academicJournals

Vol. 6(4), pp. 72-76, April 2013
DOI 10.5897/AJMCSR 12.056
ISSN 2006-9731 ©2013 Academic Journals
http://www.academicjournals.org/AJMCSR

African Journal of Mathematics and Computer Science Research

Full Length Research Paper

Profit maximization among dry season vegetable farmers

Oni N. O.[1], Osuntoki N. B.[1], Rahaman A.[1] and Amao O. D.[2]

[1]Department of Mathematics and Statistics, The Polytechnic Ibadan, P. M. B. 021, Saki Campus, Oyo State, Nigeria.
[2]Department of Agricultural Technology, The Polytechnic Ibadan, P. M. B. 021, Saki Campus, Oyo State, Nigeria.

Accepted 15 February, 2013

Dry season vegetable production in Nigeria has become as important as income generating occupation that there are always shortages of suitable land for the numerous producers. Production is undertaken under irrigation and it is characterized by intense mixed cropping. Four major inputs are put into consideration apart from land allocation in vegetable production, they are: hired labor activities, fertilizer application, fueling of pumping machine and the cost of vegetable seed. The paper discusses the cost and returns structure in the production of four major vegetables in Saki West, Atisbo and Kajola Local Government in Oke-Ogun area of Oyo State. The vegetables include Amarantus, Ewedu, Osun and Tomato. The aim is to maximize the profit incurred by the vegetable farmers by identifying the ratio at which each crop should be produced using linear programming (LP) approach. The result shows that the famers should be producing Ewedu and Osun in ratio 3:2 and the production of Amarantus and Tomato should be ignored in the study location in order to improve productivity, food security and income for the farmers.

Key words: Profit maximization, dry season, vegetable, linear programming, decision variable, parameter.

INTRODUCTION

Agriculture is a mainstay of the small scale farmers in Nigeria. Giroh et al. (2010) posits that Agricultural production in Nigeria is dominated by small scale farmers and is known to produce more than 90% of food consumed in the country. One of the major items produced is vegetable. The importance of vegetables as major and efficient sources of micronutrients in African diet cannot be over stressed. Vegetables are nourishing foods because they contain a little of all the substances needs of man like protein, mineral salts, sugars, vitamins, aromatics, colouring agencies, iron and essential oils that increase man's resistance to disease. In this class of food, man finds the wide range of nutritive elements he needs. According to Weinberger and Lumpkin (2007), Aladetoyinbo (2001), Roger and Ingawa (2003) global production of fruits and vegetables tripled from 396 million metric tones (MT) in 1961 to 1.34 billion MT in 2003.

This underscores the relevance attached to vegetables and fruits. Fruits and vegetables represent essential part of these agricultural products. Their production remains entrenched in Nigerian agriculture, and forms an important condiment in the national diet consumed by all Nigerians in almost every meal (Ibekwe and Adesope, 2010; Aina, 2005).

In Nigeria, there are two distinct seasons, the rainy season and the dry season. The rainy season is the normal cropping season and this starts from April and ends in October, while the dry season starts from November and ends in March. During the rainy season, the production of vegetable is high resulting in the saturation of the market, but during the dry season there is usually the scarcity of this important farm product thereby leading to a high

*Corresponding author. E-mail: realsuccessconsult@yahoo.com, oninat2013@gmail.com, oniolaniyi4u@yahoo.com. Tel: +2348057546020, +2348027266865.

price due to short supply (Mohammed, 2002; Okunola, 2009; Ibekwe and Adesope, 2010).

This seasonality has resulted in food insecurity which is a challenge to sustainable food production. It has also been found that most farmers do not want to go into large scale production because they are apprehensive of high risk.

This has made the farmers to grow vegetables as intercrop of low significance as a way of avoiding risk. It is surprising that after two decades of horticultural research and extension activities in Nigeria, farmers are not yet sure and confident that the extra cost concomitant with the adoption of new technologies would bring extra benefits (Afolayan, 2005; Aderinola, 2001; Okunola, 2009; Ibekwe and Adesope, 2010). This has implication for accurate assessment of the potentials of dry season vegetable production as a source of income for the farmers. This study therefore, was designed to analyze profit maximization among dry season vegetable farmers in the study area.

