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- Aqueous Extracts from Lantana
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Aqueous Extracts from Lantana (*Lantana Camara*) Roots and Leaves can Control Cowpea (*Vigna Uinguculata*) Insect Pests and Improve Grain Yields

By Tendai Dorothy Vere, Rumbidzai Debra Katsaruware, Blessing Chapepa, Gerald Masikati & Rangarirai Mapuranga

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Abstract- Crop production in sub Saharan Africa is threatened by several constraints including damage by insect and mite pests and diseases. Use of synthetic pesticides is preferred in most situations the world over. However, these have negative effects on the environment; the insect pest themselves as well as on humans. A study into the evaluation of lantana (Lantana camara) leaves and roots for the control of cowpea insect pests was carried out as a field experiment at Cotton Research Institute, Sanyati District, Zimbabwe. The experiment was laid out as a Randomized Complete Block Design with six treatments replicated three times. The treatments comprised of lantana leaves and roots at 50g/l, and 75g/l each, an uncontrolled treatment and Dimethoate 40 EC at 2.5 ml/l. Effects of these treatments on aphids (Aphis craccivora), pod borer (Maruca vitrata) and foliage beetle (Ootheca mutabilis) counts and damage and grain yield were determined. The data was analyzed using Genstat 14th edition and means were separated using Duncan's Multiple Range Test. The results of the study showed that lantana leaf and root extracts significantly ($P<0.001$) reduced A. craccivora, O. mutabilis, and M. vitrata populations at 75g/l. The leaf and roots extracts performed comparably to the Dimethoate 40 EC treatment. Different application rates of leaf extracts of 50g/l and 75g/l showed the same effect on the control of all the three insect pests. Lantana roots at 50g/l and 75g/l showed a significant difference ($p < 0.001$) in the control of A. craccivora. However, the effect of lantana roots at 50g/l and 75g/l on O. mutabilis and M. vitrata was comparable. Lantana leaves, and roots have insecticidal properties, and therefore, smallholder farmers are recommended to use them at the rate of 50g/l for the control of O. mutabilis, and M. vitrata and at 75g/l for A. craccivora.

I. Introduction

Cowpea (*Vigna unguiculata* (L) Walp) is a key legume crop, which is one of the cheapest sources of high-quality proteins, vitamins, and minerals for most rural families in Africa. Although cowpea has a high grain yield potential ranging from 1.5-3.0 t/ha, the actual yields in the traditional cropping systems in Africa are consistently low as the range is between 50 and 350 kg/ha (Oyewale *et al.,* 2013). The low yields have been attributed to several biotic and abiotic factors (Kyei-Boahen *et al*., 2017; Peksen, 2007). The biotic factors that cause yield reduction include insect pests, parasitic plants as well as viral, fungal and bacterial diseases while the abiotic factors include poor soil fertility, drought, heat, acidity, and stress due to intercropping with cereals (Amatobi *et al.,* 2005; Singh *et al.,* 2003).

Some of cowpea insect pests of economic importance are aphids *(Aphis craccivora* Koch), foliage beetles *(Ootheca mutabilis)*, flower bud thrips (*Megaluro thrips sjostedti* Tryb), legume pod borer (*Maruca vitrata* Fab) and the sucking bug complex, e.g., *Clavigralla spp*, *Nezeera viridula, Aspavia armigera* (Amatobi *et al*., 2005; Kanteh *et al*., 2014*).*

There are multiple methods utilized in combating these troublesome pests ranging from synthetic chemical use, biological and cultural control methods (Barzman *et al*., 2015). Although very effective but continuous use of synthetic chemical insecticides can affect the health of humans, contaminate the environment, hurt beneficial insects such as bees earthworms and termites (Baidoo *et al.,* 2017; Tillman and Mulrooney, 2000). Utilization of synthetic pesticides for pest control around the world has caused tremendous damage to the environment, pest resurgence, pest resistance to insecticides and legal effects on non-target organisms (Oyewale *et al*., 2013). These problems brought the idea of botanical insecticides as a promising alternative to insect pest control.

Botanical insecticides are host specific, environmentally friendly, and are more compatible with the environmental components (Isman and Machial, 2006). Thus there is a need to develop cheaper and safer alternatives for insect pest control, including plant-based products (Dayan *et al.,* 2009). Many plants possess chemical substances with a remarkable

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biological activity which provides protection, and resistance against pest and herbivores (War *et al*., 2018).

The aim of this study was, therefore, to investigate the insecticidal activity of *L. camara* leaves and roots applied at different rates in controlling cowpea insect pests (*A. craccivora*, *O. mutabilis,* and *M. vitrata*).

II. Materials and Methods

a) Site description

The research was conducted at Cotton Research Institute, Sanyati District, Mashonaland West Province, Zimbabwe. The area falls under natural farming region 11 b (Mugandani *et al*., 2012). The meteorological data showed that the mean annual rainfall ranges between 800-1000mm with an average maximum temperature of 32.5°C and an average minimum temperature of 18.5°C. The area has sandy clay loamy soils (Mugandani *et al*., 2012).

b) Experimental design and treatment description

The experiment was laid out in a Randomized Complete Block Design (RCBD) with six treatments replicated three times. The treatments are described in Table 1.

Table 1: Description of treatments

Treatment	Description	Spray mixture
1	*L. camara* leaves	50 g/l of water
2	*L. camara* leaves	75 g/l of water
3	*L. camara* roots	50 g/l of water
4	*L. camara* roots	75 g/l of water
5	Uncontrolled treatment	negative control/untreated
6	Dimethoate 40 EC	2.5 ml/l of water/positive control

c) Field operations

Land preparation, basal dressing, and sowing of cowpea

The experimental site was disc plowed and harrowed to produce a fine tilth. Pegging was conducted and the site was divided into three blocks. The blocks were separated by 100 cm pathways. Plots were marked using a hoe, and each plot measured 7.2 m^2 (4 mx1.8 m), 0.7 m alleys between plots were maintained. The inter-row spacing was 0.45 m with an in-row of 0.20 m. Planting was done on the 31st of January 2018. The planting stations were marked using hoes and three seeds were placed at each planting station 4 cm deep, and then covered with soil to maintain good seed soil contact. The seeds were sown on flat land. Basal fertilizer, compound D (N_7, P_{14}, K_7 was applied at 200 kg/ha. Gap filling was done at two weeks after crop emergence (WACE). Thinning was carried out at three WACE, to leave one plant per planting station. Other operations such as weeding were conducted according to general cowpea agronomy recommended in Zimbabwe.

d) Preparation of extracts

Fresh leaves and roots of *L. camara* were collected from the Cotton Research Institute fields. These were dried under shade to avoid photo-oxidation of active ingredients (Roshanak et al., 2016). Further preparation of the plant materials were done following the procedures described by Mapuranga *et al*., (2016). The dried leaves and roots were ground to a powder using pestle and mortar. The powder for both the extracts was then sieved using a 5 mm sieve to obtain a fine powder. The powder was then measured according to treatments. The powder for a single application for each treatment, as described in Table 1, was then soaked in water for 24 hours and then filtered using a Whatman filter paper size 15. A drop of liquid soap was added to act as an emulsifier. Early application of extracts was done to prevent the photodecomposition of extracts. This was in line with the method used by (Owolade *et al*., 2004). The treatments were sprayed at 7-day intervals from 3-7 WACE after crop emergence. The remaining mixture was discarded after each application.

e) Data collection

Data was collected from three weeks after crop emergence (WACE), within three middle rows, a distance of 0.5 m from the borders was discarded on either side of the plot, and five randomly selected plants were marked with a tag. Data on main insect pests (*Aphis craccivora, Ootheca mutabilis and Maruca mutabilis*) was recorded from the tagged plants between 7:00 and 9:00 am when the insects were inactive. Pod damage, leaf damage and yield were also assessed. The aphid population density was rated based on a visual estimation scale of 1-6 (Kanteh *et al*., 2014).

Table 2: Aphid scoring system for cowpeas

Score	Number of aphids	Appearance
1	No aphids	No infestation
2	1 – 100	A Few individuals
3	101 – 300	A few isolated colonies
4	301 – 600	Several small colonies
5	601 – 1000	Large isolated colonies
6	> 1000	Large continuous colonies

Source: (Kanteh et al., 2014)

O. mutabilis population density was assessed by physically counting and recording the number of adult beetles found on the plants. Pod damage was assessed by examining the pods during their growth period. Five plants were selected at random from the net plot, and the number of damaged pods recorded separately for each plant. This was done at 7 days intervals and the counts were non-cumulative. The

number of damaged leaves was assessed to examine the occurrence of foliage beetles and leaf eaters. The number of damaged leaves was assessed, and recorded, and the counts were also non-cumulative. The yield for the entire net plot (which measured 3 m x 0.90 m) was harvested, packed according to treatments, and weighed.

f) Data analysis

Data for insect observation and yield were analyzed for Analysis of Variance (ANOVA) and significant means separated by Fishers Least Significant Difference (LSD) at 5% level of significance.

III. Results

a) Effects of L. camara plant extracts on A. craccivora population at 3 to 6 WACE

The data shows that there were no significant differences (p=0.78) among treatments means at 3 WACE. At 4 WACE, there were significant differences (p<0.001) among treatment means, with all the plant extracts treatments (*L. camara* leaves at 50g/l, *L. camara* leaves at 75g/l, *L. camara* roots at 50g/l and *L. camara* roots at 75g/l) being comparable to the dimethoate sprayed treatment. The uncontrolled treatment had the highest aphid population (Table 3). At 5 WACE, there was a significant difference (p<0.001) between treatment means, *L. camara* leaves at 50g/l, *L. camara* leaves at 75g/l, and *L. camara* roots at 75gl^{-1} were comparable to each other and had the lowest aphid population (Table 3). The uncontrolled treatment and *L. camara* roots at 50g/l had the highest aphid population (Table 3). At 6 and 7 WACE, there were no significant differences between treatment means (p>0.10) and (p>0.56), respectively.

Table 3: Effects of *L. camara* leaf and root extracts on *A. craccivora* population at 3 to 7 WACE

Treatment	WEEKS AFTER CROP EMERGENCE (WACE)				
	3	4	5	6	7
L. camara leaves 50g/l H_2O	0.6	0.2^{a}	0.07^{a}	0.133	0.00
L. camara leaves 75g/l H_2O	0.33	0.2^{a}	0.00^{a}	0.00	0.00
L. camara roots 50g/l H_2O	0.67	0.33^{a}	0.40^{bc}	0.20	0.07
L. camara roots 75g/l H_2O	0.67	0.27^{a}	0.07^{a}	0.00	0.00
Uncontrolled treatment	0.67	1.07^{b}	0.60^{c}	0.07	0.07
Dimethoate 40 EC 2.5 ml/l H_2O	0.67	0.13^{a}	0.13^{ab}	0.00	0.00
Mean	0.6	0.367	0.211	0.07	0.02
P value	0.78	< 0.001	< 0.001	0.10	0.56
LSD (5%)	0.5333	0.4064	0.2745	0.1720	0.1089
CV (%)	13	22	20	18	32
Means followed by the same letter in a column are not significantly different at p < 0.05.					

b) Effects of L. camara plant extracts on leaf damage at 5 and 6 WACE

At five weeks, there were significant differences (p<0.001) among treatment means. *L. camara* leaves at 75g/l (2 leaves), and *L. camara* roots at 75g/l (1.87 leaves) were comparable and had the least number of damaged leaves (Table 4). *L. camara* leaves at 50g/l (2.67 leaves) and dimethoate sprayed treatment (2.47 leaves) were also comparable to each other (Table 4). The uncontrolled treatment had the highest number of damaged leaves (5.0 leaves), (Table 4). At 6 WACE, there were significant differences (p<0.001) among treatment means. *L. camara* leaves at 50g/l (no damage), *L. camara* leaves at75g/l (0.33 leaves), *L. camara* roots at 75g/l (0.33 leaves) and Dimethoate (0.53 leaves) treatments had the least number of damaged leaves which were not significantly different from each other (Table 4). *L. camara* roots at 50g/l and Dimethoate treatments were also not significantly different with 1.07 and 0.53 leaves, respectively (Table 4). The uncontrolled treatment had the highest number of damaged leaves with 1.80 leaves (Table 4).

Table 4: Effects of *L. camara* plant extracts on leaf damage at 5 and 6 WACE

Treatment	WEEKS AFTER CROP EMERGENCE (WACE)	
	5 WACE	6 WACE
L. camara leaves 50g/l H_2O	2.67^{ab}	0.00^{a}
L. camara leaves 75g/l H_2O	1.87^{a}	0.33^{a}
L. camara roots 50g/l H_2O	3.33^{b}	1.07^{b}
L. camara roots 75g/l H_2O	2.0^{a}	0.33^{a}
Uncontrolled treatment	5.0^{c}	1.80^{c}

Dimethoate 40 EC 2.5 ml/l H_2O	2.47[ab]	0.53[ab]
Mean	2.89	0.678
P value	< 0.001	< 0.001
LSD (5%)	1.197	0.6745
CV (%)	27	22
Means followed by the same letter in a column are not significantly different at p < 0.05		

c) *Effects of L. camara plant extracts on O. mutabilis population at 4 to 6 WACE*

The results of the study showed that at 4 WACE; there were no significant differences (p=0.79) among treatment means. At 5 WACE; there were significant differences (p<0.001) between treatment means. *L. camara* leaves at 50g/l, and 75g/l and *L. camara* roots at 50g/l, and 75g/l were comparable with the dimethoate treatment (Table 5). The uncontrolled treatment was different from all the other treatments. At 6 WACE, there were no significant differences (p=0.59) among treatment means.

Table 5: Effects of *L. camara* plant extracts on *O. mutabilis* population at 4 to 6 WACE

Treatment	WEEKS AFTER CROP EMERGENCE (WACE)		
	4 WACE	5 WACE	6 WACE
L. camara leaves 50g/l H_2O	0.27	0.02[a]	0.73
L. camara leaves 75g/l H_2O	0.33	0.27[a]	0.67
L. camara roots 50g/l H_2O	0.40	0.33[a]	0.93
L. camara roots 75g/l H_2O	0.53	0.20[a]	0.47
Uncontrolled treatment	0.40	1.00[b]	0.87
Dimethoate 40 EC 2.5 ml/l H_2O	0.47	0.07[a]	0.73
Mean	0.40	0.34	0.73
P value	NS	< 0.001	NS
LSD (5%)	0.3836	0.4233	0.5309
CV (%)	30	08	17
Means followed by the same letter in a column are not significantly different at p < 0.05 NS- Not Significant			

d) *Effects of L. camara plant extracts on (M. vitrata) at 5 and 6 WACE*

Assessments of *M. vitrata* population started at 5 WACE, and there were significant differences (p=0.009) between treatment means. The treatments with *L. camara* leaves at 50g/l, *L. camara* leaves at 75g/l, *L. camara* roots at 50g/l, and *L. camara* roots at 75g/l were comparable with the dimethoate treatment (Table 6). The uncontrolled treatment had the highest population mean (Table 6). At 6 WACE, there were highly significant differences (p<0.001) between treatment means. The treatments *L. camara* leaves at 50g/l, *L. camara* leaves at 75 g/l, *L. camara* roots at 50g/l, and *L. camara* roots at 75g/l were not significantly different from dimethoate sprayed treatment (Table 6).

Table 6: Effects of *L. camara* plant extracts on *M. vitrata* at 5 and 6 WACE

Treatment	WEEKS AFTER CROP EMERGENCE (WACE)	
	5 WACE	6 WACE
L. camara leaves 50g/l H_2O	0.93[a]	0.60[a]
L. camara leaves 75g/l H_2O	0.47[a]	0.267[a]
L. camara roots 50g/l H_2O	1.013[a]	0.67[a]
L. camara roots 75g/l H_2O	0.93[a]	0.33[a]
Uncontrolled treatment	2.13[b]	1.40[b]
Dimethoate 40 EC 2.5 ml/l H_2O	0.53[a]	0.27[a]
Mean	1.02	0.589
P value	0.009	< 0.001
LSD (5%)	0.931	0.539
CV (%)	15	16
Means followed by the same letter in a column are not significantly different at p < 0.05		

e) *Effects of L. camara plant extracts on pod damage at 5 and 6 WACE*

At 5 WACE, there were significant differences ($p<0.001$) between treatment means. *L. camara* leaves at 75g/l had the lowest number of damaged pods (0.53 pods). *L. camara* roots at 75g/l and dimethoate treatments were comparable, and had less damaged pods than *L. camara* leaves at 50g/l, and *L. camara* roots at 50g/l. The uncontrolled treatment had the highest number of damaged pods (3.07 pods) at 5 WACE. At 6 WACE, there was a significant difference ($p<0.001$) between treatment means. The plant extracts treatments were comparable to each other and the uncontrolled treatment had the highest number of damaged pods (1.6 pods) (Table 7).

Table 7: Effects of *L. camara* plant extracts on pod damage at 5 and 6 WACE

Treatment	Number of damaged pods per plant	
	5 WACE	6 WACE
L. camara leaves 50g/l H_2O	1.20^{ab}	0.87^{a}
L. camara leaves 75g/l H_2O	0.53^{a}	0.40^{a}
L. camara roots 50g/l H_2O	2.13^{bc}	0.93^{a}
L. camara roots 75g/l H_2O	1.40^{ab}	0.47^{a}
Uncontrolled treatment	3.07^{c}	1.60^{b}
Dimethoate 40 EC 2.5 ml/l H_2O	1.07^{ab}	0.40^{a}
Mean	1.57	0.778
P value	< 0.001	< 0.001
LSD (5%)	1.09	0.56
CV (%)	10	20
Means followed by the same letter in a column are not significantly different at p < 0.005		

f) *Effects of plant extracts on cowpea yield*

Different application rates of *L. camara* leaves had no significant effect on the yield. *L. camara* leaves at 50g/l and *L. camara* leaves at 75g/l(Figure 1. Similarly, different application rates of *L. camara* roots had no significant effect on yield, however, leaf extracts had the highest yield (1902kg/ha) as compared to roots extracts, which resulted in a yield of 1444kg/ha, (Figure 1). Treatments, where leaf extracts were used had better yield than the positive control (dimethoate), which had 1756 kg/ha.

