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Analysis of Profitability of Castor Seed Production in Yobe State, Nigeria

*Mohammed, S. T., Shettima, B. G. and Sulumbe, I. M.

*Department of Agricultural Economics, University of Maiduguri, P.M.B. 1069, Maiduguri, Borno State, Nigeria.

ABSTRACT
This study was conducted in Yobe State, North-eastern Nigeria. The study used farm level data collected from 172 and 131 randomly selected rain-fed and irrigated castor seed farmers, respectively. The data were analyzed by descriptive and inferential statistics. Socio-economic characteristics and inputs used were analyzed by percentages and means, respectively. Gross Margin method was used to determine profitability while the Stochastic Profit Frontier model was used to identify the determinants of profit in castor seed production. The results show most respondents were literate and experienced farmers. There were similarities in input usage between the rain fed and irrigated farm operators. Profit indicators show rain-fed and irrigated castor farmers made profits of ₦16, 455.40 and ₦19, 597.40 per hectare, respectively. Short-run profits were determined by decreases and increases of input costs and output price, respectively in both production systems. Output price in both production systems was found to have had higher marginal effects on profit than input costs. The study therefore, established that castor seed production is a profitable enterprise that could improve farm earnings in the study area. Furthermore, output price influenced profit more than input costs. It is therefore, recommended among others, that farmers' welfare could be enhanced considerably when policies regarding good producer price are put in place.

Key words: Profitability, Gross Margin, Stochastic Profit Frontier, Castor Seed, Nigeria

INTRODUCTION

Agriculture is the largest sector of the Nigeria's economy in terms of employment provision. The sector accounts for more than forty percent of the country's Gross Domestic Product (GDP) and has the highest growth rate of 2.4% in 2010 (CBN, 2010). In spite of the importance of the sector to Nigeria's economy, it is largely dominated by small-holder farmers that produce most of the domestic food requirement. The small-holder however, is characterized by a number of problems including individual, institutional and natural factors. The feature of individual production is largely subsistence, mainly utilizing poor and traditional methods. Institutionally, the small-holder is scarcely affected by reform policies targeted at improving the agricultural sector performance. The bulk of the benefits end up with the medium to large-scale operators. Natural factors including pest and disease incidence and irregular rainfall regimes pose great setbacks to production that largely depends on rains. Any weather mishap could translate to total crop failure or reduced output and consequent reduction in household income.

Against this backdrop, the castor, a harsh weather tolerant and high valued industrial crop was promoted in order to augment farm incomes of rural farmers in north-eastern Nigeria. The main objective of this initiative was to improve the income base of the farmers in a poverty reduction drive. The promotion of castor crop in the area adds to the existing crop enterprises and may compete for resources with the conventional cropping pattern. The success of the castor enterprise depends on its production costs and revenues obtained in relation to competing enterprises. It is therefore, important to know the effects of

*Corresponding Author:

factors that affect enterprise profit and at the same time considering ways to increase profitability in order to achieve the desired goal of the castor promotion programme.

For that purpose, a stochastic profit frontier framework was used to establish the marginal effects of individual factors that affect profit levels in castor seed production. The stochastic frontier model takes into account random factors outside farmers' control, consisting of noise and an inefficiency component of the error term. The separation of the error term into two, among others, provides more efficient estimates of the parameter coefficients (Thiam, 2001; Kumbhakar, 2001; Delgado *et al*., 2003). The stochastic profit frontier function has widely been applied in modeling agricultural production (e.g. Abdulai and Huffman, 1998; Delgado *et al*., 2003; Rahman, 2003; Hyuha *et al*., 2007).

METHODOLOGY

The study was conducted in Yobe State, North-eastern Nigeria. The State is located between latitudes 9^0 56′N and 13^0 00′N and longitudes $9^0$30′E and $12^0$45′E. It covers an estimated area of about 47,153km^2 with a population of 2,612,971 persons[1] (NPC, 2006). The State comprised 17 Local Government Councils with Damaturu as the capital. It is bounded by the Niger Republic in the North and shares border with Jigawa and Bauchi States to the West, Gombe State to the South and Borno State to the South and East.The collaboration of BENAGRO Ltd. and Yobe State Castor Seed Promotion Programme covers the entire State. For administrative convenience, the programme office divides the State into four zones; A, B, C and D. The zonal headquarters of zones A and B are sited at Buni-Yadi and Potiskum, respectively, while Gashua and Geidam are the zonal headquarters of zones C and D, respectively. A zonal coordinator oversees the activities of various field officers in each zone. Rainfed and irrigated farming systems were employed in zones A and B and zones C and D, respectively.

