	63612
4	Groundnuts with shell	2731	181198	441454
5	Oil palm	638	112511	231748
6	Tobacco unmanufactured	1780	4992	6104

Descriptive Statistics for Unit: Table IV shows the descriptive statistics for the Units considered. It could be seen from the table that tonnes unit has the highest count of 4108 with highest mean of 651382 and standard deviation of 3755167. Hg/ha unit produces the lowest count of 3309 with mean of 30978 and standard deviation of 37978. Ha unit produces count of 3439 with mean of 211943 and standard deviation of 567288.

Table IV. Mean and standard deviation for unit

S/No	Unit	Count	mean	sd
1	Ha	3439	211943	567288
2	hg/ha	3309	30978	37978
3	Tonnes	4108	651382	3755167

Descriptive statistics for Flag Description: Table V shows the descriptive statistics for the flag description. The table shows that official data has the highest count of 3394 with highest mean of 787569 and standard deviation of 3778114. Calculated data has the count of 3309 but produces the lowest mean of 30978 and standard deviation of 37978. Unofficial figure has the lowest count of 734 with the mean of 113288 and standard deviation of 609707.

Table V. Descriptive statistics for flag description

S/N	Flag Description	Count	mean	sd
1	Calculated data	3309	30978	37978
2	FAO estimate	2242	142182	790043
3	FAO imputation	976	257352	2746583
4	Official data	3394	787569	3778114
5	Unofficial figure	734	113288	609707

Crossover ANOVA Result: This section shows the significant effect of the parameters determined in different samples. It is to determine whether there are differences in their mean estimates or whether their mean estimates are significantly different.

Hypotheses:

H_0: There is significant difference in the mean effect of Area
H_0: There is significant difference in the mean effect of Item
H_0: There is significant difference in the mean effect of Unit
H_0: There is significant difference in the mean effect of Flag Description.

Table VI. Analysis of variance result (anova)

	Df	Sum Sq.	Mean Sq.	F value	P-value
Area	15	3.509e+15	2.339e+14	47.706	< 2e-16 ***
Item	5	1.836e+15	3.672e+14	74.881	< 2e-16 ***
Unit	2	9.815e+14	4.908e+14	100.076	< 2e-16 ***
Flag Description	3	1.378e+14	4.593e+13	9.367	3.52e-06 ***
Residuals	10629	5.212e+16	4.904e+12		

Table VI shows the analysis of variance using the Crossover design. The table shows the significance of the four variables. The result from the table shows that each of the variables is significant. i.e there are significant differences in the mean effect of the variables. Each variable has different levels and it simply implies that the mean effect of the various levels in each variable is difference. That is what contributes to the real significance of the variables. To know in each variable, which of the levels are significantly different from each other, we further our analysis by carrying out a post-hoc test. This will enable us to know the significance difference between the levels in mean. This will enable us to know the contributing levels to the significance of the variable. As a result of this, Turkey HSD post hoc test was carried out to achieve this purpose.

