



Gender Differentials and Optimal Combination of Crop Enterprises under Limited Resource Conditions in South Western Nigeria: A Case Study of Cocoa-based Farming Systems

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

This study investigated gender differentials and an optimal combination of crop enterprises in southwestern. Specifically, it described the socio-economic characteristics of households in cocoa-based farming by gender; determine enterprise combinations of households in the cocoa-based farming systems and profile gender participation in optimal farm plan activities in cocoa-based farming systems. A multistage sampling procedure was used to select 200 respondents, comprising 147 males and 53 females. Data were collected on socioeconomic characteristics such as age, household size, years of schooling and year of farming experience among others. Data were analyzed using descriptive statistics and linear goal programming. Descriptive statistics show that majority of the respondents aged above 60 years comprising of 46.5% male and 2% females, married comprising of 69.5% male and 20% female, and had a household size of between 7 and 12 persons, with males accounting for 25.5% and females 12.5%. Most of the respondents had primary

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school education in the study area, with 73.8% male and 26.2% female. Goal ranking showed that food security; increased income; and reduced production cost are the most important goals among farmers in the cocoa-based farming system. The linear goal programming model shows that Cocoa and Banana; Cocoa, Oil Palm and Plantain and Cocoa, Maize, Cassava and Orange are the optimal enterprise combination. It further showed that farmers will incur a cost of N38, 833.56/ha on the three basic activities to achieve the stated goals. The shadow prices for the fully utilized resources were N9348, N1352 and N6.52 for land, hired labour and capital respectively. The result further showed that 67 percent of the goal components was achieved. Percentages of female-headed households in cocoa/banana, cocoa/oil palm/plantain and cocoa/maize/cassava/orange enterprises were 45%, 31% and 0% respectively. For the goals of food security, increased income and reduced farm production costs to be accomplished in the study area, farmers should produce 0.2 ha of cocoa/banana, 1.2 ha of cocoa/oil palm/plantain and 1.25 ha of cocoa/maize/cassava/orange in the study area. Also, conscious efforts should be made by policymakers to ensure gender equality in the access and use of productive farm resources.

Keywords: *Optimal combination; crop enterprises; cocoa based farming systems; Southwestern; gender; linear goal programming.*

1. INTRODUCTION

Cocoa (*Theobroma cacao*) is an important component of smallholder farming system across the humid tropics of West Africa, Nigeria inclusive. This could be ascribed to its contribution to the nation's economy such as the provision of jobs and income to farmers, raw materials to the industries and foreign exchange to the country [1]. Nigeria is the fourth leading exporter of cocoa in the world, after Cote d'Ivoire, Indonesia and Ghana and it accounts for 0.3 percent of the agricultural GDP [2]. However, the discovery of crude oil in the 1970s with the subsequent launch of the Structural Adjustment Programme (SAP) in 1986 as well as economic liberalization policy have negatively affected in cocoa production and the subsequent decrease in its production rate in Nigeria [3]. Cocoa production in Nigeria is now left in the hands of smallholder farmers with an area of one to five hectares per farming household [4]. An average cocoa farmer in Nigeria has a farm size of 2.5ha and produces less than 5 bags of 100 kg per season [5]. Only 3 percent of the cocoa beans produced in Nigeria is used within the country, the remaining are exported or classified as utility [6].

However, decline in cocoa production in Nigeria especially in Southwestern has been traced to declining productivity on individual cocoa farms. This has been ascribed to a number of factors including non-use of improved planting materials, numerous pests and diseases of cocoa, old age of cocoa farms due to non-adoption of research recommendations, gender of household heads,

gender division of labour and old age of cocoa farmers themselves among others [7]. The low productivity associated with the cocoa-based farming systems has negatively impacted on the livelihoods of farming households.

Although both gender are responsible for food production in Nigeria [8], several scholars Larson and Murray [9] and Cadzow [10] established that female farmers have much lower yields than male farmers. The issue of gender differences in productivity has attracted special attention [11-14]. Several factors are responsible for gender differentials in productivity such as access to credits, agricultural inputs, information technology, utilization and among others. The presumption is that women are less economically efficient than men in any agricultural enterprise.

Several studies by several authors [15,16] have separately noted that increasing productivity requires efficiency in the use of available resources in the production processes either through intensification or diversification. Efficiency in the use of available resources is a major pivot for a profitable farm enterprise. Hence, an adjustment in resource allocation is vital to increasing productivity in the cocoa based farming system. Due to the fact that farmers have limited level of resources, they are, however, faced with the problem of myriads of choices for allocating the resources among the different cocoa-based enterprises so as to optimize production objectives by making efficient utilization of the available resources and optimally combining the enterprises.

