Economics of On-Farm Sorghum – Legume Strip Cropping System in Kano State, Nigeria

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Abstract. The study was conducted to carry out Economics of Alliance for Green Revolution in Africa (AGRA) on-farm Sorghum-legume strip cropping system in Kano State. Structured questionnaire was used and data were collected from 229 farmers randomly selected from three purposively selected Local Government Areas (LGAs). The Data were analyzed using descriptive statistics, gross margin analysis, profitability ratios and Paired T-test. The results revealed that 75.6% of the farmers were in active age of within 25-54 years with a mean age of 45 years. Majority of the farmers were male (93.4%); 58.5% had acquired qua'ranic education and 97.4% were married with many household size of between 7-11 household (46.3%). The results of gross margin showed that the improved practice made a profit of ₦65, 931.64k/ha and a return on every naira invested of ₦2.08, compared with ₦56, 008.62k/ha and a return on every naira invested of ₦1.94in the traditional systems. Result on T-test showed that there is significant difference between profits of some improved practices against farmers practice (p< 0.05). The constraints to production experienced by the farmers were high cost of inputs, insufficient fund, inadequate and untimely delivery of farm input, inadequate collaterals/security, inadequate loan/credit facilities, inadequate storage processing and marketing facilities, pest, and diseases. Other less severe problems identified were Striga infestation, unstable produce price and drought spells. It was concluded that the technology package is more profitable. It is recommended that farmers should increase land devoted to Sorghum- legume strip cropping system and government and other agencies like ADPs should address the challenges of shortage of extension services, credit supply to farmers, improve marketing system, input supply and affordable price of input.

Key words: Economics, On-farm, Profitability, Sorghum-legume and Strip cropping.

INTRODUCTUON

Intercropping is the growing of two or more crops together on the same pieces of land at the same time in a haphazard or systematic manner that the growth of some or all the component plant types overlap in space and time (Elemo *et al.*, 1990). It was indicated that not less than 60-70% of the cropped land is devoted to the growing of crops in mixtures. A more recent survey by Henriet *et al.*, (1997) showed that mixed cropping was the predominant system in the Sudan savannah of Nigeria with millet/cowpea, sorghum/cowpea, sorghum/groundnut and millet. Intercropping of these crops serves as a means of maximizing the use of limited farm land, food security of farmers, higher yields are obtained, suppressing the germination of *striga* weed seeds and reducing the level of inorganic fertilizer requirement.

Intercropping has long been practiced by small scale farmers in the tropics. In particular, cereal and legume intercropping is recognized as a common cropping system in developing tropical countries (Ofori and Stern, 1987). Typically C4 cereal crops such as maize (*Zea mays L.*), pearl millet *(Pennisetum glaucum L.)* and sorghum *(Sorghum bicolor L.)* are the dominant plant species, whereas C3 legume crops such as beans *(Phaseolus vulgarisL.)*, cowpea *(Vigna unguiculata* (L.)wap), groundnut *(Arachis hypogaea L.*), pigeon pea *(Cajanus cajan(L).)* and soybean *(Glycine max (L).)* are the associated or secondary species. Canopy structures and rooting systems of cereal crops are generally different from those of legume crops.

Growing legumes and cereals together for food is not only popular among subsistence farmers in the tropics, who produce the bulk of food in developing countries, but it is also expanding to the warmer regions in the tropics (Fujita and Ofosu-Budu, 1996). Intercropping is receiving attention because it offers potential advantages for resource utilization, decreased inputs and increased sustainability in crop production. Despite increasing research attention during recent years, intercropping systems are still poorly understood compared with sole-crop systems, but there is considerable evidence that

intercropping can often provide substantial yield advantages over sole cropping. Some of the mechanisms that bring about these advantages are associated with environmental factors. Intercropping might positively impact on the future food problems in developing countries (Egbe, 2005).This may be through efficient use of solar energy and other growth resources. Also, optimization of land resource use could be achieved when crops are grown under intercropping and plant population density increased.

In most cereal–legume intercropping, cereal crops form higher canopy structures than legume crops, and the roots of cereal crops grow to a greater depth than those of legume crops. This suggests that the component crops probably have differing spatial and temporal use of environmental resources. Intercrops may make use of environmental resources such as radiation, water and nutrients more efficiently than mono-cropping (Willeys, 1990).

The project is being funded by Alliance for Green Revolution in Africa (AGRA) and undertaken by Kano State Agricultural and Rural Development authority (KNARDA), and Bayero University Kano (BUK), it is being carried out in six (6) local government areas of Kano State, Namely; Gwarzo, Kabo, Tofa (sorghum belt) and Gezawa, Ajingi and Gabasawa (millet belt). At the sorghum belt farmers group were identified and in some areas new farmers group were formed. Lead farmers were identified in each farmer groups and received training on agronomic activities that would be carried out during the course of the project implementation. So also inputs are distribute to farmers in form of improved seed varieties, herbicides, insecticides and fertilizer.