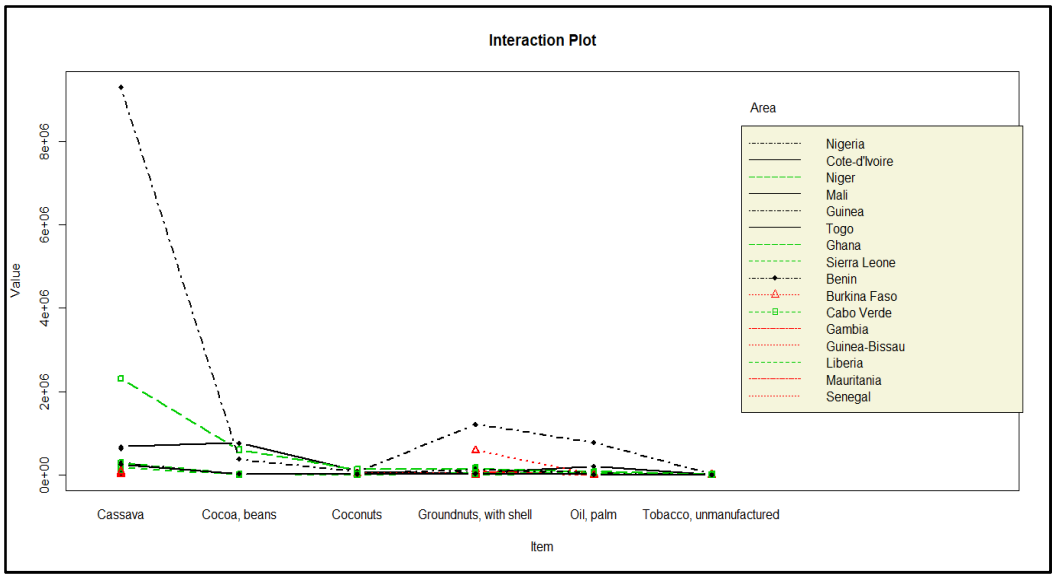

Fig. 2. Interaction Plot

Fig 2 shows the contribution of each area to the different items considered. It is evident from the plot that Nigeria has the highest production of cassava and Groundnut with shell. Production of each of the countries is also visible in the plot for each of the items.

Post-Hoc Analysis: The result here shows the Post Hoc analysis which comprises of the Turkey HSD results. The post hoc analysis is essential due to the significance of the variables considered. Under each variable are levels which contribute to this significance. Post hoc analysis enables us to see where there are significant differences in mean among these levels.

Turkey HSD for Area: Table VII shows the post hoc analysis for the significant Area. The levels in the area are the countries considered. Column 2 shows the difference (diff) between the means of the levels (countries). Column 3 and column 4 respectively show the lower (lwr) and the upper (upr) values for the difference in means. The probability adjusted (p.adj) values for the difference in means are shown in the last column. If the p adj. value is less than 0.05, it indicates significance in the mean difference.

Turkey HSD for Item: Table VIII shows the post hoc analysis for the significant Item. The levels in the Item are the products considered. Column 1 shows the difference (diff) between the means of the levels. Column 2 and column 3 (lwr and upr) shows the lower and the upper values for the difference in means. P.adj shows the probability adjusted value for the difference in means. If the adjusted p-value (p adj) shows a number less than 0.05, it implies a significance in the mean difference.

Turkey HSD for Unit: Table IX below shows the post hoc analysis for the significant Unit. The levels in the Unit are considered. Column 2 shows the difference (diff) between the means of the levels. Column 3 and column 4 (lwr and upr) show the lower and the upper values for the difference in means. P.adj shows the probability adjusted value for the difference in means. If the p adj.

value shows a number less than 0.05, it shows significance in the mean difference. The result shows the significant difference between the unit levels.

