

Analysis of cotton production in Katsina State, Nigeria

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ABSTRACT

This study sought to identify major cropping patterns adopted in cotton production, determine optimal plan in cotton production in the study area, identify factors affecting cotton production in the study area, examine technical efficiency of cotton production, and identify the constraints to cotton production. One hundred and seventy-five (175) farmers were interviewed in two Local Government Areas of Katsina State through a multistage sampling technique. Analytical tools such as descriptive statistics, Linear Programming Model and the Stochastic Production Frontier Model were used for data analysis. Results from the study show that about 60% of the farmers were full time farmers with at least 10 years of cotton farming experience. The estimated coefficient of tractor use and fertilizer are positive and significant at 1% while that of farm size and quantity of seed planted are also positive and significant at 5% and 10% levels of significance respectively. This implies that output of cotton farmers in the study area would be expected to increase with the increasing use of production inputs such as farm size, fertilizer, tractor use and quantity of seed planted. The coefficient of age and farming experience were estimated to be negative but only age was statistically significant at 10% level of significance. This implies that cotton farmers that are aged and experienced tend to be more efficient in cotton production and hence, increase in the level of their cotton output. The study concludes that ample opportunities exist for farmers to increase their productivity and income through more efficient resource utilization. It is recommended that adequate inputs such as fertilizer and improved seeds and machineries should be made available to the cotton farmers by government and non-governmental agencies.

KEYWORDS: Linear Programming, Cotton, Fiber, Stochastic Frontier, Katsina

INTRODUCTION

Cotton is primarily an agricultural crop but can also be found growing in the wild. Originally, cotton species are perennial plants but in some areas it has been selectively bred to develop as an annual plant. For example in Nigeria, varieties with high yielding qualities, early maturing (between 155 – 165 days) and resistance to disease varieties are made available by the Institute for Agricultural Research (IAR),

Samaru (Gbadegesin *et al.*, 2007). There are more than 30 species of *Gossypium* but only four species are supplied into the world market for cotton. The Nigerian cotton industry plays an important role in the country's economy (Chukwendu, 1993). Prior to the crude oil boom, cotton was one of the main sources of foreign exchange in Nigeria and cotton industry was the second largest employer of labour after the public sector (Gbadegesin *et al.*, 2007). High grade

cotton plant is important to fertiliser industries because it contains 7% nitrogen, 3% phosphorus and 2% potash. Also, the cotton plant consists of 42% fibre and 58% seed. The fibre content is used totally for textile. The seed which is derived after the plant has been ginned and the fibre extracted is made up of the hulls which are the outer covering of the cotton seed and it constitutes 42% of the cotton seed 15% cotton seeds oil, 40% cotton seed meal and 3% fibre (UNCTAD, 2001).

The major feature of cotton production in Nigeria is that about 80% of total production is by low-resource farmers under rain fed condition with the use of simple tools and animal drawn implement (Onu and Atala, 1992; Adeniji, 2002). These small scale farmers have an average farm size of about 0.5 ha and about 0.8 million farmers are growing the crop on an estimated total area of about 700,000 ha (Olukosi *et al.*, 2007). The farmers average output is still low because cultivation is still done mostly with hand, tools such as hoes, animal drawn implements and also tractors. Priority is given to food crops which results to late planting of cotton, with minimal application of fertiliser and insecticides which give a minimum output of about 300 kg/ha. A total consumption of about 80,000MT of lint was estimated 240,000MT of cotton seed annually, available data shows a sharp shortfall in the domestic production estimated at 32,000MT in 2003 (FOS, 2004). The decline experienced in cotton production in Nigeria which has posed some serious constraints to the expansion of cotton industry in Nigeria which was once a major cotton exporting country, is due to the fact that the small scale farmers are not efficient in their resource use.