LINEAR PROGRAMMING MODEL

Mathematical programming, more specifically linear programming (LP) is a method of constrained optimization. It is a mathematical model of real life problems. It is the simplest and the most widely used tools of mathematical technique for the analysis of economic problems in agriculture and other phases of life. LP maximizes an objective function subject to specified constraints. In relation to Agriculture, LP can be applied to maximize net farm income over a specified planning horizon, subject to the resources on the farm. By entering farm specified data, available options for that farm can be analyzed and the income maximization optimal farm plan identified. Optimum farm plan decisions are to maximize an objective function

$$Z_{(x)} = \sum c_i x_i$$

Subject to a set of constrains,

$$A_{(x)} \leq B$$

$$X \geq 0$$

Where: Z = value of the objective function, i.e. net return or profit, X = vector of activities whose level in the optimal farm plan to be solved or simply a decision vector, C = the amount "C" of the resources "i" used in the production of one unit of the jth activities, B = vectors of the constraint values which are limit of input or output of various activities, A = m × n matrix of technical coefficient that classically relate resources used by an activities to resources constraints, but in general, give amount of inputs and outputs for a unit of each activity.

Definition of decision variables and model parameters

Z = The objective function to be maximized, which is the gross margin per plot.

w_j = Net price per plot of the jth activity

x_j = the decision variable, representing the activity engaged in.

C_{ij} = the amount C of the resources used in the production of one unit of the jth activities.

b_i = Level of the ith resources available; $i = (1,2,...,5)$

i = Resources used in producing the jth activity

j = Activity engage in; $j = (1,2,...,3)$

Model development

$$Maximize\ Z = \sum w_j x_j \quad (1)$$

$$Subject\ to: \sum c_{ij} x_j \leq b_j \quad (2)$$

$$x_j \geq 0$$

Where: $i = 1, 2, \ldots, m; \quad j = 1, 2, \ldots, n$

Here, Equation 1 describes the profit expected from farm activities base on resource constrain Equation 2 which is further broken down.

$$Maximize\ Z = \sum w_j x_j$$

$$Subject\ \ to: \sum c_{ij} x_j \leq b_i$$

Land: $c_{1j} x_j \leq b_1$

Hired labour: $c_{2j} x_j \leq b_2$

Fuel: $c_{3j} x_j \leq b_3$

Fertilizer: $c_{4j} x_j \leq b_4$

Seed: $c_{5j} x_j \leq b_5$

$$x_j \geq 0$$

Socio-economics characteristics of the farmers

Age distribution

The age distribution of the farmers is presented in Table 1. The age of the farmers ranged between 21 and 60 years. The table shows that relative young famers between 21 and 30 years constitute about 48% of the sample while those of that are between 31 to 40 years are 20%. Also, those that fall between 41 and 50 constitute 16% of the sample. Those that are above 50 years who could be regarded as elders constitute 6% of the sample. The fact that larger proportions (78%) of the sample were adults, that is, (21 and 40)

Table 1. Age distribution.

Age interval	Frequency	Cumulative frequency	Percentage
21 - 30	24	24	48
31 - 40	15	39	30
41 - 50	8	47	16
> 50	3	50	6
Total	50	-	100

Age distribution of vegetable farmers in Saki-West, Atisbo and Kajola Local Government Area of Oyo State. Source: Field survey (2012).

Table 2. Level of education.

Level	Frequency	Cumulative frequency	Percentage
No education	0	0	0
Primary education	10	20	20
Secondary education	25	70	50
Post-secondary educaton	15	100	30
Total	50	-	100

Source: Field Survey (2012).

Table 3. Farm sizes of the farmers.