Table VII. Post hoc analysis for area

Country	Diff	Lwr	upr	p adj
Burkina Faso-Benin	-107707.106	-537505.01	322090.80	0.9999723
Cape Verde-Benin	-141424.255	-597856.23	315007.72	0.9996009
Cote-d'Ivoire-Benin	146801.520	-222603.54	516206.58	0.9934115
Gambia-Benin	-124486.470	-589510.11	340537.17	0.9999350
Ghana-Benin	438262.106	68857.05	807667.16	0.0049261
Guinea-Benin	-72189.293	-441594.35	297215.76	0.9999990
Guinea-Bissau-Benin	-130508.953	-563060.79	302042.88	0.9997108
Liberia-Benin	-114878.865	-509813.80	280056.07	0.9998155
Mali-Benin	-97895.945	-527693.85	331901.96	0.9999921
Mauritania-Benin	-158598.411	-795286.30	478089.48	0.9999743
Niger-Benin	-68207.403	-498005.31	361590.50	0.9999999
Nigeria-Benin	1944612.391	1575207.33	2314017.45	0.0000000
Senegal-Benin	45622.643	-374941.38	466186.67	1.0000000
Sierra Leone-Benin	-93113.209	-466478.75	280252.33	0.9999740
Togo-Benin	-99032.883	-468437.94	270372.17	0.9999338
Cape Verde-Burkina Faso	-33717.149	-527932.83	460498.53	1.0000000
Cote-d'Ivoire-Burkina Faso	254508.626	-160676.98	669694.23	0.7650357
Gambia-Burkina Faso	-16779.365	-518940.67	485381.94	1.0000000
Ghana-Burkina Faso	545969.212	130783.61	961154.82	0.0007363
Guinea-Burkina Faso	35517.813	-379667.79	450703.42	1.0000000
Guinea-Bissau-Burkina Faso	-22801.847	-495051.87	449448.17	1.0000000
Liberia-Burkina Faso	-7171.759	-445227.23	430883.71	1.0000000
Mali-Burkina Faso	9811.161	-459917.73	479540.05	1.0000000
Mauritania-Burkina Faso	-50891.305	-715188.27	613405.66	1.0000000
Niger-Burkina Faso	39499.703	-430229.19	509228.59	1.0000000
Nigeria-Burkina Faso	2052319.497	1637133.89	2467505.10	0.0000000
Senegal-Burkina Faso	153329.749	-307965.26	614624.76	0.9990827
Sierra Leone-Burkina Faso	14593.897	-404119.39	433307.18	1.0000000
Togo-Burkina Faso	8674.223	-406511.38	423859.83	1.0000000
Cote-d'Ivoire-Cape Verde	288225.775	-154473.89	730925.44	0.6749396
Gambia-Cape Verde	16937.784	-508200.19	542075.75	1.0000000
Ghana-Cape Verde	579686.361	136986.69	1022386.03	0.0008031
Guinea-Cape Verde	69234.961	-373464.71	511934.63	1.0000000
Guinea-Bissau-Cape Verde	10915.301	-485697.21	507527.82	1.0000000
Liberia-Cape Verde	26545.390	-437670.62	490761.40	1.0000000
Mali-Cape Verde	43528.310	-450687.37	537743.99	1.0000000
Mauritania-Cape Verde	-17174.156	-699005.79	664657.47	1.0000000
Niger-Cape Verde	73216.852	-420998.83	567432.53	1.0000000
Nigeria - Cape Verde	2086036.646	1643336.98	2528736.31	0.0000000
Senegal- Cape Verde	187046.898	-299159.84	673253.64	0.9953151
Sierra Leone-Cape Verde	48311.046	-397698.73	494320.83	1.0000000
Togo-Cape Verde	42391.372	-400308.30	485091.04	1.0000000
Gambia-Cote-d'Ivoire	-271287.991	-722840.68	180264.70	0.7913362
Ghana-Cote-d'Ivoire	291460.586	-60836.08	643757.25	0.2490643
Guinea-Cote-d'Ivoire	-218990.814	-571287.48	133305.86	0.7456508
Guinea-Bissau-Cote-d'Ivoire	-277310.473	-695346.28	140725.34	0.6438467
Liberia-Cote-d'Ivoire	-261680.385	-640661.19	117300.42	0.5734500
Mali-Cote-d'Ivoire	-244697.465	-659883.07	170488.14	0.8145576
Mauritania-Cote-d'Ivoire	-305399.931	-932316.45	321516.59	0.9547194
Niger-Cote-d'Ivoire	-215008.923	-630194.53	200176.68	0.9254954
Nigeria-Cote-d'Ivoire	1797810.871	1445514.20	2150107.54	0.0000000
Senegal-Cote-d'Ivoire	-101178.877	-506798.09	304440.33	0.9999739
Sierra Leone-Cote-d'Ivoire	-239914.729	-596362.02	116532.56	0.6188693
Togo-Cote-d'Ivoire	-245834.403	-598131.07	106462.27	0.5542421
Ghana-Gambia	562748.577	111195.88	1014301.27	0.0020930
Guinea-Gambia	52297.177	-399255.52	503849.87	1.0000000
Guinea-Bissau-Gambia	-6022.483	-510542.88	498497.91	1.0000000
Liberia-Gambia	9607.605	-463058.60	482273.81	1.0000000
Mali-Gambia	26590.525	-475570.78	528751.83	1.0000000
Mauritania-Gambia	-34111.940	-721724.63	653500.75	1.0000000
Niger-Gambia	56279.068	-445882.24	558440.38	1.0000000
Nigeria-Gambia	2069098.861	1617546.17	2520651.55	0.0000000
Senegal-Gambia	170109.114	-324172.02	664390.24	0.9986300
Sierra Leone-Gambia	31373.262	-423425.11	486171.64	1.0000000
Togo-Gambia	25453.588	-426099.11	477006.28	1.0000000
Guinea-Ghana	-510451.400	-862748.07	-158154.73	0.0000804
Guinea-Bissau-Ghana	-568771.060	-986806.87	-150735.25	0.0003557
Liberia-Ghana	-553140.971	-932121.78	-174160.17	0.0000668
Mali-Ghana	-536158.051	-951343.66	-120972.45	0.0010620
Mauritania-Ghana	-596860.517	-1223777.03	30056.00	0.0826396
Niger-Ghana	-506469.509	-921655.11	-91283.90	0.0030718
Nigeria-Ghana	1506350.284	1154053.62	1858646.95	0.0000000
Senegal-Ghana	-392639.463	-798258.67	12979.75	0.0702446
Sierra Leone-Ghana	-531375.315	-887822.61	-174928.02	0.0000384