Factors affecting cotton production in Nigeria have often been subjected to unnecessary over generalization. This is why

most policies aimed at achieving improved production have failed as it is often assumed that these factors are the same all over the country. In the recent past, price fluctuations and other related problems have been sources of discouragement for the farmers. As stated by Ubi (1987), poor marketing arrangement has been considered as one of the key factors affecting cotton production in Nigeria. This therefore shows that there is generally low investment in cotton production in Nigeria (Sabo *et al.*, 2009). This is probably because the potential investors are not aware of the profitability potential of cotton production. In view of the foregoing, there is need to assess the economic production of cotton in Katsina State. Hence, the study sought to identify major cropping patterns adopted in cotton production, determine optimal plan in cotton production in the study area, identify factors affecting cotton production in the study area, examine technical efficiency of cotton production, and identify the constraints to cotton production.

RESEARCH METHODOLOGY

Study Area

The study was carried out in Katsina State, Nigeria. The major occupation of people in these areas is farming. Katsina State is one of the few States in the country where crops are grown all the year round. Due to its vast arable land, it is currently playing a leading role in commodity/food production namely: cotton, groundnut, vegetables and cereal crops such as maize, millet, rice and sorghum. Apart from farming during the rainy season, dry season farming is done along the Dams in the State. A large number of farmers in these areas cultivate cotton and other cereal crops such as maize and sorghum.

Data Collection

Data were collected using primary and secondary source. The primary data were

collected through a well-structured questionnaire administered to cotton farmers. The questionnaire was designed to get adequate information about the production of cotton in the areas, problem confronting cotton production, profitability of the enterprise, resources use, socio-economic characteristics of the farmers, likely areas of improvement and the future of cotton farming in these areas. The administration of questionnaire was supplemented with scheduled interview with the farmers. The secondary data were collected from the Federal Office of Statistics, Katsina ADP and Ministry of Agriculture. Supplementary information was obtained from relevant textbooks, journals, and documented reports, newspapers, monographs and reference materials.

Sampling Procedure

A multistage sampling technique was used. The first is the purposive selection of two LGAs in which cotton is produced in Katsina State. This is due to the high concentration of cotton farmers and their proximity to Institute for Agricultural Research (IAR) Samaru, Zaria for access to improved cotton variety as obtained from the Katsina State Agricultural Development Program (KSADP). The second stage is the random selection of five (5) villages in which cotton is actively produced in each of these LGAs and the third to randomly select 20 farm households in each of these villages giving a total of 200 farm households that were interviewed. However, a total of 175 farm households were retrieved and used for this study.

Method of Data Analysis

Descriptive statistics such as frequency, percentages, averages etc. were used to identify major cropping patterns adopted in cotton production and to identify the constraints to cotton production. The linear

programming model was used to determine optimal plan in cotton production. The model is expressed as:

$$\begin{aligned} \text{Max } z &= \sum (p_j q_j - c_j) \\ \text{s.t } \sum a_{ij} X_{ij} &\leq b_i \end{aligned}$$

Where z = gross margin in Naira per hectare
 p_j = price of j th cropping unit in Naira, q_j = quantity of j th crop produced in kg, c_j = total variable cost per activity in Naira per hectare, a_{ij} = per unit requirement of the j th activity for the i th resource, x_{ij} = specific level at which j th activity is to be carried on, b_i = level of i th resources, b_1 = average land available per household (Ha), b_2 = average labour available per household in man-day, b_3 = average capital available per household. The stochastic production frontier function was used to identify factors affecting cotton production in the study area and to determine the technical efficiency of cotton production respectively. This function was improved and used by Olayemi (2002).

$$Y = f(X_1, \dots, X_n)$$

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \dots + \beta_n X_n + e_t$$

$$\text{Where } e_t = V_t - U_t$$

V_t = Asymmetric random error which captures the effect of control of the farmer.

U_t = technical inefficiency i.e., what is left for the farmer to reach the outer bound of the production frontier or operate on the frontier.