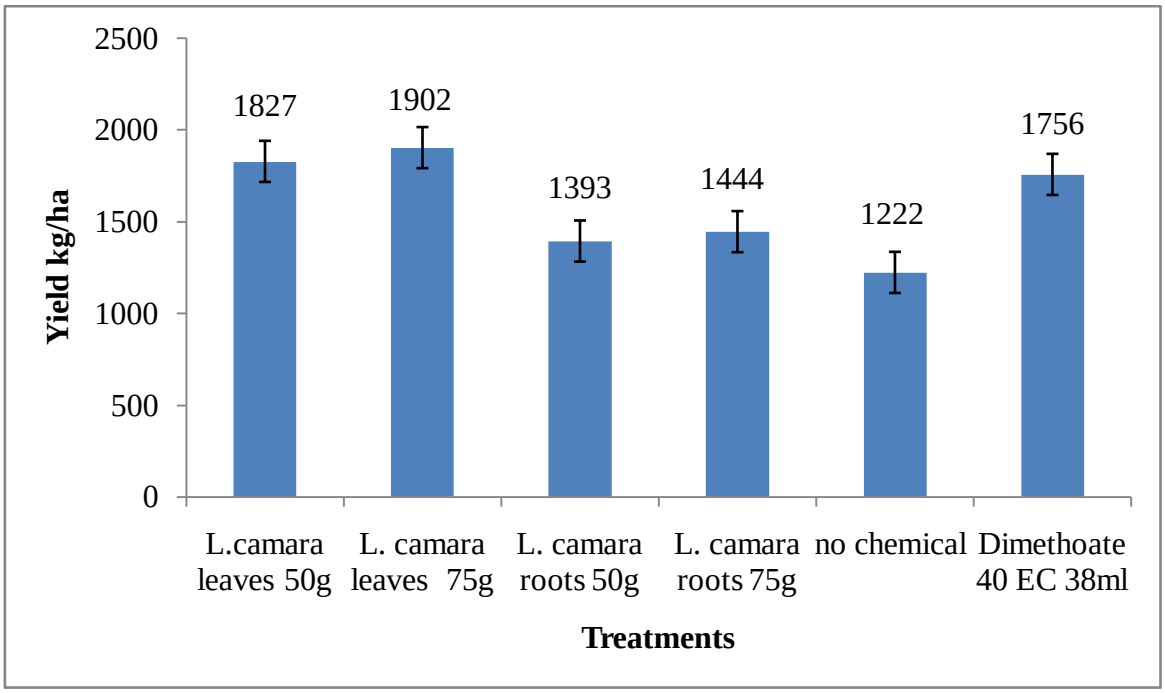

Figure 1: Effects of *L.camara* plant extracts on cowpea yield

IV. Discussion

a) Effects of L. camara plant extracts on A. craccivora population at 3 to 7 WACE

The consistent and significant decrease in the numbers of insect pests on the treated plots indicates the effectiveness of the plant extracts. *L. camara* leaf and root extracts reduced *A. craccivora* population at 4 and 5 WACE. The plant extracts showed insecticidal activity at the two application rates used (50g/l and 75g/l) on *A. craccivora* control. The finding means aphids can be controlled effectively by *L. camara* leaves and roots extracts. The use of natural products and their analogs have been done for the management of agricultural insect pests (Mvumi and Maunga, 2018). In the current study, mortality could have been due to the properties of *L. camara*, Lantadine A, and Lantadine B, which possess insecticidal properties. *Lantanine* plant metabolite from *L. camara* has been characterized as having defensive mechanisms against insect pests (Dash *et al*., 2015; Mvumi and Maunga, 2018). The obtained results corroborated the findings of Baryakabona and Mwine (2017), who found out that *L. camara* leaf extracts have pesticidal effect on the cabbage aphid. Most plants (including *L. camara*) have oils and alkaloids, which are effective as control agents against several insect pests, including aphids.

The low aphid scores on *L. camara* sprayed plots were probably due to the anti-feedent property of this plant (Yuan and Hu, 2012 and Baidoo *et al*., 2017). The results obtained concur with the work of Yuan and Hu (2012) and Isman (2005), who found out that extracts from the leaves of *L. camara* exhibited antimicrobial, fungicidal, insecticidal and nematicidal activities because it contains flavonoids, triterpenoids, and alkaloids such as lantanine which have insecticidal action. The results of this study are also in agreement with the studies done by Rajashekar *et al*., (2014), which showed that methanol extracts from *L. camara* leaf powder were efficacious against test storage pests, *Sitophilus oryzae, Callosobruchus chinesis*, *Tribolium castaneum.* This observation means they probably have an effect on other insect pests in field crops. Mvumi and Maunga (2018), also found out that *L. camara* leaves have an insecticidal effect against aphids. Seeds and leaf extract of flowering *Lantana camara* (Baidoo and Adam, 2012) have also proved efficacious against cabbage aphid (Mekuaninte *et al*., 2011).

b) Effects of L. camara plant extracts on O. mutabilis

Assessment of *O. mutabilis* population started at 4 WACE. The botanical insecticides were not effective at 4 WACE when the first assessment was done. Both Oparaeke (2006) and Isman (2008) reported that there is a time lag from the application of plant extracts, and effect observation and this is one of the main challenges of using them. The leaves and roots extracts of *L. camara* reduced the population of *O. mutabilis* at 5 WACE. The results of the study are similar to the work of Baidoo *et al*. (2017), who found out that *L. camara* leaves and roots extracts significantly reduced the numbers of the flea beetle (*Podagrica puncticollis*) on okra crop.

c) Effects of L. camara plant extracts on M. vitrata at 5 and 6 WACE

The decrease in the population of *M. vitrata* after the use of *L. camara* leaf and root extracts at 5 and 6 WACE implies that *L. camara* leaf and roots extracts can effectively control *M. vitrata*. The highest populations of *M. vitrata* were recorded in uncontrolled treatment. The results of the present study agrees with the work of Oparaeke *et al*. (2005), which shows that the aqueous leaf extracts of Neem in combination with leaf extracts of other plant species exhibited a reduction of *M. vitrata*. The suppression of *M. vitrata* numbers in cowpea flowers and pods could be due to suffocation and anti-feedant activity of *L. camara* material since the insect lives inside the preferred structures of the cowpea plant outside the reach of most insecticides (Oparaeke *et al*., 2005).

The active compounds from the plant extracts could have been absorbed by the flowers and pods through osmotic pressure and thus resulted in their anti-feedant action against the pests (Oparaeke *et al*., 2005). Another explanation could be that as the flowers or pods absorbed the spray liquid, the soft body of *M. vitrata* larvae inside the plant parts could have absorbed the active substances causing their death. The explanation above is supported by the observation that when flowers or pods of plants sprayed with these extracts were opened, some moribund *M. vitrata* larvae were seen.

d) Effects of treatments on cowpea yield

The less the cowpea that was affected by the insect pests, the more the yield because leaves had the opportunity to manufacture food for the development of the pods. Thus the leaf area index was reduced and consequently the quantities of carbohydrates that contribute to plant biomass thereby resulting in low yields of cowpea

V. Conclusion and Recommendations

a) Conclusion

L. camara leaf and root extracts have an insecticidal effect on the control of *A. craccivora*, *O. mutabilis,* and *M. vitrata* in cowpeas. The consistent and significant reduction in pest's numbers on *L camara* treatments indicated the effectiveness of the plant extracts in reducing insect pests numbers. The study also showed that applying root extracts at 75g/l was most effective in *A. craccivora* control. For *O. mutabilis* and *M. vitrata*, 50g/l and 75g/l showed the same effect for both the leaf and root extracts.

b) Recommendations

The results of this study can lead to the recommendation that farmers can use L. camara leaf, and roots extracts to control O. mutabilis and M. vitrata at 50g/l. A. craccivora can be controlled with 50g/l and 75g/l of leaf and root extracts respectively.

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Growth and Export Performance of Rice from India

By K. Nirmal Ravi Kumar

Abstract- With the emergence of World Trade Organization (WTO) in 1995, it was expected that India would be benefited through multilateral trade, as it enjoys comparative advantage with reference to majority of the agricultural commodities and also fulfill the import requirements like pulses, edible oils, technology etc. In this context, this study pertains to analyse the growth and export performance of Indian (non-basmati) rice in the international market, as its performance has undergone paradigm shift through the tremendous structural and qualitative changes. The important research questions viz., growth in export performance, export competitiveness of Indian rice and the dynamic nature of its trade pattern during through employing the first order Markov process were analysed in this study. It was found that though India is the world's largest rice exporting country, it has been facing stiff competition from neighboring Asian countries like Thailand and Vietnam majorly. Though the growth rate in MSP of paddy is on the decline during post-WTO regime compared to pre-WTO regime, this is sufficient enough to escalate the DMPs at a faster pace over and above its IPs. However, as rice being the staple food crop in India, the imports both in terms of quantity and value showed declining trend and on the contrary, the exports both in terms of quantity and value showed significant increasing trend during both pre and post-WTO regimes.

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Growth and Export Performance of Rice from India

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I. Introduction

Economic reforms and trade liberalization policies have been widely adopted by developing countries to improve their position in world trade. Since 1991, India entered the Liberalization-Privatization-Globalization (LPG) phase to overcome its debt crisis, food shortage and at the same time to gain from net agricultural exports, as it enjoys comparative advantage for majority of the agricultural commodities. With the advent of this LPG phase, more focus is now given towards export promotion through enhancing both domestic and export competitiveness of agricultural commodities. Emphasis on cost-effective and quality production of agriculture gained more significance. With the emergence of World Trade Organization (WTO) in 1995, it was expected that India would be benefited through multilateral trade, as it enjoys comparative advantage with reference to majority of the agricultural commodities and also fulfil the import requirements like pulses, edible oils, technology etc. In this context, a number of studies investigated the effects of trade liberalization on export performance of agricultural commodities in India. Many studies have identified positive effects of trade liberalization on export performance of majority of the agricultural commodities. In the post-WTO regime, Indian agricultural commodities exports performance has undergone paradigm shift through the tremendous structural and qualitative changes (Kehar Singh and InderSain, 2003).

India is the second most populous country with the fifth largest economy occupying only 13th position in world trade and earning 623 billion dollars of merchandise trade and 294 billion dollars of services trade. In India, agriculture exports have significantly increased by multiple folds from Rs. 60.12 billions to Rs. 2266 billion and registered impressive growth rates during 1990-91 to 2016-17. However, there is huge trade deficit of US$184 billion (US$330 billion of exports and US$514 billion of imports) in 2018. It is now exporting 7500 products to 190 countries and importing 6000 products from 140 countries, enjoying trade surplus with USA, UK, Bangladesh, Sri Lanka, Nepal, UAE, Hongkong, Singapore, Netherlands, Germany, Belgium, Vietnam, Malaysia, Italy etc., and having trade deficit with China, Saudi Arabia, Iraq, Iran, Switzerland, South Korea, Indonesia, Australia, Qatar, Nigeria etc. India's agricultural exports in 2018 were valued at 38.74 billion US dollars and they accounted for 11.76 per cent of the total exports from India. Main agricultural exports were marine products, basmati rice, beef, non-basmati rice, cotton, oilseed meal, spices etc. The agricultural imports into the country in 2018 were valued at 20.35 billion US dollars and they constituted only four per cent of total imports. Main imports were edible oils, pulses, spices, cashews etc. India's share of world exports was 0.53 per cent in 1994 before the WTO came into existence and this share was increased to 1.71 per cent in 2019.

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India's share of world imports in 2019 reached 2.5 per cent from about 0.7 per cent in 1994. India enjoys competitive advantage in several commodities for agricultural exports because of near self-sufficiency of inputs, relatively low labour costs and diverse agro climatic conditions. These factors have enabled export of several agricultural commodities over the years. In the basket of agricultural exports, rice is one of the major exporting commodities from India. While India holds an important position in the export market for rice, in the next decade, India is likely to witness changes in its export pattern due to both internal and external constraints. One of the major internal constraints is mounting cost of production. Similarly, one of the most important external constraints include excessive subsidization by importing countries makes Indian rice less competitive in the international market. So, the important research questions in this study include: to analyse the growth dynamics of exports, imports, Minimum Support Prices (MSPs), Domestic Market Prices (DMPs) and International Prices (IPs) of rice, to analyse the export competitiveness of rice across major importing countries during both pre and post-WTO regimes and to study the changes in size and direction of exports of rice from India.

II. Methodology

In this study, the researcher examines the computation of Compound Growth Rates (CGRs) for exports, imports, MSPs, DMPs and IPs of rice, computation of Nominal Protection Coefficients (NPCs) to analyse the export competitiveness and first order Markov process was employed to analyse dynamic nature of trade pattern to examine the gains and losses in respect of export shares of Indian rice across major importing countries. The secondary information on exports, imports, DMPs, IPs, exchange rates, export trade data, trade destinations, transportation and storage costs, port charges, freight charges, exchange rates etc, are collected from different authentic sources such as Directorate of Economics and Statistics (DES), Statistical Year Book (2018), Director General of Foreign Trade (DGFT), Food and Agriculture Organization (FAO), State Agriculture Produce, Processing and Export Corporation Ltd, Container Corporation of India etc.

III. Statistical Techniques Employed

The following techniques are employed to arrive at the realistic conclusions from the study:

- *Compound Growth Rates (CGRs):* CGR analysis is employed through fitting the exponential function to the variables of interest viz., exports, imports, MSPs, DMPs, and IPs of rice at All-India level during both pre and Post-WTO regimes. The CGRs are calculated by fitting the exponential function: $Y_t = Y_O (1 + r)^t$
- *Nominal Protection Coefficient (NPC):* The NPCs were estimated for rice under exportable hypothesis during both pre and post-WTO regimes in order to measure the extent to which DMPs diverge from border equivalent prices (IP). That is, under exportable hypothesis, the domestic goods compete with a foreign product at the foreign port or in foreign market. It was estimated as follows:
  $NPC = P_d/P_b$
  Where, P_d = DMP; and
  P_b = the border equivalent producer price.
  An NPC greater than one would show that the DMP of the commodity exceeded the border price, which discouraged the export of rice.
- *Markov Chain Analysis:* The changes in the exports of rice to different countries was analyzed by employing a first order finite Markov chain model which captured the net effect in changes in its exports over a period of time. There is a growing awareness of the usefulness of this technique for analysis and forecasting in many areas including exports, particularly when the process is constant but has a gradual change (Eswarprasad *et al*., 1997).

In this report, the structural change in the exports of selected commodities from India in terms of market retention and market switching was examined by using the Markov chain approach. The estimation of the Transitional Probability Matrix (TPM, (P)) was central to this analysis. The element P_{ij} of the matrix indicated the probability that the exports would switch from the i^{th} country to j^{th} country over a period of time. The diagonal elements P_{ij} indicated the probability that the export share of a country would be retained in the successive time periods, which in other words, measured the loyalty of an importing country to a particular exporting country. In the context of the current application, eleven major importing countries (including all other countries grouped under 'others') are considered for rice. The average exports to a particular country was considered to be a random variable which depended only on its past exports to that country and which was denoted algebraically by the following equation:

$$E_{jt} = \sum_{i=1}^{r} E_{it-1} P_{ij} + e_{jt}$$

Where,
E_{jt} = Exports from India to the i^{th} country during the year 't'
E_{it-1} = Exports to the i^{th} country during the year 't – 1'
P_{ij} = Probability that exports will shift from the i^{th} country to j^{th} country

e_{jt} = Error-term which is statistically independent of e_{jt-1}, and

r = Number of importing countries

The transitional probabilities P_{ij}, which can be arranged in a (c × r) matrix, had the following properties:

$$0 \leq P_{ij} \leq 1$$

$$\sum_{i=1}^{r} P_{ij} = 1 \text{ for all i}$$

The expected export-share of India during a particular period, 't' was obtained by multiplying the quantity of exports to the selected countries(eleven in the present study) during the previous period (t–1) with the estimated TPM (P). There are several approaches to estimate the transitional probabilities of the Markov chain model such as un weighted restricted least squares, weighted restricted least squares, Bayesian maximum likelihood, unrestricted least squares, *etc.* In the present study, Minimum Absolute Deviations (MAD) estimation procedure was employed to estimate the transitional probability, which minimizes the sum of absolute deviations. The conventional Linear Programming (LP) technique was used, as this satisfies the properties of transitional probabilities of non-negativity restrictions and row sum constraints in estimation (Mandana *et al.,*1998 and Hugar, 2002). The LP formulation on analysis was stated as per expression given below:

$$\text{Min } O P^* + I_e$$

Subject to,

$$XP^* + V = Y$$

$$GP^* = 1$$

$$P^* \geq \phi$$

where, P* is a vector of the probabilities P_{ij}; O is a null vector; I is an appropriately dimensional vector of areas; e is the vector of absolute errors (|U|); Y is the vector of exports to each country; X is a block diagonal matrix of lagged values of Y; V is the vector of errors; and G is a grouping matrix to add the row elements of P arranged in P* to unity.

P* vectors were arranged to obtain the transitional probability matrix which indicated the overall structure of the transitions that had taken place in the system. Essentially, the transitional probability matrix captures the dynamics of the changes in raw cotton exports from India. The individual probabilities P_{ij} indicate the probability of the shift from the country i to country 'j'.