Regrettably, the enterprise based combination decision among farmers within the cocoa-based farming system is often made by trial and error methods, the outcome of which is usually uncertain [17]. Farmers practice what has been handed down from generation to generation and there is no conscious investigation as to which enterprise would maximize the resources available. This study investigated gender differentials and an optimal combination of crop enterprises in southwestern to increase cocoa productivity in Southwestern Nigeria. Specifically, it describes the socio-economic characteristics of households in cocoa based farming by gender; determine enterprise combinations of households in the cocoa based farming systems and Profile gender participation in optimal farm plan activities in cocoa-based farming systems.

1.1 Conceptual Framework

Farm production planning is a complex process, wherein the input-output relations, the input-output cost price ratios, the available farm natural resources, as well as the farmers' objectives should be taken into consideration [18]. Therefore the problem of production planning could be addressed as a common problem of optimization and allocation of production resources. The theoretical model of the peasant farmer resource allocation has some basic assumptions concerning the objective function of the farmers. These assumptions include the following:

- (i). Farmers are assumed to have specified utility functions.
- (ii). The objectives or goals of the farmer are many, which are conflicting, or not.
- (iii). The objectives, in turn, assumed to be functions of the model decision variables.
- (iv). The objective of production is to achieve satisfactory levels of specified objectives subject to the limitations imposed by the system and the environment.

The mathematical programming as a method chooses between farm enterprises based on determined objective function considering a set of fixed farm constraints, thus representing the objectives of the farm [19]. Optimization is a commonly used approach to solve problems of production planning in the sense of optimal resource allocation given the changing conditions that farms face. Linear programming (LP) is the most often used mathematical programming method, due to its simplified linear and normative

nature. The LP has been introduced by Dantzig in 1947 Lee and Olson [20] and since then it has been successfully used in finding an optimal production plan in different areas, most often with an objective function for maximizing the total gross margin or net income. But it has been argued that there are other goals or objectives of production apart from profit maximization which is often seen as the sole or overriding goal of production. In case of multiple objectives of production, linear goal programming has been used as a multi-objective decision model. Following the resource allocation model of the peasant farmers and considering their multi-objective goals of production, linear goal programming was employed for this study.

2. METHODOLOGY

This section describes the survey location, the sampling procedure and sample size, data collection methods as well as the technique of data analysis.

2.1 Study Area

Southwestern Nigeria was purposively selected based on cocoa-growing zone of Nigeria and constitutes the study area of humid tropics project. The four filed sites are Iwara in Atakumosa East local government, Osun State 004°43'E 07°30'N, Osunwoyin in Ayedire local government, Osun State, 004°16'E 07°31'N, Akindele in Ido local government, 004°43'E 07°36'N and Lagbedu in Ogo-oluwa local government in Oyo State, 004°09'E 07°54'N (Fig. 1). The region is characterized by a tropical humid climate with two major bimodal rainfall distribution patterns with major peaks in July and September. The favourable climate of the area encouraged about 70 percent of the inhabitants to engage in cocoa farming. They generally grow both permanent and food crops. Farmers in the area are predominantly small scale. The climate is ideal for the cultivation of food crops like maize, yam, cassava, millet, plantain and rice which are generally done in combination as mix or intercropping. Cocoa production in Southwestern Nigeria is predominantly carried out by smallholder farmers in an integrated system involving the combination of different enterprises. To identify an optimum enterprise combination within the integrated cocoa farming system, this study adopted a two-pronged approach. The first approach involved the formation of the innovation platforms (IPs) in the four action sites which brought all stakeholders in

the cocoa based farming system together. The stakeholders involved representatives of farmer organizations, private sector (input dealers, agricultural products processors, agricultural product marketers, etc.), NGOs and civil society, governments, research institutes and universities. The Ips played two important roles in the research processes. First, it helped to bridge the gap among stakeholders within the cocoa-based farming systems a situation that contributed to the challenges and constraints by RAISS. Secondly, it ensured stakeholder's participation in the research processes which has the potential to facilitate farmer's uptake of research outputs. The second approach involved a survey of cocoa based farming households to determine the biophysical and socioeconomic characteristics of the farmers as well as the identification of different enterprise combinations practised among farmers in the field sites.

