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Full Length Research Paper

Groundnut (*Arachis hypogaea*) pod and haulm production in the tropical legume project States, Nigeria

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The production of groundnut pod and haulm is one way of addressing the challenge of scarcity of livestock feed as well as improving the incomes of small-scale farmers. This study examines the revenue associated with groundnut pod and haulm production, using data obtained from 253 participating farmers. The data was analyzed using descriptive and inferential statistics. Results showed that average haulm yield ranged from 551 to 1,364 kg ha^{-1} while the average pod yield varied from 1,208 to 1,580 kg ha^{-1}. Revenue obtained from sales of haulm and grain was sensitive to price movements and differed significantly across locations and from season to season. The average revenue from haulm was lowest at US $75.8 ha^{-1} in October to December and highest at US $215.7 ha^{-1} in July to September. Similarly, the average revenue from the sales of pod was lowest at US $447.6 ha^{-1} in October to December and highest at US $616.3 ha^{-1} in July to September. The study concludes that groundnut varieties that combine high haulm and high pod yields are desirable for farmers' livelihood and should be made readily available.

Key words: Groundnut, pod, haulm, yield, revenue.

INTRODUCTION

Livestock production contributes to the nutritional security and socioeconomic development of Nigeria. It provides 36.5% of the total protein intake of Nigerians and is a major source of livelihood to a significant proportion of the rural and urban poor households and serves as a source of food, employment, transport, a cash buffer, a capital reserve, and as a means to hedge against inflation (World Bank, 2017; Food and Agriculture Organization (FAO), 2018). Majority of livestock production occurs in the northern part of Nigeria where

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the main practice is the pastoral/agro-pastoral systems of keeping small and large ruminants. In this production system, livestock are raised on natural pasture and water resources and is characterized by seasonal movement of livestock by herders in response to changes and availability of these resources (Sitters et al., 2009). However, the productivity of livestock in the country has remained low, resulting in low household incomes, a significant gap between supply and demand and necessitating the importation of poultry and beef to meet domestic demand.

A major cause of this low productivity is nutritional constraints primarily due to scarcity and seasonality of feed. Frequent and severe droughts occurrences, increasing population pressure, heightening climate variability, and recent insecurity and violent conflicts over scarce pasture and water resources have contributed to significant decline in the quantity and quality of pasture (Pachauri et al., 2014). Furthermore, studies have shown that adequate livestock production cannot be sustained on natural pastures alone (McDonald, 2010) but must be supplemented with crop residues from cereals, concentrate feeds or forage legumes. Thus, fodder production is viewed as an important intervention for boosting livestock production due to their relatively low cost and high crude protein content.

Legumes are important crops with multiple benefits particularly in a mixed crop-livestock production system. Apart from contributing to soil fertility through nitrogen fixation, their grains are a source of highly nutritious food while their haulms serve as highly palatable fodder. Among the legumes, groundnut is a dual-purpose crop cultivated in the northern region of Nigeria, offering both grain and haulm fodder. Groundnut haulm is one of the preferred fodders fed to livestock, particularly to ruminant animals during the dry season when there is scarcity of green pasture for grazing in Nigeria.

Given the scarcity and seasonality of pasture in Nigeria, several efforts have been put into developing improved varieties which have been promoted among the groundnut farmers in many parts of the country. One of such interventions is the Tropical Legume III (TL III) project, a collaborative effort between the International Crops Research Institute for the Semi-arid Tropics (ICRISAT) and the Institute for Agricultural Research (IAR), Samaru. The TL III project in Nigeria deliberately worked on how best to solve the problem of dry season livestock feeding by releasing improved groundnut varieties that have dual purposes of producing grains and haulms that remain green even at harvest. These varieties include SAMNUT 21, SAMNUT 22 and SAMNUT 23 with pod yield range of 2.0-2.5 ton ha^{-1} and haulm yield range of 4.0-5.0 ton ha^{-1} for SAMNUT 21 and SAMNUT 22 respectively and 2.0 ton ha^{-1} for SAMNUT 23, which were earlier released for Northern Guinea Savanna. The varieties released for the Savanna and Sahel Savanna for the same purpose were SAMANUT 24, SAMNUT 25 and SAMNUT 26, which have pod yield range of 2.0-3.0 ton ha^{-1} and haulm yield range of 2.0-3.0 ha^{-1} (Vabi et al., 2019). These improved varieties were disseminated and promoted under the TL Legume Project across the project States, providing opportunities for both livestock and non-livestock farmers to cultivate for either grain, haulm or for cash. This study was carried out to examine the socio-economic characteristics of the groundnut producers, assess the seasonality of revenue associated with both pod and haulm production and examine the marketing problems associated with their production.

