Analysis of Multi-Objective of Farmers' Production in Small Scale Maize/Cowpea Farms in Nasarawa State, Nigeria

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ABSTRACT

This study examined the utilization of farm resources and multi-objectives of small scale maize / cowpea farmers. Data were collected from a randomly sample of 120 farmers from six local government areas randomly selected from the study area. These were analysed using regression analysis, gross margin and pair comparism method. The result revealed the cost of production of small scale maize/cowpea farmers was N24,145.70 per hectare and realized revenue of N39, 785.04 per hectare. The mean return over total cost of production is N15, 639.34 and the cost-benefit ratio of 0.61. The regression result of socio economic variables showed a positive and significant influence of farm size ($P<0.01$), age ($P<0.01$) and household size ($P<0.1$) on the amount of maize/cowpea yield. The coefficient of land and seed are positive and statistically significant ($P<0.05$), indicating a direct relationship between them and total farm output. The ranking of satisfying family food requirement and provision of self employment over the other objectives were statistically different at 5% with an LSD = 20.09. Therefore, government policies and programmes should be redirected with the aim of boosting farmers production ability in order to enhance their farm capital expansion rather than just satisfying family food requirement.

Keywords: *Farm resources, Multi-objective, Small scale farmers, Production objective, Cost-benefit rario, Pair comparison method.*

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Highlights of this paper

- This study examined the utilization of farm resources and multi-objectives of small scale maize / cowpea farmers.
- The result revealed the cost of production of small scale maize/cowpea farmers was N24,145.70 per hectare and realized revenue of N39, 785.04 per hectare.

1. INTRODUCTION

Nigeria is a country where food crop production remains a major component of all production activities in the agricultural sector. The food crop sub-sector has continued to be dominated by the category of farms variously referred to as small farms. This category of farms represent as much as 95 per cent of the total food crop-farming units in Nigeria and produce about 90 per cent of the total food output. The farmers are characterized by low level of operation, illiteracy of operators and labour intensive production technology with hired labour cost constituting over 60 per cent of total cash cost of production. In addition, family labour constitutes the major source (about 75 per cent) of farm labour supply, fixed capital investment is low since only simple tools and equipments are used in production. Furthermore, operating capital is low because purchased inputs are few and their average level of use is very low [1].

Empirical evidence has shown that the smallholder farmers usually posses more than one goal of farm production [2]. The goals are more often than not conflicting [2, 3]. Furthermore farmers' resources allocation decisions are influenced by individual and/or collective preference structures and goal aspiration levels based on personal or community value systems [2]. In addition, that small farmers are more likely to obey the postulate of bounded rationality and should therefore, be rightly seen as trying to "satisfy" among goals rather than maximize profit or net returns. A satisfying behaviour here refers to a situation under which farmers allocate their available resources among competing production alternatives in such a way as to attain a satisfactory level of overall performance in terms of a defined set of aspiration level in respect of their pre-specified objectives of production [2, 3].

Aromolaran and Olayemi [2] reported that there are three categories of constraints that are critical to small farms development and that it is necessary that policies be effectively directed at various components of these constraint categories if adequate responses in terms of substantial resources reorganization is to be elicited from farmers.

The constraints are categorized as:

- Physical constraints (water, tillage capacity, soil fertility, and weather constraints).
- Operational constraints (mechanization, multiple cropping systems etc.).
- Economic constraints (labour, management, power and market availability constraints).

All these constraints reveal the multifarious problems facing Nigerian agriculture and its resolution calls for a multifaceted approach. Analysis of the farmers' production objectives will therefore give a guide in fine-tuning policy objectives that will suit the needs of the rural small farm holder.

Studies like this are expected to help the agricultural policy makers who are expected to make policies that will facilitate the accomplishments of small farmer's production objectives. The central issue therefore, must be the determination of small-scale farmers goals if they differ substantially from those of large farms, one policy position could hardly be consistent with meeting the needs of both groups. The main objective is to analyze farmers multi-objective plans in small-scale maize/cowpea mixed cropping in the study area, the specific objectives are to:

- Determine the socio-economic characteristics of maize/cowpea small-scale farmers in the study area.
- Determine cost and returns of small scale maize/cowpea farmers in the study area.

- Make comparison between pair of production objectives to know which is most preferred.