2.2 Sampling Procedure and Sample Size

A multistage sampling procedure was used to obtain data for the study. The first stage was a purposive selection of two states in Southwestern Nigeria (Osun and Oyo State)

where cocoa is dominantly grown, the second stage involved purposive selection of two field sites per state to make four field sites i.e. four innovation platform of humid tropics. The third stage was a random selection of fifty cocoa farmers from the enlisted members of the innovation platform located in each of the field site to give a total of 200 respondents, consisting of 147 male farmers and 53 female farmers. The inclusion of women was to ensure that women are adequately represented in the sample. Data were collected on farmers' socio-economic characteristics such as age, education, gender, household, farm size, among others.

2.3 Analytical Techniques

Data collected were analysed with descriptive and linear goal programming.

2.4 Descriptive Statistics

Descriptive statistics were used to describe gender differences among study variables. It involved the computation of means, standard deviation and percentages.

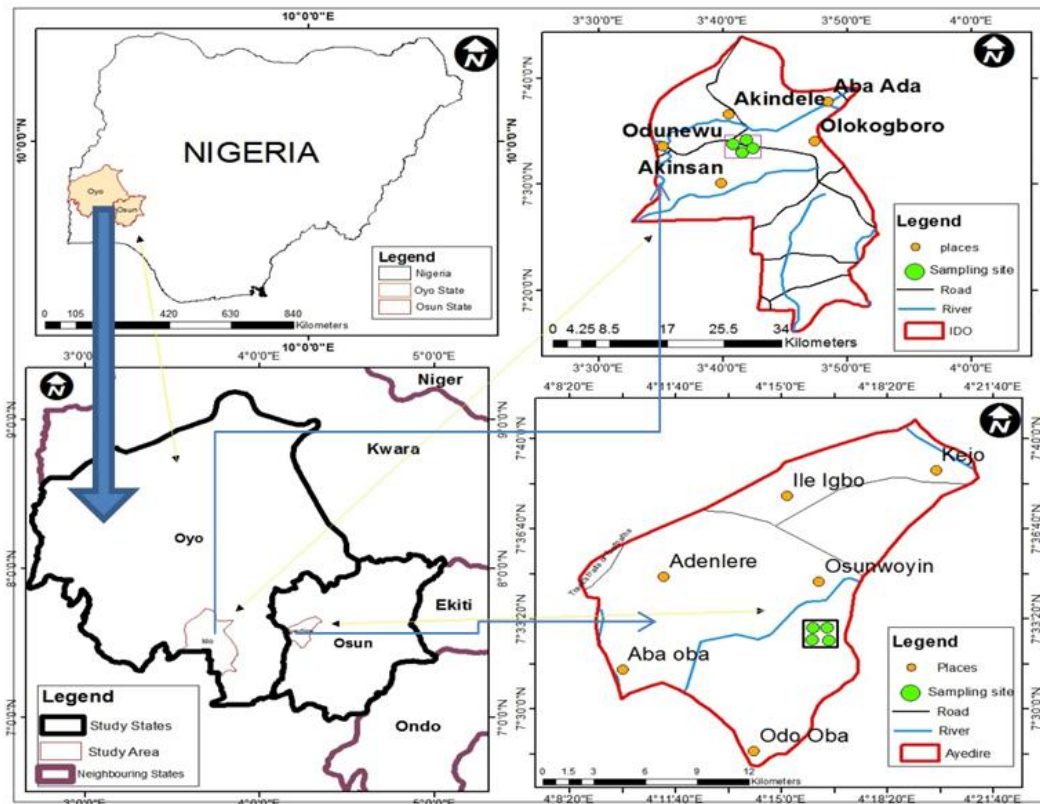


Fig. 1. Map of Nigeria showing the study area

2.5 Linear Goal Programming Model

The general theoretical framework used for analyzing the optimal enterprise combination of cocoa farming households is based on the resource allocation theory. The basic assumptions of the theory about the objective function of the farm households include the following:

1. Households are assumed to have specified utility functions.
2. The objectives or goals of the farm households are many, which are conflicting, or not
3. The objectives, in turn, assumed to be functions of the model decision variables and
4. The objective of production is to achieve satisfactory levels of specified objectives subject to the limitations imposed by the system and the environment.

The theory of production economics is concerned with the optimization of the objectives or goals while optimization implies efficiency [21]. Resource allocation according to Heady (1969) refers to the technical concept of efficiency, which brings about great product to the society from given resources. The Equi marginal principle is the neoclassical economic criterion for efficiency in resources use and allocation in multi-product firm such as smallholder economy. It simply states that, for a multi-product to be said to have allocated its resources optimally among its feasible production enterprises, it must do it in such a way that the Marginal Value Product (MVP) of every variable input is equal in all enterprises in which it is employed and also equal to price of the input.