Improved cowpea varieties used were IT-277 and IT- 205. And Samnut 22 and Samnut 23 ware used as improved groundnut varieties, Soybean varieties were TGX1444 and TGX1835 As for sorghum ICSV III and CSR 01(kaura) ware used. The local varieties were tall and long duration, adapted to low soil fertility and in high demand by farmers in areas where their stalk is used for fencing and fuel.

The technology designed extend to farmers involves Strip cropping of sorghum/ cowpea, sorghum/ groundnut and or sorghum/soybean in all the villages in 4x4 rows (4:4). However, sorghum rotates with legumes and vice versa the following year. Each farmer has 3 plots of 1,500m² each (i.e. 30 x 50 m) or 750 m² for sorghum and 750 m² for legume. Seed rate per plot was 13kg/ha for sorghum; Groundnut: 50kg/ha and Cowpea 20kg/ha, while soybeans was 75kg/ha. Spacing at 75cm x 25 cm uniformly. Fertilizer /ha was 64:30:30 for sorghum while for Ground nut/ Cowpea/Soybeans were 20:40:20, ($N:P_2O_5;K_2O$)

Objectives of the study

The broad objective of this study was to carry out economics of sorghum-legume strip cropping system and farmer practices. While the specific objectives were to:

i) describe the socio-economic characteristics of the respondents in the study area,

ii) determine the profitability of cereal-legume demonstration plot over other farmers' plots,

iii) identify and describe constraints associated with the technology packages in the study area.

METHODOLOGY

Sampling techniques

This study was conducted in three local government areas of Kano state, Nigeria. The local governments are purposively selected because of the prevalence of sorghum production in the area. The local governments are; Gwarzo, Kabo and Tofa local governments. The second stage involved a simple random selection of 5 communities from each local government. The third stage also involves simple random selection of 16 farmers from each of the five communities, thus 80 respondents were selected from each local government and a total of 240 farmers form the sample frame. However, 229 questionnaires were retrieved and used for this study.

Data collection

The study used primary data. The primary data were collected using structured questionnaire. Variables on which the data were collected includes; Socio-economic characteristics of the respondents, production information and cost/ return information.

Tools of analysis

The tools of analysis used for this study were: - Descriptive Statistics, Gross Margin Analysis and Paired T-test

Descriptive statistics

Descriptive statistics is one of the simplest and frequently utilized tools of analysis in most researches. It is employed to organize and summarize observation so that they are easier to comprehend (Edward, 1993).Therefore, for easy comprehension of findings of this research and its contribution to the body of knowledge, descriptive statistics were used to group field data which were presented in the form of frequency distribution and percentage tables. These techniques were used to achieve objectives 1, and 3

Gross margin analysis

This was used to analyze part of objective 2. It is very useful and in a situation where fixed capital forms a negligible portion of production. It is the difference between gross income (G I) and the total variable costs (TVC). According to (Olukosi *et al.*, 2005) gross margin is expressed as:-

GM= GI - TVC

Where:

Gross ratio (GR) which is the total cost (TC) divides by the gross income was also used. This ratio expresses the percentage of gross income absorbed by the total cost. It can be calculated as:

GR = TC/GI

Where, GR = Gross Ratio, TC = Total Cost and GI = Gross Income

Return on naira invested was also determined by dividing Total farm income (TFI) by total cost of production (TC).

Paired T-test

This was used to achieve part of objective 2. It is used to test the difference existing between two means to determine whether it is significant or otherwise. It is used where there are common linkages between the set of observation you are comparing.

$$T = \frac{X_A - X_B}{S_X}$$

Where

X_A = Mean of A observation (Improve practice plot)

X_B = Mean of B observation (Farmer practice plot)

S_X = Standard error

RESULTS AND DISCUSSION

Socio-economic characteristics of the on-farm sorghum-legume strip cropping system farmers in Kano State

The results in table 1 revealed that 75.6% of the farmers were in the active age of between 25-54 years, with a mean of 46.4 years. This shows that the farmers are in their active years. Majority of the farmers were males (93.4%), showing that farming is dominated by male in the study area, 58.5% had acquired Quranic ducation and (97.4%) were married with 46.3% having household size of between 7-11 percent, with 41.9% having experience of between 15-24 years. From this outlay of farmers' socio-economic characteristics, there is no doubt that these farmers who are predominantly males, in their active years and with relatively high literacy level, are better equipped to adopt new production techniques and take rational decision that will enhance the profitability of their business (Musa, 2003)

Gross margin analysis of sorghum/legumes strip cropping system and the farmer practices

Gross margin analysis was used to determine the profitability of the project. The Analysis involves estimation of gross revenue and total cost of production. Result in table 2 shows summary of cost and return of Sorghum /legume strip cropping on-farm demonstration plots and farmer practices in Kano state. The total average cost of production for demonstration plots is ₦60, 776.63/ha. Regarding farmers practice, the total average cost of production is ₦59,352.30/ha.

