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EVALUATION OF TECHNICAL, ALLOCATIVE AND ECONOMIC EFFICIENCIES OF RUBBER-CASSAVA BASED FARMING SYSTEM IN EDO STATE, NIGERIA

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ABSTRACT

This paper evaluated the technical, allocative and economic efficiency of rubber- cassava intercrop system among smallholder rubber farmers in Edo Sate Nigeria through a survey of 160 rubber farmers in a multi stage, purposive and simple random sampling techniques. Data collected were analyzed using budgetary techniques and stochastic frontier production function analysis. Budgetary analysis reveals an average total cost/ha of ₦93350, ($583.44) with ₦169,560 ($1,059.75) accrues to the farmer as revenue and ₦76210($476.31) as gross margin with a net farm income of ₦70,710($441.94). The rate of return and return per capital invested were ₦1.82 and ₦0.82 showing both viability and profitability of rubber- cassava farming. The Maximum Likelihood Estimate (MLE) of the parameters of the stochastic frontier production function of the sampled farmers revealed that planting materials, agrochemicals, labour and farm size were significantly related with cassava output. The mean technical efficiency (TE) of respondents' was 0.82 with the scope of improving their efficiency by 18%. Education and extension contact were the significant factors that increase the technical efficiency of farmers. The estimates of the parameters of stochastic cost frontier also showed that the cost of planting materials, agrochemicals, depreciation, cost of labour and output were significantly related with cost of production with mean allocative efficiency (AE) of 0.67. Age, education, farming experience and extension contact enhance the allocative efficiency of rubber farmers. The economic efficiency index ranged from 0.18 to 0.85 with the mean of 0.55 indicating wide differentials between the least and efficient farmer with the scope of improving economic efficiency among rubber farmers by 45% in the short-run. Recommendations to improve efficient allocation of resources in a rubber – cassava based farming system have been made in the study in the study.

KEY WORDS: Intercropping, Cassava, Hevea, Stochastic Frontier

INTRODUCTION

Natural rubber takes long gestation period (five to seven years) from planting to the commencement of tapping. Small rubber plantation usually have a spacing of 6.7 x 3.34 m or 6 x 3 m is wide enough for intercropping for at least the first three years of immature period. Intercrops serve a double function. Besides giving farmers additional income and increasing land and labour productivity, they also act as cover crops which can reduce soil erosion. Both food and horticultural crops were able to be intercropped during immature rubber period and had no negative effect on rubber growth. Girth increase is faster in rubber intercrops than in monoculture or sole (International Rubber Research and Development Board, IRRDB, 2007). Monoculture is a land wasted venture and has been found to be a disincentive to farmers who want to adopt rubber and its allied technologies. Effective utilization of the avenues for intercropping has been advocated to put the land under rubber cultivation for maximum benefits. It has been observed that the multiple cropping in the vast inter row of young rubber plantation holds key to attracting small holders to rubber farming.

Empirical evidence suggests wider adoption of rubber-based intercrops in many rubber-producing countries of the world. Rodrigo *et al.*,(2001a) conducted a study on priorities and objectives of smallholder rubber growers and the contribution of intercropping to livelihood strategies in Sri- Lanka and found out that over two- thirds of annual household income derived from on farm activities with 70% of this from intercropping of immature rubber land. Intercropping during the immature unproductive stage of rubber provides one means of addressing the gaps in income suffered by smallholders after replanting or new planting of rubber (Rodrigo *etal.*,2001b).The planting of rubber with food crops has also been reported in Indonesia and Brazilian Amazon forests (Schroth *et al.,* 2004). Esekhade *et al.,* (1996) conducted an on station suitability and economic viability of intercropping in rubber on acid sandy soils of southern Nigeria. The studies found both agronomic compatibility and economic viability of intercropping. The following intercrop combinations: Rubber + cowpea Rubber + melon Rubber + cassava Rubber + maize Rubber + plantain Rubber + pineapple Rubber + yam are popular among rubber farmers at immature phase rubber plantation.