IV. Results and Discussion

a) Destination-wise exports of rice

Rice is exported from India to many countries in the world. In fact, India is facing stiff competition in the international market for the export of (non-basmati) rice. India is the world's largest rice exporting country. Thailand is another large exporter of rice, but currently the demand for Thailand rice has steeply declined in the international market due to which India is likely to the world's largest exporter of rice. However, rice exports have been facing stiff competition from some of the neighboring Asian countries like Thailand and Vietnam majorly. Total India's exports of rice registered at 8.68 lakh tonnes during 1992-94 (pre-WTO regime) which increased by multiple folds to 106 lakh tonnes during 2014-2016. While in post-WTO regime, major rice importing countries from India include Saudi Arabia (10.03%), Iran (7.87%), UAE (6.73%), Senegal (6.69%), Benin (5.74%), Nepal (4.76%), Bangladesh (4.53%), Iraq (4.37%), Guinea (3.82%) etc (Table 1). In pre-WTO regime, about 94 countries imported rice from India and out of this, around 55 per cent of rice exports from India are concentrated in Saudi Arabia, United Kingdom and UAE, whereas in post -WTO regime, the rice exports from India spread to around 143 countries in the world. India emerged as the largest exporter of rice during last decade in the global market over Thailand and Vietnam. Lifting the ban on exports of rice by the Government of India, increased international demand after declined supply from the major exporting countries viz., Thailand and Vietnam and depreciating currency are the major factors contributed India for being the largest exporter of rice in the global market in recent times.

The recent developments in the Indian rice (non-Basmati rice) segment in the domestic as well as the international markets are not encouraging for the Indian rice millers, since the MSP hike has been significant during 2018-19, as against a range bound hike in the past. The increase in the MSP could result in an increase in the acreage for sowing, thus ensuring higher availability of rice for exports, on the other hand this sharp increase of MSP would increase the DMP, thereby making Indian rice costlier in the global markets, which could impact adversely on rice exports. Moreover, with the imposition of the higher import duties by the member nations (say, Bangladesh imposed a duty of 28%), the exports to member nations are likely to decline. India is facing stiff competition in the international market from Thailand, Vietnam, USA and Pakistan. There was a considerable growth in the export of rice from India during the post-WTO regime (Table 2).

Table 1: Country wise rice exports from India during Pre and Post-WTO regimes

Pre-WTO regime TE (1992-94)			Post-WTO regime TE (2014-16)		
Countries	Export Quantity (lakh tonnes)	% share in total rice exports from India	Countries	Export Quantity (lakh tonnes)	% share in total rice exports from India
Saudi Arabia	3.19	36.80	Saudi Arabia	10.74	10.03
United Kingdom	0.90	10.42	Iran (Islamic Republic of)	8.42	7.87
United Arab Emirates	0.63	7.27	United Arab Emirates	7.20	6.73
Netherlands	0.51	5.88	Senegal	7.16	6.69
Kuwait	0.45	5.21	Benin	6.14	5.74
Bangladesh	0.42	4.83	Nepal	5.09	4.76
Sri Lanka	0.24	2.74	Bangladesh	4.85	4.53
Iran (Islamic Republic of)	0.22	2.56	Iraq	4.68	4.37
Kenya	0.20	2.35	Guinea	4.09	3.82
Malaysia	0.17	1.94	Côte d'Ivoire	3.26	3.05
Germany	0.16	1.87	South Africa	3.03	2.83
USA	0.14	1.60	Turkey	2.68	2.51
Togo	0.14	1.57	Somalia	2.54	2.38
Singapore	0.13	1.51	Sri Lanka	2.42	2.26
Oman	0.12	1.32	Liberia	2.37	2.22
Bahrain	0.11	1.30	Yemen	2.25	2.10
Others	0.93	10.75	Others	30.07	28.10
Total	8.68	100.00	Total	106.99	100.00

Raw Data Source: www.fao.org

b) Growth rates of exports and imports

CGRs of exports and imports both in terms of quantity and value (Table 2) are worked out for rice during both pre and post-WTO regimes, so as to ascertain the trends and prospects in international trade. It is heartening to note that the exports both in terms of quantity and value had shown positive and significant growth rates during post-WTO regime. Further, the growth in exports both in terms of quantity and value are higher during post-WTO regime compared to pre-WTO regime. As expected, rice being the staple food crop in India, the imports both in terms of quantity and value showed declining trend. On the whole, during overall reference period 1980-2016, the growth rates of exports outweigh the growth rates of imports for rice.

Table 2: Growth rates (%) of Exports and Imports of Rice from India

Particulars		Growth Rate (%)
Pre-WTO regime (1980-1994)	Export quantity	10.22NS
	Export value	17.13**
	Import quantity	-6.48NS
	Import value	-2.03NS
Post-WTO regime (1995-2016)	Export quantity	18.16**
	Export value	32.74**
	Import quantity	-18.35NS
	Import value	-1.79NS
Overall period (1980-2016)	Export quantity	18.16**
	Export value	26.87**
	Import quantity	-36.76**
	Import value	-30.23**

*Note: ** - Significant at 1% level; NS – Non-significant Raw Data Source: www.fao.org*

In the recent period, as cheaper rice from countries such as China and Thailand begins to enter into India's traditional markets in Africa, the concerned rice exporters in India are looking to the Government for incentives to sustain their markets. This is because, an increase in MSP for paddy, coupled with strengthening rupee against the dollar, has turned the Indian rice expensive in the world market and consequently the rice shipments got affected. The rice shipments fell to 7.11 lakh tonnes during April-May, 2019 from 15.25 lakh tonnes in the corresponding period last year, 2018. In value terms, the shipments slumped to $294 million from last year's $652 million during this reference period. In July, 2019, the Indian rice is expensive by 5-10 per cent compared with other traditional competitors such as Thailand, Vietnam, Pakistan and Myanmar. However, the entry of Chinese rice into the markets in 2019 has compounded the problem for Indian exporters. Chinese State agency, China Oil and Foodstuffs Corporation (COFCO) is out in the market to liquidate old stocks of 3-4 m. tonnes and is targeting markets in Africa, including Egypt. India has around 50 per cent share in African rice market, estimated at around 15 m. tonnes annually. So, India's rice shipments slowed down during October-December, 2018 due to the impact of the higher paddy MSP, which saw an increase of 13 per cent for the kharif 2018 season. The announcement of five per cent Merchandise Exports from India Scheme (MEIS)* helped offset the impact of higher MSP. A further increase of 3.7 per cent in MSP for kharif 2019 has added to the exporters' challenge. The Government should look at a scheme such as Bhavantar Bhugtan Yojana (which sought to provide relief to farmers by providing the differential between MSPs and DMPs) ie., direct cash transfer instead of increasing MSP.

c) Growth in MSPs, DMPs and IPs

In all the three reference periods, MSPs, DMPs and IPs of rice recorded positive and significant growth rates (at 1% level), except for IPs during pre-WTO regime (recorded negative growth rate, though non-significant (Table 3). It is interesting that, the growth rates of MSPs and DMPs are much higher than IPs during the three reference periods. Further, the growth rate of MSPs is higher than growth rate of DMPs during the pre-WTO regime, unlike post-WTO regime and overall reference period. This highlights three important aspects: Firstly, the rise in MSPs of paddy by the Government of India has escalated its COP and hence, its DMPs (during pre-WTO regime). Secondly, there is slow pace of increase in MSPs of paddy during post-WTO regime compared to pre-WTO regime (with a view to reduce the cultivation of paddy as a second crop in rabi season and also considering mounting buffer stocks in Food Corporation of India (FCI) godowns), but this is sufficient enough to escalate the DMPs at a faster pace over and above its IPs. Thirdly, the higher growth rates of MSPs of paddy over and above its IPs is a warning signal for losing the export competitiveness in the international market. Further, the positive and significant growth rates of MSPs of paddy during overall reference period and also during the sub-periods imply that, the farmers are encouraged to escalate the COC and COP of these crops. This price movement from MSP to COP and to DMP for rice will have a direct relation with its export competitiveness. That is, rise in MSPs of rice have an indirect influence on their export performance from the country.

* - MEIS was introduced in the Foreign Trade Policy (FTP) for the period 2015-2020. The MEIS was launched as an incentive scheme for the export of goods. The rewards are given by way of duty credit scrips to exporters. The MEIS is notified by the DGFT (Directorate General of Foreign Trade) and implemented by the Ministry of Commerce and Industry. Under the FTP 2015-20, MEIS intends to incentivize exports of goods manufactured in India or produced in India. The incentives are for goods widely exported from India, industries producing or manufacturing such goods with a view to making Indian exports competitive. The MEIS covers goods notified for the purpose of the scheme.

Table 3: Growth in MSPs, DMPs and IPs of Indian rice

Period	Prices	Growth Rate (%)
Pre-WTO - regime (1990-1994)	DMP#	4.07**
	MSP#	14.00**
	IP	-1.97 NS
Post-WTO - regime (1995-2017)	DMP	8.61**
	MSP	7.24**
	IP	5.60**
Overall reference period (1990-2017)	DMP	7.90**
	MSP	7.43**
	IP	3.99**

*Note 1: ** - Significant at 1% level; NS – Non-significant;*
Note 2: # - DMPs correspond to Telangana State, IP is an average price of major exporting countries in respective periods
Raw Data Source: Directorate of Economics and Statistics, Government of India;
Commission for Agricultural Costs and Prices Reports
Food and Agriculture Organization (FAO)

d) Export Competitiveness of Indian rice

The export competitiveness of Indian rice was examined by using NPC. This is a measure of actual divergence or distortion DMP and IP or border price. The NPCs were calculated under exportable hypothesis (implying the domestic good competes at a foreign port)for three years viz., pre-WTO regime (1992-93) and post-WTO regime (2005-06 and 2017-18). These NPCs are estimated for three major exporting counties under each commodity and this highlights the comparative advantage the commodity that enjoys in the international market. If NPC is less than 0.5, the commodity is highly competitive, if it is between 0.5 to 0.1, it can be judged as moderately competitive and if the NPC is more than, then the commodity is not competitive for export into the international market. The NPCs for rice are estimated to the three major export destinations viz., Saudi Arabia, Iran, UAE for the above said three years (Table 4). It is evident that, rice is moderately competitive in Saudi Arabia (0.619) and UAE (0.800) from Telangana and not export competitive in Iran (1.813) during pre-WTO period, 1992-93. However, during the recent post-WTO period (2017-18), this commodity gained export competitiveness across all the above three countries.

Table 4: NPCs of Indian rice from Telangana to major importing countries during pre and post-WTO regimes

Countries	Pre-WTO period	Post - WTO period	
	1992-93	2005-06	2017-18
Saudi Arabia	0.619	0.973	0.841
Iran	1.813	1.065	0.841
UAE	0.800	1.000	0.842

Note: DMPs correspond to Telangana, IP is an average price of major exporting countries in respective periods
Raw Data Source: Commission for Agricultural Costs and Prices Reports,
Food and Agriculture Organization (FAO),
Container Corporation of India, Hyderabad

The trends in the NPCs during post-WTO regime indicated that Telangana's comparative advantage has improved for rice compared to pre-WTO regime. So, Telangana enjoy a great advantage to specialize in the production and export of rice to earn the valuable foreign exchange. The country also needs to capitalize this advantageous position thereby, ensuring its position in the international market as a stable and dependable source of low-price good-quality produce in the world. It is to be noted that the NPC values are often influenced by the individual countries' internal and external trade policies like Government interventions, import restrictions, subsidies and high tariffs, etc. Even the quality of produce also affects the trade prospects of a commodity in the international market.

e) Trade Direction of rice from India

The dynamics of changes in the export trade of rice from India was studied through the estimation of a Markov probability matrix. The probability of retaining the previous period market share (gain or loss) is interpreted by studying the diagonal and off diagonal elements of TPM. The major importing countries taken for the analysis of trade in rice exports during the post-WTO regime (2006-07 to 2016-17) were Benin, Côte d'Ivoire, Iran, Nepal, Saudi Arabia, Senegal, South Africa, UAE, Iraq, Guinea, Somalia and along with the remaining importing countries grouped under 'others'. That is, there are eleven major countries importing Indian rice in large quantity and rest of countries are pooled under 'others' category. The diagonal elements in the TPM (Table 5) for rice exports provide the information on the probability of retention of the trade, while row elements indicate the probability of loss in trade on account of competing countries. The column elements indicate the probability of gain in trade from the competing countries. TPM revealed that Saudi Arabia was found to be the most stable importer of Indian rice, as it retained its original share of around 30.40 percent which was the highest among the importing countries. It lost its remaining share of 69.60 percent to UAE, Iran and Nepal. That is, Saudi Arabia was the largest buyer of Indian rice followed by other traditional buyers like UAE, Iran, Nepal, Benin, Senegal and South Africa. UAE was also found to be stable with 5.60 percent retention of its shares, while losing major share of 94.40 percent to Saudi Arabia, Iran, Benin, Côte d'Ivoire and other countries. Côte d'Ivoire was also found to be stable with 7.20 percent of retention of its shares, while losing major share of 92.80 percent to Saudi Arabia, South Africa, Somalia, UAE and other countries. Other countries were also found to be stable with 35.70 percent of retention of their shares, while losing a share of 64.30 percent to Saudi Arabia, UAE and Benin. Superior quality of grain has made Indian rice more acceptable across the countries in the international market. The launch of paddy pledging scheme (under which 50% more price was offered than the open market price for boosting the farmers' income) by other major producers like Thailand has helped India to achieve record performance in rice exports in recent times. The higher exports to Saudi Arabia, UAE, Nepal etc., and retentions by major countries could be due to high export competitiveness of Indian rice across these countries.

It is also revealed from Table 5 that 'other' countries and Saudi Arabia were the stable markets for Indian rice among the importing countries, as reflected by high retention probability of 35.70 and 30.40 percents respectively. This was reflected in fact that India's share in total import of rice by Saudi Arabia would be on increasing trend in the future years. Next to 'other' countries and Saudi Arabia, Côte d'Ivoire is also a major importer of rice, as its retention probability is 7.2 per cent. India could not retain the previous export shares to Senegal and hence, this is an unstable market for rice, as it is having probability of retention of zero.

Table 5: TPM of rice exports from India (2006-07 to 2016-17)

Countries	Benin	Côte d'Ivoire	Iran	Nepal	Saudi Arabia	Senegal	South Africa	UAE	Iraq	Guinea	Somalia	Others
Benin	0.022	0.054	0.002	0.055	0.193	0.027	0.066	0.056	0.000	0.008	0.032	0.484
Côte d'Ivoire	0.023	0.072	0.004	0.034	0.133	0.028	0.083	0.049	0.002	0.021	0.034	0.516
Iran	0.019	0.097	0.002	0.036	0.118	0.020	0.043	0.078	0.003	0.032	0.016	0.535
Nepal	0.004	0.002	0.069	0.010	0.211	0.001	0.003	0.192	0.002	0.002	0.000	0.503
Saudi Arabia	0.002	0.002	0.170	0.010	0.304	0.000	0.001	0.291	0.005	0.000	0.000	0.214
Senegal	0.000	0.000	0.168	0.014	0.279	0.000	0.011	0.297	0.009	0.000	0.000	0.221
South Africa	0.017	0.025	0.116	0.013	0.146	0.018	0.037	0.171	0.026	0.001	0.010	0.422
UAE	0.045	0.065	0.083	0.027	0.081	0.083	0.037	0.056	0.025	0.024	0.008	0.465
Iraq	0.121	0.027	0.161	0.037	0.086	0.070	0.041	0.039	0.022	0.020	0.010	0.367
Guinea	0.054	0.019	0.092	0.048	0.098	0.062	0.030	0.042	0.021	0.030	0.017	0.487
Somalia	0.050	0.037	0.076	0.047	0.109	0.082	0.026	0.070	0.043	0.035	0.023	0.401
Others	0.069	0.036	0.067	0.047	0.093	0.055	0.029	0.092	0.07	0.052	0.032	0.357

Raw Data Source: www.fao.org

V. Summary and Conclusions

From study, it was concluded that though India is the world's largest rice exporting country, it has been facing stiff competition from some of the neighboring Asian countries like Thailand and Vietnam majorly. Recently, as cheaper rice from countries such as China and Thailand begin to enter into India's traditional markets in Africa, it is posing severe threats to Indian rice exports. Though the growth rate in MSP of paddy is on the decline during post-WTO regime compared to pre-WTO regime, but this is sufficient enough to escalate the DMPs at a faster pace over and above its IPs. This rise in MSPs of rice have an indirect influence on their export performance from the country. However, as rice being the staple food crop in India, the imports both in terms of quantity and value showed declining trend and on the contrary, the exports both in terms of quantity and value showed significant increasing trend during both pre and post-WTO regimes. The NPCs estimated to the three major export destinations viz., Saudi Arabia, Iran, UAE revealed that rice is moderately competitive across these countries during post-WTO regime. The TPM of rice revealed that Saudi Arabia is its loyal destination among the various importing countries. An increasing demand for Indian rice is found in countries like Saudi Arabia and Côte d'Ivoire. So, it is high time that the consumer preferences in newer markets, market intelligence and impediments for augmenting exports need to be researched. Further, it is essential to make available to exporters the new markets' requirement of SPS restrictions.

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Demonstrative Study of the Effectiveness of Low Cost Gully Rehabilitation Measures: The Case of Bonk District SNNPR, Ethiopia

By Wudnesh Naba, Birhanu Wolde & Abiy Gebremichael

Abstract- Gully erosion is the major environmental problem threatening the huge areas of agricultural land in Southern Ethiopia, particularly the Gamo Gofa zone of Bonke district. The present study is aimed at evaluating and demonstrating low- cost gully treatment methods for gully rehabilitation in Bonke district SNNPR, Ethiopia. Three treatments namely, Brushwood check dam+ trench+ head apron, brushwood with stone check dam+ trench+ head apron, and Stone check dam+ trench+ head apron) established in 6 gullies. Building the check-dams, Jatropha, elephant grass, and banana were planted. Data such as sediment deposition and biomass production were collected to investigate their effectiveness in reducing soil erosion and biomass production. Also, the costs for establishing the rehabilitation measures were collected. The Considerable differences among the tested trials in reducing soil erosion and biomass production was not observed. However, the rehabilitation measures maintained the restoration of grass and shrub species as well as the improvement of soil fertility. It is detected that the cost of establishing brushwood check damis considerably low compared to the other tested methods.

