Optimum Production Patterns for Cassava-based Crop Farmers in Irepodun and Moro Local Government Areas of Kwara State, Nigeria

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OPTIMUM PRODUCTION PATTERNS FOR CASSAVA-BASED CROP FARMERS IN IREPODUN AND MORO LOCAL GOVERNMENT AREAS OF KWARA STATE, NIGERIA

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Abstract

Farmers in Nigeria are faced with the problem of efficient allocation of the limited resources available to them and also identifying the best farm plans that will maximise their production and income. The study derived optimum production plans for cassava-based crop farmers in Moro and Irepodun LGAs of Kwara State, Nigeria. It specifically identified the cropping pattern of the farmers and prescribed the optimum farm plans. A multi-stage sampling technique was used to select a total of 117 respondents in the area. Data were collected through interview schedule and structured questionnaire administered to the sampled farmers. Analysis of the data collected was done using descriptive statistics and linear programming model. The study identified 15 crop production activities with 18.80% and 81.20% of the farmers practising sole and mixed cropping enterprises respectively. The linear programming solution prescribed cassava/melon, cassava/yam/maize and cassava/sorghum/groundnut on 0.4314ha, 0.2261ha and 0.7505ha respectively for the pooled data in the optimum farm plans to give a return of ₦242,548.10/ha ($1 = ₦308.28) compared to the ₦165,913.85/ha in the existing plan. It specifically prescribed cassava/yam/maize on 0.4507ha, cassava/maize/cowpea on 0.6157ha and cassava/maize/groundnut on 0.5036ha for farmers in Moro LGA to give a return of ₦241,143.50/ha; cassava/sorghum on 0.4016ha, cassava/groundnut on 0.5289ha, cassava/yam/maize on 0.3740ha and cassava/maize/okra on 0.1955ha for the farmers in Irepodun LGA to give a return of ₦240,783.20/ha. Land, labour and capital were the production factors limiting the profit maximization objective in the area. The study recommended that the farmers should adopt the prescribed optimum farm plans so as to maximize their profit and that further studies should focus on other arable crops and non-crop farm enterprises in the area.

Key Words: *Cassava-based, Farmers, Resources, Planning, Optimum, Programming, Kwara*

Introduction

Nigeria has a comparative advantage over other countries of the world in the agricultural sector given the favourable climatic condition, good soil structure and a very large arable land mass which supports the production of varieties of crops. The sector has contributed immensely to the sociological and cultural needs of the people living in Nigeria as it provides food, raw materials for agro-based industries as well as income to the farmers and a source of foreign earnings (Sani *et al.,* 2013). Onyenwea *et al.* (2008) had pointed out that the domestic economy where agriculture thrives must be improved upon and sustained, because indication of high potential for increased food production in Nigeria is glaring given that Nigeria has a cultivable land area of about 71.2 million hectares which represents about 70% of the nation's total land area. Only about 34 million hectares however is under cultivation and represents about one third of the total land area.

Agricultural planning has become an important task due to the increasing population and the demand for agricultural commodities. Sofi *et al.* (2015) opined that the increasing population and agricultural commodity demand has created a need to also increase production so as to meet up with the demand. Farm planning according to Sarker and Quaddus (2002) is the most important factor of agricultural planning. Linear programming as an analytical tool for studying the economic aspects of farm management has contributed immensely to agricultural development as its technique has been used to study the problems of resource allocation among farmers and in the present stage of development focuses on deriving optimum production plans for farmers such as the combination of crops that will increase food and farm income.

Nigeria as the most populous country in Africa with 2.59% growth rate now has an estimated population of about 182 million (World Population Review, 2015). It has also been projected that by 2050, Nigeria will be the third most populated nation in the world with an estimated population of about 400 million. With this increasing population, increasing agricultural production by increasing farm size will not be sustainable. This poses a great threat to food production planning if feeding the many mouths could not be realized.