MATERIALS AND METHODS

The study was conducted in 2019 in Tropical Legume III Project (TL III) project States including Bauchi, Jigawa, Kano, Katsina and Kebbi States. These States are located in Northern Nigeria cutting across Northern Guinea and Sudan Savanna and are notable for groundnut production in the country. Groundnut varietal demonstrations, groundnut research trials and groundnut production promotional activities have been carried out in these States under the project. A survey was carried out with the help of extension officers of the Agricultural Development Project (ADP) across the States as enumerators. Fifty respondents each were selected at random from among project participants list that cultivated groundnut in 2017 in Jigawa, Kano, Katsina, Bauchi and Katsina States. However, there were additional respondents of one and two each in Bauchi and Katsina respectively. Thus, a total of 253 respondents were used for the study. The enumerators administered the structured questionnaires on the respondents in their language, mainly Hausa to get their responses and fill the questionnaire in English. Information was collected on the socioeconomic characteristics of producers, type of variety and area cultivated, in-shell pod and haulm yields, produce prices, distance to market, market restrictions and period of sales. The data collected was analyzed using descriptive statistics and inferential statistics. Descriptive statistics used included percentages and means to assess the socioeconomic characteristics of the respondents. Also, the Analysis of Variance (ANOVA) F-test as described by Snedecor and Cochran (1980) and also utilized by Ahmed et al. (2020) was employed to compare the mean yields, prices and revenues across the States and between seasons.

RESULTS AND DISCUSSION

Socioeconomic characteristics of the respondents

The results (Table 1) show that majority of the respondents in all the states were male farmers accounting for between 80.8% in Kebbi State to 100% in Katsina State, indicating that groundnut production in the study area is predominantly carried out by male farmers. Only a negligible proportion of farmers were females which is consistent with the religious belief of the Muslims living in the study area that says male farmers play the dominant role in agricultural production while serving the role of bread winner of the household (Oladeji et al., 2015) cited in Angara (2019). The majority age group in each state is between 40-49 years. However, the mean

Table 1. Socioeconomic characteristics of groundnut grain and haulm farmers.

Characteristics	Bauchi (n_1=51)	Jigawa (n_2=50)	Kano (n_3=50)	Katsina (n_4=50)	Kebbi (n_5=52)	Total (n=253)
Sex						
Male	50(98.04)	47(94)	48(96)	50(100)	42(80.77)	237(93.68)
Female	1(1.96)	3(6)	2(4)	0(0)	10(19.23)	16(6.32)
Age (years)						
<30	1(1.96)	2(4)	1(2)	0(0)	0(0)	4(1.58)
30-39	8(15.69)	5(10)	5(10)	2(4)	10(19.23)	30(11.86)
40-49	23(45.1)	17(34)	19(38)	14(28)	18(34.62)	91(35.97)
50-59	17(33.33)	15(30)	16(32)	28(56)	18(34.62)	94(37.15)
≥60	2(3.92)	11(22)	9(18)	6(12)	6(11.54)	34(13.44)
Mean	**46**	**49**	**49**	**51**	**48**	**49**
Educational level						
No formal	4(7.84)	3(6)	3(6)	4(8)	8(15.38)	22(8.70)
Islamic	17(33.33)	24(48)	12(24)	21(42)	18(34.62)	92(36.36)
Adult	10(19.61)	9(18)	12(24)	2(4)	9(17.31)	42(16.60)
Secondary	6(11.77)	10(20)	11(22)	4(8)	10(19.23)	41(16.21)
Tertiary	14(27.45)	4(8)	12(24)	19(38)	7(13.46)	56(22.13)
Land (ha)						
<2	14(27.45)	47(94)	47(94)	42(84)	37(71.15)	187(73.91)
2-3.99	24(47.06)	3(6)	3(6)	5(10)	8(15.38)	43(17)
4-5.99	10(19.61)	0(0)	0(0)	2(4)	5(9.62)	17(6.72)
≥6	3(5.88)	0(0)	0(0)	1(2)	2(3.85)	6(2.37)
Mean	**2.66**	**1**	**0.87**	**1.20**	**1.77**	**1.51**
Distance to market (km)						
<5	30(58.82)	10(20)	18(36)	7(14)	17(32.69)	82(32.41)
5-9.99	15(29.41)	27(54)	29(58)	32(64)	26(50)	129(50.99)
10-14.99	6(11.76)	6(12)	3(6)	6(12)	5(9.62)	26(10.28)
≥15	0(0)	7(14)	0(0)	5(10)	4(7.69)	16(6.32)
Mean	**5**	**8**	**6**	**8**	**5**	**6**

