Optimal Plan For Economic Sustainability Of Agricultural Activities Among Rural Women In Kwara State, Nigeria

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Abstract: Agriculture, which is predominantly rural-based sector is very important in the development of Nigerian economy. Women in rural areas mostly engage in various forms of agricultural activities as their livelihoods. For rural women to carry out livelihoods activities continuously, they must have been convinced of the sustainability. Therefore, this study had developed an optimal plan for economic sustainability of agricultural activities among rural women in Kwara State. Interview schedule was used to elicit the needed data from 369 rural women through a two-stage sampling technique and analyzed using goal programming. The result showed that diversification of agricultural activities with emphasis on cassava processing, resulted in the optimal plan for economic sustainability of agricultural activities of rural women. It is therefore, recommended that rural women should focus more on cassava processing as this is the agricultural activities that attained the goal of meeting the minimum income requirement. Also, government should enact policy that would inspire sustainable production of other enterprises to prevent crises in national food security.

Keywords: Optimal plan, Economic sustainability, Agricultural activities, Women

I. INTRODUCTION

Agriculture which is predominantly rural-based is largely the main sector responsible for the growth and development of Nigerian economy. In the years past, the Nigerian economy, as well as of other African nations, was further boosted through increased foreign exchange earnings by the exportation of cash crops such as cocoa, groundnut, kola nut and rubber until the discovery of oil (Olatunji 2015; World Bank, 2005). Despite several bottlenecks experienced after the discovery of oil, agriculture still remains the sustainer of the populace through the provision of the bulk of food and raw materials for the country (Inusa, Daniel, Dayagal and Chiya, 2016). The

rural areas consist of small-scale indigent farmers who engage in agricultural activities, such as crop production, livestock rearing and fish farming amongst others as their main sources of livelihood. Farming is the major activity among rural dwellers. However, apart from farming, households engage in non-farm and off-farm activities in order to make ends meet (Mgbada, 2010; United Nations Conference on Trade and Development (UNCTAD, 2015).

Farming systems that have the ability to maintain their productivity and usefulness to society over time can be described as sustainable agriculture (Nwaiwu, 2013). However, agricultural production, as it is currently, gives cause for concern, as majority of the rural dwellers face

several problems. Some of these problems confronting rural women in carrying out their various production activities are reduced access to agricultural land through contending use of land for modernization and urbanization, land fragmentation, financial inaccessibility and persistently dwindling farm labour. Such problems, according to Adepoju and Obayelu (2013), reduce their productivity.

The role that women play in addition to all other efforts at increasing agricultural productivity and rural development cannot just be ignored. This was affirmed by Mohammed and Abdulquadir (2012) that women efforts cannot be neglected as far as agricultural production in rural area is concerned in Nigeria. Women carry out as much as 70 percent of the work done on the farm and produce 50 percent of all food grown in Nigeria. Women also play crucial roles in processing, household energy supply, marketing and are also not left out in animal husbandry (Ajadi, Oladele, Ikegami and Tsuruta 2015; Sahel 2014; Adenuga and Raji-Mustapha 2013). For the agricultural and related activities of rural women including crop production, processing and livestock rearing to have continued relevance, they must be able to sustain the economic needs of the rural households. Besides, such activities should be able to meet their food security need as well as alleviate the poverty status of rural households. Constantly, from stone age, rural women need and make use of resources in carrying out their agricultural activities. However, these needed resources are continually grossly inadequate to enhance or attain sustainable agricultural activities. Hence, the reason why rural women must embrace planning which, according to Ndip, Molua, Shu and Mbiafeu (2019) results in optimal farm plans which helps farmers to identify appropriate enterprises to embark on (in the farm) and how to allocate resources among these enterprises efficiently. If efficient allocation of resources was done, there would be sustainable agricultural production.

However, previous studies conducted in Nigeria by Oladeebo (2012) and Salome (2014) identified similar constraints of resources inadequacy and this probably contributes to why households in most rural communities live below the poverty line. Therefore, attaining economic sustainability in agricultural activities of rural women may equally be attributed to effective usage of the limited resources at their disposal. Hence, this study had developed optimal plan for economic sustainability of agricultural activities among rural women in Kwara State, Nigeria. Therefore, the specific objectives were to: develop goals for the rural agricultural activities anddevelop optimal plan for economic sustainability of agricultural activities for rural women in Kwara State.