A major problem faced by small-scale farmers especially the arable crop farmers, who are characterised with low literacy levels is identifying the combination of crops that will produce maximum profit on a given farm size considering the amount of labour and capital resources available to them. Bamiro *et al.* (2015) also argued that farmers often take the decision of integrated farm enterprise which will offer them the desired results by trial and error method, which usually give rise to uncertain outcome. Therefore, the need for the practicing crop farmers to have access to optimum farm plans because they suffer from a dearth of such valuable information and are struggling to optimize their objective function subject to their resource constraints given a complex mixture of many variables. This study therefore aimed to develop a prototype optimum production plans for small-scale cassava-based farmers in the area using the linear programming approach.

With the challenge to tackle global food crisis given the alarming growing population, a study of this nature was a worthy venture. The place of optimum farm plans cannot be over emphasised as it would provide a valuable guide to both new entrants and practicing farmers. Deriving optimum farm plans for the small-scale crop farmers is a huge step towards increased food production and income generation which will in the overall, enhance food security and improve the farmers' standard of living.

Focusing on the small-scale crop farmers, this study would help to promote the frontiers of knowledge and fill the knowledge gap in literature. More so, agricultural researchers and students would greatly benefit from this study as its output would provide basis for further research on the subject matter in the area. The result would also benefit agricultural project administrators, policy makers and extension agents both in the public and private sectors who may need relevant information for formulating effective policy and dissemination to farmers that will stimulate increased food production in the area and in Nigeria as a whole. It could form part of the extension teaching content to guide efficient allocation of existing resources.

Study Area

The study was conducted in selected local government areas of Kwara State, Nigeria. Kwara State has a total land area of 32,500 square kilometres, 75.3% of which is cultivable (Kwara State Ministry of Agriculture and Natural Resources (KWSMANR), 2010). Kwara State is located in Nigeria on Latitudes 7°45′ N to 9°30′ N and Longitudes 2°30′ E to 6°25′ E and shares boundaries with Niger State in the North, Osun State in the South, Kogi State in the East and Benin Republic in the West. The mean annual rainfall ranges between 1000mm and 1500mm with the average temperature ranges also between 30°C and 35°C. The topography and the climatic condition of the State favours the cultivation of various arable crops including cassava, yam, cowpea, maize, rice, groundnut, sorghum and vegetables. Besides employment in the Civil Service, farming and trading are the major occupation of the people of Kwara State. The state has a total of 99,695 and 3,274 registered crop and non-crop farmers respectively giving a sum total of 102,969 farmers, while a total of 1,094,232 of the population are engaged in direct farming (KWSMANR, 2010). The major tribes in the State are Yoruba, Nupe and Baruba. Other tribes present include Fulani, Igbo and Hausa.

Methodology

Sample Collection

A multi-stage sampling technique was employed for this study. All the cassava-based crop farmers in Irepodun and Moro LGAs of Kwara State constituted the population for the study. In the first stage, Irepodun and Moro LGAs were randomly selected. The second stage also involved the random selection of three farming communities from each of the selected LGAs. This gave a total of six farming communities. Following Nwadike (2016) at the third stage, 10% of the crop farmers were proportionately sampled from each of the communities. This gave a total of 117 cassava-based crop farmers for the study.

Primary data were used for this study. The cross-sectional data for the 2015/2016 cropping season were collected from the farmers with the aid of a structured questionnaire which was complimented with interview schedule. Resident extension agents and trained enumerators were employed to assist during the data collection for the cropping season.

