RESOURCE USE EFFICIENCY IN TOMATO AND PEPPER PRODUCTION AMONG FADAMA FARMERS IN KADUNA STATE

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ABSTRACT

This study assessed the resource use efficiency in tomato and pepper production among Fadama farmers in Kaduna State. A combination of primary and secondary data was used for the investigation. The primary data involved the use of interview through questionnaire administration. Farm budgeting technique, production function and marginal productivities were used to measure resource use efficiency. The results show that the net profit for tomato/pepper mixture was ₦70,122.6 per hectare, that of tomato sole was ₦54,192.40, and that of pepper sole was ₦ 11,711.70. The semi-log production function analysis showed that all inputs used by the farmers were not efficiently used. The paper concludes that if yield is to be increased, the use of vital inputs such as land, labour and fertilizer will have to be increased.

INTRODUCTION

The classical assumption guiding the discussion of resource efficiency lies in the motive of profit maximization (Adeniyi, 1988). This serves as an ideal frame work against which various forms of efficiencies of production can be adequately measured. The National Academy of Sciences (1975), defined efficiency as the capacity to produce desired result with a minimum expenditure on resources, while Olukosi and Erhabor (1988) referred to 'efficiency' as the quantity of output (Y) per unit of input (x) used in the production process. This is the Average Physical Product (APP).

The Hausa word `Fadama' is used extensively in geographical and agricultural writings. Turner (1977) and Alamu (1996) described Fadama as `low lying lands', relatively those areas adjacent to streams. They are water logged or flooded in the wet season. At the beginning of the wet season, they are marked by a lush of new vegetation before the upland turns green, but they are mostly conspicuous at the end of the rains when they remain prominently green as the surrounding upland turns brown.

Fadama are mostly found in the Northern States of Nigeria, located in the Sudanian and Sahelian ecological zones. Generally, Fadama fields are much smaller in size than the upland fields. But they are very much valued by Hausa farmers. In his study of 350 farmers in three Zaria villages, Norman (1972) found that although only about 9.4 percent of the total farm land cultivated were Fadama farms, their net farm income consisting of high valued crops was 22.9 percent of the total farm land income.

In Nigeria today, the major fadama (dry season) crops whose efficiency of resource use merits indepth study are the vegetables and cereals. Kabura (1977) revealed that the bulk of vegetable production in Nigeria is in the Northern States. Some major vegetables grown in Kaduna State include tomatoes, pepper, okro and onions. However, this study focuses on the production of tomato and sweet pepper.

Objectives

The objectives of this study are to:

i. Compare the profitability of tomato and pepper cultivated using different cropping systems in the Fadama, and
ii. determine and compare the economic efficiency of resource use in tomato and pepper production under different cropping systems.

LITERATURE REVIEW

Profitability Assessment of Farm Production

Farm profitability can be assessed through estimation of gross margin and net farm income (profit). Costs and returns analysis forms the basis for farm profitability assessment. This involves itemizing the cost and returns of production. Cost of production are generally of two types:- Fixed and Variable. Olukosi and Ogungbile (1989) have described the cost components as the differences between Total Revue (TR) and Total Costs (TC) of production results in Net Farm Income (NFI) or profit as expressed below:

NFI = NR – TC; while the difference between the total revenue and total variable costs is referred to as gross margin as given in the expression below:

GM = TR - TVC

Where:

GM = Gross Margin (₦)

TR = Total Revue (₦)

TVC = Total Variable Costs (₦)

The net farm income and gross margin are useful in evaluating the efficiency of an individual enterprise (or farm plan) so that comparison can be made between or among enterprises of different farm plans. It is also possible to subject these values to test of statistical significance to verify differences between enterprises.

The problems, however, associated with profitability analysis are as follows:-

i. it does not indicate the relative importance of each of the resources in production;

ii. it is location bound and specific in applicability due to use of money as the common unit of measurement and the prevailing prices for the estimates.