Togo-Ghana	-537294.989	-889591.66	-184998.32	0.0000206
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Liberia-Guinea	-42689.572	-421670.38	336291.23	1.0000000
Mali-Guinea	-25706.652	-440892.26	389478.95	1.0000000
Mauritania-Guinea	-86409.117	-713325.63	540507.40	1.0000000
Niger-Guinea	3981.891	-411203.72	419167.50	1.0000000
Nigeria-Guinea	2016801.684	1664505.02	2369098.35	0.0000000
Senegal-Guinea	117811.937	-287807.27	523431.15	0.9998189
Sierra Leone-Guinea	-20923.915	-377371.21	335523.38	1.0000000
Togo-Guinea	-26843.589	-379140.26	325453.08	1.0000000
Liberia-Guinea-Bissau	15630.088	-425127.72	456387.90	1.0000000
Mali-Guinea-Bissau	32613.008	-439637.01	504863.03	1.0000000
Mauritania-Guinea-Bissau	-28089.457	-694171.52	637992.61	1.0000000
Niger-Guinea-Bissau	62301.550	-409948.47	534551.57	1.0000000
Nigeria-Guinea-Bissau	2075121.344	1657085.53	2493157.15	0.0000000
Senegal-Guinea-Bissau	176131.596	-287730.39	639993.58	0.9959260
Sierra Leone-Guinea-Bissau	37395.745	-384143.89	458935.38	1.0000000
Togo-Guinea-Bissau	31476.070	-386559.74	449511.88	1.0000000
Mali-Liberia	16982.920	-421072.55	455038.39	1.0000000
Mauritania-Liberia	-43719.545	-686010.62	598571.53	1.0000000
Niger-Liberia	46671.462	-391384.01	484726.93	1.0000000
Nigeria-Liberia	2059491.256	1680510.45	2438472.06	0.0000000
Senegal-Liberia	160501.508	-268497.85	589500.87	0.9965270
Sierra Leone-Liberia	21765.656	-361076.58	404607.89	1.0000000
Togo-Liberia	15845.982	-363134.82	394826.79	1.0000000
Mauritania-Mali	-60702.466	-724999.43	603594.50	1.0000000
Niger-Mali	29688.542	-440040.35	499417.43	1.0000000
Nigeria-Mali	2042508.336	1627322.73	2457693.94	0.0000000
Senegal-Mali	143518.588	-317776.42	604813.60	0.9995807
Sierra Leone-Mali	4782.736	-413930.55	423496.02	1.0000000
Togo-Mali	-1136.938	-416322.54	414048.67	1.0000000
Niger-Mauritania	90391.008	-573905.96	754687.98	1.0000000
Nigeria-Mauritania	2103210.801	1476294.28	2730127.32	0.0000000
Senegal-Mauritania	204221.054	-454139.27	862581.38	0.9995954
Sierra Leone-Mauritania	65485.202	-563773.13	694743.53	1.0000000
Togo-Mauritania	59565.528	-567350.99	686482.04	1.0000000
Nigeria-Niger	2012819.794	1597634.19	2428005.40	0.0000000
Senegal-Niger	113830.046	-347464.97	575125.06	0.9999773
Sierra Leone-Niger	-24905.806	-443619.09	393807.48	1.0000000
Togo-Niger	-30825.480	-446011.09	384360.13	1.0000000
Senegal-Nigeria	-1898989.748	-2304608.96	-1493370.54	0.0000000
Sierra Leone-Nigeria	-2037725.599	-2394172.89	-1681278.31	0.0000000
Togo-Nigeria	-2043645.274	-2395941.94	-1691348.61	0.0000000
Sierra Leone-Senegal	-138735.852	-547965.22	270493.51	0.9988471
Togo-Senegal	-144655.526	-550274.74	260963.68	0.9979511
Togo-Sierra Leone	-5919.674	-362366.97	350527.62	1.0000000