Keywords: *check-dam, grasses biomass, gully rehabilitation, low cost.*

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Abstract- Gully erosion is the major environmental problem threatening the huge areas of agricultural land in Southern Ethiopia, particularly the Gamo Gofa zone of Bonke district. The present study is aimed at evaluating and demonstrating low- cost gully treatment methods for gully rehabilitation in Bonke district SNNPR, Ethiopia. Three treatments namely, Brushwood check dam+ trench+ head apron, brushwood with stone check dam+ trench+ head apron, and Stone check dam+ trench+ head apron) established in 6 gullies. Building the check-dams, Jatropha, elephant grass, and banana were planted. Data such as sediment deposition and biomass production were collected to investigate their effectiveness in reducing soil erosion and biomass production. Also, the costs for establishing the rehabilitation measures were collected. The Considerable differences among the tested trials in reducing soil erosion and biomass production was not observed. However, the rehabilitation measures maintained the restoration of grass and shrub species as well as the improvement of soil fertility. It is detected that the cost of establishing brushwood check damis considerably low compared to the other tested methods. Given there are no considerable differences in rehabilitating gullies among the tested methods, Brushwood check-dam could be preferred by farmers. The results support that adopting the tested gully rehabilitation measures and implementing them larger scales could running the rehabilitation of gullies and change them to productive land.

Keywords: check-dam, grasses biomass, gully rehabilitation, low cost.

I. Introduction

Gully erosion constitutes to be an environmental and social problem in many parts of Ethiopia (FAO, 2003).Soil erosion caused by Overgrazing and low vegetation cover is the main drivers for the creation of gullies (Abate, 2011). Because of the creation of small (<3m deep and drainage area of<20ha) to Medium (up to 3m and drainage area 20-60ha), large areas of agricultural lands are lost or have become unsuitable for cultivation (Mehretie and Woldeamlak, 2012).

Gully expansion was observed to be high in Southern Ethiopia, and mainly caused by the uilding of poorly designed roads. For example, Belayneh *et al.* (2014) showed that 20 new gullies had been created down the slope of the Hadero Tunto Durgi construction. Their development is found to be associated mainly with culverts by and roadside ditches. This study further elaborated that the rate of soil loss due to the formation gullies was estimated at 12.86tha^{-1}y^{-1}, and the total damaged area estimated at 1.6ha in 6 years' time span. studies (e.g., Alemu and Awdenegest, 2014) conducted in the southern region demonstrated that the long term gully erosion rate at watershed level is about 2.12tha^{-1}y^{-1}, with the total surface area covered by gullies ranged from 0.7 to 2ha, and estimated total volume of soil loss was varied between 8,700m3 and 36,000m^3. The most critical aspect of gully erosion control is the stabilization of gully beds. Technically it is possible to stabilize the gully head before the gully bed has achieved its stability, but only if it is possible to predict with some degree of certainty the ultimate profile, i.e., elevation of the gully bed. There is usually more than one option to threaten gully erosion. A better understanding of these gully erosion processes will result in more effective erosion control at less cost (Nissen *et al.,* 2004).The major issue is finding the treatment option that best suits the local environment and the affected land. Though there have been numerous attempts to control gully erosion in the region, the problem is still persistent (Alemu and Awdenegest, 2014). The reason was that little had been discussed about ways to prevent their onset or the use of community-based low-technology to prevent its development. Therefore, the reason for this is the cost of gabions to protect the gullies, lack of awareness regarding the degree of gully expansion by the community to rehabilitate marginal lands. Therefore, the use of low-cost materials for gully rehabilitation is essential to prevent the enlargement of gully erosion. Accordingly, the objective of the study was to demonstrate the effectiveness of different gully treatment methods for gully rehabilitation.

II. Materials and Methods

a) Description of the Study Area

The study was carried out in Bonkeworeda, Southern Ethiopia (Figure. 1). Bonke is one of the 15 woredasin Gamo Gofa Zone and lies between 5°55′N

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latitude and 37°15′E longitude with an altitude ranges from 600 to4200 masl. The land area of the Woreda is estimated to be 85,940 km^{2}andbordered on the south by the Dherashe and Alleworeda, on the west by the Weito River which separates it from Kemba, on the northwest by Deramalo, on the north by Dita, and on the eastby Arba Minch Zuriaworeda. The agro-ecology of the woreda is classified in to three zones: Dega (covers 46% of the land area), Woina Dega (30%), and Kola (24%). The mean annual average rainfall and temperature of the woreda are 1400 mm and 13.05°C, respectively (Guyo, 2016). The estimated human population of the woreda was about 205, 73of, which 102,458 males and 103,281 are females (BoFED, 2015).The soil type of the study woreda is Vertiso land Acrisols. Acrisols is the dominant soil type in the area which covers (84%). The land use pattern is dominated by agricultural land. The woreda Altitude ranges of 709-3467m.a.s.l (Meter above sea level) (FAO, 2012).

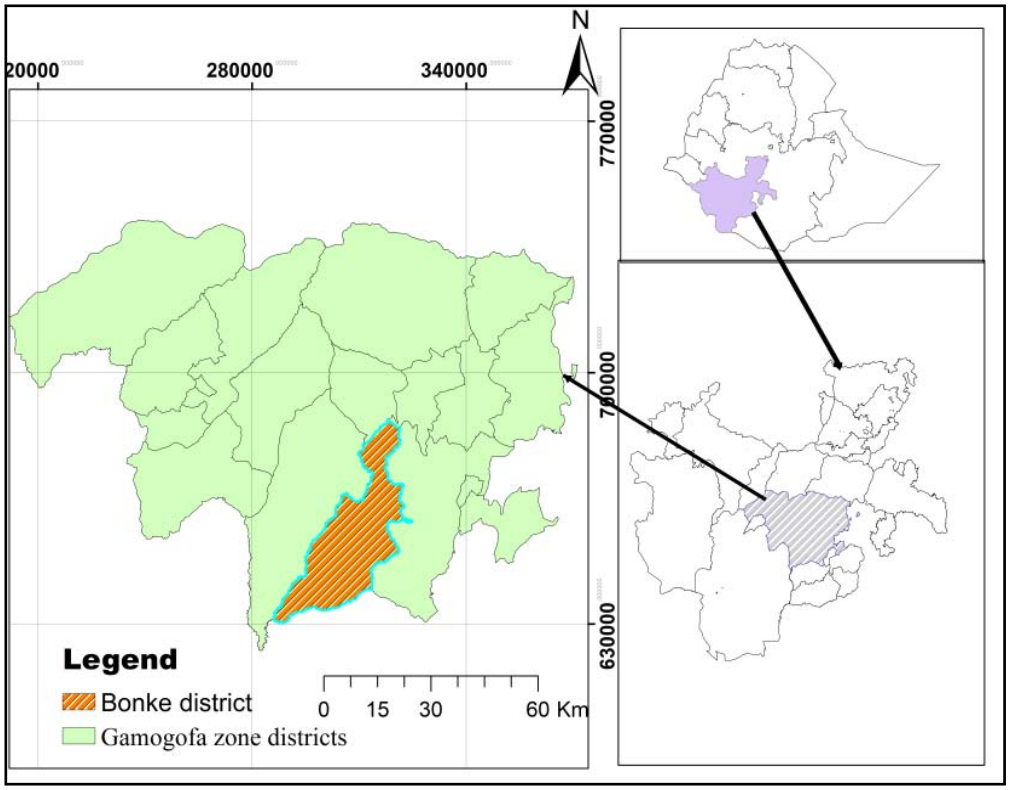


Figure 1: Map of the study area

b) Site selection, experimental design and data collection

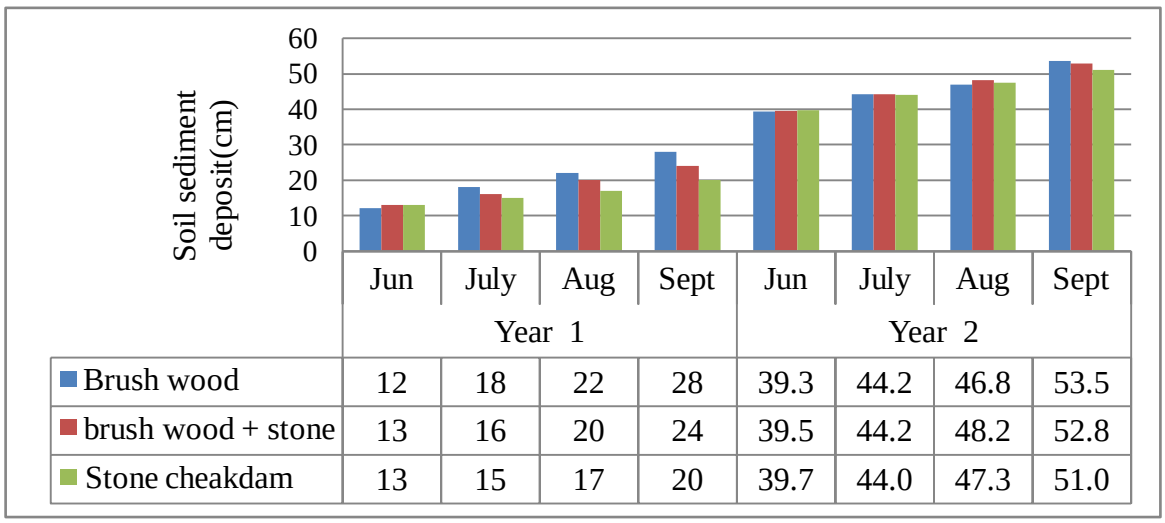
A reconnaissance survey was conducted to get a better understanding of the district and select a specific study site. Following the reconnaissance survey, six gullies that have similar dimensions (2-3m depth and 1-3m width) near the head gully was preferred for evaluation. Three treatments (Brushwood check dam+ trench+ head apron, brushwood with stone check dam+ trench+ head apron, and Stone check dam+ trench+ head apron) each were applied on any other two gullies as a replicate. The dimension of trenches in the ravine was 50cm deep and 1m widespread that is extended to 0.5m on both sides of the channel. The spacing (S) of check-dam was determined by dividing the height (H) of check-dam to channel gradient in decimal number and multiplying by a correction factor of 1.2. The check-dams have the height of 1.3m, top width 0.52m, and base width of 2.5m while the base width of drop structure and head apron is 2m.

Graduated ranging poles at the edges and centre of the gully were installed at different positions of check dams to monitor the soil deposit from each treatment. The biomass data of newly emerged vegetation was collected using a quadrant of 50cmx50cm plot to identify the rehabilitation potential of the gully area. Data on soil deposit was collected during the rainfall season for two years. To monitor the gully rehabilitation status, progressive pictures were used. At the end of the evaluation, economic analysis was made between the interventions to compare their cost of rehabilitation. The cost estimation was done using lab or cost of construction, transportation cost for required materials and maintenance. To speed up gully rehabilitation, vegetative stabilizers like Jatropha plant, Elephant grass, and Banana fruit were planted at the side of the structures.

III. Results and Discussion

a) Soil sediment deposit

The cumulative soil deposit on gully rehabilitation treatments was determined for the two consecutive years (2016 &2017) in rainy seasons (Figure 2). Figure 2 shows increasing trends of soil deposition from the onset to the end of the rainy season. This indicates that gully erosion can be treated using locally available materials within a short period. This will be effective if the gully rehabilitation is done before to its expansion to the more uncontrollable stage. This experiment was done on smaller gullies having the depth of 2-3m at active head parts. In the first year, the maximum and the minimum cumulative sediment deposition was observed on brush wood check-dams (280mm) and stone check-dams (200mm), respectively. Similarly, in the second year, the maximum and the minimum cumulative sediment deposition was found on brush wood check-dams (535mm) and stone check-dams (510mm), respectively.



	Jun	July	Aug	Sept	Jun	July	Aug	Sept
Brush wood	12	18	22	28	39.3	44.2	46.8	53.5
brush wood + stone	13	16	20	24	39.5	44.2	48.2	52.8
Stone cheakdam	13	15	17	20	39.7	44.0	47.3	51.0

Figure 2: Cumulative soil sediment deposited

b) The trend of low-cost gully rehabilitation method

i. *During construction time*

Figure 3: Gully treatments just after construction

ii. *Gull stabilization progress after six months*

A photographs in the figures below show that the progressive rehabilitation in the period of six months. The trend indicates that use of available materials could be appropriate and effective to rehabilitate small gullies before it expands to large size. Generally, the fast rate of rehabilitation of ravine was found due to the success of selected local material. The picture after six months showed that brushwood produced better progress in soil deposit, and biomass cover of vegetation. It was observed that brushwood stabilized with vegetative materials like Jatropha, elephant grass and banana could control small gullies within a year's. Since gully could not be prevented by these vegetative materials if applied only, integrating it with stones or brushwood would have the promising results to the rehabilitate gully.

Figure 4: Progressive rehabilitation system of gully by different check-dams

This finding was also consistent to study conducted to identify gully rehabilitation methods in Northwestern Ethiopia (Hailu et al., 2015). The author stated that appropriate physical gully erosion control practices coupled with biological measures have resulted in a large decrease of soil loss and stabilized the gully from enlargement, which is a main success to keep a stable and productive ecosystem. Also, the result of using these local materials is effective in controlling gully erosion under depth and width of less than 3m. According to Wolde-Aregay, (1996) check dams have been quite effective in smaller and average size gullies. During small gully reclamation, integrating vegetative materials for productive purposes has been practiced in the Tigray Region Ethiopia, with favorable agronomic results from cultivating banana, elephant grass, and sugarcane on gullied land(SIWI, 2001).It also showed that prioritizing the construction of structures in gully beds and then integrating it with stabilizer plants have multiple advantages like erosion and forages as well as fruits from plants. According to the result of Asefa (2017), grass and shrub species could reduce the probability of gully initiation and could stabilize the banks of gullies.

iii. *Gull stabilization progress after two 2 year*

The Photograph at Figure 5 indicated that vegetative stabilizers are matured and strongly supported the structures. Jatropha played a excessive role at this regard. Planting Jatropha not only maintenance of gully rehabilitation, but also provide multiple uses like fuel (Brittaine and Lutaladio, 2010). Besides to being stabilizer for check-dams in the picture above, banana and elephant grass well performed and can provide additional benefits now and onwards.

Figure 5: Gully stabilized with different check-dams and vegetative materials after two years

The change in rehabilitation resulted in the observation of different plant species in the area (Figure 5 & Table 1). The new grass and shrub specie types of about 18 were observed after two years of rehabilitation. Table 1 below indicates that the rehabilitation of smaller gullies by low- cost method could produce an average biomass yield of 32t/ha within two years period. This can provide additional advantages such as livestock forage, soil fertility improvement, erosion control, and other socio-economic benefits.

Table 1: Biomass production after gully rehabilitation under different measures

Gully treatments	Biomass mass (kg/ha)
Stone check-dams	33855
Stone faced brushwood check-dams	32485
Brushwood check-dams	29915
Average biomass production	32085

From Table 2 below, it was observed that there is a difference in the cost of rehabilitation per cubic meter constructed check-dams. Although there was no significant difference in soil sediment deposition as well as biomass production from the three treatments, the cost of brushwood check-dams is three- fold lower than stone check-dams, and two- fold lower than Stone - faced brushwood check-dams.

Table 2: Economic analysis of different low- cost gully rehabilitation measures

Treatment	Input cost	Maintenance cost	Total cost
stone check-dams	1342.00	2030.00	3372.00
Stone faced brushwood check-dams	1099.00	1097.00	2196.00
Brushwood check-dams	602.00	580.00	1182.00

IV. Conclusion and Recommendation

The results support that low-cost gully rehabilitation measures tested in this study could be an option to rehabilitate shallow gullies within a year. The tested gully rehabilitation measures also support the rehabilitation of vegetation, which resulted in increased effectiveness of the methods for reducing soil erosion, improving soil fertility, and providing an option for livelihood diversification. As there were not considerable differences in reducing soil erosion among the tested methods, brushwood check-dams could be used by farmers due to its cost advantage.

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Effects of Processing Methods on Proximate Composition of Decorticated Castor Seeds (*Ricinus Communis* L.)

By Agboola E.O, Adebayo I.A & B. W. Obe

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Keywords: *castor seed, ricinus communis, autoclaving, boiling, fermenting, soaking, and toasting.*

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Effects of Processing Methods on Proximate Composition of Decorticated Castor Seeds (*Ricinus Communis* L.)

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I. Introduction

There is a tremendous increase in the rate at which livestock industry grows in the globe, which led to the continuous rise and exhaustive use of virtually all feedstuffs processed, hence inversely or overtly increasing the cost of plant and animal sources used in aquaculture feeds [1]. Over the past few decades, there has been increased exploitation of certain unconventional feeding materials as alternative protein sources to replace the costly protein materials for fish available in the market. Also, scarcity of high-quality conventional feed materials, resulting in high competition between man and farm animals [2] [3] [4].