Economic Resource Classification and Identification

The term resource may sound so ordinary to merit any definition. However, Oni (1982); Olukosi and Erhabor (1988), defined resources as those means available for producing goods

and services. Olayemi (1982) posited that resources go beyond the quantities of material inputs available. They include capable manpower, development oriented national organisation and institutions, good infrastructural facilities, appropriate and constantly improving technology.

Tomatoes and peppers, like most vegetables require intensive cultural practices. According to Rice *et al.* (1987) the financial and inputs involved are greater than those required for most staple crops such as rice and maize. The resources used in the production of these crops include that of land, seeds, fertilizers, labour, agro-chemicals and irrigation water.

ECONOMIC EFFICIENCY IN FARM PRODUCTION

The concept of efficiency is concerned with the relative performance of the processes used in transforming given inputs into output (Mijindadi, 1981). Lau and Yotopoulus (1972), Olayide and Heady (1982) made a distinction between two types of efficiency: Technical efficiency and Economic efficiency. Technical efficiency focuses on physical productivity that occurs when larger quantity of output is consistently produced from input. According to Olayide and Heady (1982), efficiency measured as the average productivity of inputs can only be a meaningful index of technical efficiency if any of the resources is limiting in the production process.

Economic efficiency on the other hand, occurs when a firm chooses resources and enterprises in such a way as to attain economic optimum (maximum profit). The optimum implies that a given resource is being used efficiently as its marginal value product is just sufficient to offset its marginal cost (Adegeye and Dittoh, 1985). According to Farrel (1957), economic efficiency is a product of technical efficiency and price efficiency. His method has not escaped some criticisms. Aigner and Chu (1968) pointed out that the method is not general enough, since the assumption implies that it is not possible to use it in estimating a production function which conforms to the law of variable proportions.

Lau and Yotopoulos (1972) developed an alternative approach for measuring efficiency. They used a profit function rather than a production function. The Lau and Yotopoulos model consists of a single profit equation and a series of equations expressing the derived demand function for each variable input. The profit equation expresses profit level as a function of variable input prices and fixed inputs quantities.

Farm Budgeting Technique

A farm budgeting is a detailed physical and financial plan for the operation of a farm for a certain period (Olukosi and Erhabor, 1988). The aim of preparing a farm budget is to enable the comparison of several alternative plans for analysis so that decision can be taken as to which of the enterprise gives the highest net farm income. Burdgeting assist the farm manager to select factors of production more wisely, it can also be used as test and compare returns.

Production function analysis

Lingard and Rayner (1975); Koutsoyiannis (1979); Olukosi and Ogungbile (1989), referred to production function as a physical/technical relationship between factor inputs and output. Production function provides measurements of useful economic tools such as marginal productivity of factors of production, marginal rate and elasticity of substitution, factor intensity, efficiency of production and returns to scale. The purpose of the production function is to identify and estimate how variable inputs included in the model best explain the variability in output. The greater the extent to which the variable inputs are able to explain the variability in output, the larger is the influence which the inputs have on output.

METHODOLOGY

On farm study was conducted in Kaduna State. Farmers were selected from the four zones of the Kaduna Agricultural Development Project, (KADP): Maigana, Samaru-Kataf, Birnin-Gwari and Lere. Simple random sample was used to select 120 fadama farmers in the study area. The respondents comprised 40 farmers who cultivated tomato/pepper mixture and 40 each who cultivated tomato and pepper solely. Primary and secondary data were used for the study. The primary data were collected by the Kaduna State Agricultural Development Project (ADP) enumerators, who used interview schedule. The secondary information was collected from the Kaduna Agricultural Development Project (KADP).