2. MATERIAL AND METHOD

2.1. Study Area

The study was conducted in Nasarawa state;the state is located in the middle belt zone of the country. It lies between latitude 7° and 9° North and longitude 7° and 10° East, and shares common boundaries with Benue state to the South, Kogi state to the West, the federal capital territory (FCT), Abuja, to the North West, Kaduna and plateau states to the North East, and Taraba state to the south East. The state has a climate typical of the tropical zone, because of its location. It climate is quite pleasant: A mean temperature of 60° F and 80° F maximum have been recorded while rainfall varies from 313.73cm in some places to 145cm in other areas. The month of December, January and February are cold (sometimes quite cold) due to the very dry harmattan winds blowing across the state from the North-East. It is characterized by two distinct seasons: dry and wet. The dry season start from November to February, while the rainy season is from March to October. Average daily sunshine in the state is 6.2 hours and average daily vapour pressure is 26hpg.

The physical features of the study area are largely mountainous. It covers very large area of the state, much of which are rocky and of undulating highlands to average height of about 1,400m above sea level. The coastline of river Benue and its trough created alluvial fertile soil, which is very good for crop production. Other smaller rivers cover most parts of the state and empty into the river Benue. The sediments are generally comprised of sandstones, siltstones and subordinate inter-bedded clays all of cretaceous age. Alluvial soils are found along the Benue trough and their flood plains. These are always swampy in nature due to availability of water all the year round. The forest soil, which are rich in humus, and laterite soils are found in most parts of the state.

The 1991 census put the state's population at 1.2million. The state's population by 2003, estimated at the national average growth rate of 2.83% per annum, is projected to 2.0million. However, with the influx of people particularly into Karu and Keffi LGAs, due to their proximity to the federal capital territory, Abuja, as well as into Lafia, being the state capital, places the current estimated population of the state at 2,040,097 [4]. Males constitute 51% and females 49% of the population. Over 80% of the people of the state are subsistence farmers and live in rural areas. Major crops suitable to the state ecological conditions are rice, sesame, soya beans, groundnut, cassava, yam, maize, cashew, sorghum, melon, mangoes, citrus and vegetables. There is an estimated water surface area of over 5,645 square kilometer and favourable climatic conditions for the fish industry.

2.2. Method of Data Collection

Primary data were collected for this study. The primary data were obtained through a survey using structured questionnaires on the selected household. The researcher handled the administration of the questionnaires with the assistance of trained ADP staff. Information about farming house holds, socio-economic characteristics, production objectives, preferences among the objectives, levels of resource use etc were collected through selected households.

2.3. Sampling Procedures

The target population for the study is the small scale maize/ cowpea rural farm households in Nasarawa state. A two stage sampling techniques was used to select the sample for the study. The first stage involved the purposive selection of two local government areas from each agricultural zones noted for intensive production of maize/cowpea, giving a total number of six local government areas. The second stage involved the selection of

twenty (20) farming households within each of the already selected local government areas. Accordingly, a sample of one hundred and twenty farmers was taken for the study.

2.4. Method of Data Analysis

The major tools of analysis use in the study are:

- Regression analysis.
- Gross margin analysis.
- The paired comparison method.

Regression analysis: For this study multiple regressions was used because there are more than one independent variables explaining the behaviour of the dependent variable. Levin [5] gave the formula for the estimating equation describing the relationship between Y and then n independent variable:

$$X_1X_2 \ldots \ Xnas \ldots . bnXn + U \qquad (1)$$

Model specification one: Multiple regression analysis was used to determine the contribution of farmer's age (years), farming experience (years), farm size (hectare), household size, household member engaged in farming and distance of farm to farmers residence (kilometers) to total farm output (kilograms) by small scale maize/cowpea farmers. The regression model was thus expressed as:

$$TFO = a + b_2F_2 + b_3F_3 + b_4F_4 + b_5F_5 + b_6F_6 + b_7F_7 + U \quad (2)$$

Where

TFO= Total farm output (Kg).

F_2 = Age (Years).

F_3 = Farming experience (Years).

F_4 = Farm size (Hectare).

F_5 = Household size.

F_6 = Household in farming.

F_7 = Distance to farm from farmers residence (Km).

U = Random error term.