Values in brackets are percentages.

age of the farmers varies from 46 in Bauchi State to 51 years in Katsina State. In essence, groundnut production is done mainly by middle age and agile farmers across the States, corroborating the work of Usman et al. (2013) and Girei et al. (2013) that most of the farmers belonged to the middle age. An examination of the level of education attained showed that Kebbi State has the highest number of respondents without any form of education (15.4%). Thus, the respondents were literate enough (84.6%) and according to Sani and Oladimeji (2017), educated farmers have better ability to access and absorb new information and to adopt productive practices that will enhance their productivity (Table 1).

The land area allocated to the production of groundnut haulm is also the area used for the cultivation of in-shell pod as the two products are actually joint products from the same production system. When groundnut plant is physiologically matured, it is pulled out of the ground, left on the field for a week or two to dry properly and then, the pods are removed leaving the haulm which consists of the yellow-to green parts above the ground and the root parts from where the pods have been removed. The haulm is gathered together and tied in bundles and then moved home to a cool dry place. The result indicates a high variability in area cultivated across the States with the average area of land devoted to groundnut production in Bauchi State to be 2.66 ha and in Kano State, it was 0.87 ha but the average for the entire States is 1.51 ha. This result is consistent with Abdullahi and Murtala (2020) that argues that small scale farmers constituted the majority of over 70% of Nigeria population involved in farming. The markets where groundnut haulm is sold

Table 2. Frequency distribution of groundnut haulm variety type among groundnut haulm farmers based on States.

Variety	Bauchi (n_1=51)	Jigawa (n_2=50)	Kano (n_3=50)	Katsina (n_4=50)	Kebbi (n_5=52)	Total (n=253)
Local	19 (37.25)	36 (72)	0 (0)	19 (38)	9 (17.31)	83 (32.81)
Improved	32 (62.75)	14 (28)	50 (100)	31 (62)	43 (82.69)	170 (67.19)

Values in brackets are percentages.

varies in distance from farmers' homesteads. Groundnut haulm demand is seasonal and follows the production season. At groundnut harvesting time of September to November, it is readily available and farmers sell to traders or livestock producers directly in bags. Beyond that period, traders who buy and trade in it extend the supply to other markets. The result indicates that distance from the farm to markets is lowest in Bauchi and Kebbi States at 5 km while Jigawa and Katsina States have the longest distance of 8 km. However, the average distance for all the States is 6 km, signifying that farmers necessarily have to incur transportation cost in buying farm inputs and in selling their outputs.

Varieties of groundnut cultivated

Majority of the groundnut farmers in Bauchi, Kano, Katsina and Kebbi States cultivated improved varieties in the 2018 cropping season. Across the states, 67 and 33% cultivated improved and local varieties respectively (Table 2). Some of the local varieties may actually be improved varieties as most farmers do not know the varieties by their improved names. Among the Institute for Agricultural Research (IAR) improved groundnut varieties cultivated, SAMNUT 24 stood out and was cultivated by 40.47% of the producers. This was followed by SAMNUT 26 (6.69%) and SAMNUT 25 (4.35%). The specific varieties cultivated from which both in-shell pods and haulms have been obtained are shown in Table 3.