Of the vast vegetation across the globe, castor oil seeds (*Ricinus communis* L.) is considered as one of those alternative feedstuffs, and it has been underutilized all along [5]. The plant belongs to Euro phorbiaceae, a spurge family, easy to cultivate, early matured, and grow all the year round [6]. Its species is distributed in the tropical and sub-tropical regions across the globe [7] with Brazil, China, India, and Mozambique serving as the main producers in the world [8] but India ranks its highest producer [9]. It grows well on fertile soil and tolerates not less than daytime temperatures of 20°C throughout the growing period [10]. Castor bean plant has several branches, each terminated by a spike which is 15 to 30 cm long, bearing 15 to 80 capsules [11]. A capsule contains three seeds each, which, at maturity, split to release the seeds. The seeds of the castor plant that grow in the northern states of Nigeria are classified into seven distinct varieties according to their sizes and colors [12]. However, the seeds are more classified into three groups that include large seeds (variety major), medium seeds (variety intermediate), and the small seeds (variety minor). The commonest seeds that grows in the northern parts is the minor [13].[14] reported that some castor seeds developed so far are; I. Agricultural Science Academy of Zibo in China developed; ZiboCastor No. 2; a middle-late castor with high oil content and 3750 – 5399 kg/hm2 seed yield II. ZiboCastor No. 3; a spineless, big seeded castor variety III. ZiboCastor No. 4; a high yielding castor (4500 – 6000 kg/hm2) with a lot of spikes IV. ZiboCastor No. 5; A middle-maturing, thorn less hybrid with 4500 – 6450 kg /hm2 V. ZiboCastor No. 6; Early maturing hybrid variety, yielding between 4579.5 kg/hm2 and 6750 kg/hm2 VI. ZiboCastor No. 8; A middle-maturing hybrid with about 4500 to 6000 kg/hm2.Castor Seed Cake (CSC) is available to the tune of 1.12 million t and has potential to be used as a protein supplement in animal diets because of its high crude protein and energy compared to the conventional ones but limited because of potent anti nutritional factors such as ricin, ricinine, allergen and chlorogenic acid [15] [16] [17].

Several authors had reported castor seed cake contained about 32-48% crude protein of good amino acid profile depending on the forms of detoxification adopted such as physical: boiling, soaking, autoclaving, toasting, steaming, extrusion, decortication and deoiling [18][6][19][20][21] chemical: application of calcium compounds, formaldehyde, sodium hydroxide, tannic acid, sodium chloride and lime [22][23][24] and fermentation [25].For instance, [19] reported 30.82% for crude protein, 11.42% crude fiber, 20.72% ether extract, 5.54% ash and 31.16% nitrogen-free extract.[21]also reported crude protein 23.00%, crude fiber 6.85%, carbohydrate 27.50% fat 22.67%, moisture 17.00% and ash 2.98%. However, [26] recommended the need for

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further research on the detoxification process for castor seed meal so that more economic benefit can be derived from its utilization.

Since there is an urgent need to investigate the nutritional properties of the non-conventional feedstuff to know their suitability before recommendation for animal/fish feed formulation [27], the aim of this study, to work on different methods of detoxification; each at further different levels (5x3 methods in this case), on castor seed, to find out which would be considered best in the formulation of fish feed in particular.

II. Materials and Methods

a) Study Area

The study was conducted at the fishery laboratory of the Department of Fisheries and Aquaculture, Faculty of Agricultural Science, Ekiti State University, Ado-Ekiti. Ado-Ekiti is in the Western tropical rain forest region of Nigeria, latitude 7.67^{0}N, and longitude 5.25^{0}E and at an altitude of 431m above sea level. The mean average annual rainfall of Ado-Ekiti is about 1800mm. The mean monthly temperature is about 28^{0}C, while the monthly relative humidity is about 65% [28] being in Ekiti State.

The following experiments and analysis were carried out namely

(i) Detoxification of the raw *Castor* seeds (CS) using five different treatment methods, boiling, roasting, soaking, autoclaving, and fermentation; with three different levels for each adopted. Each of the levels was replicated thrice.
(ii) Proximate analysis of both the raw and processed castor seeds was carried out thereafter.

Sample Collection/Identification: Castor seeds from dehiscence mature capsules of the plants (ZiboCastor No. 3 variety) were fetched within Ado-Ekiti metropolis, Nigeria, and used for this research. The plant capsule and seed samples were identified at the Herbarium of the Department of Plant Science and Biotechnology, Ekiti State University, Ado-Ekiti.

Sample Preparation: The collected seed samples were sorted, screened and distributed into six batches based on different treatment methods namely: (i) raw seed, (ii) boiled, (iii) toasted, (iv) soaked, (v) autoclaved, and (vi) fermented, respectively.

For each of the treatments, apart from raw seeds, three levels/ranges were worked upon to ensure proper investigation [29].

Processing of Untreated (Raw) Seeds: Two hundred (200) grams of raw castor seeds were washed, decorticated, sundried, and grounded for use of proximate analysis.

Boiling: According to [5] castor seed is best detoxified by boiling between 40-60 minutes at 100^{0}C. 2kg of castor seed samples were treated at 100^{0}C using tap water at the ratio of 1kg to 10 liters of water in a 15liter metal cooking pot for a duration of 60 minutes [30]. A portion (600g) of the original seed samples was removed from the boiling water with a sieve at 40, 50, and 60 minutes intervals, respectively, using a stopwatch while the boiling continues [29]. Samples were sun-dried separately to a constant weight; dehauled, ground, oil extracted, and packed in air-tight polythene bags against the subsequent analysis.

Toasting: Toasting time ranges for castor seed as reported by [31] and [32] between 20 and 30 minutes at 140°C, respectively. In this study, toasting was done at 20, 30 and 40 minutes using [31] method. 2kg of the raw sample of castor oil bean in a medium of sand was put in an open pan at 140°C for 40 minutes. The beans and sand were stirred continuously to avoid charring using a hand shovel. The temperature of the sand medium was monitored using a 150°C thermometer. 600g sample was removed at 20, 30, and 40 minutes intervals, then spread separately and allowed to cool on clean trays placed on concrete slabs. The processed seeds were dehauled, ground, defatted to form a cake, and then stored separately in tightly sealed labeled polythene bags.

Soaking in water: According to [19], the minimum and maximum duration of soaking CS ranges between 48-96 hours. In this study soaking of castor seed was carried out at 48, 72, and 96 hours. 2kg of Raw *RC* samples was put into a bowl containing tap water at the room temperature (30 ± 2^{0}C) in seed to water ratio of 1:10(w/v) at the rate of 5kg to 10litres [30]. The samples were removed at the rate of 600g with a sieve at 48, 72, and 96 hours respectively and then spread separately on clean trays to sundry. Dehauling, grinding, and oil extraction to enhance cake formation followed accordingly.

Autoclaving: According to [33], the minimum and maximum minutes of autoclaving for castor seed range between 20-40 minutes. In this study, autoclaving of CS at 121^{0}C was carried out for 20, 30, and 40 minutes to examine the best level. 2kg raw seeds sample were parboiled for 2 minutes in water at 60^{0}C to ease dehulling. 600g was removed at each time interval. Samples were sun-dried separately to a constant weight, dehauled, and oil extracted. The samples were then packed in air-tight polythene bags against the subsequent proximate analysis.

Fermentation: According to [21], the minimum and maximum duration of fermentation of CS range between 48-96 hours. This study fermented castor seed at 48, 72, and 96 hours. 2kg of raw castor seed sample was used for the fermentation technique. Slightly warm water (60^{0}C) was poured on the seeds and then covered in an air-tight container [34] to allow natural fermentation to take place; 600g was collected at the expiration of each time (48, 76, and 96 hours) interval. Each of the samples

was sun-dried separately to a constant weight, dehauled, oil extracted, and then packed in air-tight polythene bags against the subsequent analysis.

Chemical Analysis: The properly labeled processed seeds for all the treatments (16), each of which was replicated thrice, were taken to the Laboratory of the Department of Fisheries and Aquaculture, Ekiti State University, for proximate analysis.

Determination of nitrogen/crude protein by Kjeldahl method [35]: The principle of this method is to digest the organic matter with sulphuric acid in the presence of a catalyst to render the reaction alkaline, and then distill and titrate the liberated ammonia.

Determination of Crude Fiber [35]: This involves sequential digestion of the sample with dilute acid and alkaline solution. The residue was ignited to obtain crude fiber.

Determinations of nitrogen-free extract (NFE) [35]: The total carbohydrate content was determined by the difference method. The sum of the percentage moisture, % ash, % crude lipid, % crude protein, and % crude fiber was subtracted from 100. NFE= 100- (ash + crude lipid + crude protein + crude fiber).

Determination of ash content [35]: The ash content was determined from the loss in weight that occurred during igniting the sample at 550°C in muffle furnace, which was enough to allow all organic matter to burn off, hence the decomposition of the ash constituent occured.

Determination of moisture content and Dry Matter [35]: This is based on the difference between the net weight and the weight after drying. This also determines the weight of dry matter. A clean crucible was dried to a constant weight in an air oven at 110°C, cooled in a dessicator and weighed (W1). 2g of finely pulverised sample was weighed in the crucible and then re-weighed (W2). The crucible and its content were dried in an oven to a constant weight (W3). The percentage moisture was calculated thus: % Moisture content = {(W2-W3)/ (W2-W1)} x 100.

Determination of crude lipid content [35]: This is the continuous extraction of fat content from the sample using suitable solvent, e.g. petroleum ether in Soxhlet, since the non-polar component of the sample is easily extracted into the organic substance (ether).

III. Statistical Analysis

Data obtained were subjected to a one-way analysis of variance (ANOVA) to determine the significance of the variations between parameters was examined at ($P<0.05$). Means obtained were segregated using Duncan's multiple range tests (DMRT) with the aid of SPSS version 20

IV. Results

The proximate composition of the autoclaved castor seed at 0, 20, 30, and 40 minutes time intervals are shown in Table 1. For the moisture contents, significantly different ($p>0.05$) were obtained in all the treatments, including the control. However, the sample autoclaved at 20 minutes was highest (5.53±0.03), while the 0 minute recorded the least value (4.85±0.03). In the same vein, the crude protein, fats, ash, crude fiber, and nitrogen-free extract (NFE) contents are significantly different ($p>0.05$) among the various levels of autoclaving. Crude protein and fats were highest in raw (control) (38.29±0.11, 28.65±0.15) and lowest at 20 minutes (5.13±0.07, 16.53±0.13) respectively. Ash was highest at 20 minutes treatment (5.47±0.02) and lowest in 30 minutes treatment (4.60±0.03). The crude fiber was highest in castor seeds autoclaved for 20 minutes (3.53±0.08) and least recorded at 0 minutes (2.08±0.05). NFE was recorded highest at 20 minutes autoclaved (48.29±0.23) and lowest in control (16.50±0.14).

Table 1: Percentage proximate composition of autoclaved Castor seed cake (CSC) at different time intervals

	Parameter	Moisture	Protein	Fats	Ash	Crude Fiber	NFE
Treatments	$RCSC_{00}$ (Control) (00 min)	4.85 ± 0.03^{a}	38.29 ± 0.11^{d}	28.65 ± 0.15^{d}	4.79 ± 0.02^{b}	2.08 ± 0.05^{a}	16.50 ± 0.14^{a}
	$ACSC_{20}$ (20 min)	5.53 ± 0.03^{d}	15.13 ± 0.07^{a}	16.53 ± 0.13^{a}	5.47 ± 0.02^{d}	3.53 ± 0.08^{d}	48.29 ± 0.23^{d}
	$ACSC_{30}$ (30 minutes)	5.29 ± 0.01^{b}	36.25 ± 0.13^{c}	22.76 ± 0.16^{b}	4.60 ± 0.03^{a}	2.65 ± 0.09^{b}	23.18 ± 0.19^{b}
	$ACSC_{40}$ (40 min)	5.44 ± 0.02^{c}	21.43 ± 0.18^{b}	25.63 ± 0.23^{c}	5.20 ± 0.02^{c}	3.23 ± 0.03^{c}	32.65 ± 0.47^{c}

Values shown are means ± standard error. Those with different letters along the same column are significantly different at $p<0.05$.

The proximate composition of the boiled castor seed at 0, 20, 30, and 40 minutes time intervals are shown in Table 2. The mean values recorded in terms of moisture, crude protein, fats, crude, ash, fiber, and NFE contents are significantly different ($p>0.05$) from one another. However, the mean values for moisture, crude

protein, fats, and ash were highest in control (4.85±0.05, 38.29±0.11, 28.65±0.15 and 4.79±0.02) but lowest in 40 minutes boiled (4.15±0.00), 60 minutes boiled (33.97±0.07); 50 minutes boiled (22.32±0.18 and 3.83±0.05) respectively. Mean value for crude fiber was highest in 60 minutes boiled CSC (2.71±0.01) and lowest in control, 0 minutes (2.08±0.05). NFE mean value was highest in 50 minutes, boiled CSC (31.19±0.23). and lowest in control (16.500.14).

Table 2: Percentage proximate composition of boiled Castor seed cake (CSC) at different time intervals

	Parameter	Moisture	Protein	Fats	Ash	Crude Fiber	NFE
Treatments	$RCSC_{00}$ (Control) (00 min)	4.85±0.03^{d}	38.29±0.11^{d}	28.65±0.15^{b}	4.79±0.02^{d}	2.08±0.05^{a}	16.50±0.14^{a}
	$ACSC_{20}$ (20 min)	4.15±0.0^{a}	36.98±0.16^{c}	24.19±0.01^{b}	3.86±0.04^{b}	2.53±0.03^{b}	28.30±0.16^{b}
	$ACSC_{30}$ (30 minutes)	4.23±0.0^{b}	35.79±0.01^{b}	22.32±0.18^{a}	3.83±0.05^{a}	2.65±0.01^{c}	31.19±0.23^{d}
	$ACSC_{40}$ (40 min)	4.38±0.0.02^{c}	33.97±0.07^{a}	26.40±0.20^{c}	3.88±0.02^{c}	2.71±0.01^{d}	28.67±0.11^{c}

Values shown are means ± standard error. Those with different letters along the same column are significantly different at p<0.05.

The proximate composition of the fermented castor seed at 0, 48, 72, and 96hours time intervals are shown in Table 3. The mean values recorded in terms of moisture, crude protein, fats, crude, ash, fiber, and NFE contents are significantly different (p>0.05) from one another. However, the mean values of moisture, crude protein, and ash were highest in control (4.85±0.03, 38.29±0.11 and 4.79±0.02) but lowest in 48 hours fermented CSC (4.110.01, 29.51±0.11 and 3.33±0.03) respectively. The fats and crude fiber mean values were highest in 96 hours fermented CSC (32.60±0.20 and 2.63±0.03) and lowest in control CSC (28.65±0.15 and 2.08±0.05) respectively. The NFE mean value was highest in 48 hours fermented CSC (30.94±0.23), and lowest in raw CSC (16.50±0.14).

Table 3: Percentage proximate composition of fermented Castor seed at different time intervals

	Parameter	Moisture	Protein	Fats	Ash	Crude Fiber	NFE
Treatments	$RCSC_{00}$ (Control) (00 min)	4.85±0.03^{d}	38.29±0.11^{d}	28.65±0.15^{b}	4.79±0.02^{d}	2.08±0.05^{a}	16.50±0.14^{a}
	$ACSC_{20}$ (20 min)	4.11±0.01^{a}	29.51±0.11^{a}	29.65±0.15^{b}	3.33±0.03^{a}	2.48±0.02^{b}	30.94±0.23^{d}
	$ACSC_{30}$ (30 minutes)	4.23±0.01^{b}	31.50±0.10^{b}	30.25±0.15^{c}	3.43±0.02^{b}	2.55±0.01^{c}	28.05±0.29^{c}
	$ACSC_{40}$ (40 min)	4.27±0.01^{c}	33.23±0.03^{c}	32.60±0.20^{d}	3.60±0.01^{c}	2.63±0.03^{d}	23.68±0.21^{b}

Values shown are means ± standard error. Those with different letters along the same column are significantly different at p<0.05.

The proximate composition of the soaked castor seed at 0, 48, 72 and, 96 hours time intervals are shown in Table 4. The mean values recorded in terms of moisture, crude protein, fats, crude, ash, fiber, and NFE contents are significantly different (p>0.05) from one another. However, the mean value for moisture was highest in control (4.85±0.03), diminishes down to 3.83±0.04 while the soaking duration lasted. 38.29±0.11. The protein content of the CSC sample reduced after 48 hours soaking (32.67±0.11); further at 72 hours (30.46±10), but increased to 34.11±0.03 after 96 hours. The fats content increased after subjecting it to soaking for 48 hours (30.43±0.15) but reduced along with the trend of the soaking period. Ash content was lessened irregularly from 4.70±0.02 in the raw sample to 3.91±0.03, 3.95±0.02, and 3.70±0.01 in the soaked seeds (48, 72, and 96 hours) respectively. The mean values of crude fiber increased with an increase in the length of soaking periods. NFE mean value increased at 48 hours soaking (26.28±0.23) and then increased further at 72 hours (30.00±0.29) but declined to 26.60±0.21 at 96 hours soaking.

Table 4: Percentage proximate composition of soaked Castor seed at different time intervals

	Parameter	Moisture	Protein	Fats	Ash	Crude Fiber	NFE
Treatments	$RCSC_{00}$ (Control) (00 min)	4.85±0.03[d]	38.29±0.11[d]	28.65±0.15[b]	4.79±0.02[d]	2.08±0.05[a]	16.50±0.14[a]
	$ACSC_{20}$ (20 min)	4.19±0.01[a]	32.67±0.11[b]	30.43±0.15[d]	3.91±0.03[b]	2.53±0.02[b]	26.28±0.23[b]
	$ACSC_{30}$ (30 minutes)	4.34±0.01[b]	30.46±0.10[a]	28.88±0.15[c]	3.95±0.02[c]	2.62±0.01[c]	30.00±0.29[c]
	$ACSC_{40}$ (40 min)	4.44±0.01[c]	34.11±0.03[c]	28.52±0.20[a]	3.70±0.01[a]	2.64±0.03[d]	26.60±0.21[b]

Values shown are means ± standard error. Those with different letters along the same column are significantly different at $p<0.05$.

