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Resource Use Efficiency of Millet/ Cowpea Intercropping in Niger State, Nigeria

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RESOURCE USE EFFICIENCY OF MILLET/COWPEA INTERCROPPING IN NIGER STATE, NIGERIA

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ABSTRACT

The study examined the profitability and resources-use efficiency of millet/cowpea mixed farmers production in Niger state Nigeria. The primary data for the study was obtained using structured questionnaire administered to 80 randomly sampled farmers in Kotangora Local Government Area of Niger State. Farm budgeting technique and exponential production function were used to analyze the data. The results showed that the estimated gross margin, net farm income, gross ratio, operating ratio and returns on investment are ₦57,542.42 per hectare, ₦54,240.40 per hectare, 0.37, 0.31 and 2.15. The regression result shows that seed and family labour were statistically significant at 1% level of probability, while farm size and hired labour were statistically significant at 5% level of probability. The allocative efficiency results show that seeds, family labour and agrochemicals were under-utilized. Farm size and hired labour were over-utilized. Efficiency and productivity could be improved if the farmers use more seed, family labour, agrochemicals, less of hired labour and land.

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INTRODUCTION

The Nigeria food problem which started in the mid 1960's, has continued to deepen several years after independence. In Nigeria, food consumption accounts for a high proportion of total households' expenditure. According to the Central Bank of Nigeria (CBN) 1995, it accounted for about 50% of total household's expenditure in 1994 and increased to 72% in 1995. Food demand has been growing at the rate of 3.5% per annum; food production has been growing at a rate just above 2% per annum in recent years but the annual rate of population growth has been as high as 2.9 percent, thus creating a serious food gap (Shaib *et al.*, 1997 and Baiyegunhi *et al.*, 2010). The ability of Nigeria agriculture to perform its role in development has been declining thus creating wide gap between the demand for and supply of food (Alabi and Esobhawan, 2006).

Some of the factors responsible for Nigeria's food insufficiency are low crop yields, use of unimproved crop varieties, inconsistent macroeconomic policies, pest and disease outbreak, wrong choice of enterprise combination and cropping system. The food demand – supply gap that has been created resulted in increased food imports and high rate of food prices due to supply deficit despite food importation. Several schools of thought exist when it comes to strategies to bring about significant increase in food production.

A school advocates for effective contribution of measures aimed at increasing the level of farm resources, making efficient use of resources already committed to the food subsector and combining the enterprises in an optimal manner (Alam *et al.*, 1995, Tanko, 2004). Another school of thought affirms that it is ideal to lay emphasis on allocating and distributing adequate resources inputs, investment in research and eliminating the bottle necks to efficient resource utilization at the farm level.

Millet is a very important crop in the savannah area of Nigeria, its importance is reflected in the position it occupies as the most dependable source of food for a large number of people in the environment for which it has a special adaptation. Millet is grown as a subsistence crop in Nigeria and most of it is used for human consumption. Cowpea grain contains about 25% protein and 64% carbohydrate (Bressani, 1985), thus it has a high potential to reduce malnutrition. Intercropping millet with cowpea is a common practice among the traditional farmers of Nigeria savannah.

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 Henriette *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.

Notable problems in millet/cowpea intercropping includes small farm size (less than 2 hectares), inappropriate decision on how best to allocate resources, tools are simple and hand operated, very limited mechanization, tractor-drawn implements is increasing but is of no significance. Resource availability must be complemented with efficient use in order to increase farm productivity. Therefore, it is important to examine the allocative efficiency of resource use in the millet/cowpea cropping system. This will be used to determine the direction of resource adjustments that could lead to higher productivity in millet/cowpea intercropping. In addition to this, the result will be used for planning and implementation of millet/cowpea production improvement programme in Niger State, Nigeria and wider application in other areas in the country.