II. LITERATURE/THEORETICAL UNDERPINNING

According to neo-classical economic theory, sustainability can be viewed from the perspective of the maximization of human welfare over time (Harris, 2003). However, Western Sustainable Agriculture Research and Education (Western SARE) (2012) opined that sustainable agriculture diametrically seeks to sustain farmers, resources and communities by promoting farming practices and methods that are profitable, environmentally sound and good for communities. This presupposed that sustainability in agriculture consists of many important aspects of human welfare which include food, clothing, shelter, economy, environment, etc. It is then important therefore, to ask if the agricultural activities of the rural women can take care of their needs in terms of both feeding and income needed for other expenses now and foreseeable future. Similarly, maximization of welfare has been simplified further by attaching it with the maximization of utility derived from consumption. However, sustainability is an economic concept that is valid because according to standard economic theory, maximization of utility from consumption requires efficient allocation of resources (Harris, 2003). The efficient allocation of these scarce resources over a long period of time can therefore, be described as sustainability. This requires that there should be fairness in allocating resources between generations, thus applying the concept of intergenerational equity (Anand and Amartya, 2000).

Intergenerational equity has been interpreted as resources being allocated across generations in such a way that the wellbeing of previous generation is relatively equal to that of present generation and as well the same for future generation. Supposedly, welfare/wellbeing of each generation is equal to the other. Similarly, Solow (1986) felt that when the fact of substitutability is recognized, this leads to the conversion of a matter of simple justice into a question of resource allocation. In this view, wellbeing means being supported by both economic resources and non-economic resources such as income and aspects of peoples' lives, respectively. It therefore, means that sustainability depends on whether stocks of capital that are important, beneficial and essential for people's lives are passed on to future generations. Brown (2008) had explained that as members of the present generation, we hold the earth in trust for the future generations and at the same time, we are beneficiaries entitled to use the benefits from it. In this respect, the principle of intergenerational equity could also be applied to the domain of agricultural activities. Since the principle emphasizes the act of sustaining the goodness inherent in the present and bequeathing same to the future. In this perspective, agricultural activities that promote profitability will be sustained. While, also, transferring same unto the future generations. Spijkers (2018) had posited that what exactly the present people has to offer to future people is what intergenerational equity is all about. Hence, agricultural practices that are profitable, lucrative and sustainable, in the present generation, would be bequeathed to the future generation.

III. THEORY OF PRODUCTION

The role of rural women in production cannot be overemphasized. Such roles involve producing one good or the other in the course of carrying out different agricultural activities. In essence, the rural women's major activity centers on production which can be defined as the process whereby some goods and services that are referred to as inputs are transformed into other goods and services called output. Production is a process due to the fact that it occurs over time; it therefore means that it can be measured as the rate of output

per period of time. The process of production has been known to occur in three aspects, comprising; the amount of goods or services that are produced, the form of goods or services created, and the temporal and spatial distribution of goods or services that are produced (Byrns &Stone, 1984). Hence, production in this study is when the rural women produce different quantities of crops, rear livestock and process their output into different forms of goods over time. The concept of production becomes much clearer when it is being considered in the context of goods. In this case it becomes easier to specify the exact input and also to identify the amount and quality of output. The rural women make use of different types and quantities of input such as seed, fertilizer, feed, raw cassava and animal stock to make different types and quantities of output. According to Gould and Ferguson (1980), production in a general sense, means, the creation of any good or services that people will buy. The act of production requires the usage of human resources and some other inputs such as capital equipment and raw or processed materials. Inputs are also termed sometimes as resources or factors of production (Adegeye and Dittoh, 1982). The production theory has to do with analyzing how entrepreneur combines different inputs to be able to produce a stipulated output in a way that is efficient economically (Gould and Ferguson 1980). In other words, production is the process by which an entrepreneur makes use of fixed and variable inputs in order to produce output.

The production function is the law that relates inputs to outputs. It shows a physical relationship between the input and output which can be expressed in a functional form mathematically as follows:

$Y = f(X_i)$

Where inputs X_1 could be land, labor, management capital or any other factor necessary for the production of the output which is Y. In essence, the relationship between the amount of inputs required to produce a good and the amount of output that is produced is called the production function. The purpose of the production function is to identify and measure the ability of the variable inputs in explaining the variability in outputs (Olayide and Heady, 1982). The production function determines the maximum output that can be produced from a given amount of inputs.