Mathematically, the equimarginal principle is expressed as:

$$\text{Given a production function } Y_j f(X_1) \quad (1)$$

$$\text{MVP}_{i1} = \text{MVP}_{i2} = \dots = \text{MVP}_{in} \leq P_i$$

$$\text{For all } i, (i = 1 \dots n; j = 1 \dots m) \quad (2)$$

Where,

MVP = Marginal value product of i^{th} input (X) used in the j^{th} product Y and P_i = Unit price of the input i.

Following the above frameworks, the estimation model was developed to determine an enterprise combination for the households is the linear programming model. Goal programming has been found to be a versatile tool for analyzing multi-objective decision-making problems. The concept of goal programming evolved as a result of unsolvable linear programming problems and the occurrence of the conflicting multiple objectives goal. Goal programming is used to manage a set of conflicting objectives by minimizing the deviations between the target values and the realized results. The original objectives are re-formulated as a set of constraints with target values and two auxiliary variables. Two auxiliary variables are called positive deviation d^+ and negative deviation d^- , which represent the distance from this target value. The objective of goal programming is to minimize the deviations hierarchically so that the goals of primary importance receive first priority attention; those of second importance receive second-priority attention, and so forth. Then, the goals of first priority are minimized in the first phase. Using the obtained feasible solution result in the phrase, the goals of second priority are minimized and so on.

A linear goal programming model approach was used to analyze the resource allocation behaviour of the farmers. Linear programming tools find easy application in the optimization problem, where the aim is to maximize or minimize a linear objective function subject to a set of linear constraints. For optimal enterprise combination problem, the linear goal programming is considered appropriate because the farmer is interested in an enterprise combination that maximizes his or her gross margin [22]. Thus, the solution of the linear program matrix represents the profit-maximizing enterprise combination and this solution can be tested for changes in resource availability under alternative enterprise combination. This same technique was utilized by several authors [23,24] to achieve their objectives. The model was also to generate constrained optimal solutions to the resource allocation problem of the farmer. The objective function is to maximize returns (product term of the average yield of an enterprise and its unit price) over variable cost (costs associated with the use of the variable inputs). The linear goal programming model is specified as follows.

$$\text{Maximize Gross Returns } Z = \sum_{j=1}^n C_j X_j \quad [j = 1, 2, 3, \dots, n] \quad (3)$$

Table 1. Tabular representation of the objectives function structure of the basic linear goal programming model for the average farm household

| Objectives of farm production | Goal statement: Achievement of | Objective function statement: To minimize | Deviation variable in objective function | Priority level | Pre-emptive weights |
|--|---|--|---|-----------------------|----------------------------|
| 1. Farm Household Food Security | Minimum expenditure on food | Underachievement | d^- | 1 | 7 |
| 2. Gross Farm Income | Desired level of farm income | Underachievement | d^- | 2 | 5 |
| 3. Limited Cash Expenditure on Material Inputs | Specified level of expenditure on material inputs | Overachievement | d^+ | 3 | 4 |
| 4. Limited Cash Expenditure on Labour | Specified level of expenditure on labour | Overachievement | d^+ | 4 | 3 |

Source: Constructed after field survey by ranking goals and attaching relative weights to them