The data collected were analysed with descriptive statistics which involved the use of frequency distribution, percentages and means and a linear programming model. The linear programming model was adopted from Igwe (2012), modified and specified mathematically below in an expanded form following Reddy *et al.* (2004). The objective function of the model (equation 2) was to maximize the profit of the crop farmers which is total farm income (Gross Income) minus the total cost of production. The farm budgeting model adopted from Yusuf *et al.* (2008) as specified in equation (1) was used to compute the farmers' profit.

$$\pi = \sum_{i=1}^{n} P_{yi}Y_i - \sum_{j=1}^{m} P_{xj}X_j - \sum_{k=1}^{o} F_k \qquad (1)$$

Where;
Π = Profit in Naira per hectare,
Y_i = Enterprise's product per hectare (where i = 1, 2, 3, ...,n products),
P_{yi} = Unit price of the product,
X_j = Quantity of the variable inputs per hectare (where j =, 1, 2, 3, ...,m variable inputs),
P_{xj} = Price per unit of variable inputs, and
Fk = Cost of fixed input per hectare (where k =, 1, 2, 3, ...,o fixed inputs).
The objective function:

$$\text{Maximize } \pi = P_1X_1 + P_2X_2 + P_3X_3 + \ldots + P_nX_n \qquad (2)$$

Subject to:

$$A_{11}X_1 + A_{12}X_2 + A_{13}X_3 + \ldots + A_{1n}X_n \leq L_s(\text{Land}) \qquad (3)$$
$$A_{21}X_1 + A_{22}X_2 + A_{23}X_3 + \ldots + A_{2n}X_n - L_t \leq H_t(\text{Labour}) \qquad (4)$$
$$A_{31}X_1 + A_{32}X_2 + A_{33}X_3 + \ldots + A_{3n}X_n - M_t \leq C_t(\text{Capital})(5)$$
$$A_{41}X_1 + A_{42}X_2 + A_{43}X_3 + \ldots + A_{4n}X_n - E_t \leq S_t(\text{Seed})(6)$$
$$A_{51}X_1 + A_{52}X_2 + A_{53}X_3 + \ldots + A_{5n}X_n - B_t \leq F_t(\text{Fertilizer})(7)$$
$$A_{61}X_1 + A_{62}X_2 + A_{63}X_3 + \ldots + A_{6n}X_n - K_t \leq A_t(\text{Agrochemical})(8)$$
and
$$X_1 \geq 0, X_2 \geq 0, X_3 \geq 0, \ldots, X_n \geq 0 \qquad (9)$$

Where;
π = Farm profit
$X_1, X_2, X_3, \ldots X_n$ = Different crop activities or enterprise undertaken (decision variables),
$P_1, P_2, P_3 \ldots P_n$ = Output coefficients (profit) per hectare of the different crop activities maximized,
A_{ij} = Input-Output coefficients, that is, quantity of i^{th}resource (land, labour, capital, seed, fertilizer and agrochemical) required to produce a unit output of j^{th}crop activity,
L_s= Level of available land in hectare for crop activities with s restriction,
H_t= Level of available labour in man-day for crop activities in t^{th} period,
C_t= Level of available working capital in Naira for crop activities in t^{th} period,
S_t= Level of available seed in kilograms for crop activities in t^{th} period,
F_t= Level of available fertilizer in kilograms for crop activities in t^{th} period, and
A_t= Level of available agrochemical in litres for crop activities in t^{th} period.

Results and Discussion

Cropping Pattern Adopted by Respondents

The result presented in Table 1 shows the identified cropping patterns existing in the study area. The results revealed that 23.64%, 14.52% and 18.80% of the respondents in Moro and Irepodun LGAs and pooled data cultivated cassava as a sole crop, while 76.36 %, 85.48% and 81.20% respectively cultivated cassava as crop mixture in the area. The crops cultivated in the study area comprised of tubers, cereals, legumes and vegetables. There were thirteen and fourteen different cassava mixtures respectively in both LGAs and pooled data. These mixtures include cassava/maize, cassava/melon, cassava/yam, cassava/sorghum, cassava/groundnut, cassava/soybean, cassava/yam/maize, cassava/maize/cowpea, cassava/sorghum/groundnut, cassava/maize/groundnut, cassava/yam/melon, cassava/soybean/maize, cassava/maize/melon and cassava/maize/okra. These crop mixtures are similar to that of Igwe (2012) who reported fifteen different cassava crop mixtures which include cassava/maize, cassava/melon, cassava/yam, cassava/maize/yam and cassava/maize/melon among others in Abia State, Nigeria.