THEORETICAL FRAMEWORK

Production is the process of transforming inputs such as capital, labour, and land into goods and services called output. These resources can be organized into firm or producing unit whose ultimate objectives may be profit maximization, output maximization, cost minimization or utility maximization or combination of the four. Efficiency of production according to Farrell (1957) can be divided into technical, allocative and economic efficiencies. Economic efficiency embodies both technical and allocative efficiencies, once the issues of technical inefficiency have been removed from the question of choosing between the set of technically efficient alternative methods of production, allocative efficiency comes to forefront (Inoni, 2007).

A farmer is allocatively efficient if production inputs are allocated according to their relative prices (Torkamani and Hardaker, 1996). According to Oh and Kim (1980), allocative efficiency is the ratio between total costs of producing a unit of output using actual factor proportions in a technically efficient manner, and total costs of producing a unit of output using optimal factor proportions in a technically efficient manner. It is important to note that, a farm using a technically efficient input combination may not be producing optimally depending on the prevailing factor prices. Thus, the allocatively efficient level of production is where the farm operates at the least – cost combination of inputs.

The condition of optimum use of input x_i as predicted by the theory of equilibrium in factor markets under profit maximization is that the marginal value product (MVP) equals the price of the input (P_i). If MVP is lower than P_i the resource is over-utilized and lowering the quantity used at the current price will increase the MVP and restore optimality. On the other hand, if MVP is greater than P_i the resource is under-utilized and using more of it will bring additional gains to the producer. A measure of allocative efficiency (AE) is as follows,

$$AE = \frac{MVP_i}{P_i} \quad (1)$$

Therefore allocative efficiency measure, quantifies how near an enterprise is to using the optimal combination of production inputs when the goal is to maximize profit (Richetti and Reis, 2003). Allocative efficiency is only achieved when the quantity of input used satisfies the condition of $AE=1$ (Beattie and Taylor, 1993). Allocative efficiency is an economic criterion based on the concept of the production function.

STUDY AREA

The study was conducted in Kontagora Local Government Area of Niger State. Kontagora falls between latitude $9^{\circ} 36'$ north and longitude $6^{\circ} 22'$, it is an agrarian state and the majority of the people are peasant farmers. There are two main season in the area, dry and rainy season with a mean annual rainfall that varies from 1,100mm in the northern part of the state to 1,600mm in the southern parts. The raining season begins towards April and ends towards October. The cropping pattern ranges from mixed to mono cropping, some of the crops grown in the area are cowpea, melon, millet, sorghum, groundnuts and yam, livestock such as goats, sheep, poultry and cattle are also raised.

DATA COLLECTION AND SAMPLING TECHNIQUE

The respondents were selected using simple random sampling techniques. A total of 80 farmers were selected from the two districts in Kontagora Local Government Area. The two districts include Kontagora Gabas and Kontagora Yamma. These two districts were selected because of the high prevalence of millet and cowpea production in the area. Four villages each were randomly selected from of the two districts given a total of eight (8 villages). Ten farmers were selected from each of the eight villages using simple random sampling techniques. Data were collected with the aid of a structured questionnaire designed to collect information on resources employed, costs, yields and prices. The outputs of millet and cowpea were aggregated using the grain equivalent table.

METHOD OF DATA ANALYSIS

Profitability assessment of production: Farm budgeting (gross margin and net farm income) was used to assess the profitability of millet/cowpea enterprise. The gross margin and net farm income are useful in evaluating the efficiency of an individual enterprise (or farm plan) so that comparisons can be made between or among enterprises of different farm plans. Costs and returns analysis forms the basis for farm profitability assessment. There are two types of cost in production: fixed and variable costs. Gross margin is the difference between Gross Farm Income (GFI) and the Total Variable Cost (TVC) (Olukosi and Erhabor, 1988).

$$GM = GFI - TVC \quad (2)$$

Where GM = Gross Margin

GFI = Gross Farm Income

TVC = Total Variable Cost

Net Farm Income (NFI) = Gross Margin (GM) – Total Fixed Cost (TFC)

Gross ratio of the farm: this is a profitability ratio that measures the overall success of the farm. The lower the ratio, the higher the return per Naira invested.

$$GR = \frac{TFC}{GI} \quad (3)$$

Where GR = Gross Ratio, TFE = Total Farm Expenses, and GI = Gross Income.