Groundnut haulm yield, seasonal prices and revenues

The results of the analysis of yield, seasonal prices and revenues of groundnut haulm across the TL III States are reported in Table 4. The result indicates that average haulm yield differed significantly across locations with the highest average yield recorded in Kano State at 1,364 kg ha^{-1} and the least average yield of 551 kg ha^{-1} in Bauchi while the mean across the Project States was 1,058 kg ha^{-1}. The yields are statistically different from one state to another at 1% level of probability (F= 5.54). Both pod yield and haulm yield were far below the potential yields expected of the improved varieties shown in Vabi et al. (2019). The low yields and variability is attributed to rainfall pattern, soil quality, variety type, the level of inputs used by farmers, and the presence or absence of pests and diseases (Samireddypalle et al., 2017; Ahmed et al., 2020).

Groundnut haulms were available and sold throughout the year and the price of haulm at farm level differs from season to season in all the locations and also depends on the market where it is sold. The price of groundnut haulm was lowest during the harvest season (October-December) and is uniform at US \$0.06 kg ha^{-1} across all States. However, as the season progresses and green pastures become more difficult to obtain for grazing, the price doubles by January- March to between US \$ 0.11 to US \$0.13 kg^{-1}. In addition, the prices are significantly different from one location to another and from season to season at 1% level of probability. The prices remain fairly stable at January-March levels in all the States probably because, this time some green pastures are available for grazing by herders. However, by the last quarter of July-September, the prices substantially increase in all the locations ranging from US\$ 0.15 kg^{-1} in Bauchi, Jigawa and Katsina States to US\$ 0.16 kg^{-1} in Kano State. Thus, F-test1 results show there is significant differences between the mean prices of haulm across seasons for each state and also for the revenues from haulm for each state across season (F-test2 results). However, the unit price differences across the different locations is not statistically significant for October-December, April-June and July- September periods of the year while that of January-March was statistically significant at 1% level of probability (F=5.19). This corresponds to the season when the haulm trade between states picks up as demand for dry season feeds increases in the other states.

As a result of fluctuations in prices, the revenues from haulm sales also fluctuate. The average revenue across the States was US\$75.8 ha^{-1} in October- December, US\$158.2 ha^{-1} in January- March, US\$158.9 ha^{-1} in April-June and US\$215.7 ha^{-1} in July- September. In all cases, the mean revenues significantly differ at 1% level of probability between seasons for each state (F-test2 results) and across locations using the F-statistics (Table 4).

Table 3. Distribution of the names of groundnut varieties cultivated by farmers.

Name of variety	Frequency	Percentage
Samnut 24	121	40.47
Samnut 26	20	6.69
Yar Dakar	19	6.35
Mai Bargo	15	5.02
Sadiyya	14	4.68
Yar Kosoma	13	4.35
Samnut 25	13	4.35
Yankwance	11	3.68
Yar Gyada	11	3.68
Yar Baushe	10	3.34
Samnut 23	10	3.34
Yar Kano	9	3.01
Mota	9	3.01
Mankwai	6	2.01
Yarmadani	4	1.34
Mai Atamfa	3	1.00
Samnut 18	3	1.00
Kwankwaso	2	0.67
Yar Kumbi	1	0.33
Yar Yanswado	1	0.33
Samnut 15	1	0.33
Yar Jam	1	0.33
Yar Malikawa	1	0.33
Yar Singilia	1	0.33
Total	**299**	**100**

Groundnut in-shell pod yield, seasonal prices and revenues

The in-shell pod yield from the respondents varies from the lowest of 1,208 kg ha^{-1} in Bauchi State to the highest of 1,580 kg ha^{-1} in Kano State and the mean yield across the States is 1,386 kg ha^{-1} (Table 5). The F-statistics show that yields are significantly different from one location to another at 1% level of probability. The variability in in-shell pod yield is attributed to factors such as differences in rainfall pattern, soil quality, variety, the level of inputs used by farmers, and the presence or absence of pests and diseases (Samireddypalle et al., 2017; Ahmed et al., 2020). Thus, Samireddypalle et al. (2017) identified low rainfall, poor soil fertility and striga attack as factors that can potentially depress groundnut haulm and in-shell pod yield. The early and late droughts experienced in several States particularly in Bauchi and Jigawa States in the 2017 cropping season, for example, led to poor yields to the extent that some farmers could only harvest groundnut as haulm as the pods were not filled properly before cessation of rains.