The climate of the area is tropical with distinct dry and rainy seasons. The dry season starts from October to June, while the rainy season starts from July to September. Annual rainfall amount ranges from 400mm-500mm in the north and 600mm-1000mm in the southern part of the State. The mean minimum and maximum temperatures are 22^0C and 40^0C, respectively, with a relative humidity of about 65% (YSG, 2010).

The vegetation is Sahel in the north and Sudan and Northern Guinea Savannahs in the south. The economy is largely agrarian. Major crops grown include rice, maize, millet, sorghum, wheat, beans and groundnuts. Substantial amount of assorted vegetable crops are grown around the *Fadama* areas. Castor crop is widely found growing in the wild until recently when its commercial production was promoted. Livestock kept include cattle, sheep and goats.

A random sampling procedure was employed to select respondents for this study. Accordingly, lists of castor farming communities in the two farming systems were compiled. From the lists, a random sample of 10 village communities each from the irrigation and rain-fed farming systems were selected. The register of castor farmers for the selected villages was obtained from the State Programme Office and used as sampling frame. Using the sampling frame, 131 and 172 irrigation and rain-fed farmers, respectively, were randomly selected. The data for the study were collected from both primary and secondary sources. Primary data were collected through administration of structured questionnaires to respondents while the secondary data were obtained from the records of BENAGRO Ltd.

Means and percentages were used to categorize farmers based on their socioeconomic variables and production inputs usage. The Gross Margin (GM) Analysis was used for profitability analysis. The GM

[1]Population estimated using 3.2% growth rate based on the 2006 population census figures.

model is expressed as: $GM = \Sigma p.q - \Sigma r_i x_i$ …………………………………………………………… (1)

Where:

GM = farm gross margin (₦/ha)

p = price of output (castor seed) (₦)

q = quantity of output (kg)

r = price of variable input (₦)

x = quantity of variable input (kg)

i = 1, 2… 6 variable inputs used in castor seed production.

The Maximum Likelihood Estimates (MLE) of the stochastic profit frontier function was used to estimate the coefficients of factors affecting profit levels in castor production.The Translog profit frontier function is expressed as:

$\ln\Pi = \alpha_0 + \Sigma\, \alpha_j \ln P_j + 0.5\, \Sigma\, \Sigma \gamma_{jk} \ln P_j \ln P_j + \Sigma\, \Sigma \zeta_{jl} \ln P_j \ln Z_l + \Sigma\, \beta_l \ln Z_l + 0.5\, \Sigma\, \Sigma \theta_{lt} \ln Z_l \ln Z_l + v - u$ …. ..... (2)

and the inefficiency model as: $u = \delta_0 + \Sigma\, \delta_d W_d + \omega$ ……………………..(3)

Where;

Π = restricted profit normalized by the price of farm power

P_{ij} = price (₦) of j^{th} variable input faced by the i^{th} farm divided by price of farm power

j = 1, price of output, = 2, price of fertilizer, = 3, price of chemical, = 4, price of seed, = 5, price of irrigation flow (applies only to irrigated production)

Z_{ik}= level of k^{th} fixed factor on the i^{th} farm

k = 1, farm size (ha)

= 2, labour (man day)

= 3, depreciation on capital equipment (₦)

v = two sided random error

u = one sided half-normal error

ln = natural logarithm

W_d= variables representing farmers' characteristics that explain inefficiency

d = 1, education (number of years spent in school)

= 2, experience (years in farming)

= 3, household size (number of persons)

= 4, non-agricultural income (available=1, not available=0)

= 5, extension contact (number of times in a season)

= 6, nearness to market (number of kilometres away)

= 7, access to credit (number of sources)

= 8, membership in cooperatives (member=1, non-member=0)

= 9, storage facility (available=1, not available=0)

= 10, soil type (upland (*Jigawa*) =1, lowland (*Fadama*) =0)

ω = two sided random error

α_0, α_j, γ_{jk}, ζ_{jk}, β_l, θ_{lt}, δ_0 and δ_d are parameters estimated.