Table 2. Socio-economic characteristics of respondents

| Variable (%) | Field sites | | | | | | | | | | | | Pooled | | |
|---------------------------|-------------|-------------|---------------|------------|-------------|---------------|------------|-------------|---------------|------------|-------------|---------------|---------------|--------------|---------------|
| | Iwara | | | Akindele | | | Lagbedu | | | Osunwoyin | | | All (n=200) | Male (n=147) | Female (n=53) |
| | All (n=50) | Male (n=37) | Female (n=13) | All (n=50) | Male (n=37) | Female (n=13) | All (n=50) | Male (n=37) | Female (n=13) | All (n=50) | Male (n=35) | Female (n=15) | | | |
| Age (years) | | | | | | | | | | | | | | | |
| 20-29 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 2 | 0 | 0 | 0 | 0.5 | 0 | 0.5 |
| 30-39 | 4 | 4 | 0 | 4 | 0 | 4 | 4 | 2 | 2 | 0 | 0 | 0 | 3 | 1.5 | 1.5 |
| 40- 49 | 10 | 10 | 0 | 14 | 10 | 4 | 6 | 4 | 2 | 10 | 4 | 6 | 10 | 7 | 3 |
| 50– 59 | 40 | 26 | 14 | 22 | 16 | 6 | 26 | 16 | 10 | 24 | 14 | 10 | 28 | 10 | 10 |
| >60 | 46 | 34 | 12 | 60 | 48 | 12 | 62 | 52 | 10 | 66 | 52 | 14 | 58.5 | 46.5 | 24 |
| Mean (SD) | | | | | | | | | | | | | 52.22 (12.52) | | |
| Marital status | | | | | | | | | | | | | | | |
| Single | 16 | 4 | 12 | 12 | 10 | 2 | 10 | 10 | 10 | 4 | 2 | 2 | 10.5 | 4 | 6.5 |
| Married | 84 | 70 | 14 | 88 | 68 | 20 | 90 | 74 | 16 | 96 | 66 | 30 | 89.5 | 69.5 | 20 |
| Household size | | | | | | | | | | | | | | | |
| Below 6 | 18 | 10 | 8 | 24 | 18 | 6 | 12 | 8 | 4 | 10 | 2 | 8 | 16 | 9.5 | 6.5 |
| 7 – 12 | 40 | 28 | 12 | 34 | 28 | 6 | 48 | 32 | 16 | 30 | 14 | 16 | 38 | 25.5 | 12.5 |
| 13 – 17 | 36 | 30 | 6 | 30 | 22 | 8 | 32 | 26 | 6 | 44 | 38 | 6 | 35.5 | 29 | 6.5 |
| 17 – 23 | 4 | 4 | 0 | 8 | 8 | 0 | 6 | 6 | 0 | 10 | 8 | 2 | 7 | 6.5 | 0.5 |
| Above 23 | 2 | 2 | 0 | 4 | 2 | 2 | 2 | 2 | 0 | 6 | 6 | 0 | 3.5 | 6.5 | 0.5 |
| Mean (SD) | | | | | | | | | | | | | 9.64 (5.49) | | |
| Educational status | | | | | | | | | | | | | | | |
| Non-formal | 14 | 8 | 6 | 30 | 16 | 14 | 24 | 14 | 10 | 30 | 16 | 14 | 24.5 | 13.5 | 11 |
| Primary | 46 | 36 | 10 | 40 | 34 | 6 | 26 | 16 | 10 | 48 | 32 | 16 | 40 | 29.5 | 10.5 |
| Secondary | 34 | 26 | 8 | 28 | 26 | 2 | 28 | 24 | 4 | 14 | 12 | 2 | 26 | 22 | 4 |
| Tertiary | 6 | 4 | 2 | 2 | 2 | 0 | 20 | 18 | 2 | 2 | 2 | 0 | 7.5 | 6.5 | 1 |
| Mean (SD) | | | | | | | | | | | | | 28.54 (1.5) | | |
| Farming experience | | | | | | | | | | | | | | | |
| 1 -9 | 4 | 2 | 2 | 6 | 6 | 0 | 4 | 4 | 0 | 6 | 4 | 2 | 5 | 4 | 1 |
| 10 – 19 | 26 | 18 | 8 | 20 | 12 | 8 | 26 | 20 | 6 | 16 | 8 | 8 | 22 | 14.5 | 7.5 |
| 20 – 29 | 20 | 16 | 4 | 26 | 9 | 4 | 13 | 22 | 6 | 34 | 26 | 8 | 26.5 | 20.5 | 6 |
| 30 -39 | 32 | 20 | 12 | 20 | 16 | 4 | 18 | 10 | 8 | 22 | 12 | 10 | 23 | 14.5 | 8.5 |
| 40 – 49 | 4 | 6 | 0 | 14 | 14 | 0 | 14 | 8 | 6 | 14 | 12 | 2 | 11.5 | 10 | 1.5 |
| 50 -59 | 4 | 4 | 0 | 12 | 10 | 2 | 6 | 4 | 2 | 6 | 4 | 2 | 7 | 5.5 | 1.5 |
| >60 | 10 | 8 | 2 | 2 | 2 | 0 | 6 | 6 | 0 | 2 | 2 | 0 | 5 | 4.5 | 0.5 |

Source: Field survey, 2015

Table 3. Basic cropping activities and their land allocation (ha)

| S/No | Basic activity (Enterprise combination) | Land allocation (ha) |
|----------------------|---|----------------------|
| 1 | Cocoa and Banana | 0.20 |
| 2 | Cocoa, Oil Palm and Plantain | 1.20 |
| 3 | Cocoa, Maize, Cassava and Orange | 1.25 |
| Total Land Area (ha) | | 2.65 |

Source: Data Analysis, 2015

Table 4. Resource allocation and use pattern

| Resource | Use status | Slack variable | Shadow price (MVP) |
|--------------|----------------|----------------|--------------------|
| Land | Fully utilized | 0 | 9348 |
| Hired Labour | Fully utilized | 0 | 1352 |
| Capital | Fully utilized | 0 | 6.52 |