Y = Output in Kg. X_n = Vector of inputs, X_1 = Farm size in hectares, X_2 = Number of hours which tractor is used, X_3 = labour in man-days, X_4 = cotton seeds in Kg, X_5 = Quantity of fertilizer used in Kg, X_6 = Quantity of pesticide used, X_7 = Quantity of herbicide used, β = is the vector of parameter to be estimated. To estimate β , we revised the stochastic frontier model to have $\ln Y = \beta_0 + \beta_1 \ln x_1 + \beta_2 \ln x_2 + \beta_3 \ln x_3 + \dots + \beta_n \ln x_n$

$$U_t = \alpha_0 + \alpha_1 Z_1 + \alpha_2 Z_2 + \alpha_3 Z_3 + \alpha_4 Z_4 + \theta_1 d_1 + \theta_2 d_2$$

The above regulation is the technical inefficiency effects and it also indicates that

these effects in a stochastic frontier are expressed as

Z_1 =Age of the farmer, Z_2 =Family size,

Z_3 =Number of years of formal education

Z_4 =Number of years of farming experience,

d_1 =Gender of the farmer. It takes the value of 1 for male and 0 otherwise, d_2 =cropping

system. It takes the value of 1 for mixed cropping and 0 other wise.

RESULTS

Socio-economic and demographic characteristics of the respondents such as age, sex, marital status, household size amongst other are shown on Table 1

Table 1: Socio-Economic and Demographic Characteristics of the Respondents

Characteristics	Frequency	Percentage
i. Sex of respondents		
Male	155	88.6
Female	20	11.4
Total	175	100
ii. Age of respondents		
21-30	7	4
31-40	40	22.9
41-50	93	53.1
51-60	22	12.6
>60	13	7.4
Total	175	100
iii. Marital status of respondents		
Single	31	17.7
Married	115	65.7
Widowed	13	7.4
Divorced	16	9.2
Total	175	100
iv. Family size of respondents		
1-10	37	21.1
11-20	61	34.9
20-30	71	40.6
>30	6	3.4
Total	175	100
v. Level of Education of respondents		
Adult literacy	21	12
No education	49	28
Primary	14	8
Secondary	7	4
Qur'anic	84	48
Total	175	100

vi. Main occupation of respondents		
Farming	105	60
Trading	57	32.6
Civil service	13	7.4
Total	175	100
vii. Years of farming Experience		
1-10	89	50.9
11-20	56	32
21-30	25	14.2
>30	5	2.9
Total	175	100
viii. Co-operative Membership		
Members	139	79.4
Non-members	36	20.6
Total	175	100
ix. Cotton As Main Income Source		
Yes	104	59.4
No	71	40.6
Total	175	100
x. Farm size in Ha of respondents		
0.10-1.00	76	43.4
1.10-2.00	52	29.7
2.10-3.00	29	16.6
>3.00	18	10.3
Total	175	100
xi. Source of land Acquisition		
Inherited	112	64
Purchased	22	12.6
Lease	41	23.4
Total	175	100
xii. Source of Cotton seeds Planted		
IAR	50	28.6
Open market	36	20.6
Dealers	89	50.9
Total	175	100

As shown on Table 1, most of the cotton farmers were male (88.6%). This result may be in line with the custom and traditions of the people of the study area since most

women are usually not directly involved in agricultural land cultivation. Over 70% of respondents fell within the range of 31-50 years. This age range represents the active work force of cotton production in the study

area. The mean age of the farmers was observed to be 45 years.

The Cropping Pattern Adopted

The cropping pattern adopted by cotton farmers in study area is shown in Table 2.