The stochastic profit frontier and inefficiency functions specified in equations 2 and 3 were jointly estimated using FRONTIER 4.1 (Coelli, 1996). The programme combines the two-stage procedure in one. The maximum likelihood method estimates the profit function parameters and that of the inefficiency model of the stochastic profit frontier function.

RESULTS AND DISCUSSION

Socioeconomic characteristics of castor seed farmers

The socioeconomic characteristics studied include household size, education and farming experience. Table 1 presents the socio-economic characteristics of the castor seed farmers in the study area.

Table 1: Socio-economic Characteristics of Castor Seed Farmers

Socioeconomic Variables	**Rain fed Farmers**		**Irrigated Farmers**	
	Frequency	**Percentage**	**Frequency**	**Percentage**
Household Size (Number)				
1-5	39	22.7	27	20.8
6-10	85	49.4	66	50.8
11-15	41	23.8	26	20.0
>15	7	4.1	11	8.5
Education (Years spent in school)				
No education	17	9.8	12	9.2
1-6	58	33.3	59	45.0
7-13	67	38.5	42	32.1
14-18	29	16.7	21	16.0
Above 18	3	1.7	9	6.9
Farming Experience (Years)				
1-10	36	20.9	9	6.9
11-20	46	26.8	63	48.1
21-30	54	31.4	45	34.3
>30	36	20.9	14	10.7
Distance to Market (Km)				
1-5	70	40.7	44	33.6
6-10	58	33.7	24	18.3
11-15	10	5.8	34	26.0
>15	34	19.8	29	22.1
Extension Contact (Number)				
1-2	120	69.8	96	73.3
3-4	32	18.6	14	10.7
>4	20	11.6	21	16.0

Source: Field Survey, 2010

The distribution of household members shows that about 49.4% of rain fed castor farmers had family size of between 6 and 10 persons. While about 22.7% and 23.8% had one to five and 11 to 15 persons, respectively. Only about 4.1% had more than 15 persons in their households. The distribution shows that 50.8% of irrigated castor seed farmers had family sizes that ranged from 6 to 10 which is typical of African traditional agriculture where household size determines family's scale of production due to farm labour availability. Studies (Abdulai and Huffman, 1998; Kolawole, 2006; Hyuha *et al*., 2007) around Africa have attested tothis fact, hence large household size may be an indication that families could take advantage of the labour availability for yet additional crop enterprise such as the recently introduced castor crop.

Table 1 also revealed the educational levels of rain-fed and irrigated castor farmers. The results show about 33.3% and 45.0% of rain-fed and irrigated farmers, respectively had between one and six years of formal schooling. About 38.5% and 32.1% of rain fed and irrigated farmers, respectively, had between seven and 13 years of formal education. Farmers with up to 18 years of education were 16.7% and 16.0% for rain-fed and irrigated farm operators, respectively. The proportions of farmers without formal schooling was 9.8% and 9.2% for rain-fed and irrigation farmers, respectively, while those with school years above 18 were accounted for 1.7% for rain-fed farmers and 6.9% for irrigation farmers. These findings suggest that castor seed farmers in the area were literate, with a good number having at least a school certificate. The implication of this finding is that the level of education of the castor seed farmers could influence easy comprehension of technical information that would enhance their profits.

The distribution of farmers by experience indicates varying years put into farming. About 47.7% and 55.0% rain-fed and irrigation farmers, respectively, had up to 20 years farming experience. While farmers with experience between 21 and 30 years were in the proportion of 31.4% and 34.3%, those with experience greater than 30 years were 20.9% and 10.7%, respectively, for rain-fed and irrigation farm operators. The results suggest that farming is an age long occupation in the study area. Studies (Abdulai and Huffman, 1998; Amaza, *et al*., 2007; Hyuha *et al*., 2007) have attested that farming has a long standing history in Africa. Consequent to that, more experienced farmers are envisaged to perform well in castor seed production notwithstanding its recent introduction into the study area.