Source: Data Analysis, 2015

Table 5. Goal target and attainment in the optimal farm plan

| Goal | Target | Optimal value | Under-achievement | Over-achievement | Degree of attainment |
|--|--------|---------------|-------------------|------------------|----------------------|
| Food Security | 25,855 | 75,870.36 | 0 | 50,015 | Achieved |
| Increased Income | 51,005 | 91,920.79 | 0 | 40,915.79 | Achieved |
| Reduced Production Cost (Hired Labour) | 33,731 | 134,920 | 101,189 | 0 | Not Achieved |

Source: Data Analysis, 2015

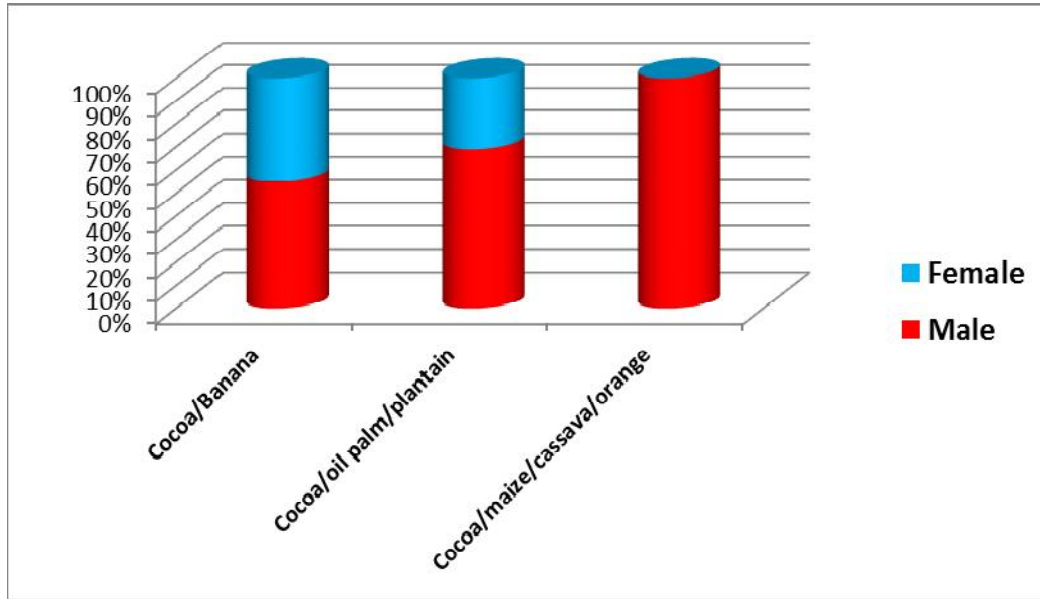


Fig. 2. Gender participation in optimal farm plan activities

Subject to:

$$\sum_{j=1}^n a_{ij}X_j \leq a_i \text{ Land Restriction} \quad (4)$$

$$\sum_{j=1}^n b_{ij}X_j \leq b_i \text{ Labour Restriction} \quad (5)$$

$$\sum_{j=1}^n c_{ij}X_j \leq c_i \text{ Fertilizer Restriction} \quad (6)$$

$$\sum_{j=1}^n d_{ij}X_j \leq d_i \text{ Seed Restriction} \quad (7)$$

$$\sum_{j=1}^n e_{ij}X_j \leq e_i \quad \text{Chemical Restriction} \quad (8)$$

$$\sum_{j=1}^n f_{ij}X_j \leq f_i \quad \text{Livestock feed restriction} \quad (9)$$

$$\sum_{j=1}^n g_{ij}X_j \leq g_i \quad \text{Livestock drug restriction} \quad (10)$$

Where;

Z_i = Objective functions ($i=1$ = Food security; $i=2$ = increased income; $i=3$ = reduced production cost, hired labour); X_j = area under j^{th} crop production activity; C_j = Gross margin per unit of the j^{th} crop activity; a_{ij} = land coefficient for j^{th} crop; b_{ij} = labour requirement for j^{th} crop activity; c_{ij} = fertilizer requirement for j^{th} crop activity; d_{ij} = seed requirement for j^{th} crop activity e_{ij} = insecticide requirement for j^{th} crop activity; f_{ij} = livestock feed for j^{th} livestock activity; g_{ij} = livestock drugs for j^{th} livestock activity; a_i = available land in hectares; b_i = human labour available in man hrs; c_i = available fertilizer in Kg; d_i = quantity of seed available in Kg; e_i = quantity of insecticides available in litres; f_i = quantity of feed available in kg; g_i = quantity of drugs available in litres; n = Number of crop and livestock production activities.