Table 2: Cropping Pattern and Crop Combination Adopted by Respondents

Cropping pattern	Frequency	Percentage
Cotton/Cowpea	67	38.9
Cotton/Maize	42	24
Cotton/Soybeans	10	5.7
Cotton	56	32
Total	175	100

Optimal Farm Plan in Cotton Production

Cotton production is the main source of income of respondents in the study area. Four enterprises were identified to be most commonly grown by respondents. The farmer's perception of profitability and income from each enterprise influences his farm management decisions. In order to establish the optimal allocation of available resources so as to maximize profit for each enterprise, Linear Programming Model was used. Table 4 shows the summary of linear programming analysis. The following activities were analyzed for linear programming

X_1 – Cotton/Cowpea, X_2 – Cotton/Maize, X_3 – Cotton/Soybeans, X_4 – Cotton

Linear Programming Model is estimated as:

$$\text{Max } Z = 165,650.45X_1 + 92,474.40X_2 + 137,280X_3 + 42,100X_4$$

$$\text{Subject to: Land: } 1X_1 + 1X_2 + 1X_3 + 1X_4 \leq 1.92 \text{ Ha}$$

$$\text{Labour: } 89.59X_1 + 64.76X_2 + 74.99X_3 + 58.46X_4 \leq 122.55 \text{ Man-days}$$

$$\text{Capital: } 61,270.70X_1 + 65,847.90X_2 + 67,571.97X_3 + 34,465.$$

Table 3: Summary of Linear Programming

Variable	Solution	Opportunity cost	Obj. Coeff.	Min. Obj. Coeff.	Max. Obj. Coeff.
X_1	0.9956	0	165650.5	124478.27	+infinity
X_2	0	85550.95	92474.4	–infinity	178025.34
X_3	0	45406.51	137280	–infinity	182686.52
X_4	0	51081.11	42100	–infinity	93181.12

Maximized objective = N164,918.60K

Table 4: Resource Constraints

Constraints	Status	RHS	Shadow prices	Slack/Surplus	Min. RHS	Max. RHS
Land	Loose	≤ 1.92	0	0.92	0.99	Infinity
Labour	Loose	≤ 122.55	0	33.35	89.19	Infinity
Capital	Tight	$\leq 60,999.97$	2.7	0	0	83,812.09

The estimated parameters of the stochastic frontier function and related statistical test result obtained from the analysis are presented in Table 5. It is evident from Table 5 that the estimate of gamma (γ) is significantly different from zero indicating a

good fit and correctness of the specified distributional assumption. The estimated coefficients of years of formal education, gender of farmer and cropping pattern were positive and not significant at any level of significance.

Table 5: Maximum Likelihood Estimates of the Parameter of the Stochastic Frontier Production Function

Variables	Parameter	Co-efficient	Standard Error	T-ratio
Production Factors				
Intercept	β_0	1060	124	8.56
Farm size in Ha (X_1)	β_1	194**	94.8	2.04
Tractor use in Hrs (X_2)	β_2	18.6*	6.98	2.67
Labour in man-day (X_3)	β_3	2.36***	1.29	1.83
Quantity of seed in Kg (X_4)	β_4	1.05***	0.56	1.9
Fertilizer used in Kg (X_5)	β_5	0.948*	0.196	4.83
Pesticide used in Litres (X_6)	β_6	1.13	4.42	0.577
Herbicide used in Litres (X_7)	β_7	-12.60	5.06	-1.46
Inefficiency effects				
Intercept	α_0	-794.00	506	-1.58
Age (Z_1)	α_1	-8.47	4.75	-1.79
Family Size (Z_2)	α_2	31.6*	9.4	3.36
Years of formal education (Z_3)	α_3	10.7	31	0.343
Farming experience (Z_4)	α_4	-1.08	7.48	-0.144
Gender (Z_5)	α_5	12.7	75.4	0.169
Cropping pattern (Z_6)	α_6	16.7	156	0.107
Diagnostic Statistics				

Log likelihood function	μ	-1270.00		
Sigma-squared	σ^2	1.68	8.21	2.05
Gamma	γ	105	0.119	104
Sample size	175	0.595		4.98
L-R Statistics	χ^2			
		20.6		

significant at 1%, **significant at 5%, *significant at 10%*

Frequency Distribution of Technical Efficiency

The frequency distribution of the technical efficiency of the cotton farmers is shown in Table 6. Table 6 reveals that the technical efficiency of the sampled cotton farmers was less than one. That is, less than 100% and indicating that the farmers produced below the maximum efficiency frontier. The distribution of the technical efficiency indices of the cotton farmers ranged from

41% to 96%. The average technical efficiency was 76%. This implies that there is a generally high technical efficiency among cotton farmers in the study area as most of the cotton farmers (over 80%) produce above 0.50 efficiency index. However, only 56% of the cotton farmers in the study area produce above the estimated average technical efficiency index of 0.71.