The gross farm income for demonstration plots was found to be ₦126, 708.27/ha. The gross margin was obtained to be ₦65, 931.64/ha. The return on every naira invested was ₦2.08 and the gross ratio was 0.48. This ratio indicated that total cost was 48% of the gross income. Moreover, the gross farm income for farmers practice was found to be ₦115, 360/ha and gross margin was found to be ₦56, 008.62/ha. In addition the return on every naira invested was obtained as ₦1.94 and gross ratio of 0.52. From this analysis the result shows that demonstration plots is more profitable than farmers practice in the study area. This result further explain that the use of high yielding improved varieties in a strip cropping system with four cereal rows: four legume rows appears to be economically superior to the traditional one cereal row: one legume row, as traditionally practiced.

Results in table 3 shows that the combination of improve practices particularly CSR01/SoybeanTGX1448 is statistically significant. (P<0.05).More so, CSR01/ Samnut22 and CSR01/Samnut23 were also superior to LS/LG. (P<0.05). From the result it has also been observed that some of the improved practices are not statistically different from local practices, this is probably due to low yield observed in some combination especially those with cowpea variety IT205 as it refused to produce pod at the maturity stage.

The result from this trial however, showed that the 4:4 sorghum: legume cropping system was not only superior to the local practices but is also appropriate to the socio-cultural practices of the resource poor farmers. It is therefore a good developmental tool

to alleviate poverty of farmers. The adoption of improved strip cropping systems and improved varieties of crops coupled with trainings of farmers and extension agents has been shown to be a key to increasing the productivity and income generations of resource poor farmers of Kano State in a sustainable manner.

Constraints of sorghum/ legume production system

This means the problems associated with the production in the study area, which involves both biotic and abiotic component. Over the years, farmers are not receiving the type of attention accorded agricultural production. The farmers have continued to face problems in their production. Some of the problems associated with sorghum/legume cropping system in the study area were highlighted. The main constraints to production as indicated by the respondents were high cost of input and insufficient fund   (92.14%, 89.08%). The farmers (87.9%) also indicated lack of timely delivery of farm input as most of them get input from open market with no guarantee and exorbitant price. Furthermore, loan/credit facilities could not be adequately supplied as indicated by (68.56%) of the farmers and stressed the fact that increase production could be achieved if there is access to more fund. The implication is that farmers have not been able to transform their farming from subsistence to commercial scale. Land tenure system also affect expansion and therefore affect their productions indicated by (59.39%) of the respondents. Unstable produce price (51.09%).

Apart from these major constraints, other constraints include; striga infestation as indicated by (31.44%) of the respondents, Drought spell (22.27%), pest and diseases (21.40%), inadequate extension service (20.09), inadequate training (13.97%) and lastly poor road net work as indicated by (10.48%) of the respondents.

SUMMARY AND CONCLUSION

Intercropping has long been practiced by small scale farmers in the tropics. In particular, Sorghum and Legume intercropping is recognized as a common cropping system in developing tropical countries. This system is intended to provide the farmer with a

useful harvest while at the same time improving the fertility of the soil. Increased cultivation of legumes is essential for the regeneration of nutrient-deficient soils and for providing needed protein, minerals, and vitamins to humans and livestock.

The study carried out economics of on-farm Sorghum/legume strip cropping system in Kano State. The result of the study disclosed that majority of the farmers (93.4%) were males and (75.6%) of them were within the age category of 25-54 years, only 2.6% were above 65 years. Most of the farmers were married (97.4%) and (46.3%) had a household size of 7-11. However, majority (58.5%) attended Islamic education only while 16.4% attended tertiary education.

The result from gross margin analysis showed a profit of ₦60, 249.007k/ha and a return of ₦2.17 on every naira invested, for improve practice. Regarding former practice, a gross margin of ₦ 40,813.64k/ha and a return on investment of ₦1.74 was realized. The gross ratios were found to be 0 .46 and 0.57 for the improved practice and farmers practice respectively.

Many constraints were discovered to militate against production and they include, high cost if input, in accessibility to credit, low volume of capital, land tenure system and a host of other constraints. By and large, the study recommends timely provision of input and at subsidized price smothers access to credit facilities and provision of processing and marketing facilities.