Farm size (plot)	Frequency	Cumulative frequency	Percentage
<1	3	3	6
1 - 5	6	9	12
6 - 10	21	30	42
11 - 15	14	44	28
16 - 20	6	50	12
Total	50	-	12

Source: Field survey, 2012.

indicates that the use of the modern farming techniques and innovation would be easy to be employed. Also, there is assurance of increase in productivity since higher percentage of the farmers is still in their adult age.

Level of education

Table 2 shows that about 0% had no education and 20% had primary school education while 50% had secondary school education and 30% has post-secondary education. The result shows that the farmers in the study area are literate which will enable the use of modern techniques and innovation by the farmers.

Farm size

Table 3 shows distribution of farm sizes of the farmers. Among sampled farmers, 6% had farm sizes lesser than 1 plot, 12% had between 1 and 5 plots, 42% had between 6 and 10 plots while 40% had plots between 11 and 20.

Linear programing analysis

Matrix format

The matrix format applies to production problem in the farms in Saki-West, Atisbo and Kajola Local Government area of Oyo State. Four different crops were considered that is, Amarantus, Ewedu, Osun and Tomato. The mathematical expression of problem arrangement is deduced from the matrices of the study area as shown in Table 4. Since Ewedu and Amarantus have the same amount of resource used in production (c_{ij}) and the same profit, one would expect that the two vegetables would be included in the optimum farm plan but the result of the optimal plan fail to support this (Table 5) Where: $x_1 = A\,unit\ of\ Ewedu$, $x_2 = A\,unit\ of$ Amarantus, $x_3 = A\,unit\ of\ Osun$, $x_4 = A\,unit\ of\ Tomato$.

Table 4. Data presentation.

Variable	Ewedu	Amarantus	Osun	Tomato	Available resources
Land (Plot)	1	1	1	1	≤ 10
Hired labour	3800	3800	7550	9500	≤ 17700
Fuel (lts)	30	30	65	68	≤ 135
Fertilizer (kg)	187.5	187.5	250	187.5	≤ 437.5
Seed	1350	1350	1500	1000	≤2950
Profit	14500	14500	18500	12550	

Source: Computed from field survey (2012).

Table 5. LP matrix formulated for the farm.

Variable	x_1	x_2	x_3	x_4	Available resources
Land (Plot)	1	1	1	1	≤10
Hired Labor	3800	3800	7550	9500	≤17700
Fuel (lts)	30	30	65	68	≤135
Fertilizer (kg)	187.5	187.5	250	187.5	≤ 437.5
Seed	1350	1350	1500	1000	≤ 2950
Profit	14500	14500	18500	12550	

Source: Computed from Field Survey (2012).

Put in canonical form for LP

$$Max\ Z = 14500x_1 + 14500x_2 + 18500x_3 + 12550x_4,$$
$$Land:\ x_1 + x_2 + x_3 + x_4 \le 10$$
$$Hired\ Labour:\ 3800x_1 + 3800x_2 + 7500x_3 + 9500x_4 \le 17700$$
$$Fuel:\ 30x_1 + 30x_2 + 65x_3 + 68x_4 \le 135$$
$$Fertilizer:\ 187.5x_1 + 187.5x_2 + 250x_3 + 187.5x_4 \le 437.5$$
$$Seed:\ 1350x_1 + 1350x_2 + 1500x_3 + 1000x_4 \le 2950$$
$$x_1,\ x_2,\ x_3,\ x_4\ \le 0$$

Where: Z = Objective function to be maximized which is the net farm income.
$x_1,\ x_2,\ x_3,\ x_4$ = Decision variables to be maximized that is, Ewedu, Amarantus, Osun and Tomato.