The proximate composition of the toasted castor seed at 0, 48, 72, and 96 hours time intervals are shown in Table 5. The mean values recorded in terms of moisture, crude protein, fats, crude, ash, fiber, and NFE contents are significantly different ($p>0.05$) from one another. However, the mean value of moisture was highest in control (4.85±0.03), diminishes down to 3.83±0.04 while the toasting duration lasted. The protein content of the CSC sample reduced after 20 minutes toasting (33.08±0.73); further at 30 minutes (30.66±04), and 40 minutes (28.55±0.35). The fats content reduced after subjecting it to toasting for 20 minutes 26.17±0.07), and further at 30 minutes (24.50±0.10), but increased to 28.25±0.15 at 40 minutes toasting period. Ash content reduced from 4.79±0.02 in the raw sample to 4.32±0.02 when subjected to 20 minutes toasting. The values, however, increased up to 4.77±0.03 as the toasting period lasted. The mean values of crude fiber increased with an increase in the toasting periods, from 2.08±0.05 in raw samples to 2.33±0.03 and 2.43±0.01 at 20 and 30 minutes, respectively. It, however, declined at 40 minutes toasting level (2.42±0.02). NFE mean value increased from 16.50±0.14 of the raw sample to 29.99±0.64 and 33.99±0.12at 20 and 30 minutes toasting levels, respectively. The value declined to 32.19±0.58 at 40 minutes toasting level.

Table 5: Percentage proximate composition of toasted Castor seed at different time intervals

	Parameter	Moisture	Protein	Fats	Ash	Crude Fiber	NFE
Treatments	$RCSC_{00}$ (Control) (00 min)	4.85±0.03[d]	38.29±0.11[d]	28.65±0.15[d]	4.79±0.02[d]	2.08±0.05[a]	16.50±0.14[a]
	$ACSC_{20}$ (20 min)	4.13±0.03[c]	33.08±0.73[c]	26.17±0.07[b]	4.32±0.02[a]	2.33±0.03[b]	29.99±0.64[b]
	$ACSC_{30}$ (30 minutes)	4.02±0.01[b]	30.66±0.04[b]	24.50±0.10[a]	4.50±0.02[b]	2.43±0.01[d]	33.99±0.12[d]
	$ACSC_{40}$ (40 min)	3.83±0.04[a]	28.55±0.35[a]	28.25±0.15[c]	4.77±0.03[c]	2.42±0.02[c]	32.19±0.58[c]

Values shown are means ± standard error. Those with different letters along the same column are significantly different at $p<0.05$.

V. Discussion

a) Protein content

The crude protein (CP) values recorded in the processed castor seeds in this study were significantly different ($p>0.05$) and lower than the control. The protein content reported in this work (38.29±0.11) is higher than that reported by [36] [19] [21], 33.09%, 30.82% and 23.00% respectively, in raw undecorticated castor seeds. The observed differences may be a related to differences in geographical distribution and variety [18]. In this study, the boiled seeds gave the highest mean value (36.98±0.16) of crude protein at 40 minutes duration of boiling, while autoclaving for 20 minutes gave the least (15.13±0.07) of crude protein. All the processing methods reduced the protein content of castor seed. This trend corroborates the reports of [37] [38] [21] [39] [19] who reported reduction effect of autoclaving, boiling, fermentation, soaking, and toasting on the crude protein of castor seeds and walnuts [40]. This result may be related to the effect of temperature during autoclaving, boiling, and toasting periods [37] [38] [40] then hydrolysis and microbial activities during

the fermenting and soaking periods [41].The least value of CP obtained in autoclaved castor seeds at 20 minutes in this work corroborates with [42] report, which indicated low protein value in *A. nilotica* make it a bad source of proteins. However, the mean values of CP obtained in all (except autoclaving at 20 and 40 minutes periods) the processed methods adopted fell within the acceptable percentage [43][5][32] of 28.55±0.35 and 36.98±0.16; an indication that boiling, fermenting, soaking, and toasting can be recommended as acceptable treatments for castor seeds in fish feed formulation.

b) Crude fiber content

Crude fiber (CF) values in all the treatments are significantly different($p < 0.05$) from one another. It is highest in castor seed sample autoclaved at 20 minutes ($ACSC_{20}$), 3.53±0.08, and least in control sample 2.08±0.05. The low values recorded in this study were an improvement over 4.71% and 6.42% reported by [44][21],respectively. This disparity could be as a result of variety, geographical location, and probably processing techniques. The reduction in CF values among the various treatments is due to softening and subsequent dehauling of the seeds [38].Since high CF affect digestibility, dry matter, and pellet durability [45], dehauling castor seed, as done in this study, should be used when using the seeds in fish feed. [46] reported low CF enhances digestibility, but a high level can lead to intestinal irritation, lowered digestibility, and decreased nutrient absorption, hence not appropriate for consumption [47]. A low CF diet prevents constipation and reduces cholesterol levels in the blood [48].

c) Lipids/Fats content

Lipid provides the body with maximum energy and lends a pleasant taste and texture in food [36], regulates the action of hormones, and facilitates transmission of the nerve impulse [49]. Hence its estimation is considered among the vital factors for nutritional evaluation of any material [50]. The mean value of lipid recorded was highest(32.60±0.20) in castor seeds, fermented for 96 hours ($FCSC_{96}$),and least (16.53±0.13) in seeds autoclaved at 20 minutes duration.This result is in contrast with the values, 6.57 ± 0.23, 5.13 ± 0.19, and 4.24 ± 0.11 reported for *Morus alba* L., *Morus nigra* L. and *Morus rubra* L. respectively by [51]. The lowest value obtained in the autoclaved seed could be attributed to the denaturing effect of heat and loss of volatile essential fatty acids. The concentration of lipid reduced progressively from raw to autoclaved, boiled and toasted, but increased with fermentation and soaking. This result is in tandem with the report of [52] [53], who obtained a decrease in lipids with increasing duration of boiling and toasting in *Bauhinia* and *Parkia* seed respectively. The observation could be attributed to solubilization and leaching of oil in the process of treatment. This observation is in tandem with that of [54][19], who worked on *Canavalia ensiformis* and castor seeds, respectively. The values obtained in this work are near the range of conventional plant materials such as Soybeans. [36] reported lipid content in Bauhinia was 28.70%, a value that compared with other oil seeds like Soya bean (27%)[55]. [56] reported a plant-based food that provides more than 12 % of its caloric value from protein is considered as a good source of proteins. High lipid content, if not defatted or antioxidant added to seed, can cause rancidity to feed [43].

d) Ash content

In this study, all the values in various levels in each treatment are significantly different ($p > 0.05$). In each of all the levels, there was a reduction in the ash content of castor seed from 4.79±0.02 except in autoclaving at 20 and 40 minutes levels where the values increased above the control value, 5.47±0.02 and 5.20±0.02 respectively. Hence, the highest Ash value (5.47±0.02) was obtained in autoclaved seed sample ($ACSC_{20}$), while the least mean value was recorded in the fermented seed sample at 48 hours ($FCSC_{48}$), 3.33±0.03.[42] reported a similar ash value of 5.0±0.01% in the proximate profile of *Acacia nilotica*. The substantial reduction of most of these treatments corroborates the reports of [57] [19] [58]. This might be due to the effect dehauling had on the seeds, and the leaching of its elements along with the treatments. High ash content recorded in autoclaving indicates the presence of an heavy amount of inorganic nutrients in plant material [59]. The least ash value of the fermented seed makes it stands a better chance as energy source among other treatments since ash does not involve in total digestible nutrients (TDN) [60].

e) NFE content

The nitrogen-free extra (NFE) increased at all the levels of processing used for the castor seeds. Whereas the mean values of NFE recorded range between 23.18±0.19 to 33.99±0.12, while, the raw value was 16.50±0.14. However, all the treatments are significantly different ($p < 0.05$). The highest value was in toasting treatment at 30 minutes level ($TCSC_{30}$). This result corroborates with the work of [52], where, the mean value of 27.45% was recorded against roasted Bauhinia seeds. The trend of NFE values obtained from boiled and soaked castor seeds in this work are similar to values reported by [19]. Although toasting at 30 minutes period was highest, boiling at 40 minutes ($BCSC_{40}$) is considered better because of its corresponding highest protein value. This is an indication that boiling at 40 minutes will enhance a high value of TDN [60].

f) Moisture content

In this study, all the moisture content values among various levels of treatments are significantly different ($p>0.05$). The disparity could be due to experimental error and processing techniques. The highest value obtained was 5.53 ± 0.03 in autoclaved castor seeds at 20 minutes ($ACSC_{20}$) and least (3.83 ± 0.04) in seeds toasted at 40 minutes ($TCSC_{40}$). Apart from autoclaving treatment levels, there was a significant reduction in the levels of moisture in all other treatments (boiling, fermenting, soaking, and toasting) compared to the value (4.85 ± 0.03) obtained in the control sample ($RCSC_{00}$). The decrease in moisture content recorded was in contrast with the report of [21], which increased drastically up to between 17.00% and 31.00% for castor seeds subjected to levels of fermentation. The moisture contents of the processed castor seed meals were generally low. This report agreed with [61], who reported low moisture below 15% content is required as safe storage limit for plant food materials.

VI. Conclusion

Based on the results of this study, the boiled castor seed gave the best results in terms of maximum levels of proximate components compared to autoclaving, fermenting, soaking, and toasting. The high crude protein value (36.98%) and low crude fiber (2.53%), fats (24.19%), and ash (3.86%) contents recorded in the 40 minutes boiled seed ($BCSC_{40}$) in this study make it the best boiling level for treatment of castor seed. The results also showed that castor seed has appreciable nutritional potential and can be a better source and supplement for fish feed formulation.

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The Effect of Government Agricultural Spending on Economic Growth in Nigeria (1970-2013)

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Abstract- This research examined the effect of government agricultural spending on economic growth in Nigeria. This research effort was necessary, given the importance of agriculture in Africa. The result shows that less than 5% of government total spending is spent on the agricultural sector. Data covering the relevant variables over the period 1970 to 2013 was obtained from the annual reports and statistical bulletins of the National Bureau of Statistics, Central Bank of Nigeria, Food and Agriculture Organization and the World Bank. The data were analyzed using descriptive statistics, cointegration, error correction estimation, and Granger Causality test. Government spending was stationary at first difference. Also, a long-run relationship among the growth rate of the economy and government spending in agriculture, education, fertilizer, health services, transport and communication given by the coefficient of Error Correction Model (ECM) of -0.0081 is established.

Keywords: *government spending; agriculture; GDP; growth rate.*

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Keywords: government spending; agriculture; GDP; growth rate.

I. Introduction

a) Background of the Study

Nigeria is regarded as an agro-based economy with abundant land and water resources to enhance agricultural development. Agriculture contributes immensely to the Nigerian economy in the provision of food for the increasing population, supply of raw materials to industries as a major source of employment and generation of foreign exchange earnings (Okunmadewa, 1997; World Bank, 1998; FAO, 2006 and Francis, 2013). The agricultural sector in the 1960s contributed up to 70% of the total GDP of Nigeria; this gradually declined to 48% in the 1970s during the oil boom (Ukeje, 2003). The agricultural sector in 2014 contributed up to 22.90% while in the first quarter of 2015 contributed up to 19.79% of the total GDP of Nigeria (NBS, 2015).

The first decade after independence was described as an agrarian economy because agriculture served as the engine of growth of the overall economy (Ogen, 2003). From the findings, agriculture was regarded as the leading sector in terms of occupational distribution and contribution to GDP (Itodo *et al.*; 2012) considering the fact that it accounted for about 70% the Gross Domestic Product (GDP) in the '60s; this was a period when the country was virtually self-sufficient in the production of food crops, provided raw materials for industries, and for export (Ekerete, 2000). Indeed, agriculture provided the stimulus to national economic growth despite the small farm holdings production systems.

Nigeria is said to have diverse agro-ecological conditions that can support a variety of farming systems. However, successive administrations over the years was said to have neglected agriculture and failed to diversify the economy away from over-dependence on the oil sector. Nigeria, which was regarded as the largest net exporter of agricultural produce in West Africa as depicted by the contribution of groundnuts (42%), palm oil (27%), soya beans (28%) and cocoa (18%) in the 1960s, now spends over ₦1.2 trillion importing palm oil, canned beans and other food items (Akintola, 2011). The country, however, has the potentials to return to its previous position if adequate attention is given to the agricultural sector through finance and the provision of rural infrastructure (Francis, 2013). It has been stressed that size and structure of public expenditure will determine the pattern and form of growth in output of the economy (Taiwo & Abayomi, 2011). For instance, a collaborative study was carried out by the International Food Policy and Research Institute (IFPRI) and the World Bank in 2008, revealed that Nigeria's public expenditure on agriculture is less than 2% of total federal annual budget expenditure which is significantly low compared to other developing countries like Kenya (6%), Brazil (18%) and the assumed 10% recommended by the African Leaders Forum, under the Comprehensive Africa Agricultural Development Programme (CAADP).

Despite inadequate investment, agriculture has on the average contributed 32% of the country's GDP from 1996 to 2000 and 42% between 2001 and 2009 (CBN, 2010). For many developing countries, agriculture is considered as the largest sector in terms of its share in the nation's total Gross Domestic Product (GDP) and employment (Fan *et al.*; 2008; Fan *et al.*; 2009). Against this background, this study investigated the effect of

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government agricultural spending on economic growth in Nigeria from 1970 to 2013.

b) Statement of the Problem

Despite Nigeria's agricultural resource endowment, it was said that there was a gradual decline in agriculture's contributions to the nation's economy (Manyong *et al.*; 2005; Ekpo and Umoh, 2012; Mohammad and Atte, 2006), as evident in the contribution of agriculture to the GDP of the nation as well as the rising value of food import (CBN, 2010). In the 1960s, agriculture accounted for 65-70% of total exports which later fell to about 40% in the 1970s, and crashed to less than 2% in the late 1990s. The decline in the agricultural sector was due to a rising in crude oil revenue in the early (1970s). Less than 50% of the Nigeria's land is under cultivation. Even then, smallholder farmers who use rudimentary production techniques, with resultant low yields, cultivate most of this land. The constrained faced by smallholder farmers including poor access to modern inputs and credit, poor infrastructure, inadequate access to markets, and environmental degradation, and research and extension services. The inability to capture the financial services requirements of farmers and agribusiness owners constituted about 70 percent of the population is equally inclusive (Lawal, 2011).

Despite all the policies and programs of government with an emphasis on food security and the recent Agricultural Transformation Agenda of the past administration, the performance of the Agricultural sector in Nigeria is still abysmal in terms of product, factor, market and foreign exchange contribution (Ehigiamusoe, 2012) coupled with the rising value of food import. Presently, in Nigeria, there has been a conflicting view about spending on agriculture; the performance of the agricultural sector had fared better than it was before independence.

Study revealed that, the share of government total agricultural spending in the total government spending in the Nigerian economy is dismally low (Ayoola and Oboh, 2000), asit lags behind countries like Burkina Faso, Ethiopia, Mali, Malawi, and Senegal. It is equally far from the Comprehensive Africa Agriculture Development Programme (CAADP, 2003) recommended allocation of 10% government total spending in the entire economy to the agricultural sector of the economy (Mogues *et al.*; 2008; Fan *et al.*; 2009). The share of government total agricultural spending in Nigeria was 1.67% of government total spending in the economy in 1978. It increased to 2.50% in 1983 and increased further to 4.59% in 1989. In 1995, it declined to 1.90% and dipped further to 0.59% in 1996. In 2001, it increased to 6.38% and slumped again to 1.31%. It increased again in 2005 to 3.99% and increased further to 5.28% in 2008. In the entire period of the study covered (1978-2008), the average share of government total agricultural spending in the total government spending in the economy was 3.11% (CBN, 2009).

The problem, therefore, is that, how can an extremely important sector like the agricultural sector of the Nigerian economy that contributes more than 30% of national output receive less than 5% of government total spending? Therefore, isolating and neglecting the effect of government agricultural spending on economic growth in Nigeria poses some problems because of the importance of the sector to the Nigerian economy.

c) Research Objectives

The objective is to examine the effect of agricultural government spending on economic growth in Nigeria.

Specifically, the study seeks to:

1. Evaluate the effect of fertilizer spending on agriculture on economic growth in Nigeria.
2. Examine the influence of government spending on human capital development on economic growth in Nigeria.
3. Examine if there is a significant relationship between government agricultural expenditure (spending) and economic growth in Nigeria.
4. Examine if there is a causal relationship between recurrent and capital agricultural expenditure on economic growth in Nigeria.

II. Research Methodology

a) Scope of study

Nigeria is one of the countries in West Africa. It shares a border with the Republic of Benin to the west, Chad and Cameroon to the east and Niger republic to the north. Its coast lies on the Gulf of Guinea. Nigeria has between latitudes 4°16' and 13°53' North and longitudes 2°40', and 14°41' East. It has a total land area of 923,768 square kilometers, Nigeria is the most populous nation in Africa, with a population of about 160million people (NPC, 2012).The research focused on federal government total agricultural spending and other variables such as transportation and communication expenditure, health expenditure, education expenditure, and fertilizer spending and Gross Domestic Product Growth rate (EG) in Nigeria from 1970-2013.

b) Nature and sources of data

This research used a secondary dataset of 44 years (1970-2013) which was obtained from the annual reports and statistical bulletins of various issues of the National Bureau of Statistics and the Central Bank of Nigeria (1985, 2009, 2012 and 2014) respectively as well as the FAO (2012) and the World Bank Development indicator (WDI, 2015). The dataset includes budgetary allocation to agriculture, gross domestic product growth rate, transportation and communication expenditure, health expenditure, education expenditure, and fertilizer spending of Nigeria.

c) *Method of Data Analysis*

- *Unit Root Test*

The study applied the Augmented Dickey-fuller (ADF) test to check whether each data series is integrated and has a unit root. *The ADF tests was used to examine the stationarity of the dataset to overcome the problem of spurious* regression that is common in the time-series analysis.