Operating Ratio of the farm: The operating ratio is directly related to the farm variable input usage. The lower the ratio the higher the profitability of the farm business.

$$OR = \frac{TOC}{GI} \quad (4)$$

Where OR = Operating Ratio, TOC = Total Operating Cost, and GI = Gross Income.

Return on capital Invested: - This is defined as gross margin divided by Total Variable Cost.

$$RI = \frac{GM}{TVC} \quad (5)$$

Where RI = Return in capital Invested, GM = Gross Margin and TVC Total Variable Cost.

Efficiency of Resource-use: The basic approach to estimate allocative efficiency is through the MVP. The MVP is calculated from econometrically estimated production function. Allocative efficiency is determined by comparing the MVP with the MFC. We assume that farmers are price takers in the input market, so that the price of factor i approximates MFC. Allocative efficiency of resource (AE) is given as

$$AE = \frac{MVP_i}{P_i} \quad (6)$$

Marginal value product is the monetary value of marginal physical product (MPP). Equation (6) indicate that when

AE= 1, Resources is efficiently utilized

AE > 1, indicates under-utilization of resources

AE < 1, indicates over-utilization of resources

The implicit form of the production function used is expressed as

$$Y = (X_1, X_2, X_3, X_4, X_5, X_6, X_7, e_i) \quad (7)$$

Where Y = Output (kg)

X_1 = Farm size (ha)

X_2 = Seed (₦)

X_3 = Agrochemicals (₦)

X_4 = Family Labour in Man days

X_5 = Hired Labour in Man days

X_6 = Fertilizer (kg)

X_7 = Capital (₦)

e_i = Random Error Terms

The exponential production function was the lead equation for this study and its explicit form is given by:

$$\text{Log } y = b_0 + b_1x_1 + b_2x_2 + b_3x_3 + b_4x_4 + b_5x_5 + b_6x_6 + b_7x_7 + e_i \quad (8)$$

Where $y, x_1 \dots x_7$ is as defined above

b_0 = constant term

$b_1 \dots b_7$ = coefficients

e_i = Random error term

The elasticity for exponential function was computed using the following formula:

$$e = b_i \cdot \bar{X}_i$$

Where: e = elasticity of input x_i

b_i = estimated regression coefficient of input x_i

\bar{X}_i = the geometric mean of input x_i

RESULTS AND DISCUSSION

Gross Margin Analysis:

Gross margin analysis of millet/ cowpea mixed farmers is shown in Table 1. It shows that the cost of hired labour constitute 26.99% of the total cost of production in millet/ cowpea mixed farming, fertilizer 21.58%, e.t.c.

Table 1: Estimated Gross Margin Analysis for millet/cowpea mixed farmers production.

Cost items	Cost (₦/ha)	% of total cost
VARIABLE COST (₦)		
Hired Labour	8130.20	26.99
Fertilizer	6502.33	21.58
Herbicide	2176.16	7.22
Insecticide	2444.76	8.11
Seed	150.20	0.59
Cost of hiring Tractor	6616.27	21.96
Cost of Maintenance	773.94	2.86
Total Variable Cost (TVC)	26823.86	89.02
FIXED COST(₦)		
Total Fixed Cost (TFC)	3301.48	10.96
Total Cost = (TVC + TFC)	30125.34	100.00
Gross income (GI)=	84,366.28	
Gross margin (GI- TVC)=	57,542.42	
Net farm income (GM-TFC)=	54,240.94	
Returns on naira invested=	2.15	
Operating Ratio=	0.31	
Gross Ratio=	0.37	

Source: Field Survey, 2009

A confirmation of profitability of millet/cowpea mixed production is shown by the net income of ₦54,290.94. Also the returns on naira invested were ₦ 2.15 while gross and operating ratio were 0.37 and 0.31 respectively. The entire ratio was less than one, indicating profitability of the farm.

Production function analysis: The production function that was used to determine the nature of input relation in millet/cowpea mixed production is shown in Table 2.