There is seasonality in prices with the lowest price range of US$0.40-0.45 kg^{-1} in October- December. Prices of in-shell pods start to increase from US 0.49- 0.54 kg^{-1} in January- March, then to US 0.49 - 0.66= kg^{-1} in April - May and finally to US$0.55- 0.64 kg^{-1} in July-September when new produce begin to arrive the market in most of the States. Also, the F-statistics show that mean prices are significantly different from one location to another at 1% level of probability. The average revenue was US$ 447.6 ha^{-1} in October–December, US$531 ha^{-1} in January-March US$606.6 ha^{-1} in April-June and US$616.3 ha^{-1} in July–September. The test of significance between the mean seasonal prices in each state shows that in Bauchi, Jigawa, Kebbi, Kano and Katsina the difference was statistically significantly at 5% level of probability (F-test1 results). On the other hand, revenue also show seasonal variations in revenue was statistically significant at 1% level in Jigawa, Kano and Katsina, 5% level in Bauchi State and 10% level in Kebbi State (F-test2 results). The findings from this study shows that groundnut farmers in addition to making a lot of revenue from in-shell pod, also make significant amount of money from the haulm sales. For instance, the average revenue from haulm was 16.93% of revenue from in-shell pod in October-December, 29.78% in January-March, 26.19% in April-June and 35% in July- September. Further discussions with the farmers under the TL III Project revealed that the revenue from haulm sale was enough to

Table 4. Average yield, price and revenue of groundnut haulm by seasons.

Period	Bauchi (n_1=51)	Jigawa (n_2=50)	Kano (n_3=50)	Katsina (n_4=50)	Kebbi (n_5=52)	Total (n=253)	F-test
Yield (kg ha^{-1})	551	1,155	1,364	1,312	924	1,058	5.54***
	(358)	(510)	(585)	(671)	(491)	(607)	
Oct-Dec							
Price (US$ kg^{-1})	0.06	0.06	0.06	0.06	0.06	0.06	1.18
	(1)	(1)	(0)	(2)	(2)	(2)	
Estimated Revenue (US$ ha^{-1})	67.06	69.86	86.46	79..56	76.19	75.79	4.76***
	(26.3	(29.1)	(16.1)	(25.4)	(26.9)	(25.9)	
Jan-Mar							
Price (US$ kg^{-1})	0.12	0.12	0.11	0.11	0.13	0.12	5.19***
	(1)	(5)	(7)	(4)	(13)	(8)	
Estimated Revenue (US$ ha^{-1})	138.5	145.3	174.7	162	170.1	158.2	4.13***
	(53.3)	(62.9)	(42.4)	(55.7)	(58)	(56.2)	
Apr-Jun							
Price (US$ kg^{-1})	0.11	0.12	0.12	0.12	0.18	0.12	0.82
	(5)	(8)	(7)	(5)	(10)	(7)	
Estimated Revenue (US$ ha^{-1})	135.5	149.7	178.5	165.0	165.8	158.9	4.12***
	(55.1)	(75.2)	(41.8)	(52.4	(60.8)	59.5)	
Jul-Sep							
Price (US$ kg^{-1}	0.15	0.15	0.16	0.15	0.16	0.16	0.93
	(4)	(6)	(13)	(5)	(14)	(9)	
Estimated Revenue (US$ ha^{-1})	185.8	193.7	251.1	224.1	224.1	215.7	5.71***
	(72.0)	(84.7)	(66.3)	(72.6)	(91.8)	(81.0)	
F-test1	2856.14***	789.27***	248.02***	1061.70***	162.83***	1766.37***	
F-test2	62.74***	48.83***	157.66***	87.40***	69.89***	361.06***	

Values in brackets are standard deviations. ***<0.01; 1US$= 365 NGN at the time of study. F-test1 =Difference test in prices of haulm across seasons; F-test2 =Difference test in revenue of haulm across seasons.

cover the cost of production of the in-shell pods in some cases.