Table 6: Frequency Distribution of the Technical Efficiency of Cotton Farmers

Efficiency Index	Frequency	Percentage
<0.40	0	0
0.41-0.50	7	4.00
0.51-0.60	26	14.86
0.61-0.70	44	25.14
0.71-0.80	61	34.86
0.81-0.90	19	10.86
>0.90	18	10.29
Total	175	100
Mean	0.76	
Maximum	0.96	
Minimum	0.41	

Constraints to Cotton Production in Study Area

Some constraints were highlighted by the farmers during the course of the study. These problems hinder farmers' desires to expand production and their level of output.

These constraints are shown in Table 7. Inadequate fertilizer and low pricing of produce were the most severe constraints encountered by the respondents.

Table 7: Constraints Affecting Cotton Production in the Study Area

Constraints	Average index	Rank
Inadequate fertilizer	3.9	1st
Low pricing of produce	3.89	2nd
Inadequate credit	3.43	3rd
High labour requirement	3.14	4th
Pests and diseases	2.91	5th
Poor storage of produce	2.11	6th
High Cost of Transportation	1.68	7th
Inadequate market for produce	1.43	8th
High Rainfall	1.22	9th

DISCUSSION

The respondents had relatively large family size with a mean household size of 18 persons. This may be as a result of polygamous marriage practised in the area and large number of dependants. This household size implies that a high amount of family labour will be available for cotton production in the study area. Over 70% of the respondents do not have formal education. This high level of illiteracy may reduce their rate of adoption of new technology and efficient allocation of scarce resources. This could have a negative impact on cotton production in the study area. This may also be the cause of poor record keeping attitudes exhibited by the respondents.

A sizeable number of the respondents (60%) were full time farmers with at least 10 years of cotton farming experience. Farming experience is very important especially in largely illiterate farming communities where the farmers learn by continuous practice. The remaining 40% of the respondents were engaged in other non-farming occupations such as trading and working with the civil service. About 80% of the respondents are members of co-operatives. This implies that cotton farmers may have benefits such as access to funds for cotton production, pricing of produce, collective buying and

selling of inputs and marketing from their co-operatives. It was observed that about 60% of the respondents are small scale farmers who cultivate cotton as their major source of income on an average land size of 1.92 hectares. This may have a great influence on cotton output in the study area since the smaller the area of land cultivated, the smaller the output. Most of these cotton farmers (64%) acquired their land through family inheritance while the remaining 36% acquired their land through long lease and by purchase. Over 70% of respondents purchased their cotton seeds which they plant from the dealers and the open market while the Institute for Agricultural Research (IAR), Samaru, accounted for 28% of the cotton seed source. This could be because the cotton seeds sold here commands a higher price than that of other sources.

Sixty-eight (68%) of the respondents practiced mixed cropping (planting cotton with other food crops). This may be a means of security against crop failure. It may also be a means of maximizing the use of their inputs. Only 32% of the respondents grow cotton as sole crop. Out of the four major enterprises employed by the respondents, the Cotton/Cowpea combination was the most profitable. The table also shows that sole cotton production had the least gross margin per hectare (N26, 339.94) in a growing

season. This may be an indication that cotton if produced in a mix with other suitable crops will be more profitable than if grown as a sole crop in the study area.