The data were analysed using farm budgeting technique, production function analysis and marginal productivities. Profitability of each production system was determined through Gross Margin Analysis, while the production function analysis was used to explain the technical relationship between input and output in each of the regression systems and marginal productivities used to measure resource use efficiency. Four regression analysis were run. They included (i) pooled data for all respondents (ii) data comprising both tomato and pepper mixture (iii) tomato sole and (iv) pepper sole. In these regression analyses, the semi-log production function was chosen as it gave the best fit. This was determined using a combination of coefficient of determination (R^2), the level of significance of the overall equation (F-statistics), the level of significance of each coefficient (t-statistics) and the correct signs of the coefficients relative to *a-priori* expectations.

The empirical models of the regression are given as:
The Semi-Log Production Function (SPF):

$$Y = \log a + b_1 \log x_1 + b_2 \log x_2 + b_3 \log x_3 + b_4 \log x_4 + b_5 \log x_5 + b_6 \log x_6 + b_7 \log x_7 + U.$$

Where:
Y = Output of tomatoes and pepper.
X_1 = Size of Fadama (ha)
X_2 = Quantity of seeds used (kilogram)
X_3 = Quantity of Nitrogen used (kg)
X_4 = Quantity of Phosphorus used (kg)
X_5 = Quantity of Potassium used (kg)
X_6 = Total Labour used (man day)
X_7 = Total Water used (ltrs)
U = Error term

Marginal Productivities

This measure of resource use efficiency was derived by computing the marginal productivities of the resources. In the semi-log production function, the marginal productivity of resource (x_1) in tomato and pepper production was derived using the following formula:

$$MVP_{X1} = MPP_{x1}.PY$$

Where:

$$MPP_{xi} = \frac{dy}{dx_1} = \frac{b_1}{\bar{x}_1} 1$$

MPP_{X1} = Marginal Physical Product of Factor x_1

b_i = Regression coefficient of factor x_i
= Arithmetic mean of input x_i
$\bar{x}_i$
PY = Unit price or output
MVP_{xi} = Marginal Value Product of Factor x_i

RESULTS AND DISCUSSION

Total Cost of Production

This is made up of the variable cost and fixed cost. The total cost of production per hectare for all respondents was ₦ 57,442.1. Table 1 shows that the total variable cost per hectare accounted for 84 percent of this amount, while the total fixed cost incurred accounted for the remaining 16 percent. This is not in consonance with the 97 percent and 3 percent recorded for total variable and total fixed cost component of Abdulrahman (1996). This is not unexpected because the fixed cost component of Abdulrahman's work was mainly on small implements such as hoes and cutlasses, whereas this study has added the depreciation cost of washbore and water pump.

Gross Return

An average of ₦17 and ₦25 per kilogram were adopted for tomato and pepper respectively. This is because the average price farmers sold these crops vary between Local Government Areas. The gross return for mixed cropping was ₦137,254.9 per hectare, while that of tomato sole and pepper sole were ₦110,160.00 and ₦61,875.00 respectively. From Table 1 total cost per hectare for tomato and pepper mixed were ₦67,132.74, that of tomato sole was ₦55,967.60, while that of pepper sole was ₦50,163.30. The table also shows that the total revenue per hectare for tomato and pepper was ₦ 137,254.90; that of tomato sole was ₦110,160.00 while that of pepper sole was ₦61,875.00. The net farm income (profit) for tomato and pepper mixed per hectare was ₦70,122.16, that of tomato sole was ₦54,192.40 while that of pepper sole was ₦11,711.70. The average profit per hectare for all respondents was ₦45,654.80.

Results Of The Production Function Analysis

The results of the production function analysis in Table 2 shows that 76.1%, 84%, 85% and 72% of the variation in output were accounted for by the fitted independent variable for pooled equation, mixed tomatoes and pepper, sole tomato and sole pepper equation respectively.

The F value of 6145, 23.38, 25.13 and 11.76 for pooled, mixed cropped (tomato/pepper), sole (cropped) tomato and sole (cropped) pepper equations, which determine the strength of association between the dependent and independent variables, were significant at 1 percent probability level for all equations.