It can be concluded that, the prospect of sorghum- legume strip cropping system in the study area was bright as indicated by the profit or return per Naira realized as compared to farmer practice. Moreover, Farmers in the study area perceived the technology package as effective. The study has clearly shown that adequate technologies and skill development through training is very important in transferring the fortune of the resource poor farmers who are the major producers of food in Kano state.

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Table 1: Socio-economic characteristics of the respondents (n= 229)

Variables	Frequency	Percentage
Age		
25-34	19	8.3
35-44	78	34.1
45-54	76	33.2
55-64	44	19.2
65-74	12	5.2
Mean	**46.4 years**	
Sex		
Male	214	93.4
Female	15	6.6
Marital Status		
Married	223	97.4
Single	3	1.3
Widow	3	1.3
Education		
Never	5	2.2
Quranic	134	58.5
Primary	32	14.0
Secondary	22	9.6
Tertiary	36	15.7
House Hold Size		
2-6	65	28.4
7-11	106	46.3
12-16	50	21.8
17-21	5	2.2
22-26	3	1.3
Mean	**9 people**	
Years of Experience		
2-14	77	33.6
15-24	96	41.9
25-34	43	18.8
35-44	13	5.7
Mean	**19 years**	
Source of Capital		
Personal saving	192	83.8
Bank	21	9.2
Relatives and Friends	2	0.9
Farmers association	6	2.6
Money Lenders	8	3.5
Total	**229**	**100**

Source: Field survey, 2012

Table 2: Estimated gross margin for cereal/legume cropping system

Variable Description	Demonstration Plots	Farmers Practices
Total Cost/ha	60,776.63	59,352.30
Total Revenue/ha	126,708.27	115,360.92
Gross Margin/ha	65,931.64	56,008.62
Return/N-invested	N2.08	N 1.94
Gross Ratio	0.48	0.52

Source: Field survey, 2012

Table 3: Comparison of the mean profit of demonstration plot and farmer practices

Paired	Combination	Mean Profit (₦)/ha	DF	T-Value	Prob. Level
Paired T-test 4					
Demonstration plot	CSR01/TGX1448	88,819.49	12	2.570	.025**
Farmer Practice	LS/LSOY	51,523.08			
Paired T-test 5					
Demonstration plot	ICSV111/IT499	71,013.17	14	.956	.355NS
Farmer Practice	LS/LC	55,398.56			
Paired T–test 6					
Demonstration plot	CSR01/SAMNUT22	84,277.04	9	2.569	.030**
Farmer Practice	LS/LG	28,615.21			
Paired T-test 7					
Demonstration plot	ICSV111/SAMNUT22	37,244.67	9	.537	.605NS
Farmer Practice	LS/LG	28,615.21			
Paired T-test 8					
Demonstration plot	CSR01/IT499	37,375.64	11	-.569	.581NS
Farmer Practice	LS/LC	55,398.56			
Paired T-test 9					
Demonstration plot	ICSV111/TGX1448	34,246.84	4	-1.371	.242NS
Farmer Practice	LS/LSOY	51,523.08			
Paired T-test 10					
Demonstration plot	CSR01/TGX1835	65,769.78	10	1.674	.125NS
Farmer Practice	LS/LSOY	51,523.08			
Paired T-test 11					
Demonstration plot	CSR01/IT277	79,749.13	14	1.047	.313NS
Farmer Practice	LS/LC	55,398.56			
Paired T-test 12					
Demonstration plot	ICSV111/IT205	45,815.26	8	-.919	.385NS
Farmer Practice	LS/LC	55,398.56			
Paired T-test 13					
Demonstration plot	CSR01/IT205	35,168.02	8	-1.643	.139NS
Farmer Practice	LS/LC	55,398.56			
Paired T-test 14					
Demonstration plot	ICSV111/TGX1835	35,265.05	6	-1.115	.307NS
Farmer Practice	LS/LSOY	51,523.08			
Paired T-test 15					
Demonstration plot	CSR01/SAMNUT23	76,996.47	14	2.579	.022**
Farmer Practice	LS/LG	28,615.21			

Source: Field survey, 2012

Table 4: Constraints associated with sorghum/legume production system

Constraints	Frequency	Percentage
Land tenure affects expansion	136	59.39
High cost of input	211	92.14
1nsufficient fund	204	89.08
Inadequate training	32	13.97
Inadequate and untimely Delivery of farm input	164	71.62
Inadequate credit/loan facilities	157	68.56
Inadequate extension service	46	20.09
Unstable produce price	117	51.09
Poor road network	24	10.48
Drought spell	51	22.27
Striga infestation	72	31.44
Pest and diseases	49	21.40

Source: Field survey, 2012

*** Multiple response exit hence greater than 100%