RAISING THE INCOME OF SMALLHOLDER FARMERS IN KWARA STATE, NIGERIA: A CASE STUDY OF CASSAVA-BASED CROP FARMERS

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Ethiopian Journal of Environmental Studies & Management 11(6): 697 – 706, 2018.
ISSN:1998-0507 doi: https://ejesm.org/doi/v11i6.4
Submitted: April 28, 2018 Accepted: November 11, 2018

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Abstract
Smallholder farmers suffer from a dearth of valuable information to guide them in taking farm decisions that would raise their income and improve their standard of living. This study derived optimum farm plans that would raise the income of smallholder cassava-based crop farmers in Kwara State, Nigeria. Data were elicited from 164 farmers in the state through structured questionnaire and interview schedule. Data analysis was done using descriptive statistics and linear programming model. The study identified 15 crop production activities with 34.15% and 65.85% of the farmers practising sole and mixed cropping enterprises respectively. The linear programming solution prescribed cassava/maize, cassava/soybean and cassava/sorghum/groundnut on 0.4379ha, 1.0886ha and 0.6435ha respectively in the optimum farm plans to raise their income by 69.82% from $635.02/ha in the existing plan to $1,078.39/ha in the optimum plan. Cassava/melon and cassava/groundnut had the least tendency to depress farmers' income if forced into the plan. Land, hired labour, capital and agrochemical were the production factors limiting the profit maximization objective among the smallholder cassava based-crop farmers in Kwara State. Optimum farm plans should be incorporated into the extension teaching contents designed for the farmers to enhance increased food production and income generation among the famers.

Key Words: *Smallholder farmers, Income, Resource allocation, Linear Programming*

Introduction

At various times the Nigerian government initiated various agricultural programmes and policies for increased productivity and efficiency of the agricultural sector. These programmes include Agricultural Development Projects (ADPs) (1972), River basin Development Authorities (RBDA) (1977), Green Revolution (GR) (1979), National Agricultural Land development Authority (NALDA) (1992), National *Fadama* Development Project (NFDP) (1992), Nigerian Agricultural Cooperative and Rural Development Bank (NACRDB) (2000) and National Agricultural Development Fund (NADF) (2002) among others. Ajibefun *et al*. (2002) argued that these programs and policies placed the small holder farmers in central focus which was due to the fact that the nation's agriculture has always been dominated by the smallholder farmers who represent a substantial proportion of the total farming population and produce over 90% of the total agricultural output in the country.

A major problem faced by smallholder farmers particularly the arable crop farmers, who are characterised with low literacy levels is identifying the combination of crops that will raise their income considerably. This may be unconnected with the fact that these farmers are also characterised with limited level of production resources. Bamiro *et al.* (2015) also argued that farmers often take the farm production decision by trial and error method, which usually give rise to uncertain outcome. They suffer from a dearth of valuable guiding information on optimum farm production decision making and are struggling to optimize their farm objective subject to their resource constraints. Therefore, the farmers need help to identify the optimum combination of crops that will raise their income considerably and improve their living standard. Also, as pointed out by Sofi *et al.* (2015) that the increasing population and demand for agricultural commodity has created a need to also increase production so as to meet up with the demand. In view of this, optimum agricultural planning has become paramount. 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. At this stage of development, it therefore focuses on deriving optimum production plans that will increase food and farm income for the farmers. This study therefore aimed to develop a prototype optimum production plans for smallholder cassava-based farmers in Kwara State using the linear programming approach.

With the smallholder crop farmers in focus, this study would help to promote the frontiers of knowledge and fill the knowledge gap in literature on how farmers could be helped to efficiently allocate their limited recourses and raise their income level considerably. More so, agricultural researchers and students would be able to bank on the output of this study for further research on the subject matter in the area and elsewhere. The result would also benefit key agricultural players, agencies and institutions both in the public and private sectors that may need relevant information for formulating effective policy and dissemination to farmers towards increased food production and income generation in the area and in Nigeria as a whole. It could also form part of the extension teaching content to guide efficient allocation of limited resources.

Methodology

Study Area

The study was carried out in Kwara State, Nigeria. Kwara State has 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 on Latitudes 7°45′ N to 9°30′ N and Longitudes 2°30′ E to 6°25′ E and shares boundaries with Niger, Osun, Oyo, Ekiti and Kogi States and Benin Republic. 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 Kwarans. The state has a total of registered 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. The map of Nigeria showing the study area is presented in Figure 1.