Test of significance showed that the coefficient of farm (Fadama) size, quantity of nitrogen used and labour used were significant at 1 percent for the pooled equation, while water used was significant at 5 percent.

For the tomato/pepper mixture equation, Fadama farm size was significant at 1 percent, while labour was significant at 10 percent. Also, Fadama size, quantity of seeds and water used were significant at 1 percent for the tomato sole equation, while quantity of fertilizer used was significant at 10 percent. For pepper sole equation, the quantity of labour utilised and quantity of water used were significant at 1 percent, while size of Fadama was significant at 5 percent.

From the foregoing, it is evident that Fadama farm size, quantity of seeds, quantity of fertilizer, labour and water used were the most important variables that explained the variation in output under pooled equation, while, the size of fadama cropping and labour used were the major determinants under the mixed cropping (tomato/pepper). For the tomato sole, Fadama size, quantity of seeds, quantity of phosphorus and water used constituted the most important variables that explained the variation in output, while for the pepper sole, labour used, water used and fadama size were the most important variables.

Resource Use Efficiency

From the production estimated, the efficiency of the factors of production were evaluated. A given resource is said to be efficiently utilised if its marginal value product (MVP) is equal to its factor cost. For this study, the marginal value products derived from the semi-log functional form fitted for all the equations, were computed for those resources that were found to be statistically significant.

To achieve objective 2 of this study, the MVPs of Fadama size and labour were estimated for the mixed cropping (tomato/pepper) equation. For the tomato sole equation, MVPs of Fadama size, seed and water used were estimated, while for the pepper equation, MVPs of labour used, water used and Fadama size were estimated.

Table 3 shows the estimated MVPs of the statistically significant inputs and their respective factors costs for the mixed and sole cropped equations.

From Table 3, it can be observed that land and labour were under utilized under tomato/pepper mixture. These are represented by values of 108.9 and 4.98 for Fadama farm size and labour, respectively. The results also show that land, phosphorus and water were under utilized by farmers who cultivated tomatoes solely, while quantity of seeds used was over-utilized. For pepper sole, Fadama size and labour were under-utilised, while water was over-utilised.

CONCLUSION

The results of the study show that almost all the inputs for production were under-utilized. Thus, the level of profit, particularly for pepper was low. It can be concluded that if yield is to be increased, the use of vital inputs such as land, labour and fertilizer will have to be increased for all the cropping patterns. For farmers cultivating tomatoes sole, however, there may be need to reduce the use of seeds, while pepper farmers should curtail the volume of irrigation water.

REFERENCES

Abdulrahman, A. (1996). "Economic Analysis of Dry-season Irrigated Tomato Production in Bomo Village". Unpublished M.Sc. Thesis, Department of Agricultural Economics and Rural Sociology, Ahmadu Bello University, Zaria.

Adegeye, J.A. and Dittoh, J.S. (1985). *Essentials of Agricultural Economics*. Impacts Publishers Nigeria Limited, Ibadan, Nigeria.

Adeniyi, J.P. (1988). "Farm Size and Resource Use Efficiency in Small Scale Agricultural Production: The Case of Rice Farms in Kwara State, Nigeria". *The Nigerian Agricultural Journal* Vol. 23, No. 2 pp. 43-49.

Aigner, D.Z. and Chu, S.F. (1968). "On Estimating the Industry Production Function". *American Economic Review* Vol. 58, No. 4 pp. 826-839.

Alamu, J.F. (1996). Marketing of Fadama Tomatoes, Pepper and Onion: A Case Study of Kano and Jigawa States of Nigeria. An Unpublished Ph.D. Thesis, Department of Agricultural Economics and Rural Sociology, Ahmadu Bello University, Zaria.

Farell, M.J. (1957). "The Measurement of Productive Efficiency". *Journal of the Royal Statistical Society* Vol. 120pp. 254-289.