The linear algebraic form of the model was used.

Model specification two: Maize/cowpea production function was estimated using regression analysis. Three functional forms were derived to estimate the maize/cowpea production function; these functional forms were modeled in linear, semi-log and double-log. The production function was specified as follows:

2.5. Linear Functional Form

$$TFO = a + b_1X_1 + b_2X_2 + b_3X_3 + b_4X_4 + b_5X_5 + U \qquad (3)$$

2.6. Semi – Log Functional Form

$$TFO=Loga + b_1LogX_1 + b_2LogX_2 + b_3LogX_3 + b_4LogX_4 + b_5LogX_5 + LogU \qquad (4)$$

2.7. Double Log Functional Form

$$LogTFO = Log\ a+b_1LogX_1 + b_2LogX_2 + b_3LogX_3 + b_4LogX_4 + b_5LogX_5 + LogU \quad (5)$$

Where

TFO = Total farm output (Kg).

X_1 = Seed (Kg).

X_2 = Land (Ha).

X_3 = Labour (Mandays).

X_4 = Fertilizer (Kg).

X_5 = Insecticide (l).

U = Random error term.

Gross margin analysis: The gross margin, the return over variables cost is an appropriate measure of profitability used for comparing enterprises for short run annual planning decision [6]. It forms the basis of most analysis and planning procedure and enables a practicing farmer to understand his business better:

$$\text{Gross margin} = \text{Total revenue} - \text{Total variable cost} \quad (6)$$

This research used gross margin to determine the return over variable cost per hectare for small scale maize/cowpea farm in the study area. The gross margin model used was expressed as:

$$\text{Gross Margin/Ha} = \frac{\text{Total Revenue} - \text{total Variable cost}}{\text{Total Area of the farm}} \quad (7)$$

The paired comparism method (PCM): The method of paired comparism used by Willis and Perlack [7]; Durojaiye [3]; Adewumi, et al. [8] was use to develop the ranking of a goal hierarchy for the respondents. The assumptions of the paired comparism model used in this study are as used by Mosteller [9]. The model allows the determination of a rank ordering of the goals and with the selection of one goal scale values are developed for each goal. This places the goals on a relative continuum.

This method requires that the respondent with a list of all possible pairs of elicited production objectives and that the respondent select the goal in each pair. The number of pairs for a given set of objectives is given by:

$$\lceil n\,(n-1)/2 \rceil \quad (8)$$

Where

n = number of production objectives to be ranked.

The relative frequency with which an objective is chosen was used to establish its ordinal rank. This objective ranking was tested for statistical significance using the method reported in Urquhart and Clyde [10]. The test statistic was obtained at the 0.05 level of significance.

$$LSD = 1.96\,\lceil SF\,(n)\,(n+1)/6 \rceil^{1/2} \quad (9)$$

Where

LSD = least significant difference.

SF = Number of surveyed farming household.

N = number of production objectives ranked.

The Hypothesis tested are:

Ho: Farmers production objectives are not equally ranked.

Hi: Farmer production objectives are equally ranked.

The null hypothesis is rejected if the difference between the preference frequencies is greater than calculated least significant difference.

3. RESULT AND DISCUSSION

Cost and returns analysis:The Profitability of Any agricultural enterprise depends on the components of its costs and returns. The cost of production consists of all expenses incurred in the process of producing a given product. These costs include cost of labour, seed, insecticide, fertilizer, empty bags and transportation, while the returns are sales of maize and cowpea grains per 100kg bag in hectare. The cost inquired and returns obtained by

small scale maize/cowpea farmers are presented in Table 1. Labour cost constitutes the largest part of production costs (₦10, 450.71/ha) in the study area. This is closely followed by the cost of fertilizer ₦9, 510.20. The cost of production of small scale maize/cowpea farmers was ₦24,145.70 per hectare and realized revenue of ₦39, 785.04 per hectare. The mean return over total cost of production is ₦15, 639.34. The cost-benefit ratio of 0.61, which means that small scale maize/cowpea farmers in the study area expend a mean of 61 per cent o f the total revenue realized in paying for the production on expenses incurred in the farm. The farmers' margin of 39 per cent of the total revenue makes this enterprise a viable one.

Table-1. Cost and returns analysis of small scale maize/cowpea farmers.