Distance of farms to the markets was also analyzed. Table 1 shows that most of the rain-fed and irrigated castor farms were located close to markets, with 80.2% and 77.9% located within a distance of 1.0 to 15 km. Only about 19.8% and 22.1% of rain-fed and irrigation farms were located at a distance greater than 15 km. This implies that castor seed farms were located within a reasonable distance from the nearest markets. Proximity to market provides convenience and reduced transaction costs for farmers. When farms are located close to markets, inputs can be easily accessed and transaction costs are greatly reduced. Outputs on the other hand are easily disposed. Consequent to these, farm gross margin will improve and the general welfare of the farmers would be enhanced.

The distribution of extension visits indicates that 69.8% and 73.3% of rain-fed and irrigated castor seed farmers respectively were at most visited twice during the period under study. While about 18.6% and 10.7% received three to four visits, only 11.6% and 16.0% rain-fed and irrigation farmers respectively were visited more than four times in a season. This is a clear indication that castor seed farmers received few visits from extension staff. This could have adverse effects on farmers’ practices especially when the castor crop is just being introduced. Extension visits among small-scale farmers in developing countries is generally low as attested by empirical evidences (Rahman, 2003; Hyuha, *et al*., 2007; Ojo, 2011). Frequency of extension visits is expected to give room for information exchange between the farmers and extension staff. However, effective extension service faces severe setbacks in many developing countries as reported by World Bank (2008) that extension is public service dominated characterised by lack of staff incentives, weak political commitment and staff not being abreast with emerging technological developments.

Productive inputs used in castor seed production

Table 2 presents the summary of productive inputs used by the castor seed farmers. Relevant variables studied include prices of inputs used and farm size. Mean expenses on fertilizer, chemical and seeds were similar in both categories. This could be ascribed to the subsidy placed on these inputs. Farmers therefore, had similar cost outlay on the purchase of these inputs. Farm power was imputed as the cost of employing the services of farm implements for land preparation and other activities during the period of crop life. The mean expenses for the rain-fed and irrigation farmers were ₦3, 492.4 and ₦3, 360.7, respectively. This also shows similarities in the mean expenses with rain fed paying a little higher than irrigated farmers. However, for irrigated farms it varied from a minimum of ₦1, 000 to a maximum of ₦ 20,000 against its rain- fed counterpart that varied from ₦1, 500 to a maximum of ₦12, 000. This relative disparity may result from the number of farmers below the average expense being smaller than those operating above it among rain-fed farmers as indicated by the standard deviation. Expenses for farmers above average therefore, jacked up the mean expense paid by the group.

Table 2: Summary statistics of productive inputs used by castor seed farmers

Variable	**Rain fed**			**Irrigated**		
	Min	**Max**	**Mean**	**Min**	**Max**	**Mean**
Fertilizer(₦)	900.0	21,600.0	3,393.3	100.0	16,900.0	4,262.6
Chemical(₦)	100.0	4,400.0	819.5	100.0	6,100.0	834.4
Seed(₦)	30.0	300.0	77.6	30.0	300.0	65.9
Farm power(₦)	1,500.0	12,000.0	3,492.4	1000.0	20,000.0	3,360.7
Irrig. expenses(₦)	-	-	-	100.0	12,400.0	3,092.8
Farm size(ha)	0.25	2.00	0.72	0.25	2.00	0.67
Farm lab.(days)	10.0	65.0	36.6	8.0	58.0	28.4
Depreciation(₦)	75.0	6,480.0	1,826.1	70.0	15,000.0	5,940.6

Source: Computed from Field Data, 2010.

Irrigation variable comprised expenses on fuel, lubricants and maintenance of water pumping units and canals that provide water to crops. Table 2 also shows that the mean expense was ₦3, 092.8 and varied from a minimum of ₦100 to a maximum of ₦12, 400. The mean cost of irrigation may look smaller considering that crops were produced under irrigation which will warrant higher expenses for running the irrigation units. A closer look at the irrigation areas however, shows that substantial number of the farmers involved, mainly produce in oases and in the Fadama flood plains. The use of machines or any device to water the crops in these areas was only required for supplementary irrigation. Areas under exclusive irrigation were less relative to the sample studied; this could justify the variation between the minimum and maximum expenses incurred.