The resources on the farm consist of land, labour, fertilizers, other chemicals and capital. The availability of these resources serves as constraints in the optimization of a feasible plan. Some of these constraints include:

- (i) Land; (ii) Family labour period I; (iii) Hired labour period I; (iv) Family labour period II; (v) Hire labour period II; (vi) Working Capital; (vii) Fertilizers and chemicals.

For the three objectives assumed, the indicators will be as follows:

- (i) The indicator for adequate food expenditure will come from the 2/3 of mean expenditure on food in the study area.
- (ii) The monetary income indicator corresponds to a minimum of the average household expenditure in the study area.
- (iii) The labour saving indicator is represented by desired level of cash expenditure on paid labor in the study area.
- (iv) The minimum expenditure on labour is represented by desired level of cash expenditure on paid labor in the study area.

Major Activities Included in the Model were as follow:

Cocoa and Oil palm; Cocoa and Orange; Plantain and Banana; Cocoa, Oil palm, Banana and Plantain; Cocoa, Orange, Banana and Plantain; Cocoa, Cashew, Oil palm and Mango; Cocoa, Kolanut, Oil palm and Cashew; Cocoa, Cashew, Maize and Cassava; Cocoa, Maize, Yam, Cocoyam and Tomato.

3. RESULTS AND DISCUSSION

3.1 Socio-economic Characteristics of Respondents

The socio-economic characteristics of farmers are shown in Table 2. It shows that the average age of the respondents who were mainly household heads was 52 years. In all, about 58.5% of the respondents aged above 60 years in the Study. A gender analysis of the age structure showed that 46.5% of farmers above 60 years were male and 2% were females. The findings agree with Jibowo [25] assertion that a higher percentage of the rural farming population in most African countries are old. This suggests an ageing farm population and could be connected to the migration of most young people from rural areas to cities in search for white collar jobs [26]. Most of the respondents (89.5%) were married comprising of 69.5% male and 20% female. Respondents were largely married and this may not be unconnected with the desire to have children to help them with farm work and other domestic engagements coupled with the age of the respondents who are mainly household heads. The average household size was (10±5.49). It is important to note that a relatively larger number of farmers (38%) had household size of between 7 and 12 persons, with males accounting for 25.5% and females 12.5%. This reiterates the fact that household is the main supplier of labour available for agriculture in the study area. The result further showed that a larger percentage of the respondents had primary school education in the action site. Out of 80 farmers in this category, 73.8% were male and 26.2% female. This is capable of enhancing the level of management as well as boost farm productivity. The respondents are likely to be more receptive to innovations/improved farm practices introduced to them. The majority (26.5%) of respondents have between 20 and 29 years of farming experience, males accounted for 20.5% and females accounted for 6%. This implies that

majority of the respondents are highly experienced in farming activities.

3.2 Household Enterprise Combination in the Cocoa-based Farming System

The result of goal programming showing the optimal farm plan and the basic enterprise combinations in the cocoa-based farming systems are presented in Table 3. The optimal farm plan was generated under the assumption of cost minimization as the underlying behavioural principle guiding the farmers in their resource use and allocation decisions. Out of the 17 activities (i.e. enterprise combinations) included in the model (cocoa/cherry, cocoa/oil palm, cocoa/plantain, cocoa/orange, cocoa/orange/banana, cocoa/oil palm/banana, cocoa/plantain/banana, cocoa/cashew/mango, cocoa./oil palm/cashew, cocoa/ cashew/maize, cocoa/maize/cassava, cocoa/maize/cassava/tomato, cocoa/maize/cassava/mango and cocoa/kolanut/oil palm/cashew), only three basic activities: Cocoa and Banana; Cocoa, Oil Palm and Plantain; and Cocoa, Maize, Cassava and Orange; entered the programme. The programme value of ₦38, 833.56 shows that for the optimum farm plan to be executed, the farmer will incur a cost of ₦38, 833.56 on the three basic activities. Any attempt made at forcing non-basic activities into the programme will increase the cost of production; hence it is advisable to do away with the non-basic activities.

From Table 3, the average farmer should allocate his resources in such a way that the three crop enterprises are produced according to the land area allocated to each of them. The recommended pattern of land allocation shows that from a total 2.65ha, the land allocation to the most important enterprises in the model is: Cocoa/Banana (0.20 ha), Cocoa/Oil palm/Plantain (1.20 ha) and Cocoa/Maize/Cassava/Orange (1.25 ha). The striking feature of this plan is that there is no sole cropping enterprise included in the model because one could hardly find a smallholder farmer in the study area who practised sole cropping. Also, a larger percentage of the enterprises are tree crops.