IV. MATERIALS AND METHODS

Kwara State is divided into four Agricultural Zones by the Kwara State Agricultural Development Project (KWADP) in line with the project administrative convenience, cultural practices, and ecological characteristics. The zones are Zone A: Baruteen and Kaiama Local Government Areas; Zone B: Edu and Patigi Local Government Areas; Zone C: Asa, Ilorin East, Ilorin South, Ilorin West and Moro Local Government Areas; and Zone D: Ekiti, Ifelodun, Irepodun, Isin, Offa, Oke-Ero and Oyun Local Government Areas (KWADP, 2010). A two-stage random sampling technique was used for the sample selection. The first stage was proportional random selection of 3% of the villages in each of the four agro-ecological zones in the State making 40 villages out of 1,258 total villages listed in the study area. The second stage involved random selection of 10 rural women in each of the selected villages giving a total of four hundred rural women. However, only three hundred and sixty nine respondents gave sufficient data found useful for this study. Cross sectional data were collected from the rural women involved in agricultural activities using structured interview schedule. This was based on crop and livestock production for the previous season as well as monthly processing activities of the rural women. Goal programming was used to develop the optimal plan for sustainable agriculture among rural women in Kwara State.

V. GOAL PROGRAMMING TECHNIQUE

A. DEVELOPMENT OF GOAL PROGRAMMING (GP) MODEL

The Goal Programming (GP) model was used to develop an optimal plan for sustainable agricultural activities among rural women as adapted from Ibrahim and Omotesho (2011). Goal programming is an efficient tool that allows the decision maker to find feasible and optimal solutions to multiple objectives. Weighted goal programming considers all goals simultaneously in a composite objective function that minimizes the sum of all the deviations among goals and their targets. The deviations are weighted according to the relative importance of each goal for the decision maker (Adejobi, 2004). The Weighted Goal Programming was chosen for this study because it assigns equal priorities to all objectives but attaches weight, which reflect the relative contribution of each objective based on the assumption that rural women's goals of production have equal priorities.

The objective function of the goal programming model was to minimize the cost of production and negative deviations between the target values and the actual values from agricultural activities goals of production that are required by the rural women. The goals for this study were to produce enough food for the family, generate income sufficient for household expenses, to reduce household's poverty level while the constraints were amount of food available for consumption, and the amount of income realized.

The model as follows:

$$\text{Minimize } Z_i = \sum_{i=1}^{g} (\alpha_i n_i + \alpha_i p_i) \dots\dots\dots\dots (1)$$

Subject to

$$\sum_{i=1}^{g} A_{ij} X_j + n_i - p_i = a_i \quad \dots\dots\dots\dots (2)$$

$$\sum_{j=1}^{m} A_{kj} X_j \leq b_k \quad \dots\dots\dots\dots (3)$$

$X_j , n_i, p_i \geq 0$ for all $_j$ and $_i$

Where,

Z_i = Function of objectives that include the total cost of production per unit as well as the negative and positive deviations for the goals, respectively (Adejobi, 2004; Njiti & Sharpe, 1994).

n_i = negative deviation if a_i under achieved,

p_i = positive deviation if a_i is over achieved

$\alpha_{i,}$ = weight or relative importance attached to deviation n_i and p_i.

A_{ij} = matrix of a_{ij}

a_{ij} = marginal contribution of x_j for achieving goal a_i

a_i = aspiration or threshold level for the ith goal

X_j = j^{th} agricultural activity

A_{kj} = coefficient of the use of b_k for the jth agricultural activity

b_k = level of the kth resource available

m = number of resources

g = number of goals.

$n_i * p_i = 0$

The condition ($n_i * p_i = 0$) implies that the product of the deviations must equal zero for any goal. Thus, there cannot be both over and under achievement of a goal simultaneously.

B. WEIGHTED GP MODEL

The major agricultural activities carried out by at least 25% of the rural women were included in the model of Omotesho and Muhammad-Lawal (2010) and was adapted for this study. Such agricultural activities were (maize and cassava production, maize production, sheep/goat rearing and poultry production, as well as cassava processing and shea butter processing). These were indicated as variables $X_1 - X_6$. The coefficient for each production activity in the objective function is the total cost of production per unit of the different production activities which are; hectare, tropical livestock unit, and kilogram. A tropical livestock unit is the common unit for conversion of numbers of livestock and it is based on 250kg weight of cattle.