Mean farm sizes for rain fed and irrigated farmers were 0.72 and 0.67 ha, respectively. It varied from a minimum of 0.25 to a maximum of 2.0 hectares for both farmer categories. Small-scale farmers are characterized by small land holdings. Studies (Abdulai and Huffman, 1998; Rahman, 2003; Amaza *et al*., 2007; Hyuha *et al*., 2007) involving small-scale farmers in developing countries have attested to that. In this study however, production was restricted to certain farm sizes by BENAGRO Ltd - the programme implementing agency. This explains the similarities in the use of productive inputs in both farmer categories.

Man-days spent on castor production varied from a minimum of 10 to a maximum of 65, with an average of about 37 days in rain-fed farming. In contrast, the average number of days spent on irrigated castor seed farms was about 28 days and varied from a minimum of 8 to a maximum of 58 days. This finding appears surprising because one would expect days of labour to be higher in irrigation farms due to irrigation, however, this was explained under irrigation expense. Another possible reason for this disparity may be explained by how farm labour was measured.

Farm labour was measured in man-day (eight hours of work) rather than the quantity and quality of work done. By this, one can work in four hours what another could take eight hours to accomplish. By implication, the latter could be said to perform better in error. The tendency is that the quality of labour supplied on rain-fed farms was low compared to what was obtained in irrigated farms even though the former puts in more days of labour. It is observed that only a minimum skill was required for certain farm operations under rain-fed which every family member could offer including women and children. However, under irrigation, a certain degree of specialization is required and therefore, provided only by those with such qualities. This tendency may be one of the reasons for this difference.

The cost of running capital items on the farm was imputed as the depreciation of such items for wear and tear over the period of their life span. Farm capital depreciation therefore, is proportional to the number of capital assets on the farm. Table 2 shows mean farm capital depreciation of ₦1, 826.1 and ₦5, 940.6 for rain-fed and irrigation farms, respectively. There are significant differences (P<0.01) between cost of capital assets under rain-fed and irrigation. This is very clear from the stand point of what obtains in terms of capital items found on the two categories of farms. Capital items on rain fed farms were largely simple and traditional tools like hoes and cutlasses (with negligible annual depreciation) as against water pumps and other accessories found on irrigation farms, in addition to the conventional tools found on rain fed farms. Putting the two together could raise the cost on irrigation farms higher.

Profitability of castor seed production

Profitability of castor seed enterprise under rain fed and irrigated production systems was estimated using GM method. Table 3 presents results of the farm profitability analysis in castor seed production. The results show GM per hectare of ₦16, 455.4 and ₦19, 597.4 for rain-fed and irrigated farms respectively. Mean test of the two profit levels was significant (p<0.01) indicating that profit level significantly differ between the two production systems. The reason for this could apparently be due to the groups' respective profit efficiency levels.

Table 3: Enterprise Gross Margin in Naira per Hectare for Castor Seed Production

Item	**Rain fed** ₦/%	**Irrigated** ₦/%)
Gross Revenue	**35, 218.2**	**39, 733.8**
Variable Costs:		
Fertilizer	3, 393.3(18.09)	4, 262.6(21.17)
Chemical	819.5(4.37)	834.4(4.14)
Seed	77.6(0.41)	65.9(0.33)
Farm Power	3, 492.4(18.61)	3, 360.7(0.17)
Irrigation	-	3, 092.8(15.36)
Labour	10, 980.0(58.52)	8,520.0(42.31)
Total	**18, 762.8**	**20, 136.4**
Gross Margin	**16, 455.4**	**19, 597.4**

Source: Computed from Field Data

Variable cost items employed by castor seed producers include fertilizers, chemicals and seeds. These variable inputs were subsidized, hence the similarity between the two production systems in the cost outlay. Other variable inputs were expenses on farm power, irrigation and labour. Labour constituted the largest proportion of the variable cost incurred by castor seed farmers amounting to 58.5% and 42.3% of total variable cost for rain-fed and irrigated farms, respectively. In this study, respondents mostly reported use of family labour for castor seed production. Monetary value was attached to the man-days spent by the family to account for the cost of labour. Family labour is one of the most readily available resources to peasant farmers and is often not used efficiently, apparently due to the fact that its cost is not directly reflected in the production cost. Empirical evidence (Mohammed and Bila, 2005; Ojo, 2011) have shown family labour to be over utilized in small-scale agricultural production. The implication for this is that additional profit could be obtained when labour is efficiently utilized.