Putting the combination in standard form, we have

$$Max\ Z = 14500x_1 + 14500x_2 + 18500x_3 + 12550x_4 + 0x_5 + 0x_6 + 0x_7 + 0x_8 + 0x_9$$

Subject to: $x_1 + x_2 + x_3 + x_4 \le 18$

$$3800x_1 + 3800x_2 + 7500x_3 + 9500x_4 + 0x_5 + x_6 + 0x_7 + 0x_8 + 0x_9 = 21500$$
$$30x_1 + 30x_2 + 65x_3 + 68x_4 + 0x_5 + 0x_6 + x_7 + 0x_8 + 0x_9 = 165$$
$$187.5x_1 + 187.5x_2 + 250x_3 + 187.5x_4 + 0x_5 + 0x_6 + 0x_7 + x_8 + 0x_9 = 625$$
$$1350x_1 + 1350x_2 + 1500x_3 + 1000x_4 + 0x_5 + 0x_6 + 0x_7 + 0x_8 + x_9 = 4300$$
$$x_1,\ x_2,\ x_3,\ x_4 \ge 0$$

RESULTS AND DISCUSSION

Results of the optimum plan are given in Appendices I, II, and III. The table shows that Ewedu and Osun were included in the optimum farm plan with the income obtained being 33277.78, while Amarantus and Tomato was excluded. Although, Ewedu and Amarantus require the same resources to be cultivated, and produce the same amount of profit, yet, Amarantus was excluded in the optimum table.

The result shows that seed and fertilizer are exhausted by the optimum farm plan while there were unused resources of 7.89 plots of land, ₦7177.78 of hired labor and 48.33 L of fuel. For any farmer in the study area to maximize his profit, he has to produce 1.44 of Ewedu with 0.67 of Osun which are the only crops that can be best advised to specialize on.

RECOMMENDATIONS

(i) The vegetable farmers must try to cultivate Amarantus, Ewedu and Osun in ratio 3:2,
(ii) Efforts should be made by the Government to ensure that farmers benefit the monetary assistance renders to them thorough monitoring,
(iii) Farmers should be encouraged to keep farm record of their activities, through the assistance of FADAMA or Oyo State Agricultural Development Program Extension Officers because most of the farmers depend on the memory call before they could supply information.

REFERENCES

Aderinola EA (2001). Strategic planning and mission review for Fadama projects in Ondo State, Nigeria. A paper presented at Seminar on Supervisory Management of Available Resources for Fadama Development Project in Ondo State, 18th Dec. pp. 3-7.

Afolayan SO (2005). Water management in Fadama vegetable production in capacity Building in fadama vegetable production. Natl. Hortic. Res. Inst. pp. 45-47.

Aina AS (2005). Utilization of improved vegetable production practices among Fadama farmers in Odeda L.G areas of Ogun state. An unpublished M.Sc. Project submitted to the Department of Agric. Extension and Rural Development. University of Ibadan. P. 66.

Aladetoyinbo RO (2001). Designing an operational analysis and field layout procedure for fadama development. A paper presented at a Seminar on Fadama Development in Ondo State, 18th Dec. pp. 2-3.

Giroh DY, Waizah Y, Umar HY (2010). Technical efficiency and cost of production among gum Arabic farmers in Jigawa State. Report Opin. 2(1):52-57.

Ibekwe UC, Adesope OM (2010). Analysis of Dry Season Vegetable Production in Owerri West Local Government Area of Imo State, Nigeria. Report Opin. 2010:2(12) http://www.sciencepub.net/report.

Mohammed Y (2002). Farmers’ awareness building on Integrated Pest Management (IPM). Research Report, ICIPE/EARO Vegetable IPM Project. P. 16.

Okunlola AI (2009). Factors associated with Fadama production of vegetables by small-scale farmers in Ondo State, Nigeria. P. 32.

Roger MB, Ingawa YS (2003). Resolving conflict manual, second National Fadama development Project. pp. 12-16.

Weinberger K, Lumpkin TA (2007). Diversification into Horticulture and poverty reduction: A Research Agenda. World Development 2007: 35(8):1464-1480.