Kabura, B.H. (1997). "Sustaining Production of Vegetables in Yobe State". A paper presented at the workshop on Sustainable Crop Production Beyond Withdrawal of Subsidy on Fertilizer. Ministry of Agriculture and Natural Resources, Damaturu, Yobe State. pp. 1-2.

Koutsoyiannis, A. ([illegible]) *Modern Microeconomics* Macmillan Press Ltd. Houndmills Basingstoke Hampshire and London pp. [illegible]

Lau, L.J. and Yotopoulos, P.A. (1972). "Profit, Supply and Factor Demand Functions". *American Journal of Agricultural Economics* Vol. 54 No. 1 pp. 11-18.

Lingard, J. and Rayner, A.J. (1975). "Productivity Growth in Agriculture. A Measurement Framework". *Journal of Agricultural Economics* Vol. xxvi No. 1, Agricultural Economics Society Publication. Department of Agricultural Economics. The University, Reading.

Mijindadi, N.B. (1981). Production Efficiency on Farm in Northern Nigeria Unpublished Ph.D Thesis. Cornell University, USA.

National Academic of Science (1975). *Agricultural Production Efficiency*. National Academy of Sciences Publication, Washington, D.C. USA., pp. 21-23.

Norman, D.W. (1972). "An Economic Study of Three Villages in Zaria Province: Input-Output Study. Vol. 1, Basic Data and Survey Forms. *Samaru Miscellaneous Paper* 37 p. 87.

Olayemi, J.K. (1982). "Assessment of Technical and Economic Efficiencies in Farming" Paper Presented at the Fourth National Training Workshop for Agricultural Planners. Ibadan, Oyo State. pp. 1-10.

Olayide, S.O. and Heady, E.O. (1982). *Introduction to Agricultural Production Economics*. University Press, Ibadan, Nigeria.

Olukosi, J.O. and Erhabor, P.O. ([illegible]) *Introduction to Farm Management Economics* [illegible] AGITAB Publishers Zaria, Nigeria [illegible]

Olukosi, J.O. and Ogungbile, A.O. (1988). *Introduction to Agricultural Production Economics : Principles and Application*. AGITAB Publishers Ltd., Zaria, Nigeria.

Rice, R.P., Rice, L.W. and Tindall, H.D. (1987). *Fruit and Vegetable Production in Africa*. Macmillan Publishers Ltd. London and Basingstoke.

Turner, B. (1977). "The Fadama Lands of Central Northern Nigeria: Their Classification, Spatial Variation, Present and Potential Use". An Unpublished Ph.D Dissertation, University of London.

World Bank (1992). *National Fadama Development Programme Staff Appraisal Report*. Nigeria. pp. 1-2, 3-21, 41-42.