Table 2: Estimated Exponential Production Function (Lead Equation)

VARIABLES	REGRESSION COEFFICIENT	T-VALUE
Constant	6.923	87.031***
Farm size (X_1)	0.0606	1.665**
Seed (X_2)	0.232	21.560***
Agrochemicals (X_3)	0.002853	1.734*
Family labour (X_4)	0.001659	2.639***
Hired labour (X_5)	-0.00381	-2.421**
Fertilizer (X_6)	0.0004827	1.376
Capital items (X_7)	0.00773	3.901
R ²	0.902	
F-ratio	111.997	

Source: Computed from field survey data, 2009

The asterisks (*, ** and ***) represents statistical significance at 1%, 5% and 10% level of respectively.

Exponential production function was chosen as the lead equation based on the statistical criteria ranging from the sign of the coefficient, R^2 value and number of significant variables. The value of coefficient of determination (R^2) indicated that 90% of the variation of output of

millet/cowpea mixed production was explained by the regression model. The regression coefficient of land (X_1), seed (X_2), agrochemicals (X_3), family labour (X_4), fertilizer (X_6) and capital (X_7) were positive indicating that an increase in these inputs, holding others constant will lead to an increase in the output. The regression coefficient of hired labour (X_5) was negative indicating that an increase in these inputs, holding others constant will lead to a decrease in the output.

Resource use efficiency: Estimates of allocative efficiency of production resources employed in millet/cowpea enterprise were 314.998, 3.0632, and 0.5798 respectively for seed, agrochemicals and family labour, the result shows that these variables were under-utilized (Table3).

Table 3: Estimated Efficiency Ratios

Variables	Elasticity (e)	MVP (e. P_y)	MFC	MVP/MFC	% deviation from optimality = $(1-AE) \times 100$
Farm size (X_1)	0.671145	2013.435	6000	0.3356	66.44
Seed (X_2)	12.5999	37799.76	120	314.998	-313.99
Agrochemicals (X_3)	0.91895	2756.85	900	3.0632	-206.32
Family labour (X_4)	0.07730	231.9	400	0.5798	42.02
Hired labour (X_5)	-0.63760	-1912.8	400	-4.782	-378.2

Source: Computed from field survey, 2009. **Note:** P_y (N3000) = Price of unit of output (100kg bag)

The allocative efficiency for farm size and hired labour were 0.3356 and -4.872 respectively and were over-utilized. The over utilization of land is in agreement with the findings of Tanko *et al*, (2007) and Jirgi *et al*, (2007). The under utilization of seed for large scale farms was also reported by Baiyegunhi *et al*, (2010) in their study on resource use efficiency in sole sorghum production in three villages of Kaduna state Nigeria.

Seed was underutilized probably because most of the farmers use local varieties which they save from previous harvest and perhaps some of the farmers buy the seeds from the market

which is always expensive during planting period as such they may not be able to buy the quantity required for their farm size. Improved seed markets are not common in the study area. Agrochemicals were underutilized probably because they are expensive and sometimes not available at the time farmers need them. The under utilization of family labour could be attributed to the unavailability of children to work on the farms because they attend schools. This is attributed to the launching of the Universal Basic Education (UBE) in the country in 1999. Most hired labour work on the farms are done with little or no supervision and this must have contributed to the overutilization of labour. The results also showed that farm size, seed, agrochemicals, family labour and hired labour were all far from optimality. Efficiency and productivity could be improved if the farmers use more seed, family labour, agrochemicals, less of hired labour and land.

CONCLUSION

The study examined the allocative efficiency of millet/cowpea mixed production among famers in Kontogora Local Government Area of Niger state Nigeria. The specific objectives were to determine the profitability and efficiency of resources-use in millet/cowpea production. The results show millet/Cowpea intercropping is a profitable enterprise. The allocative efficiency result showed that seeds, family labour and agrochemicals were under-utilized. Farm size and hired labour were over-utilized. Efficiency and productivity could be improved if the farmers use more seed, family labour, agrochemicals, less of hired labour and land.

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