Determinants of profit under rain-fed castor seed production

The Maximum Likelihood (ML)estimate of the Stochastic Profit Frontier Function for rain-fed farmers is presented in Table 4. The first-order coefficients of the explanatory variables were significant (P<0.01) except for normalized price of chemical. All coefficients bear correct signs (positive for price of output and negative for input costs) as expected and given that coefficients were less than unity suggests castor seed farmers were operating at stage two of the classical production function.

Profit was found to be influenced by price of castor seed as it exhibits a strong (P<0.01) positive effect on the function. The coefficient of 1.2 suggests other factors remaining constant, a 1% increase in price of castor seed would increase profit level by 1.2%. A similar study involving related products reported output price to have positive and significant relationship with profit level. Delgado *et al*. (2003) found a positive (1.60) and significant relationship (P<0.01) between output price and profit in poultry enterprises in developing countries.

Table 4: Maximum Likelihood Estimates of the Translog profit frontier function for rain fed operated farms

Variables	Parameter	Coefficient	t-ratio	Variables	Parameter	Coefficient	t-ratio
Constant	α_0	7.430	6.085***	lnPch×lnZ_2	ζ_{32}	0.047	0.567
Lnpc	α_1	1.200	15.130***	lnPch×lnZ_3	ζ_{33}	-0.004	-0.159
Lnpf	α_2	-0.203	-8.760***	lnPs×lnZ_1	ζ_{41}	0.732	2.51**
Lnpch	α_3	-0.145	-1.205	lnPs×lnZ_2	ζ_{42}	-0.288	-0.366
Lnps	α_4	-0.662	-6.768***	lnPs×lnZ_3	ζ_{43}	0.420	0.221
1/2lnPc×lnPc	γ_{11}	-0.477	-6.321***	lnZ_1	β_1	46.990	15.033***
1/2lnPf×lnPf	γ_{22}	0.790	2.489**	lnZ_2	β_2	0.068	0.623
1/2lnPch× lnPch	γ_{33}	7.921	3.411***	lnZ_3	β_3	-0.3030	-1.097
1/2lnPs×lnPs	γ_{44}	758.384	757.220***	1/2lnZ_1× lnZ_1	ω_{11}	0.756	1.021
lnPc×lnPf	γ_{12}	-0.290	-0.888	1/2lnZ_2× lnZ_2	ω_{22}	-11.861	-5.137***
lnPc×lnPch	γ_{13}	-0.974	-1.234	1/2lnZ_3× lnZ_3	ω_{33}	0.179	4.165***
lnPc×lnPs	γ_{14}	-2.720	-2.620***	lnZ_1×lnZ_2	Θ_{12}	0.121	1.387
lnPf×lnPch	γ_{23}	-4.271	-3.989***	lnZ_1×lnZ_3	Θ_{13}	-0.102	-0.431
lnPf×lnPs	γ_{24}	6.483	2.923***	lnZ_2×lnZ_3	Θ_{23}	-6.146	-4.312***
lnPch×lnPs	γ_{34}	-56.348	-39.490***				
lnPc×lnZ_1	ζ_{11}	-3.850	-4.582***				
lnPc×lnZ_2	ζ_{12}	0.057	0.093				
lnPc×lnZ_3	ζ_{13}	-0.181	-1.113				
lnPf×lnZ_1	ζ_{21}	1.628	2.425**				
lnPf×lnZ_2	ζ_{22}	0.038	0.492				
lnPf×lnZ_3	ζ_{23}	-0.013	-2.251**				
lnPch×lnZ_1	ζ_{31}	-0.320	-1.376				