In this study, the ADF tests were conducted on the level and first differenced observations by estimating the following two models of (1) intercept no trend and (2) intercept and trend model;

$$\Delta Y_t = \beta_0 + \gamma Y_{t-1} + \sum_{t=1}^{n} \beta_t \Delta Y_{t-1} + \mu_t \quad \text{..... (1)}$$

$$\Delta Y_t = \beta_0 + \beta_{2t} + \gamma Y_{t-1} + \sum_{t=1}^{k} \beta_t \gamma \Delta Y_{t-1} + \mu_t \quad \text{.....(2)}$$

Where $=\Delta$ is the first difference of the series and $\beta's$ are parameters to be estimated and μ_t is stochastic disturbance term. The two equations differ in the inclusion or exclusion of the deterministic elements and β_{2t} .Having established the nonstationarity of the variables, the next step is to test for the presence or absence of a long-run equilibrium among the variables.

$$\Delta Y_t = \gamma Y_{t-1} + \mu_t \quad \text{..... (3)}$$

Where $\gamma = (\rho - 1)$ and Δ as usual, is the first-difference operator we estimate (3) and test the (null) hypothesis that $\delta = 0$. If $\gamma = 0$, then $\gamma = 1$, that is we have a unit root, meaning the time series under consideration is nonstationary. Before we proceed to estimate (3), it may be noted that if $\gamma = 0$.The null hypothesis ($_0$: $\gamma = 0$) implies that the series has a unit root (non-stationary or integrated of order zero) and the alternative hypothesis ($_1$: $\gamma < 0$) indicates that the series is stationary. The decision rule is to accept the null hypothesis assuming the calculated ADF statistics is less than the Mackinnon critical values. The null hypothesis is rejected otherwise.

Johansen Cointegration Test: The Johansen Cointegration test was employed to examine the long-term relationship between or among the variables under study after establishing the stationarity. A linear combination of two or more I(1) series may be stationary or I(0), in which case the series are cointegrated. The null hypothesis for the Johansen Cointegration test (H_0: = 0) implies that cointegration does not exist, while the alternative hypothesis (H_1: > 0) implies that it does. Since, the null hypothesis for non-cointegration was rejected, the lagged residual from the cointegrating regression is imposed as the error correction term in an error correction model (ECM) given below as:

$$\Delta Y_t = \Pi Y_{t-1} + \sum_{i=1}^{k-1} \Gamma_i \Delta Y_{t-1} + \mu_t \quad \text{..... (4)}$$

Where:

Δ_t= First Difference of A_n (n x 1) Vector of the n Variables of Interest; Π = (n x n) Coefficient Matrix; Y_{t-1}

= Lagged Values of t, Υ = (n x (k-1)) Matrix of Short-Term Coefficients; μ= (n x 1) Vector of Constant ; Σ_t = (n x 1) Vector of White Noise Residuals; Πy_{t-1} = Error Correction term

The loading coefficients (α multiplied by the error $\beta' Y_{t-1}$ so that the Y's move in the direction to bring the system back to equilibrium) indicate the cointegration relationships in the individual equations of the system and of the speed of adjustment to disequilibrium. This represents the causality in the system and the direction of the causality flows, while the cointegrating vectors ($\Delta Y=0$ or $\Delta Y^*=0$ which is equivalent to $\Pi Y^* = \alpha(\beta' Y^*) = 0$ represent the long-term equilibrium relationship.

- *Granger Causality Test*

Granger Causality test was conducted to identify the causal relationship between the variables Gross Domestic Product Growth rate (EG), Agriculture Expenditure (Recurrent and Capital), Transportation and Communication Expenditure (TRANS), Health Expenditure (HEA), Education Expenditure (EDU) and Fertilizer spending (FERT) to determine whether the current lagged values of one variable affect another. According to Granger (1969), a variable *Y* is caused by another variable *X* if *Y* can be predicted well from past values of *Y* and *X* than from past values of *Y* alone. Two regressions must be performed to test for causality between the two variables, Y and X. The statistical significance of the coefficients of past values of a variable was tested. The Granger test was explained with the following equations:

$$\Delta Y_t = \alpha + \sum_{i=1}^{m} \beta_i \Delta Y_{t-1} + \sum_{j=1}^{n} \beta\varphi \Delta X_{t-1} + \varepsilon_t \quad \ldots\ldots (5)$$

$$\Delta X_t = X + \sum_{i=1}^{m} \phi_i \Delta X_{t-1} + \sum_{j=1}^{n} \mu_i \Delta Y_{t-1} + \nu_t \quad \ldots\ldots (6)$$

Where Y_t and X_t are two stationary series, and i and j stand for lag lengths. The unilateral causality existed when $Y_t$is said to be Granger caused by X_t which means that the coefficients on the lagged of X_t are statistically significant. On the other hand, a bilateral causality existed when both coefficients are statistically significant, and there is independence when both are statistically insignificant.

d) Engle and Granger Method of Cointegration Analysis

The procedure was carried out in two steps after determining the order of integration of the variables through the unit root test.

The first step consists of the long-run relationship that we wish to verify. Its existence is verified by estimating an equation using ordinary least squares with the entire variable in level.

The second step consists of extracting the error term or residuals resulting from this regression. The stationarity of the residuals at level form depicts a long-run relationship between the variables otherwise it does not exist. The absence of a long-run relationship between the variables led to an ordinary least squares regression with I(0) variables in level form and I(1) in first difference and so on, to get consistent results. In this study, the unit root results are presented first. They followed by the estimation of the long-run relationship. We then extracted the error term (denoted ECM) on which we carry out a unit root test at the level form I(0) to confirm the existence of cointegration. If cointegration exists, then we estimate the Error Correction Model (ECM) with the one-lag residuals as an explanatory variable. For the error correction model, we difference all the variables and include the error correction term lagged by one period ECM (-1) to capture the effects of year to year variations. Theoretically, it was expected that the coefficient of ECM (-1) to be significantly negative and less than one for the error correction mechanism to exist. The essence of using the Error Correction Model is to allow obtaining more reliable estimates than those we could have had if we had used the long-term relationship.

e) Model Specification

Abu & Abdullahi (2010) as well as Ditimi & Amassoma (2011) specified the model below except Fertilizer spending which was included to compliment the effect of agricultural spending on economic growth in Nigeria:

$$EG = f\ (AGR, HEA, EDU, TRANS\&FERT) \ldots\ldots (7)$$

In a simple linear equation form, model (7) becomes:

$$Y_t = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \mu_t \ldots\ldots (8)$$

Taking the natural log of equation (8), the model is as follow:-

$$LNY_t = \beta_0 + \beta_1 LNX_1 + \beta_2 LNX_2 + \beta_3 LNX_3 + \beta_4 LNX_4 + \beta_5 LNX_5 + \mu_t \ldots\ldots (9)$$

Semi-log function:

$$Y = \beta_0 + \beta_1 LNX_1 + \beta_2 LNX_2 + \beta_3 LNX_3 + \beta_4 LNX_4 + \beta_5 LNX_5 + \mu_t \ldots\ldots (10)$$

Where;

LNY_t = the Natural Logarithm of Dependent Variable (EG); X = Independent Variables; LNX_1 = Natural logarithm of Agriculture Expenditure (Spending) (AGR); LNX_2 = Natural logarithm of Health Expenditure (Spending) (HEA); LNX_3 = Natural logarithm of Education Expenditure (EDU); LNX_4 = Natural logarithm of Transportation and Communication (TRANS); LNX_5 = Natural logarithm of Fertilizer Spending (FERT); t = Time-series (Annual) values; β_0 = Represents the constant term or intercept on y axis; $\beta_1 - \beta_5$ = Are the regression coefficient estimated; μ_t= error or stochastic term.

(Barro 1990; Kelly 1997) analyzed how government expenditures contribute to economic growth as well as Keynesian-macroeconomic view point explaining the relationship between government expenditure (spending) and economic growth ,therefore, economic growth (EG) based on constant 2011 US$ (US Dollar) was modeled to be a function of budgetary allocation to agriculture (AGR). However, to avoid the omission of relevant variables and the misspecification

of the model, Health Expenditure (HEA), Education Expenditure (EDU), Transportation and Communication (TRANS) and Fertilizer Spending (FERT) were included in the model as other components of government spending variables that influence economic growth. The model for the long-term relationship between the variables is given explicitly as:

$$LNEG_t = \beta_0 + \beta_1 LNAGR_t + \beta_2 LNHEA_t + \beta_3 LNEDU_t + \beta_4 LNTRANS_t + \beta_5 LNFERT_t + \mu_t \quad \ldots\ldots (11)$$

The general Error Correction Model adopted for the study is specified as follows:

$$\Delta LNEG_t = \beta_0 + \beta_1 \Delta LNAGR_t + \beta_2 \Delta LNHEA_t + \beta_3 \Delta LNEDU_t + \beta_4 \Delta LNTRANS_t + \beta_5 \Delta LNFERT_t + \psi ECM_{t-1} + \mu_t \quad \ldots\ldots (12)$$

Where: EG = GDP Growth Rate (Annual %); AGR = Agricultural Spending (₦ Million); HEA = Health Spending (₦ Million); EDU = Education Spending (₦Million); TRANS = Transportation and Communication Spending (₦ Million); FERT = Fertilizer Spending (₦ Million); = Error Correction Term; ECM_{t-1} = One period lagged error correction term estimated from;

ϵ_t = Error or random term at period t;
Δ = Difference Operator
LN = Natural logarithm

III. Results and Discussion

a) Augmented Dickey-Fuller (ADF) Unit Root Tests

The results of the unit root tests was presented in table 1.

The empirical result from table 1 indicated that the variables EG, AGR, HEA, EDU, FERT and TRANS were integrated of order one, meaning that the variables was integrated of the same order I(1).The unit root at level form showing non stationarity of the variables in ADF test for with intercept as well as with trend and intercept The absolute value for each variable, made us realized that three of the variables are less than their respective t-statistic values at various levels of significance of 1%, 5%, and 10%. This implies that five of the variables was non-stationary at I (0) expect the GDP growth rate.

It observed that the test statistics of ADF tests in the first difference for with intercept as well as with trend and intercept are more than the critical values of 5% and 10% respectively. Thus, the series is said to be stationary at first difference, as indicated below.

Table 1: Unit Root Test at Level and First Difference Showing Augmented Dick-Fuller Results

AUGMENTED DICK-FULLER TEST AT LEVEL I(0)				
Variables	With Intercept	With Trend and Intercept	Decision	Remark(s)
LnEG	-4.005291	-3.880237	I(0)	Stationary/Non Stationary
lnAGR	-1.433614	-2.996221	I(0)	Non Stationary
lnEDU	-0.636226	-3.760665	I(0)	Non Stationary
lnHEA	-0.321029	-4.191827	I(0)	Non Stationary
lnTRANS	-1.554095	-2.760592	I(0)	Non Stationary
lnFERT	-2.304214	-4.271606	I(0)	Non-Stationary/ Stationary
N.B (Intercept @ 1%, 5% & 10% are -3.596616, -2.933158 & -2.604867 respectively). (Trend & Intercept @ 1%, 5% & 10% are -4.192337, -3.520787& -3.191277 respectively).				
AT FIRST DIFFERENCE I(1)				
LnEG	-6.945506	-4.259499	I(1)	Stationary
LnAGR	-8.793682	-8.827642	I(1)	Stationary
LnEDU	-8.871546	-8.776039	I(1)	Stationary

LnHEA	-11.84318	-11.64724	I(1)	Stationary
lnTRANS	-2.760592	-8.111942	I(1)	Stationary
lnFERT	-11.02163	-10.94618	I(1)	Stationary

N.B (Intercept @ 1%, 5% & 10% are -3.596616, -2.933158& -2.604867 respectively).
(Trend & Intercept @ 1%, 5% & 10% are -4.192337, -3.520787& -3.191277 respectively).

Source: Computations by Author's using Eview 7

b) Johansen Cointegration Test

Having confirmed the stationarity, the presence or non-presence of cointegration among the variables is examined. When a cointegration relationship is present, it means that all the six (6) variables employed, share a common trend and long-run equilibrium, as suggested theoretically. Cointegration analysis is employedusing the Johansen cointegration test. Tables 2 and 3 below show the result of the cointegration test. In the table, both trace and maximum Eigenvalue statistics indicate that there is a presence of cointegration at 5 percent level significance, which rejects the null hypothesis of not having a cointegrating equation (r = 0). In other words, the series for all the variables in the model used were tested for cointegration using the trace tests and maximum eigenvalue tests as explained on the one cointegrating variables, and the maximum eigenvalue tests indicate that there are one cointegrating variable, in Tables2 and 3 indicate that the GDP growth rate and the explanatory variables were cointegrated at 95% level of confidence which shows that there is cointegration or long-run relations between the variables tested, that is, GDP growth rate (EG) and the explanatory variables AGR, HEA, EDU, FERT, and TRANS at 5% level of significance. Consequently, the existence of a long-run relationship also provides for the short term dynamics of the relationship. An attempt to absolve the fluctuations/dynamics, an Error Correction Model (ECM) was estimated.

Table 2: Johansen Cointegration Test

Trend assumption: Linear deterministic trend,
Series: EG HEA TRANS FERT EDU AGR, Lags interval (in first differences): 1 to 1,
Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.925060	136.5184	95.75366	0.0000
At most 1 *	0.893695	82.10590	69.81889	0.0038
At most 2	0.649161	35.03568	47.85613	0.4461
At most 3	0.298269	13.03967	29.79707	0.8898
At most 4	0.220477	5.601358	15.49471	0.7421
At most 5	0.017504	0.370831	3.841466	0.5426

***MacKinnon-Haug-Michelis (1999) p-values*
Source: Computations by Author's using Eview 7

Table 3: Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.925060	54.41248	40.07757	0.0007
At most 1 *	0.893695	47.07022	33.87687	0.0008
At most 2	0.649161	21.99600	27.58434	0.2206
At most 3	0.298269	7.438313	21.13162	0.9346
At most 4	0.220477	5.230528	14.26460	0.7125
At most 5	0.017504	0.370831	3.841466	0.5426

Max-eigenvalue test indicates 2 cointegrating eqn(s) at the 0.05 level
** denotes rejection of the hypothesis at the 0.05 level; **MacKinnon-Haug-Michelis (1999) p-values*
Source: Calculations by Author's using Eview 7

c) Error Correction Model (ECM)

The results of the vector error correction as shown in table 4 shows long-term estimates and diagnostic statistics. The R square value of 0.5817 implies that 58.17% of the variation in economic growth was due to the influence of explanatory variables (AGR, EDU, HEA, TRANS and FERT) that was included in the model. The F statistic value was significant at the 1% probability level, indicating the joint significance of the explanatory variables of the model (goodness of fit of the model).

The long-term estimates show that AGR is negatively related to EG in the long-run and is therefore inconsistent with a priori expectation, thus, AGR is not

significant in influencing economic growth. Findings, revealed that AGR which was said have been positive and significant, owing to the integral role of finance in agriculture, which is known to be the major contributor to gross domestic product in Nigeria. In addition, the long-term relationships between AGR and EG has been attributed to insufficient budgetary allocation to agriculture relative to other sectors of the economy; as well as the poor implementation of the 2007 and 2008 budget which is said to less than 25% (Ujah & Okoro 2009).

The Error Correction Model (ECM) test result indicates as expected shows a negative sign. The coefficient of the Error Correction Model (ECM) is (-0.008091), meaning that the system corrects to its previous disequilibrium at a speed of 0.81% approximately at 1% a year. Also, the sign of the Error Correction Model (ECM) is negative, further validating our long-run equilibrium relationship between the series. Furthermore, EG can say to be influenced by changes in AGR, EDU, TRANS, HEA and FERT. The study revealed that government spending on education, transportation, and communication as well as fertilizer spending had a positive effect on GDP growth and that health and agriculture were negatively related to economic growth. The findings of the study were in line with Kalio (2000), especially on education and transportation and communication spending while the spending on agriculture was on the opposing side to the finding of my study. The spending on education and that of health were also in line with Ranjan and Sharma (2008) on the long-run effect on economic growth. It concluded that the allocation of government resources towards the education sector is favored to enhance growth. Also, Saad and Kalakach (2009) found that the government spending on education has a positive effect on growth in the long-run while spending on health negatively influencing on economic growth in the long-run and spending on agriculture has been found to be insignificant in the long-run,this is very much in line with this study. Above all, these results supported the findings of Abu and Abdullahi (2010) and Loto (2011) which shows that amount of federal government spending on agriculture does not follow a prior expectation and the contribution to GDP is in direct relationship with government spending to the sector and Olopade and Olepede (2010) show that there is unsignificant relationship between most of the components of spending and economic growth in Nigeria. Again our Error Correction Model (ECM) is not a spurious regression or model as the computed values of 0.008091 are lower than 1.66 (Durbin Watson Statistics), which indicates that there is no evidence of first-order serial correlation. FERT conforms with a priori expectation in the long-run. This implies that an increase in the procurement and distribution of fertilizer to the farmer of the country the better over well it will be for the economy, which would likely increase economic growth. The findings on Transportation and communication, as well as education spending, were in line with the Keynesian model, which says an increase in government expenditure (on infrastructures) leads to higher economic growth. The result from our regression also shows that other variables are significant but has insignificant effect on economic growth in Nigeria.