Table 1: Distribution of Respondents According to Cropping Pattern and Combination Adopted

Variable	Moro LGA	Irepodun LGA	Pooled data
Cropping pattern			
Sole	13 (23.64)	9 (14.52)	22 (18.80)
Mixed	42 (76.36)	53 (85.48)	95 (81.20)
Total	55 (100.00)	62 (100.00)	117(100.00)
Sole crop			
Cassava	13 (23.64)	9 (14.52)	22 (18.80
Mixed crops (combination)			
Cassava/Maize	9 (16.36)	19 (30.65)	28 (23.94)
Cassava/Melon	4 (7.27)	6 (9.68)	10 (8.55)
Cassava/Yam	6 (10.91)	3 (4.84)	9 (7.69)
Cassava/Sorghum	2 (3.64)	7 (11.29)	9 (7.69)
Cassava/Groundnut	1 (1.82)	2 (3.23)	3 (2.56)
Cassava/Soybean	2 (3.64)	1 (1.61)	3 (2.56)
Cassava/Yam/Maize	5 (9.09)	2 (3.23)	7 (5.98)
Cassava/Maize/Cowpea	4 (7.27)	-	4 (3.42)
Cassava/Sorghum/Groundnut	-	1 (1.61)	1 (0.85)
Cassava/Maize/Groundnut	1 (1.82)	3 (4.84)	4 (3.42)
Cassava/Yam/Melon	3 (5.45)	-	3 (2.56)
Cassava/Soybean/Maize	2 (3.64)	2 (3.23)	4 (3.42)
Cassava/Maize/Melon	3 (5.45)	3 (4.84)	6 (5.14)
Cassava/Maize/Okra	-	4 (6.45)	4 (3.42)
Total	55 (100.00)	62 (100.00)	117 (100.00)

Note: figures in parentheses are percentages

Crop Yields and Gross Value per Hectare in the Existing Plan

The yield and gross value per hectare of each crop combinations were computed and presented in Table 2. The gross values of each crop output per hectare were calculated based on prevailing market prices in the study area.

Table 2: Crop Yield, Price and Gross Value per Hectare

Crop	Yield (Kg/ha)	Price (₦/Kg)	Value of output (₦/ha)
Cassava	8,323.00	15	124,845.00
Cassava/Maize			
Cassava	7,769.33	15	116,540.00
Maize	915.50	100	91,550.00
Cassava/Melon			
Cassava	8,033.33	15	120,500.00
Melon	428.20	250	107,050.00
Cassava/Yam			
Cassava	7,055.33	15	105,830.00
Yam	1,530.33	120	183,640.00
Cassava/Sorghum			
Cassava	8,181.33	15	122,720.00
Sorghum	852.23	110	93,745.29
Cassava/Groundnut			
Cassava	7,715.33	15	115,730.00
Groundnut	1,082.08	130	140,670.42
Cassava/Soybean			
Cassava	7,897.33	15	118,460.00
Soybean	832.68	140	116,575.00
Cassava/Yam/Maize			
Cassava	7,950.00	15	119,250.00
Yam	1,488.50	120	178,620.00
Maize	908.95	100	90,895.00
Cassava/Maize/Cowpea			
Cassava	8,166.67	15	122,500.00
Maize	1,041.75	100	104,175.25
Cowpea	430.00	160	68,800.00
Cassava/Sorghum/Groundnut			
Cassava	7,654.67	15	114,820.00
Sorghum	862.75	120	103,530.00
Groundnut	1,057.31	130	137,450.00
Cassava/Maize/Groundnut			
Cassava	7,833.33	15	117,500.00
Maize	964.50	100	96,450.00
Groundnut	810.80	130	105,404.50
Cassava/Yam/Melon			
Cassava	7,363.33	15	110,450.00
Yam	925.54	140	129,576.00
Melon	350.00	250	87,500.00
Cassava/Soybean/Maize			
Cassava	8,050.00	15	120,750.00