Source: Computed from Field Data (2010). ***Significant at 1% **Significant at 5%

Coefficient of price of chemical also bears negative sign consistent with expectation. It was however, not significant. All the fixed inputs bear correct signs as expected. However, only farm size was found to be statistically significant (P<0.01). The positive coefficient of farm size is indicative of increase in farm profit with increase in land holding under castor seed cultivation *ceteris paribus.* The increase in profit could be brought about by reduction in production cost per unit of output due to scale economies. In line with this finding, a similar result was obtained among *Fadama Telfairia* farmers where the study (Nwachukwu and Onyenwaku, 2007) revealed a significant positive relationship between farm profit and farm size. Similarly, profits were found to be significantly increased with increase in land under Bangladeshi rice production as reported by Rahman (2003).

Determinants of profit under irrigated castor seed production

The determinants of profit under irrigated castor production are presented in Table 5. The first-order explanatory variables bear correct signs,with positive output price and negative input costs and are statistically significant (P<0.01) except for irrigation expense. The coefficient on price of output was positive and significant in influencing farm profit levels. A coefficient of 5.148 suggests an increase of over five fold in profit with a unit increase in price of output. This coefficient under rain fed was also positive (1.200) and significant, meaning that profit is much more influenced by output price under irrigated production than rain-fed. This difference was however, not expected given the fact that one sales outlet existed for the two categories of farmers. A plausible explanation to this scenario may be based on the relative efficiencies of the two categories of farmers.

Table 5: Maximum Likelihood Estimates of the Translog Profit Frontier Function for Operators of Irrigated Castor Farms

Variables	Parameter	Coefficient	t-ratio	Variables	Parameter	Coefficient	t-ratio
Constant	α_0	-7.524	-6.784***	lnPf×lnZ_2	ζ_{32}	-0.377	-1.238
Lnpc	α_1	5.148	5.492***	lnPf×lnZ_3	ζ_{23}	-0.036	-0.829
Lnpf	α_2	-0.423	-3.612***	lnPch×lnZ_1	ζ_{31}	0.907	1.401
Lnpch	α_3	-0.616	-6.004***	lnPch×lnZ_2	ζ_{32}	0.115	0.568
Lnps	α_4	-0.261	-26.219***	lnPch×lnZ_3	ζ_{33}	0.176	1.139
LnPi	α_5	-0.372	-0.391	lnPs×lnZ_1	ζ_{41}	-0.549	-0.799
1/2lnPc×lnPc	γ_{11}	-0.173	-0.861	lnPs×lnZ_2	ζ_{42}	1.151	1.407
1/2lnPf×lnPf	γ_{22}	-0.324	-0.652	lnPs×lnZ_3	ζ_{43}	0.294	0.298
1/2lnPch×lnPch	γ_{33}	-4.074	-3.948***	lnPi×lnZ_1	ζ_{51}	28.568	27.842***
1/2lnPs×lnPs	γ_{44}	309.494	309.402***	lnPi×lnZ_2	ζ_{52}	-0.338	-0.389
1/2lnPi×lnPi	γ_{55}	-0.220	-0.719	lnPi×lnZ_3	ζ_{53}	-1.067	- 2.453**
lnPc×lnPf	γ_{12}	-0.611	-1.450	lnZ_1	β_1	1.502	2.973***
lnPc×lnPch	γ_{13}	-0.914	-1.413	lnZ_2	β_2	2.281	2.752***
lnPc×lnPs	γ_{14}	-3.692	-3.534***	lnZ_3	β_3	-19.734	-20.761***
lnPc×lnPi	γ_{15}	1.947	3.405***	1/2lnZ_1× lnZ_1	ω_{11}	-1.419	-2.640***
lnPf×lnPch	γ_{23}	4.403	4.750***	1/2lnZ_2× lnZ_2	ω_{22}	-0.117	-0.863
lnPf×lnPs	γ_{24}	-16.276	-14.656***	1/2lnZ_3× lnZ_3	ω_{33}	0.168	0.859
lnPf×lnPi	γ_{25}	-1.832	-2.252**	lnZ_1×lnZ_2	Θ_{12}	-0.383	-1.338
lnPch×lnPs	γ_{34}	-29.381	-29.015***	lnZ_1×lnZ_3	Θ_{13}	3.927	5.417***
lnPch×lnPi	γ_{35}	2.017	2.252**	lnZ_2×lnZ_3	Θ_{23}	0.095	0.534
lnPs×lnPi	γ_{45}	10.437	10.270***				
lnPc×lnZ_1	ζ_{11}	-2.922	-2.746***				
lnPc×lnZ_2	ζ_{12}	2.938	2.708***				
lnPc×lnZ_3	ζ_{13}	-0.083	0.155				
lnPf×lnZ_1	ζ_{21}	-1.031	-1.111				