Table 1: Cost and Returns Analysis for Tomato and Pepper Production per Hectare

Item	Unit/ha	Tomato/Pepper Mixtu		% of tota	Tomato sole			Pepper sole			All respondents		
		Value/ Unit	Total cost (₦		Unit/ha	Total cost (₦	% of to	Unit/ha	Total cost (	% of tota	Unit/ha	Total cost (₦	% of total
Yield (kg)													
Tomato	4899.7	17.0			6480			2475			3793.20		
Pepper	2158.4	25.0									1544.50		
Gross return (₦)													
Tomato			83294.90	60.70		110160						64484.40	62.50
Pepper			53960.00	39.30					61875			38612.50	37.50
Total			137254.90	100.00		110160			61875			103096.90	100
Fixed Cost Depreciation													
-Washbore			1956.34	2.9		2020			1723.00	3.4		1886.50	3.3
-Water pump			6234.50	9.3		6953			4072.50	8.1		5753.30	10.0
-Rent on land		1500	1500.00	22		1500	2.7		1500.00	3.0		1500.00	2.6
Total			6990.84			10473			7295.00			9136.80	
Variable cost													
Fertilizer (kg)	270.8	30	8123.90	12.1	265.8	7973.60	14.2	241.4	7242	14.4	250.47	7514.10	13.1
Seed (kg) Tomato	0.32	4500											
Pepper	0.43	5800	3934.00	5.9	0.51	2288.10	4.1	0.64	3703.8	7.4	0.70	3308.6	5.8
Fuel cost (ltrs)	233	25	5832.10	8.7	168.00	4188.00	7.4	212.00	5291.0	10.5	202.80	5068.80	8.8
Agrochemicals (ltrs)			459.00	0.7		964.40	1.5		587.0	1.2		637.2	1.1
Labour (man-day)											52.5		
-Land preparation	69.9				46.6			41.0			80.0		
-Ridging	99.99				77			62.5			90.0		
-Planting/transplanting	116.6				84.4			68.0			90.0		
-1st weeding	91.7				98.1			80.2			70.0		
-2nd weeding	92.9				64.4			51.8			210.0		
-Water application	236.1				200.4			193.5			18.0		
-Thinning	33.8				9.9			9.3			20.0		
-Fertilizer application	27.2				17.6			14.9			12.0		
-Pest & diseases control	17.3				10.1			8.3			75.0		
-Harvesting	78.5				79.4			67.2			60.0		
-Weighing & bagging	69.2				60.8			50.0			776.2		
Total Labour	933.1	30.0	27993.0	41.7	748.7	22461.0	40.1	646.7	19401.0	38.7		23286.0	40.5
Other variable costs			11099.90	16.5		7719.50	13.8		6643	13.2		8187.60	14.8
Total variable cost			57771.90			45494.60			42867.80			48302.30	
Total cost			67132.74			55967.60			50163.30			57442.10	
Profit			70122.16			54192.40			11711.70			45654.80	

Table 2: Regression Coefficient and T-values for Tomato and Pepper Production Functions.

Cropping pa		Fadama size	Qty of seeds us	Qty of Nitroge used	Qty of Phospho Used	Qty of Potassiu Used	Labour Used	Water Used	R^2	F-value
Pooled	Coefficient values	633.60* (3.19)	3.70 (0.01)	1396.72* (9.75)	87.85 (1.17)	36.34 (0.34)	2065.34* (3.35)	363.77** (2.19)	0.76	61.15*
Mixture (T/	Coefficient values	2133.15* (6.63)	133.55 (0.25)	-56.86 (-0.37)	135.92 (0.92)	26.73 (0.12)	1554.69** (1.74)	-65.97 (-0.25)	0.84	23.38*
Tomato sole	Coefficient values	2809.90* (5.03)	3957.63 (-2.94)	226.50 (0.75)	563.02*** (2.02)	124.27 (0.63)	2240.28 (1.07)	1447.56* (3.49)	0.85	25.13*
Pepper sole	Coefficient values	257.23** (2.08)	280.81 (1.04)	37.35 (0.65)	-6.01 (0.10)	6.56 (0.11)	1564* (3.41)	409.87* (4.10)	0.72	11.76

* Significant at 1% level
** Significant at 5% level
*** Significant at 10% level

Table 3: Marginal Value Product and Arithmetic Means for Significant Arables.

Variable in production function		MPP/ha	MVP	MFC	MVP/MFC
Tomato and pepper mixture					
Fadama size	0.47	4538.62	163,390.32	1500	108.90
Labour used	374.50	4.15	149.40	30	4.98
Tomato sole					
Fadama size	0.45	6244.22	156,105.50	1500.00	104.1
Quantity of seeds used	0.15	-26,384.2	-659,605.00	6935.37	-95.1
Quantity of phosphorus used	7.90	71.24	1781.75	2.50	712.7
Quantity of water used	558,135.00	0.003	0.075	0.05	1.5
Pepper sole					
Fadama size	0.42	612.45	25,110.45	1500	16.7
Labour used	331.30	4.72	193.52	30	6.5
Water used	550,900.00	0.00074	0.03	0.05	0.6