Soybean	659.29	140	92,300.00
Maize	749.64	100	74,963.71
Cassava/Maize/Melon			
Cassava	7,620.00	15	114,300.00
Maize	890.55	100	89,054.50
Melon	320.00	250	80,000.00
Cassava/Maize/Okra			
Cassava	7,850.00	15	117,750.00
Maize	669.91	100	66,991.25
Okra	870.00	110	95,700.00

Source: Computed from field survey data, 2016 Exchange rate: $1 = ₦308.28

Determination of Optimum Farm Plans

The optimization result which shows the optimum cropping activities, the shadow prices of the excluded activities, factors limiting the profit maximization objective, difference in existing and optimum plans in the study area are presented in Tables 3, 4, 5 and6 respectively.

Existing and Optimum Farm Plans

The cropping pattern in the existing and optimum farm plans is presented in Table 3. The results of the optimum plan prescribed 0.4507ha, 0.6157ha and 0.5036ha for cassava/yam/maize, cassava/maize/cowpea and cassava/maize/groundnut respectively for cassava-based farmers in Moro LGA. The LP results further prescribed 0.4016ha, 0.5289ha, 0.3740ha and 0.1955ha for cassava/sorghum, cassava/groundnut, cassava/yam/maize and cassava/maize/okra respectively cassava-based farmers in Irepodun LGA and 0.4314ha for cassava/melon, 0.2261ha for cassava/yam/maize and 0.7505ha for cassava/sorghum/groundnut in the pooled data. Interestingly, all the cassava crop activities in the optimum plan were crop mixtures across the two LGAs and in the pooled data. This implies that cassava crop mixtures are in better competitive position to yield more than cassava sole cropping in the study area. It is also interesting to note that four major categories of crop, that is, tuber, cereals legumes and vegetables were reflected in the optimum plans prescribed.

Table 3: Cropping Pattern in the Existing and Optimum Farm Plans

Cropping pattern	Moro LGA		Irepodun LGA		Pooled data	
	Existing plan (ha)	Optimum plan (ha)	Existing plan (ha)	Optimum plan (ha)	Existing plan (ha)	Optimum plan (ha)
Cassava	1.0400	-	0.9100	-	0.8400	-
Cassava/Maize	1.2100	-	1.1000	-	0.9100	-
Cassava/Melon	1.0000	-	0.8400	-	1.2400	0.4314
Cassava/Yam	0.9300	-	1.1500	-	1.2300	-
Cassava/Sorghum	0.6000	-	1.5100	0.4016	1.0100	-
Cassava/Groundnut	0.9000	-	0.6500	0.5289	0.7800	-
Cassava/Soybean	1.3000	-	1.0000	-	1.1400	-
Cassava/Yam/Maize	1.1200	0.4507	1.0800	0.3740	1.0000	0.2261
Cassava/Maize/Cowpea	0.4000	0.6157	-	-	0.8000	-
Cassava/Sorghum/Groundnut	-	-	0.6300	-	1.3600	0.7505
Cassava/Maize/Groundnut	0.9500	0.5036	1.5000	-	1.3000	-
Cassava/Yam/Melon	1.4000	-	-	-	1.2800	-
Cassava/Soybean/Maize	1.0200	-	1.2000	-	1.1000	-
Cassava/Maize/Melon	1.3500	-	0.7500	-	1.0300	-
Cassava/Maize/Okra	-	-	0.4050	0.1955	1.4000	-