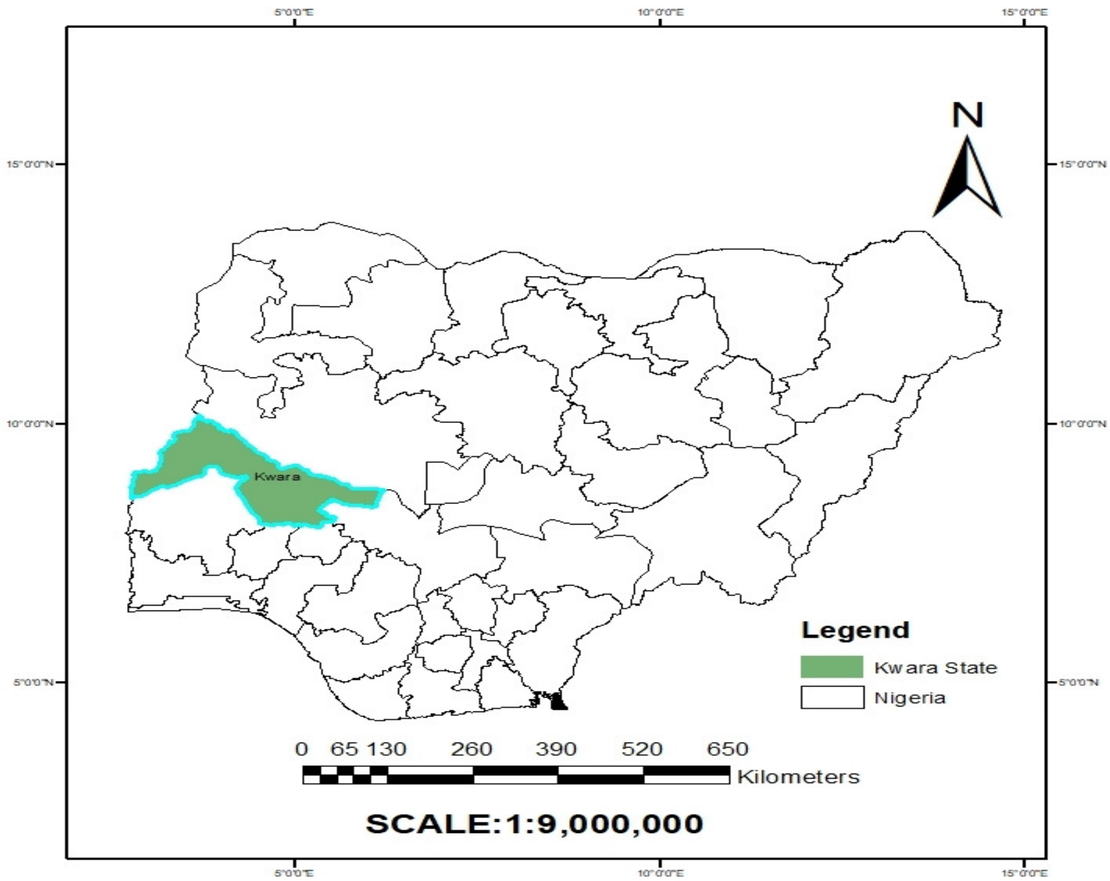

Fig. 1: Map of Nigeria showing the study area

Sampling Procedure and Sample Size

A multi-stage sampling technique was employed for this study. All the cassava-based crop farmers in Kwara State constituted the population for the study. In the first stage, Irepodun, Patigi 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 nine 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 164 cassava-based crop farmers for the study.

Method of Data Collection

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.

Analytical Techniques

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 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.

Farm budgeting model:

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

Where;

$\boldsymbol{\pi}$ = Profit in US Dollar 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

F_k= Cost of fixed inputs per hectare (where k =, 1, 2, 3, …,o fixed inputs).

Linear programming model:

The objective function:

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

Subject to:

$$A_{11}X_1 + A_{12}X_2 + A_{13}X_3 + \ldots. + A_{1n}X_n \leq L_S(\text{Land}) \quad (3)$$

$$A_{21}X_1 + A_{22}X_2 + A_{23}X_3 + \ldots. + A_{2n}X_n - L_t \leq H_t(\text{Hired Labour}) \quad (4)$$

$$A_{31}X_1 + A_{32}X_2 + A_{33}X_3 + \ldots. + A_{3n}X_n - L_t \leq F_t(\text{Family Labour}) \quad (5)$$

$$A_{41}X_1 + A_{42}X_2 + A_{43}X_3 + \ldots. + A_{4n}X_n - M_t \leq C_t(\text{Capital}) \quad (6)$$