Daily Goals	Goal Statement	Objective function to minimize	Deviational variable in Objective Function	Priority level	Weight
Meeting the minimum calorie requirement for household per capita	2470kcal/capita	Underachievement	$5d_1^- d_1^+$	1	5
Meeting the minimum vegetable protein requirement for household per capita	30g/capita	Underachievement	$5d_2^- d_2^+$	1	5
Meeting the minimum animal protein requirement for household per capita	35g/capita	Underachievement	$5d_2^- d_2^+$	1	5
Meeting the minimum income requirement for household per capita	₦617.50/capita	Underachievement	$5d_3^- d_3^+$	1	5

Source: Data Analysis, 2018

Table 1: Structure of the weighted goal programming model for calorie, protein and income requirement from agricultural activities

C. GOAL CONSTRAINTS

The goals for the study were meeting minimum calorie requirement, protein requirement and income requirement. The coefficient for each goal in the objective function is the weight attached to that goal. The deviational variables for a specific goal have a coefficient of -1 and +1 for the level of goal under achievement and over achievement, respectively for that specific goal in its goals constraint while other goals have zero as their coefficients. A total of three resource constraints were included in the model. They are land, animal stock, and quantity of raw produce. Inputs such as seed, stem cuttings, fertilizer, herbicide, pesticide, labour, feed and drug were valued to estimate the cost of agricultural activities minimized in the goal programming model used for the study. The gross margin analysis was used to determine the costs and returns of the different agricultural activities. The gross margin presents the difference between the total revenue and the total variable costs (Lunduka and Kelly, 2009). The calorie requirements from different activities were obtained using the proportional distribution of rural women across crop and livestock production. On the other hand, income requirements from different production activities were determined by proportional distribution across crop, livestock and processing activities.

VI. RESULTS AND DISCUSSION

A. THE OPTIMAL PLAN RECOMMENDED

The optimal plan recommended three agricultural activities out of the six agricultural activities that were used in the model; these are maize production, sheep/goat rearing and cassava processing. The programme plan obtained was a minimum cost of ₦35,286.79 on 0.80 hectares for maize production, a minimum cost of ₦1244.81 for 0.15 tropical livestock unit for goat production and a minimum cost of ₦327,060 for 5031kg of raw produce for cassava processing for a year.

Types of Agricultural Activities	Quantity of resources	Minimum cost
Maize production	0.80 ha	35,286.79
Sheep/Goat rearing	0.15 tlu	1244.81
Cassava processing	5031kg	327,060.00

Source: Data Analysis, 2018

Table 2: Optimal Plan for Agricultural Activities among Rural Women in Kwara State

B. ATTAINMENT OF GOALS FOR SUSTAINABLE AGRICULTURAL ACTIVITIES

Table 3 shows the extent of attainment of goals for sustainable agricultural activities. The deviations obtained from the different activities were stated as underachievement and overachievement of the various activities, respectively. All the goals to attain minimum calorie, protein and income requirement were not achieved with the exception of cassava processing which provided the minimum income requirement. All the constraints were tight with no shadow price. This implies that all the available calorie, protein and income provided by the different activities were used up.

Activity	Target	Optimal farm plan	Under achievement	Over achievement	Degree of Attainment
(i) Crop production					
Calorie from maize	4699689	1039875	3659814	0	Underachieved
Protein from maize	74131.5	5996.88	68134.6	0	Underachieved
Income from maize	946041.5	37282.4	908759	0	Underachieved
(ii)Livestock rearing					
Calorie from goat	916265.3	93750	822515.3	0	Underachieved
Protein from goat	86486.75	7312.5	79174.25	0	Underachieved
Income from goat	183104	4675.99	178428	0	Underachieved
(iii) Processing					
Income from cassava processing	389097.7	452488.1	0	63390.4	Overachieved

Source: Data Analysis, 2018.
Table 3: Goals Attainment in Agricultural Activities

VII. CONCLUSION AND RECOMMENDATION

The study concluded that diversification of agricultural activities with emphasis on cassava processing resulted in the optimal plan for economic sustainability of agricultural activities. The optimal plan recommended three agricultural activities; these were maize production, sheep/goat rearing and cassava processing. It was only cassava processing that attained the goals of production of the rural women agricultural activities by overachieving with ₦63,390.40. It is therefore, recommended that rural women focus more on diversifying their agricultural activities such as maize production, sheep/goat rearing and cassava processing but with much emphasis on cassava processing as it contributes greatly to their poverty reduction by meeting the goals of their minimum income requirement. Also, government should formulate policy that would stimulate sustainable production of other enterprises to prevent crises in national food security.

VIII. FUTURE RESEARCH

This study used minimum calorie, protein and income requirements as goals of production. The suggestion for future research is that more goals of production that would capture other dimensions of sustainability could be used.

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