Restriction of farmers to haulm markets

In the study location, groundnut farmers participate in the haulm markets. However, these farmers are constrained by certain factors which act to depress profits realized from the sale of their produce. About 89.3% of the farmers encountered no restrictions in the sale of their haulm in the market. However, some of the farmers have to sell through commission agents located within the markets, have to pay market fines and revenue to government officials or were asked to become members of the feed sellers' association in the market in order to participate in the haulm markets. Overall, the results suggest that groundnut farmers can significantly improve their income by participating in the haulm markets directly rather

Table 5. Average yield, price and revenue of in-shell pod by seasons.

Period	Bauchi (n_1=51)	Jigawa (n_2=50)	Kano (n_3=50)	Katsina (n_4=50)	Kebbi (n_5=52)	Total (n=253)	F-test
Yield (kg ha^{-1})	1,208	1,270	1,580	1,459	1,418	1,386	19.75***
	(464)	(529)	(293)	(454)	(475)	(466)	
Oct-Dec							
Price (US$ kg^{-1})	0.41	0.40	0.43	0.45	0.43	0.42	8.79***
	(14)	(13)	(12)	(17)	(20)	(16)	
Estimated Revenue (US$)	225.6	468.9	585.9	571.6	392.8	447.6	21.64***
	(148.8)	(218.7)	(244.05)	(282)	(216.4)	(260.3)	
Jan-Mar							
Price US$ kg^{-1})	0.50	0.49	0.50	0.54	0.49	0.50	8.37***
	(0)	(16)	(16)	(22)	(21)	(18)	
Estimated Revenue (US$)	278.4	569.0	682.3	692.7	441.3	531	21.7***
	(180.6)	(247.6)	(298.8)	(350.2)	(229.6)	(308)	
Apr-Jun							
Price US$ kg^{-1})	0.49	0.66	0.59	0.60	0.52	0.57	17.32***
	(0.06)	(0.13)	(0.07)	(0.21)	(0.06)	(0.13)	
Estimated Revenue (US$)	269.2	759.6	805.6	738.7	471.95	606.6	23.94***
	(185.9)	(331.7)	(370.4)	(468.7)	(254.1)	(391.7)	
Jul-Sep							
Price (US$ kg^{-1})	0.58	0.58	0.58	0.64	0.55	0.59	10.45***
	(0.03)	(0.03)	(0.09)	(0.13)	(0.05	(0.08)	
Estimated Revenue (US$)	316.9	671.7	785.4	810.3	507.5	616.3	22.29***
	(193.9)	(303.1)	(337.0)	(406.5	(280.7)	(360.3)	
F-test1	514.96***	295.55***	77.38***	66.28***	68.00**	469.82***	
F-test2	3.48**	7.76***	5.69***	5.81***	2.90*	18.45***	

Values in brackets are standard deviations. ***<0.01, ***<0.05, *<0.10; F-test1= Difference test in prices of in-shell pod across season; F-test2 = Difference test in revenues of in-shell pod across seasons.

than go through the market intermediaries.

Conclusion

This study shows that groundnut is an important legume crop that provides economic opportunities for farmers. In addition to the grains which provide both food and cash for farmers, groundnut haulms are a source of feed for livestock. Apart from the all- year- round increased availability of livestock feed, farmers that participate in fodder production earn revenue from the sales of haulms, thus providing additional source of income. Groundnut farmers can significantly improve their income by participating in the haulm markets directly since majority of them face little or no restrictions to the markets. This study recommends strategies and

efforts aimed at promoting seed availability and out-scaling of improved groundnut varieties that combine high haulm yield with high in-shell pod yield among the farmers by government, private sector and Non-Governmental Organizations (NGOs).

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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