Component	Amount (₦/HA)
Production cost	
Seed	795.55
Fertilizer	9,510.20
Insecticide	574.84
Labour	10,450.71
Empty bags	1,013.60
Transportation	1,800.80
Total production cost (TPC)	24,145.70
Returns	
Sales of maize grains	27,235.37
Sales of cowpea grains	12,549.67
Total revenue (TR)	39,785.04
Gross margin (GM)	15,639.34
Cost-benefit ratio	0.61
Returns on naira invested	1.61

Source: Field survey, 2019.

Estimate of socio-economic variables: The result of the estimated regression equation of maize/cowpea yield as against some socio-economic variables of the farmers is presented in Table 2. Linear algebraic regression model was used to determine the estimates. The regression result showed a positive and significant influence of farm size (P<0.01), age (P<0.01) and household size (P<0.1) on the amount of maize/cowpea yield.

Table-2. Estimated regression equation for total farm output with some socio-economic characters of small scale maize/cowpea farmers.

Estimated parameters	Linear form
Constant	1.066^{NS} (352.330)
Age (F_2)	2.13*** (0.028)
Farming experience (F_3)	2.14^{NS} (0.996)
Farm size (F_4)	15.602*** (66.088)
Household size (F_5)	2.020* (3.646)
Household in farming (F_6)	0.900^{NS} (7.622)
Distance to farm (F_7)	0.890^{NS} (47.745)
R^2	74.1
Estimated parameters	Linear form

Source: Field survey, 2019.
Note: Figures in parenthesis are standard errors.
*** Significant at P<0.01
* Significant at P<0.1
NS Non – Significant.

Farmers' farming experience, household engaged in maize/cowpea and distance of farm to farmers' residence were positive and non – significant on the amount of maize/cowpea yield. The positive and significant relationship

between the yield and farm size, age and household size, confirm a natural pattern of relationship. The implication is that increases farm size poses greater yield and also as the farmers grows older his ability to manage and sense problems in the production process increases. Joint variation of the variables explained 74.1 per cent of yield.

Production function estimates: The regression result in Table 3 indicates that 89.00 per cent of the variations in total farm output among the sampled farmers were explained by the production inputs specified in the model. This is reasonably high considering other explanatory factors, such as difference in soil fertility and farmers' management abilities. The coefficient of land and seed are positive and statistically significant (P<0.05), indicating a direct relationship between them and total farm output. That is the two parameters land and seed have increasing effect on total farm output. The coefficient of labour, fertilizer and insecticide are positive and statistically in significant, indicating non increasing effect on the yield of maize and cowpea.

Table-3. Estimated regression equation for total farm output (kg) with production inputs in small scale maize/cowpea farms.

Estimated parameters	Functional forms	Estimated parameters	Functional forms
	Linear		Linear
Constant	-1.660*	Constant	-1.660*
	(91.532)		(91.532)
Seed (X_1)	2.277**	Seed (X_1)	2.277**
	(10.359)		(10.359)
Land (X_2)	2.260**	Land (X_2)	2.260**
	(258.553)		(258.553)
Labour (X_3)	0.153^{NS}	Labour (X_3)	0.153^{NS}
	(0.101)		(0.101)
Fertilizer (X_4)	0.819^{NS}	Fertilizer (X_4)	0.819^{NS}
	(0.652)		(0.652)
Insecticide (X_5)	0.20^{NS}	Insecticide (X_5)	0.20^{NS}
	(146.400)		(146.400)
R^2	89.00	R^2	89.00

Source: Field survey, 2019.
Note: Figures in parenthesis are standard errors.
*** Significant at P< 0.01
** Significant at P, 0.05
* Significant at P<0.1
NS Non – Significant.

Farming households production objectives: Using the method of pair comparison Table 4 shows the frequency matrix and ranking of the maize/cowpea farmers production objectives. The eight objectives as preferred by the farming households were used in this study. These are; satisfying family food requirement, maximization of profit, minimization of production cost, attainment of higher social status, provision of self employment, avoiding years of low profit and loss, reduction of farm debt and increase in leisure. All the households had various combinations of these objectives. The result reveals that satisfying family food requirement ranked first with a total preferences frequency of 622, provision of self-employment objective ranked second with a total frequency of 535, the third is maximizing profit with a total frequency of 402, followed by minimizing production, cost, attainment of higher social status, avoiding years of low profit and loss, reduction of farm debt and increase in leisure ranked in that order. This indicates that maize/cowpea croups farming in the area is more of the subsistence than the commercial, as maize is the common staple food in the rural setting. Durojaiye [3] stated that farm management decision of small scale farmers were base on multiple production objectives.