APPENDIX I

LINEAR PROGRAM -- ORIGINAL DATA

Title: profit maximization

	Ewedu x1	Amaran x2	Osun x3	Tomato x4		
Maximize	14500.000	14500.000	18500.000	12550.000		
Subject to						
(1)	1.000	1.000	1.000	1.000	<=	10.000
(2)	3800.000	3800.000	7550.000	9500.000	<=	17700.000
(3)	30.000	30.000	65.000	68.000	<=	135.000
(4)	187.500	187.500	250.000	187.500	<=	437.500
(5)	1350.000	1350.000	1500.000	1000.000	<=	2950.000
Lower Bound	0.000	0.000	0.000	0.000		
Upper Bound	infinity	infinity	infinity	infinity		
Unrestr'd (y/n)?	n	n	n	n		

APPENDIX II

SIMPLEX TABLEAUS -- (Starting All-Slack Method)

Title: profit maximization

Iteration 1	Ewedu	Amaran	Osun	Tomato	
Basic	x1	x2	x3	x4	sx5
z (max)	-14500.000	-14500.000	-18500.000	-12550.000	0.000
sx5	1.000	1.000	1.000	1.000	1.000
sx6	3800.000	3800.000	7550.000	9500.000	0.000
sx7	30.000	30.000	65.000	68.000	0.000
sx8	187.500	187.500	250.000	187.500	0.000
sx9	1350.000	1350.000	1500.000	1000.000	0.000
Lower Bound	0.000	0.000	0.000	0.000	
Upper Bound	infinity	infinity	infinity	infinity	
Unrestr'd (y/n)?	n	n	n	n	

Basic	sx6	sx7	sx8	sx9	Solution
z (max)	0.000	0.000	0.000	0.000	0.000
sx5	0.000	0.000	0.000	0.000	10.000
sx6	1.000	0.000	0.000	0.000	17700.000
sx7	0.000	1.000	0.000	0.000	135.000
sx8	0.000	0.000	1.000	0.000	437.500
sx9	0.000	0.000	0.000	1.000	2950.000

Iteration 2	Ewedu	Amaran	Osun	Tomato	
Basic	x1	x2	x3	x4	sx5
z (max)	-625.000	-625.000	0.000	1325.000	0.000
sx5	0.250	0.250	0.000	0.250	1.000
sx6	-1862.500	-1862.500	0.000	3837.500	0.000
sx7	-18.750	-18.750	0.000	19.250	0.000
x3	0.750	0.750	1.000	0.750	0.000
sx9	225.000	225.000	0.000	-125.000	0.000
Lower Bound	0.000	0.000	0.000	0.000	
Upper Bound	infinity	infinity	infinity	infinity	
Unrestr'd (y/n)?	n	n	n	n	

Basic	sx6	sx7	sx8	sx9	Solution
z (max)	0.000	0.000	74.000	0.000	32375.000
sx5	0.000	0.000	-0.004	0.000	8.250
sx6	1.000	0.000	-30.200	0.000	4487.500
sx7	0.000	1.000	-0.260	0.000	21.250
x3	0.000	0.000	0.004	0.000	1.750
sx9	0.000	0.000	-6.000	1.000	325.000

Iteration 3	Ewedu	Amaran	Osun	Tomato	
Basic	x1	x2	x3	x4	sx5
z (max)	0.000	0.000	0.000	977.778	0.000
sx5	0.000	0.000	0.000	0.389	1.000
sx6	0.000	0.000	0.000	2802.778	0.000
sx7	0.000	0.000	0.000	8.833	0.000
x3	0.000	0.000	1.000	1.167	0.000
x1	1.000	1.000	0.000	-0.556	0.000
Lower Bound	0.000	0.000	0.000	0.000	
Upper Bound	infinity	infinity	infinity	infinity	

APPENDIX III

Unrestr'd (y/n)?	n	n	n	n	
Basic	sx6	sx7	sx8	sx9	Solution
z (max)	0.000	0.000	57.333	2.778	33277.778
sx5	0.000	0.000	0.003	-0.001	7.889
sx6	1.000	0.000	-79.867	8.278	7177.778
sx7	0.000	1.000	-0.760	0.083	48.333
x3	0.000	0.000	0.024	-0.003	0.667
x1	0.000	0.000	-0.027	0.004	1.444