$$A_{51}X_1 + A_{52}X_2 + A_{53}X_3 + \ldots. + A_{5n}X_n - E_t \leq S_t(\text{Seed}) \quad (7)$$

$$A_{61}X_1 + A_{62}X_2 + A_{63}X_3 + \ldots. + A_{6n}X_n - B_t \leq F_t(\text{Fertilizer}) \quad (8)$$

$$A_{21}X_1 + A_{22}X_2 + A_{23}X_3 + \ldots. + A_{2n}X_n - K_t \leq A_t(\text{Agrochemical}) \quad (9)$$

and

$$X_1 \geq 0, X_2 \geq 0, X_3 \geq 0, \ldots., X_n \geq 0 \quad (10)$$

Where;

$\boldsymbol{\pi}$ = 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, hired labour, family 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 hired labour in man-day for crop activities in t^{th} period,

F_t= Level of available family labour in man-day for crop activities in t^{th} period,

C_t= Level of available working capital in US Dollar 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 1shows the identified cropping patterns existing in the study area. The results revealed that 34.15% of the farmers in entire study area cultivated cassava as a sole crop, while 65.85% cultivated cassava as crop mixture. Interestingly, the crops cultivated in the study area comprised of tubers, cereals, legumes and vegetables. Fourteen different cassava mixtures were recorded. 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 farmers according to cropping pattern adopted

Cropping pattern	Frequency
Cassava	56 (34.15)
Cassava/Maize	30 (18.29)
Cassava/Melon	12 (7.31)
Cassava/Yam	9 (5.49)
Cassava/Sorghum	10 (6.09)
Cassava/Groundnut	4 (2.44)
Cassava/Soybean	4 (2.44)
Cassava/Yam/Maize	7 (4.27)
Cassava/Maize/Cowpea	6 (3.66)
Cassava/Sorghum/Groundnut	5 (3.05)
Cassava/Maize/Groundnut	4 (2.44)
Cassava/Yam/Melon	3 (1.83)
Cassava/Soybean/Maize	4 (2.44)
Cassava/Maize/Melon	6 (3.66)
Cassava/Maize/Okra	4 (2.44)
Total	164 (100.00)

Note: Figures in parentheses are percentages

Gross Value of Crops in Naira per Hectare in the Existing Plan

The 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. The result shows that cassava as a sole crop has the least output value per hectare which was $534.72. An examination of crops grown under mixed cropping enterprise revealed cassava/yam/maize has the highest output value of $1,261.08 while cassava/maize has the least output value of $739.88 per hectare. This implies that cassava mixed cropping yielded more returns on per hectare basis and could translate to increased income for the smallholder farmers. Further critical examination on why some respondents who are practicing crop mixture and intercropped with legume crops may be due to the fact that, leguminous crops has high ability of improving soil fertility and in turn increase crop yield. Hence little or no cost is committed in purchasing inorganic fertilizer to boost soil fertility, and besides, crops grown in mixture are an insurance against crop failure. This is consistent with the argument of Zhang and Li (2003) that, crop mixture is geared towards improved productivity per unit land area and time, and also impartial and judicious exploitation of land resources and farming inputs including labour.

Table 2: Gross value of crops in US Dollar per hectare

Crop	Value of output ($/ha)
Cassava	534.72
Cassava/Maize	739.88
Cassava/Melon	803.00
Cassava/Yam	938.98
Cassava/Sorghum	799.49
Cassava/Groundnut	831.71
Cassava/Soybean	846.75
Cassava/Yam/Maize	1,261.08
Cassava/Maize/Cowpea	1,120.65
Cassava/Sorghum/Groundnut	1,219.02
Cassava/Maize/Groundnut	1,100.80
Cassava/Yam/Melon	1,062.43
Cassava/Soybean/Maize	1,128.89
Cassava/Maize/Melon	1,016.46
Cassava/Maize/Okra	909.70

Exchange rate: $1 = ₦308.28

Cropping Pattern in the 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 0.4379ha for cassava/maize, 1.0886ha for cassava/soybean and 0.6435ha for cassava/sorghum/groundnut. Interestingly, all the cassava crop activities prescribed in the optimum plan were crop mixtures. This implies that cassava crop mixtures are in better competitive position to yield more and translate to increased income for the farmers than cassava sole cropping in the study area. It is also interesting to note that three major categories of food crop, that is, tuber, cereal and legumes were reflected in the optimum plans prescribed.