The least significant differences (LSD) statistics was calculated to be 20.09 at 0.05 level of significant. Given the test criterion and LSD statistics, the analysis failed to reject the null hypothesis in the case of maximization of profit, minimizing production cost, attainment of high social status, avoiding years of low profit and lost and reduction of farm debt, indicating they are of equal importance to the farming house holds. However, the ranking of

satisfying family food requirement and provision of self employment over the mentioned objectives were statistically different from family food requirement and self employment for the rural dwellers, as the farming sector employs about 70 per cent of the country's population.

Table-4. Frequency matrix and rank of household's production objectives.

	A	B	C	D	E	F	G	H	Total
A		14	16	23	41	20	22	12	148
B	96		42	49	65	39	41	36	368
C	94	68		49	75	43	42	25	394
D	87	61	49		73	58	44	32	404
E	69	45	37	37		19	15	13	235
F	90	71	57	52	91		50	25	446
G	88	69	68	44	95	60		35	459
H	98	74	85	78	97	85	75		592
Preference frequency	622 a	402b	364b	332b	535a	324b	289b	179c	3046
Preference frequency	88.5	57.42	52	47.43	76.42	46.28	41.28	25.42	
Objective ranking	1st	3rd	4th	5th	2nd	6th	7th	8th	

Source: Held survey, 2019.
LSD = 20.09 at 5%.
Note: The number in each rows are frequency with which a given column objectives was selected over a given row objective. Frequencies with the same latter are not significantly different at 0.05.
A – Satisfying family food requirement.
B – Maximization of profit.
C – Attainment of higher social status.
E – Provision of self employment.
F – Avoiding years of low profit and loss.
F – Reduction of farm debt.
G – Increase in leisure.

Constraints to Increased Maize/Cowpea Production: The constraints to increase maize/cowpea production in the study area are presented in Table 5. High cost of inputs, low and unstable product price, high cost of labour and high cost and late delivery of fertilizer constitutes the major problems to maize/cowpea production in the study area. These were reported by 87 (79.09 per cent) for high cost of inputs, 80 (72.73 per cent) for high, labour cost and late delivery of fertilizer. Other problems include lack of credit facilities 44 (40 per cent) and poor rural road to convey product. These problems encountered by maize/cowpea farmers could be eradicated provided lasting solutions are found. Government should come to the farmers' aid by subsidizing inputs and making it available to farmers.

Table-5. Constraints to increased maize/cowpea production as perceived by respondents in the study area.

Constraints	Frequency
High cost and late delivery of fertilizer	64(58.18)
Lack of credit facilities	44(40.00)
High cost of labour	64(58.15)
Low and unstable product price	80(72.73)
High cost of other inputs	87(79.09)
Poor rural roads to convey produce	24(21.82)
Inadequate storage and processing facilities	11(10.00)
Inadequate extension services	2(1.82)
Lack of high yielding varieties	7(6.36)
High incidence of insect infestation	9(8.18)

Note: Value in bracket are percentages of total.
Source: Field survey, 2019.

4. CONCLUSION

Land was found to be an increasing factor to the production of maize/cowpea, as such for proper utilization of land resource an intercrop of maize/cowpea should be encouraged and farmers' production ability should be boasted

as they only produce for consumption and little to sell to cater for family needs. This is evident from their production objective preference for satisfying family food requirement.

5. RECOMMENDATION

1. With proper management and good season, intercropping maize with cowpea should be encouraged as it does not depress either crop; rather one would enjoy price advantage of either crop in case of rise in price and demand.
2. The positive and significant effect of land on total farm output indicate that land have been properly utilized, as such a mixture of maize/cowpea production should be encouraged as small land area would yield more output as compare to sole crop.
3. Government should provide farmers with production inputs to boast their production at a commercial level, as farmers' preference for satisfying family food requirement is an evidence of low productivity.

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