Table 4: Error Correction Model (ECM) Test Results

Variable	Coefficient	Standard Error	t- Statistic	Probability
Constant	-0.026105	0.228330	-0.114328	0.9107
ΔlnEG(-1)	-0.561432	0.228820	-2.453592	0.0290**
ΔlnAGR(-1)	-0.668727	0.389390	-1.717371	0.1096
ΔlnEDU(-1)	0.920097	0.417687	2.202839	0.0463**
ΔlnHEA(-1)	-0.552534	0.487946	-1.132368	0.2779
ΔlnTRANS(-1)	0.335606	0.269258	1.246408	0.2346
ΔlnFERT(-1)	0.034027	0.267072	0.127409	0.9006
ECM(-1)	-0.008091	0.007568	-1.069128	0.3045
Diagnostic Statistics				
R-squared	0.581693	Mean dependent var		0.012361
Adjusted R-squared	0.356450	S.D. dependent var		1.040712
S.E. of regression	0.834875	Akaike info criterion		2.759263
Sum squared resid	9.061220	Schwarz criterion		3.157176
Log likelihood	-20.97226	Hannan-Quinn criter.		2.845621
F-statistic	2.582519	Durbin-Watson stat		2.217463
Prob(F-statistic)	0.066334			

*N.B: * denotes p < 0.1, ** denotes p < 0.05, *** denotes p < 0.01*
Source: Computations by Author's using Eview 7

Granger Causality Test between Real Gross Domestic Product and Agricultural (Recurrent and Capital) Expenditure

Table 5 and 6 shows that no feedback is observed between Agricultural recurrent expenditure (AGREXP) and EG, in other words causality do not runs in both directions while unidirectional causation is observed between Agricultural capital expenditure and EG, in the same both lag which is significant at 5% and 10% with causality running from EG to Agricultural capital expenditure (AGRCEXP), indicating that the size of the economy (EG) is a significant predictor of the size (amount) of Agricultural capital expenditure.

Table 5: Pair-wise Granger Causality of the Agricultural Recurrent Expenditure Results

Null Hypothesis:	Lag(s)	F-Statistics	Probability	Decision	Causality
AGREXP does not Granger Cause EG	2	0.30058	0.7445	Reject	No Feedback
EG does not Granger Cause AGREXP	2	0.36623	0.6990	Reject	
AGREXP does not Granger Cause EG	4	0.24250	0.9042	Reject	No Feedback
EG does not Granger Cause AGREXP	4	2.58640	0.1434	Reject	

*N.B: * denotes p < 0.1, ** denotes p < 0.05, *** denotes p < 0.01*
Source: Computations by Author's using Eview 7

Table 6: Pair-wise Granger Causality of the Agricultural Capital Expenditure Results

Null Hypothesis:	Lag(s)	F-Statistics	Probability	Decision	Causality
AGRCEXP does not Granger Cause EG	2	2.90585	0.0838*	Accept	Uni-directional
EG does not Granger Cause AGRCEXP	2	2.40572	0.1221	Reject	
AGRCEXP does not Granger Cause EG	4	5.31684	0.0356**	Accept	Uni-directional
EG does not Granger Cause AGRCEXP	4	0.23878	0.9065	Reject	

*N.B: * denotes p < 0.1, ** denotes p < 0.05, *** denotes p < 0.01*
Source: Computations by Author's using Eview 7

IV. Conclusion & Recommendations

This research examines the effect of government agricultural spending on economic growth in Nigeria using secondary data. Annual time-series data from 1970 to 2013 were used and tested for stationarity and Error Correction Model (ECM) was estimated. The long-run relationship results indicated that governments spending on fertilizer, transportation and communication as well as education have positive effects on economic growth. Government spending on agriculture and health was negatively related to economic growth which implies that spending on agriculture and health were not contributing to economic growth. In other words, government spending in these sectors concentrated more on unproductive activities than productive activities.

The negative association found between government spending on agriculture and economic growth could further affirm the call for the African States under the Maputo Declaration to allocate at least 10 percent of the budgetary resources to agriculture in support of accelerated implementation of national agricultural investments formulated in line with Comprehensive African Agriculture Development Programme (CAADP) has established by the World Bank in 2008, that Nigeria's public expenditure on agriculture is less than 2% of total federal annual expenditure which shows that the country lags behind countries like Burkina Faso, Ethiopia, Mali, Malawi, Kenya, and Senegal as well as Brazil.

Based on the findings, the study suggests that policies designed based on the current state of Nigeria's economy:

- The government should ensure that capital expenditure and recurrent expenditure are properly managed in a manner that will raise the nation's productive capacity and accelerate economic growth.
- Owing to the shortfall in agricultural output as a result of inadequate financing by government as revealed in the study, government should be more proactive in setting aside funds annually for agricultural financing to compliment government efforts.
- There is an urgent need for the Federal Government to implement the Maputo Declaration to allocate at least 10 percent of the budgetary allocations to agriculture in support of accelerated implementation

of national agricultural investments formulated along the lines of the Comprehensive African Agriculture Development Programme (CAADP) in order to boast agricultural production, which will subsequently lead to economic growth.

- Also, the government should encourage the education and health sectors through increased funding so has to enhance human capital development and ensuring that the resources are properly managed; the private sector should also be encouraged to complement the effort of government in financing education and health sectors to efficiently and effectively harness human resources;

Above all, the Federal Government needs to take a holistic appraisal of agricultural programs and schemes, with a view of streamlining them to meet the dynamics of times, for the benefits of the Nigerian citizenry.

The above recommendations if implemented will not only go a long way to making Nigeria to be food sufficiency but also discourage over reliance on oil which lead to economic growth.

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Memberships

Fellows/Associates of Science Frontier Research Council

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22. Report concluded results: Use concluded results. From raw data, filter the results, and then conclude your studies based on measurements and observations taken. An appropriate number of decimal places should be used. Parenthetical remarks are prohibited here. Proofread carefully at the final stage. At the end, give an outline to your arguments. Spot perspectives of further study of the subject. Justify your conclusion at the bottom sufficiently, which will probably include examples.

23. Upon conclusion: Once you have concluded your research, the next most important step is to present your findings. Presentation is extremely important as it is the definite medium though which your research is going to be in print for the rest of the crowd. Care should be taken to categorize your thoughts well and present them in a logical and neat manner. A good quality research paper format is essential because it serves to highlight your research paper and bring to light all necessary aspects of your research.

Informal Guidelines of Research Paper Writing

Key points to remember:

- Submit all work in its final form.
- Write your paper in the form which is presented in the guidelines using the template.
- Please note the criteria peer reviewers will use for grading the final paper.

Final points:

One purpose of organizing a research paper is to let people interpret your efforts selectively. The journal requires the following sections, submitted in the order listed, with each section starting on a new page:

The introduction: This will be compiled from reference matter and reflect the design processes or outline of basis that directed you to make a study. As you carry out the process of study, the method and process section will be constructed like that. The results segment will show related statistics in nearly sequential order and direct reviewers to similar intellectual paths throughout the data that you gathered to carry out your study.

The discussion section:

This will provide understanding of the data and projections as to the implications of the results. The use of good quality references throughout the paper will give the effort trustworthiness by representing an alertness to prior workings.

Writing a research paper is not an easy job, no matter how trouble-free the actual research or concept. Practice, excellent preparation, and controlled record-keeping are the only means to make straightforward progression.

General style:

Specific editorial column necessities for compliance of a manuscript will always take over from directions in these general guidelines.

To make a paper clear: Adhere to recommended page limits.

Mistakes to avoid:

- Insertion of a title at the foot of a page with subsequent text on the next page.
- Separating a table, chart, or figure—confine each to a single page.
- Submitting a manuscript with pages out of sequence.
- In every section of your document, use standard writing style, including articles ("a" and "the").
- Keep paying attention to the topic of the paper.
- Use paragraphs to split each significant point (excluding the abstract).
- Align the primary line of each section.
- Present your points in sound order.
- Use present tense to report well-accepted matters.
- Use past tense to describe specific results.
- Do not use familiar wording; don't address the reviewer directly. Don't use slang or superlatives.
- Avoid use of extra pictures—include only those figures essential to presenting results.

Title page:

Choose a revealing title. It should be short and include the name(s) and address(es) of all authors. It should not have acronyms or abbreviations or exceed two printed lines.

Abstract: This summary should be two hundred words or less. It should clearly and briefly explain the key findings reported in the manuscript and must have precise statistics. It should not have acronyms or abbreviations. It should be logical in itself. Do not cite references at this point.

An abstract is a brief, distinct paragraph summary of finished work or work in development. In a minute or less, a reviewer can be taught the foundation behind the study, common approaches to the problem, relevant results, and significant conclusions or new questions.

Write your summary when your paper is completed because how can you write the summary of anything which is not yet written? Wealth of terminology is very essential in abstract. Use comprehensive sentences, and do not sacrifice readability for brevity; you can maintain it succinctly by phrasing sentences so that they provide more than a lone rationale. The author can at this moment go straight to shortening the outcome. Sum up the study with the subsequent elements in any summary. Try to limit the initial two items to no more than one line each.

Reason for writing the article—theory, overall issue, purpose.

- Fundamental goal.
- To-the-point depiction of the research.
- Consequences, including definite statistics—if the consequences are quantitative in nature, account for this; results of any numerical analysis should be reported. Significant conclusions or questions that emerge from the research.

Approach:

- Single section and succinct.
- An outline of the job done is always written in past tense.
- Concentrate on shortening results—limit background information to a verdict or two.
- Exact spelling, clarity of sentences and phrases, and appropriate reporting of quantities (proper units, important statistics) are just as significant in an abstract as they are anywhere else.

Introduction:

The introduction should "introduce" the manuscript. The reviewer should be presented with sufficient background information to be capable of comprehending and calculating the purpose of your study without having to refer to other works. The basis for the study should be offered. Give the most important references, but avoid making a comprehensive appraisal of the topic. Describe the problem visibly. If the problem is not acknowledged in a logical, reasonable way, the reviewer will give no attention to your results. Speak in common terms about techniques used to explain the problem, if needed, but do not present any particulars about the protocols here.

The following approach can create a valuable beginning:

- Explain the value (significance) of the study.
- Defend the model—why did you employ this particular system or method? What is its compensation? Remark upon its appropriateness from an abstract point of view as well as pointing out sensible reasons for using it.
- Present a justification. State your particular theory(-ies) or aim(s), and describe the logic that led you to choose them.
- Briefly explain the study's tentative purpose and how it meets the declared objectives.

Approach:

Use past tense except for when referring to recognized facts. After all, the manuscript will be submitted after the entire job is done. Sort out your thoughts; manufacture one key point for every section. If you make the four points listed above, you will need at least four paragraphs. Present surrounding information only when it is necessary to support a situation. The reviewer does not desire to read everything you know about a topic. Shape the theory specifically—do not take a broad view.

As always, give awareness to spelling, simplicity, and correctness of sentences and phrases.

Procedures (methods and materials):

This part is supposed to be the easiest to carve if you have good skills. A soundly written procedures segment allows a capable scientist to replicate your results. Present precise information about your supplies. The suppliers and clarity of reagents can be helpful bits of information. Present methods in sequential order, but linked methodologies can be grouped as a segment. Be concise when relating the protocols. Attempt to give the least amount of information that would permit another capable scientist to replicate your outcome, but be cautious that vital information is integrated. The use of subheadings is suggested and ought to be synchronized with the results section.

When a technique is used that has been well-described in another section, mention the specific item describing the way, but draw the basic principle while stating the situation. The purpose is to show all particular resources and broad procedures so that another person may use some or all of the methods in one more study or referee the scientific value of your work. It is not to be a step-by-step report of the whole thing you did, nor is a methods section a set of orders.

Materials:

Materials may be reported in part of a section or else they may be recognized along with your measures.

Methods:

- Report the method and not the particulars of each process that engaged the same methodology.
- Describe the method entirely.
- To be succinct, present methods under headings dedicated to specific dealings or groups of measures.
- Simplify—detail how procedures were completed, not how they were performed on a particular day.
- If well-known procedures were used, account for the procedure by name, possibly with a reference, and that's all.

Approach:

It is embarrassing to use vigorous voice when documenting methods without using first person, which would focus the reviewer's interest on the researcher rather than the job. As a result, when writing up the methods, most authors use third person passive voice.

Use standard style in this and every other part of the paper—avoid familiar lists, and use full sentences.

What to keep away from:

- Resources and methods are not a set of information.
- Skip all descriptive information and surroundings—save it for the argument.
- Leave out information that is immaterial to a third party.

Results:

The principle of a results segment is to present and demonstrate your conclusion. Create this part as entirely objective details of the outcome, and save all understanding for the discussion.

The page length of this segment is set by the sum and types of data to be reported. Use statistics and tables, if suitable, to present consequences most efficiently.

You must clearly differentiate material which would usually be incorporated in a study editorial from any unprocessed data or additional appendix matter that would not be available. In fact, such matters should not be submitted at all except if requested by the instructor.

Content:

- Sum up your conclusions in text and demonstrate them, if suitable, with figures and tables.
- In the manuscript, explain each of your consequences, and point the reader to remarks that are most appropriate.
- Present a background, such as by describing the question that was addressed by creation of an exacting study.
- Explain results of control experiments and give remarks that are not accessible in a prescribed figure or table, if appropriate.
- Examine your data, then prepare the analyzed (transformed) data in the form of a figure (graph), table, or manuscript.

What to stay away from:

- Do not discuss or infer your outcome, report surrounding information, or try to explain anything.
- Do not include raw data or intermediate calculations in a research manuscript.
- Do not present similar data more than once.
- A manuscript should complement any figures or tables, not duplicate information.
- Never confuse figures with tables—there is a difference.

Approach:

As always, use past tense when you submit your results, and put the whole thing in a reasonable order.

Put figures and tables, appropriately numbered, in order at the end of the report.

If you desire, you may place your figures and tables properly within the text of your results section.

Figures and tables:

If you put figures and tables at the end of some details, make certain that they are visibly distinguished from any attached appendix materials, such as raw facts. Whatever the position, each table must be titled, numbered one after the other, and include a heading. All figures and tables must be divided from the text.

Discussion:

The discussion is expected to be the trickiest segment to write. A lot of papers submitted to the journal are discarded based on problems with the discussion. There is no rule for how long an argument should be.

Position your understanding of the outcome visibly to lead the reviewer through your conclusions, and then finish the paper with a summing up of the implications of the study. The purpose here is to offer an understanding of your results and support all of your conclusions, using facts from your research and generally accepted information, if suitable. The implication of results should be fully described.

Infer your data in the conversation in suitable depth. This means that when you clarify an observable fact, you must explain mechanisms that may account for the observation. If your results vary from your prospect, make clear why that may have happened. If your results agree, then explain the theory that the proof supported. It is never suitable to just state that the data approved the prospect, and let it drop at that. Make a decision as to whether each premise is supported or discarded or if you cannot make a conclusion with assurance. Do not just dismiss a study or part of a study as "uncertain."

Research papers are not acknowledged if the work is imperfect. Draw what conclusions you can based upon the results that you have, and take care of the study as a finished work.

- You may propose future guidelines, such as how an experiment might be personalized to accomplish a new idea.
- Give details of all of your remarks as much as possible, focusing on mechanisms.
- Make a decision as to whether the tentative design sufficiently addressed the theory and whether or not it was correctly restricted. Try to present substitute explanations if they are sensible alternatives.
- One piece of research will not counter an overall question, so maintain the large picture in mind. Where do you go next? The best studies unlock new avenues of study. What questions remain?
- Recommendations for detailed papers will offer supplementary suggestions.

Approach:

When you refer to information, differentiate data generated by your own studies from other available information. Present work done by specific persons (including you) in past tense.

Describe generally acknowledged facts and main beliefs in present tense.

The Administration Rules

Administration Rules to Be Strictly Followed before Submitting Your Research Paper to Global Journals Inc.

Please read the following rules and regulations carefully before submitting your research paper to Global Journals Inc. to avoid rejection.

Segment draft and final research paper: You have to strictly follow the template of a research paper, failing which your paper may get rejected. You are expected to write each part of the paper wholly on your own. The peer reviewers need to identify your own perspective of the concepts in your own terms. Please do not extract straight from any other source, and do not rephrase someone else's analysis. Do not allow anyone else to proofread your manuscript.

Written material: You may discuss this with your guides and key sources. Do not copy anyone else's paper, even if this is only imitation, otherwise it will be rejected on the grounds of plagiarism, which is illegal. Various methods to avoid plagiarism are strictly applied by us to every paper, and, if found guilty, you may be blacklisted, which could affect your career adversely. To guard yourself and others from possible illegal use, please do not permit anyone to use or even read your paper and file.

Criterion for Grading a Research Paper (Compilation) by Global Journals

Please note that following table is only a Grading of "Paper Compilation" and not on "Performed/Stated Research" whose grading solely depends on Individual Assigned Peer Reviewer and Editorial Board Member. These can be available only on request and after decision of Paper. This report will be the property of Global Journals.

Topics	Grades		
	A-B	**C-D**	**E-F**
Abstract	Clear and concise with appropriate content, Correct format. 200 words or below	Unclear summary and no specific data, Incorrect form Above 200 words	No specific data with ambiguous information Above 250 words
Introduction	Containing all background details with clear goal and appropriate details, flow specification, no grammar and spelling mistake, well organized sentence and paragraph, reference cited	Unclear and confusing data, appropriate format, grammar and spelling errors with unorganized matter	Out of place depth and content, hazy format
Methods and Procedures	Clear and to the point with well arranged paragraph, precision and accuracy of facts and figures, well organized subheads	Difficult to comprehend with embarrassed text, too much explanation but completed	Incorrect and unorganized structure with hazy meaning
Result	Well organized, Clear and specific, Correct units with precision, correct data, well structuring of paragraph, no grammar and spelling mistake	Complete and embarrassed text, difficult to comprehend	Irregular format with wrong facts and figures
Discussion	Well organized, meaningful specification, sound conclusion, logical and concise explanation, highly structured paragraph reference cited	Wordy, unclear conclusion, spurious	Conclusion is not cited, unorganized, difficult to comprehend
References	Complete and correct format, well organized	Beside the point, Incomplete	Wrong format and structuring

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