3.3 Resource Allocation and Use for Optimal Farm Plan

The resource utilization pattern for the basic cropping activities in the goal programming model is shown in Table 4. All the specified resources land, hired labour, and capital (i.e.

cash on material input) were fully utilized in arriving at the optimal solution. The shadow prices for the fully utilized resources were ₦9348, ₦1352 and ₦6.52 for land, hired labour and capital respectively; suggesting that the cost of production will reduce by ₦9348, ₦1352 and ₦6.52 respectively if additional units of the resources are used.

The marginal opportunity cost (MOC) which signifies by how much the programme value will increase if any of the non-basic activities, which erstwhile did not enter the programme, were forced into the programme was ₦20,135, ₦45,405.84, ₦40,847.80, ₦23,268.75, ₦26,399.42, ₦43,937.49, ₦18,955.40, ₦134,710.67, ₦25,498.14, ₦41,359.10, ₦35,517.96, ₦4,258.43, ₦100,283.33 and ₦9,688.10 for cocoa/cherry, cocoa/oil palm, cocoa/plantain, cocoa/orange, cocoa/orange/banana, cocoa/oil palm/banana, cocoa/plantain/banana, cocoa/cashew/mango, cocoa./oil-palm/cashew, cocoa/cashew/maize, cocoa/maize/cassava, cocoa/maize/cassava/tomato, cocoa/maize/cassava/mango and cocoa/kolanut/oil palm/cashew, respectively. This means that the optimal cost of production will increase by a margin equal to the MOC value of the excluded non-basic activities. The most detrimental of all the excluded activities was cocoa/cashew/mango with an MOC of ₦134,710.67 and the least detrimental was cocoa/kolanut/oil palm/cashew, with an MOC of ₦9,688.10.

3.4 Resource Allocation and Optimization of Farm Household Production Goals

The targeted goals and their degree of attainment in the cocoa-based farming system are shown in Table 5. Of the three targeted goals (food security, increased income, and reduced production cost), two (food security and increased income) accounting for 67 percent of the goal components were achieved, implying that the remaining 33 percent for the goal of reduced production cost was underachieved with large variations. This suggests that given the optimal solution and that the farmers follow the recommended enterprise combinations, a larger percentage the preferred goals of an average farming household in the cocoa-based farming system in the study area would be achieved.

3.5 Gender Participation in Optimal Farm Plan Activities

The percentage of male and female-headed households involved in the basic enterprise

combinations is presented in Fig. 2. The percentages of female headed households in cocoa/banana, cocoa/oil palm/plantain and cocoa/maize/cassava/orange enterprises were 45%, 31% and 0% respectively. This shows that even though men dominated the three basic enterprises in the optimal farm plan, female involvement was notable for two enterprise combinations (cocoa/banana; cocoa/oil palm/plantain) while there was no female involvement in the third crop combination (cocoa/maize/cassava/orange).

4. CONCLUSION AND RECOMMENDATION

The paper shows gender variations in the socio-economic characteristics and optimum plan activities of both male and female farmers. A gender analysis of the age structure showed that 46.5% of farmers above 60 years were male and 2% were females. Majority of respondents are relatively old and have many years of farming experience with large household size. The study revealed that about 58.5% of the respondents aged above 60 years. The majority (26.5%) of respondents have between 20 and 29 years of farming experience, males accounted for 20.5% and females accounted for 6%. This implies that majority of the respondents are highly experienced in farming activities. The study further shows that the best enterprise combinations in the cocoa-based farming system are Cocoa and Banana; Cocoa, Oil Palm and Plantain; and Cocoa, Maize, Cassava and Orange. It further reveals that male cocoa Farmers dominated the three basic enterprises in the optimal farm plan. In the light of the above findings, the paper recommends that crop farmers in South-West Nigeria and by extension in Nigeria as a whole should concentrate and intensify their enterprise combination practices with Cocoa and Banana which is the most efficient and optimal combination enterprise followed by Cocoa, Oil Palm and Plantain and Cocoa, Maize, Cassava and Orange. The paper further recommend that for the goals of food security, increased income, and reduced farm production costs in terms of labour as identified by the cocoa farming households in the study area to be accomplished, they should produce 0.2 ha of cocoa/banana, 1.2 ha of cocoa/oil palm/plantain and 1.25 ha of cocoa/maize/cassava/orange. Also, conscious efforts should be made by policymakers to ensure gender equality in the access and use of productive farm resources.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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