Shadow Prices of Excluded Activities

The result presented in Table 4 shows the various shadow prices of the excluded crop activities from the optimal production plan for the cassava based crop farmers in Kwara State. In a maximization LP problem, shadow prices are the income penalties indicating the amount by which farm income would be reduced if any of the excluded activity is forced into the programme. The result showed that ten, nine and twelve activities were excluded from the programme in Moro and Irepodun LGAs and the pooled data respectively. Cassava as a sole crop had the highest shadow prices of ₦29,872.59, ₦35,202.20 and ₦66,486.69 respectively across the two LGAs and the pooled data. For the mixtures, cassava/sorghum in Moro LGA, cassava/maize/melon in Irepodun LGA and cassava/maize/melon in the pooled data had the highest shadow prices of ₦23,981.52, ₦14,289.31 and ₦16,675.53 respectively. This implies that if these activities are forced into the programme or undertaken, the value of the objective function will be reduced by the values of their respective shadow prices as they have the highest propensity to depress profit as prescribed by the programme. Same applies to other excluded activities. Mixture cassava/soybean/maize in Moro, cassava/sorghum/groundnut in Irepodun and cassava/maize/cowpea in the pooled data however had the least shadow prices of ₦3,469.88, ₦171.28 and ₦701.025 respectively. It therefore means that these mixtures are in a better competitive position in the programme as compared to other excluded activities in their respective LGAs. This further means that cassava/soybean/maize, in Moro; cassava/sorghum/groundnut in Irepodun and cassava/maize/cowpea in the pooled data would have been the next activity to be included in the optimal plan since they decreased the value of the objective function by the least amount on a comparative basis.

Table 4: Shadow Prices (₦) of Excluded Activities in Profit Maximizing Objective of Cassava-Based Crop Farmers

S/No	Excluded Activities	Moro LGA	Irepodun LGA	Pooled data
1	Cassava	29,872.59	35,202.20	66,486.69
2	Cassava/Maize	7,733.39	2,632.31	4,707.45
3	Cassava/Melon	5,045.24	8,921.77	0.00
4	Cassava/Yam	9,148.72	3,213.54	2,952.69
5	Cassava/Sorghum	23,981.52	0.00	11,549.12
6	Cassava/Groundnut	12,457.04	0.00	9,488.76
7	Cassava/Soybean	12,093.09	6,910.51	4,979.62
8	Cassava/Maize/Cowpea	0.00	0.00	701.03
9	Cassava/Sorghum/Groundnut	0.00	171.28	0.00
10	Cassava/Maize/Groundnut	0.00	6,882.33	2,457.82
11	Cassava/Yam/Melon	4,015.45	0.00	5,944.53
12	Cassava/Soybean/Maize	3,469.88	5,972.89	4,199.50
13	Cassava/Maize/Melon	15,944.28	14,289.31	16,675.53
14	Cassava/Maize/Okra	0.00	0.00	1,462.746

Exchange rate: $1 = ₦308.28

Marginal Value Product of Resources

The factors limiting the achievement of the profit maximization objective in the study area as obtained from the LP output are presented in Table 5. The result showed that in Moro LGA, land, labour and capital were used up by the programme and had shadow prices of ₦97,658.38, ₦691.4768, and ₦1.2088 respectively. Furthermore, the result showed that land, labour, capital and agrochemical were used up by the programme in Irepodun LGA and had shadow prices of ₦45,811.58, ₦1,801,416, ₦1.0613 and ₦57.8575 respectively. For the pooled data, land, labour and capital were also used up by the programme and had shadow prices of ₦60,505.79, ₦1,097.221, and ₦1.0863 respectively. This implies that these resources used up by the programme as presented in Table 5 in the respective LGAs and the pooled data were therefore the limiting resources in cassava-based cropping system in the study area as they constrained the attainment of the profit maximization objective. It further implies that an increase in these resources by a unit will lead to an increase in the optimal profit by the values of their respective shadow prices. This further agreed with the findings of Hassan *et al.* (2005) who opined that efficient and full utilization of resources leads to maximization of output.

Conversely, the resources that were surplus were seed, fertilizer and agrochemical in Moro, seed and fertilizer in Irepodun and seed, fertilizer and agrochemical for the pooled data as they were not used up by the programme. With zero shadow prices, the results showed that these resources were in excess of the actual requirements by the cassava-based crop farmers in the study area and were therefore non-limiting. This agrees with Olayemi and Onyenweaku (1999) who asserted that any resource that was not used up was not a limiting resource and has a zero shadow price as it does not constraint the attainment of a programme's objective and vice versa.