***Significant at 1% **Significant at 5% Source: Computed from Field Data (2010).

Major input prices that significantly influence levels of farm profit were prices of fertilizer, chemical and seed. They all bear negative signs indicating decrease in profit with increase in these prices. Price of chemical was found to be statistically significant under irrigation contrary to what obtained under rain-fed. Possible explanation could be made based on the level of employment of this resource under irrigation in relation to rain-fed condition. The likelihood is that, pest infestation was mostly experienced in the irrigated zone therefore, use of pesticides significantly influenced crop survival and yield and consequently farm profits. Moreover, pest infestation could be time-bound and season specific. Rahman, (2003) and Okoruwa *et al*. (2009) also reported that use of pesticides had significant negative effects on farm profits in rice production.

The coefficient of seed price was highly significant in influencing the level of farm profits. It however, has the least marginal effect (-0.261) among all the significant variables. This means that increase in price of seed pose a relatively lowest decrease in farm profit than the other significant variables. This may explain the effect of the subsidy on seed input such that its cost has only a negligible effect on farm profit. Seed was subsidised at ₦30 per Kg and the recommended rate was 2.0-3.0 Kg/ha which puts total expense on seed at about ₦90 per hectare.

The coefficient of irrigation representing the expenses incurred on fuel, lubricants and maintenance in irrigating the crops was not significant. This was rather surprising at first thought. It was expected that increase in money expenses on irrigating castor seed would have had significant negative effect on profits. On a second thought however, it was observed that a number of communities under irrigated castor seed, produced in Fadama flood plains and oases where negligible cash expenses for irrigation were reported. Thus,lead to the non-significance of the irrigation coefficient. Where substantial investments were made in irrigation, it was not feasible to associate all expenses to castor seed enterprise alone because the facilities were also used for other crops growing concurrently. It was however, observed that households' irrigation facilities were used commonly for all the crops under cultivation at the period. Expenses incurred for using such facilities were therefore, spread over the entire farm holding making individual effect inconsequential.

The coefficients of quasi-fixed inputs were all significant (P<0.01). Farm size and farm labour were positive while farm assets was negative. The implication is that while increase in farm size and farm labour increase profits, increase in cost of owning farm asset decrease profits. The coefficient of farm asset was however, outstandingly large (-19.73) compared to that of farm size (1.50) and labour (2.81). Farm assets considered in this study include all tools and equipment owned by the farming households. The cost of owning these assets therefore, is associated with all functions and activities they are put into in all the households' farm enterprises. A relatively high coefficient should be expected if only one farm enterprise is considered for analysis. In this regard, the amount by which castor enterprise profit decreases with increase in depreciation cannot therefore, be wholly associated to castor seed enterprise alone. Similar results were obtained under rain-fed however; the wide difference between the magnitudes of the coefficients may explain the difference in the level of stock of farm assets possessed by the two farmer categories.

Conclusion and policy implications

The study has established that castor seed production in the study area was profitable with a positive gross margin per hectare. This implies that castor seed production could be used to increase farm incomes of the largely agrarian population. It was also established that profit level was determined by both inputs costs and output price. Profit levels were negatively related to input costs and positively related to output price. Higher marginal effects were however, found with output price than with costs of inputs. Policy implication of this finding is that profit level would be significantly increased with policies that ensure better producer price. With good producer price, castor seed farmers could make enough profit to stay in business even when input costs are liberalised.

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