Table VIII. Post hoc analysis for item

	diff	lwr	upr	p adj
Cocoa, beans-Cassava	-916354.74	-1135160.54	-697548.94	0.0000000
Coconuts-Cassava	-1012730.62	-1206662.92	-818798.32	0.0000000
Groundnuts, with shell-Cassava	-778432.88	-953014.75	-603851.01	0.0000000
Oil palm-Cassava	-930637.04	-1210170.03	-651104.05	0.0000000
Tobacco, unmanufactured-Cassava	-1065283.94	-1262136.79	-868431.08	0.0000000
Coconuts-Cocoa, beans	-96375.88	-328953.75	136201.99	0.8460704
Groundnuts, with shell-Cocoa, beans	137921.86	-78784.29	354628.01	0.4566210
Oil, palm-Cocoa, beans	-14282.30	-321888.25	293323.64	0.9999944
Tobacco, unmanufactured-Cocoa, beans	-148929.20	-383947.86	86089.46	0.4617125
Groundnuts, with shell-Coconuts	234297.74	42737.52	425857.95	0.0065359
Oil palm-Coconuts	82093.58	-208346.05	372533.21	0.9665894
Tobacco, unmanufactured-Coconuts	-52553.32	-264608.81	159502.17	0.9812435
Oil palm-Groundnuts, with shell	-152204.16	-430096.71	125688.39	0.6243679
Tobacco, unmanufactured-Groundnuts, with shell	-286851.06	-481367.44	-92334.67	0.0003812
Tobacco, unmanufactured-Oil, palm	-134646.90	-427044.72	157750.92	0.7782552

Table IX. Post hoc analysis for unit

	diff	lwr	upr	p adj
hg/ha-ha	-182048.7	-309557.3	-54540.2	0.0023659
tonnes-ha	484391.9	362702.6	606081.1	0.0000000
tonnes-hg/ha	666440.6	544640.6	788240.7	0.0000000

Table X. Post hoc analysis for flag description

	diff	lwr	upr	p adj
FAO estimate-Calculated data	-82157.57	-247419.21	83104.08	0.6557488
FAO imputation-Calculated data	43988.88	-176078.04	264055.79	0.9825292
Official data-Calculated data	103332.86	-44265.98	250931.70	0.3119131
Unofficial figure-Calculated data	-285350.96	-531845.95	-38855.97	0.0137803
FAO imputation-FAO estimate	126146.44	-105541.24	357834.13	0.5720008
Official data-FAO estimate	185490.42	21066.73	349914.12	0.0178273
Unofficial figure-FAO estimate	-203193.39	-460116.56	53729.78	0.1960680
Official data-FAO imputation	59343.98	-160094.37	278782.33	0.9476528
Unofficial figure-FAO imputation	-329339.84	-624513.60	-34166.07	0.0198167

Conclusion

This study examines the annual cash crop production record for 58 years (1961-2018) among the sixteen (16) West African countries using secondary data from Food and Agriculture Organization (FAO). Each of the variables considered is significant at different levels and Post hoc analysis also shows that there are significance differences in mean among these levels. It also implies that a country like Nigeria with the highest average production area has the tendency to produce most of these cash crops in greater quantities than many of its West African counterparts and should make every necessary effort to maximize its production. This would ensure stable cash flow from these cash crops with tremendous positive effect on the economy despite the adverse effects of the Corona virus outbreak.

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