Table 5: Marginal Value Product of Resources

Resource	Use Status	Slack/Surplus	Shadow price (₦)
Moro LGA			
Land	Fully Utilized	0.0000	97,658.38
Labour	Fully Utilized	0.0000	691.4768
Seed	Not Fully Utilized	117.8026	0.0000
Capital	Fully Utilized	0.0000	1.2088
Fertilizer	Not Fully Utilized	23.4925	0.0000
Agrochemical	Not Fully Utilized	0.8408	0.0000
Irepodun LGA			
Land	Fully Utilized	0.0000	45,811.5800
Labour	Fully Utilized	0.0000	1,801.4160
Seed	Not Fully Utilized	141.7407	0.0000
Capital	Fully Utilized	0.0000	1.0613
Fertilizer	Not Fully Utilized	25.2479	0.0000
Agrochemical	Fully Utilized	0.0000	57.8575
Pooled data			
Land	Fully Utilized	0.0000	60,505.7900
Labour	Fully Utilized	0.0000	1,097.2210
Seed	Not Fully Utilized	141.7407	0.0000
Capital	Fully Utilized	0.0000	1.0863
Fertilizer	Not Fully Utilized	25.2479	0.0000
Agrochemical	Not Fully Utilized	1.7823	0.0000

Exchange rate: $1 = ₦308.28

Comparison of Net Profit (₦/ha) in Existing and Optimum Farm Plans

The results in Table 6 indicated that the net profit in Naira per hectare in the existing plan was ₦176,361.70 in Moro LGA, while in the optimum plan, it was ₦241,143.50. This depicts that there is a 36.73% increase in the optimum plan. It further revealed a 41.98% increment that is ₦71,199.10 increase in the optimum plan from ₦169,584.10 to ₦240,783.20 in Irepodun LGA. In the pooled data, the profit of the cassava-based crop farmers increased by ₦76,634.25 representing a 46.19% increment in the optimum plans. It is worthy to note that in the optimum plans, profit increased across the two LGAs and also in the pooled data. It however increased proportionately highest in the pooled data and least in Moro LGA. The implication of these increments in the optimum plans is that, an average cassava farmer in the study area has the potential to increase and maximize net profit.

Table 6: Net Profit (₦/Ha) in Existing and Optimum Farm Plans

Location	Net profit for existing plan (₦/ha)	Net profit for optimum plan (₦/ha)	Increase in profit over existing plan (₦/ha)	Percentage increase
Moro LGA	176,361.70	241,143.50	64,781.80	36.73
Ireopodun LGA	169,584.10	240,783.20	71,199.10	41.98
Pooled data	165,913.85	242,548.10	76,634.25	46.19

Exchange rate: $1 = ₦308.28

Conclusion

Based on the findings of this study, it was concluded that resources were not optimally allocated in the existing farm plans. The cassava crop mixtures were in a better competitive position than cassava as a sole crop in the optimum plans. The linear programming solution prescribed three three-crop mixtures for Moro LGA, two two-crop mixtures and two three-crop mixtures for Irepodun LGA and for the pooled data, one two crop-mixtures and two three crop-mixtures for the cassava-based crop farmer. A typical cassava-based crop farmer in the study area has the potential to realize more profit per hectare in the optimum plan.

Cassava-based farm households should take good advantage of the outcome of this study by adopting the optimum farm plans prescribed across the two LGAs, that is, produce the various crop mixtures that fit into the plan based on their hectare allocation. This would help them to achieve food security, increased farm income and reduced cost of production. Also, government through the relevant agricultural agencies in the study area should promote and provide adequate and effective farm advisory/extension services to the farmers on optimum cropping patterns and farm resource allocation. This should be incorporated into programs geared towards increased agricultural productivity among farmers. Further studies of this nature should focus on other arable crops and non-crop farm enterprises in the study area.

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