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

Cropping pattern	Existing plan (ha)	Optimum plan (ha)
Cassava	0.8400	-
Cassava/Maize	0.9100	0.4379
Cassava/Melon	1.2400	-
Cassava/Yam	1.2300	-
Cassava/Sorghum	1.0100	-
Cassava/Groundnut	0.7800	-
Cassava/Soybean	1.1400	1.0886
Cassava/Yam/Maize	1.0000	-
Cassava/Maize/Cowpea	0.8000	-
Cassava/Sorghum/Groundnut	1.3600	0.6435
Cassava/Maize/Groundnut	1.3000	-
Cassava/Yam/Melon	1.2800	-
Cassava/Soybean/Maize	1.1000	-
Cassava/Maize/Melon	1.0300	-
Cassava/Maize/Okra	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 twelve activities were excluded from the programme. Cassava/yam/maize had the highest shadow prices of $185.21 and was followed by cassava as a sole crop with a shadow price of $145.82. 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. Results also revealed that mixtures cassava/melon, cassava/groundnut, cassava/maize/groundnut and cassava/soybean/maize however had the least shadow prices of $2.95, $13.71, $39.20 and $50.30 respectively. It therefore means that these mixtures are respectively in a better competitive position in the programme as compared to other excluded activities. This further means that cassava/melon, cassava/groundnut, cassava/maize/groundnut and cassava/soybean/maize respectively 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 amounts on a comparative basis.

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

Variable	Reduced Cost
Cassava	145.82
Cassava/Melon	2.95
Cassava/Yam	127.36
Cassava/Sorghum	71.04
Cassava/Groundnut	13.71
Cassava/Yam/Maize	185.21
Cassava/Maize/Cowpea	73.17
Cassava/Maize/Groundnut	39.20
Cassava/Yam/Melon	107.85
Cassava/Soybean/Maize	50.30
Cassava/Maize/Melon	105.29
Cassava/Maize/Okra	53.76

Exchange rate: $1 = ₦308.28

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

The result presented in Table 5 indicated that the net profit in Naira per hectare in the existing cropping plan was estimated to be $635.02. The result from the optimum cropping plan however revealed that the farmers' net profit was $1,078.39. This depicts that there is a 69.82% increase in the optimum plan. The implication of this increment in the optimum plan is that, an average cassava-based crop farmer in Kwara State has the potential to increase and maximize net profit.

Table 5: Net profit ($/ha) in existing and optimum farm plans

Net profit for existing plan ($/ha)	Net profit for optimum plan ($/ha)	Increase in profit over existing plan ($/ha)	Percentage increase
635.02	1,078.39	443.37	69.82

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 were presented in Table 6. The result revealed that land, hired labour, capital and agrochemical were used up by the programme and had shadow prices of $281.29, $1.47, $0.01 and $9.46 respectively. The implication of this is that these resources used up by the programme as presented in Table 6 were the limiting resources in cassava-based cropping system in the study area as they constrained the attainment of the profit maximization objective. Therefore, 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 is consistent with the assertion of Hassan *et al.* (2005) that efficient and full utilization of resources leads to maximization of output. Conversely, family labour, seed and fertilizer were found to be surplus as they were not used up by the programme. The zero shadow prices for these resources imply that they were in excess of the actual requirements to raise the income of the cassava-based crop farmers in the study area. They 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 6: Marginal Value Product of Resources

Resource	Use Status	Slack/Surplus	Shadow price (₦)
Land (ha)	Fully Utilized	0.00	281.29
Hired labour (man-day)	Fully Utilized	0.00	1.47
Family labour (man-day)	Not Fully Utilized	11.90	0.00
Seed (kg)	Not Fully Utilized	163.64	0.00
Capital ($)	Fully Utilized	0.00	0.01
Fertilizer (kg)	Not Fully Utilized	57.02	0.00
Agrochemical	Fully Utilized	0.00	9.46

Exchange rate: $1 = ₦308.28

Conclusion

Apparently, resources were not optimally allocated by the cassava-based crop farmers in Kwara State. The linear programming solution indicated that cassava crop mixtures were in a better competitive position than cassava as a sole crop to raise the income of the farmers in the optimum plans. The LP solution prescribed two two-crop mixtures and one three-crop mixtures for the cassava-based crop farmer. The farmers have the potential to raise their income by adopting the optimum farm plans prescribed in the LP solution. That is, produce the various crop mixtures that fit into the plan based on their hectarage allocation. The government through the relevant agricultural agencies in the Kwara State 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 the farmers.

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