Also, Table 4 shows that an additional unit of capital will increase the value of the program by ₦2.70. The range at which resources should be allocated is given by the minimum RHS and maximum RHS. Land and labour are used in excess with surplus of 0.9244 and 33.3569 respectively. Capital as a constraint is tight with no surplus.

Table 5 shows that the estimated coefficient of tractor use and fertilizer are positive and significant at 1% while that of farm size and quantity of seed planted are also positive and significant at 5% and 10% levels of significance respectively. This observation is in line with the apriori expectation and it implies that the output of cotton farmers in the study area would be expected to increase with the increasing use of production inputs such as farm size, fertilizer, tractor use and quantity of seed planted. Amaza and Olayemi (2002), Onyenweaku *et al.* (2005) and Ebong *et al.* (2009) also reported a positive and significant relationship between farm size, fertilizer and technical efficiency in urban farming in Uyo metropolis in Akwa Ibom State, Nigeria. However the coefficient of pesticide although positive is not significant at any level of significance. This positive relationship between pesticide and technical efficiency of cotton farmers shows the importance of pesticide in enhancing the increase in the level of cotton output in the study area. The coefficient of herbicide is negative and not significant at any level of significance. This implies that an increase in the use of herbicide in the study area may not necessarily increase output. Onwuchekwa (2008) also reported a similar relationship between herbicide and technical efficiency in the report of this study.

The coefficient of age and farming experience were estimated to be negative but only age was statistically significant at 10% level of significance. Farming experience was not significant. The implication of these is that cotton farmers that are aged and experienced tend to be more efficient in cotton production and hence, increase in the level of their cotton output. This result conforms with Onu *et al.* (2000) in his report that age and farming experience were significant determinants of technical efficiency of cotton farmers. This shows that cotton farmers with more years of farming experience are more efficient probably due to their ability to acquire technical knowledge through learning on the job.

The coefficient of family size was positive but statistically significant at 1%. This implies that increase in household size could lead to increase in technical inefficiency of cotton farmers. This report agrees with Ebong *et al.* (2009) but is inconsistent with the findings of Ebong (2005) and Onyenweaku *et al.* (2005) in which they identified a positive relationship between household size and technical efficiency among crop farmers. From Table 6, the distribution of technical efficiency suggests that the potential gain among the cotton farmers is not much. Thus, in the short run, there is a scope of increasing cotton production by the averagely efficient farmer and the most technically inefficient farmer by 25% and 55% respectively if they adopt the technology and technique of the most efficient cotton farmer in the study area. This agrees with the report of Ebong *et al.* (2009) which indicated a wide gap between the maximum, the average and the minimum technically efficient farmers of urban farming.

From Table 7, the farmers complained of fertilizer not being available for purchase. As a result, they end up using little or no

fertilizer for their cotton farms which in turn affect their cotton output. The farmers also face a problem of low pricing of their cotton produce. Other severe constraints include inadequate credit, poor storage, pest and diseases and high labour requirement.

CONCLUSION AND RECOMMENDATION

The study revealed possibility of growing cotton profitably if mixed cropping is employed and production is accompanied with good managerial practices. It also showed that ample opportunities exist for farmers to increase their productivity and income through more efficient resource utilization. Hence, it is recommended that the government should provide efficient regulatory measures for the marketing, stabilization and pricing of cotton, as these facilitate the increase in cotton. Also, adequate inputs such as fertilizer and improved seeds and machineries should be made available to the cotton farmers by government and non-governmental agencies. These inputs should be supplied at affordable prices and should be provided timely so as to encourage the usage at the proper time and quantity. These supplies will serve as appropriate incentives and security to risk in cotton production which will in turn encourage farmers to increase their cotton production.

Effective cotton production education and awareness on profitability of cotton should be given to the farmers. This could be in the form of intensified extension services directed at educating farmers to encourage investment in cotton. These awareness programs may also include the dissemination of better management practices of cotton production to the farmers. Credits should also be provided to the farmers by the Agricultural Credit Banks

and other lending institutions through cooperatives and community banks.

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