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The focus in the study is the use of cassava in a rubber based intercropping. Cassava (*Manihot esculenta* Crantz), is cultivated throughout the tropics where it is the most important root crop. Efforts to reverse this trend of low cassava production in Nigeria have led to the development of improved cassava production technologies which include the use of improved varieties; herbicides to control weeds, insecticides to control the major insect pests, fertilizers to improve soil fertility, correct spacing for optimum plant population and yield, tractors for land preparation, and proper storage(Emokaro and Erhabor, 2006a). North Central zone of Nigeria is the highest producer with 7 million tonnes, South - South, 6 million tonnes. Benue and Kogi State are largest producer in North Central , Cross River, Rivers Akwa Ibom and Delta dominate the South - South while Edo State is the least with 450,940 tonnes from 5688 ha and Delta State with 695,000 tonnes in 6592 hectares(Emokaro and Erhabor, 2006b). Nigeria is currently the largest cassava producer in the world with estimated annual production of about 40million metric tonnes. About 90% of this is however, consumed as food. The country is yet to fully harness the socio-economic potentials of cassava that would translate to higher ranking of cassava next to petroleum as major contributor to the Gross Domestic Product (GDP).

The study of productive efficiency started with the pioneering works of Michael Farrell in 1957 where three types of efficiency were identified: technical, allocative and economic efficiencies. Technical Efficiency (TE) is the achievement of the maximum potential output from a given quantity of inputs under a given technology. It is the attainment of production goal without wastage (Jondrow *et al.,* 1982; Amaza and Olayemi,2002). Abdourahmane *et al.* (2001) defined economic efficiency as the ability to produce a given level of output using a cost minimizing input ratios. Economic efficiency combines both technical and allocative efficiency. It occurs when a firm chooses resources and enterprises in such a way as to attain economic optimum (Bravo – Ureta and Pinheiro 1997, Ajibefun, 1998). Allocative efficiency has to do with the extent to which farmers make efficient decision by using inputs up to the level at which their marginal contribution value is equal to the factor cost (Adewuyi and Okunmadewa, 2001). Wider application of stochastic frontier production function have been reported in both developed and the developing countries of the world. In Nigeria for instance, Ogundari (2009) conducted study on a Meta analysis of technical efficiency in Nigerian agriculture from 1999- 2008 and reported that out of the 64 studies, 63% were on food crops, 14% cash crops while livestock related studies accounted for 23%. A drop was witnessed in the cash crop sector especially permanent crops such as cocoa, rubber and oil palm which were further corroborated by Central Bank of Nigeria, CBN (2006). Ojo and Imoudu (2000) conducted a comparative study on productivity and technical efficiency of oil palm farms in Ondo State of Nigeria and found out that training of farm settlers increase their technical efficiency than those not trained and concluded that technical efficiency positively correlates with training. Okoye *et al.*, (2006) employed a stochastic frontier cost and production function to measure the allocative efficiency and its determinants in smallholder cocoyam farmers in Anambra State, Nigeria. The result of the analysis showed that the mean allocative efficiency of the farmers was 65% with farm size, fertilizer and credit access significant and directly related to allocative efficiency. Awotide and Adejobi (2006) studied technical efficiency and costs of production among plantation farmers in Oyo State using stochastic frontier production function. The results indicated that the farmers were fairly efficient in the use of resources and greater reduction in cost can be achieved through efficiency improvement.

Considerable researches have been conducted on the natural rubber in the areas of crop improvement and other production innovations in Nigeria (Esekhade *et al.,* 1996; Giroh and Adebayo 2007; Giroh and Adebayo 2009; Mesike *et al.,* 2010), but have not examined the technical, allocative and economic efficiencies of rubber – cassava based farming system in Edo State of Nigeria. A study of this nature is required to bridge the gap in order to examine the efficient allocation of resources in a rubber- cassava based intercropping in immature rubber plantation. This research was therefore conducted to examine the allocative, technical and economic efficiency of rubber-cassava intercrop system among smallholder rubber farmers of Edo State. The specific objectives are to examine cost and return to rubber intercropped with cassava and to evaluate the technical efficiency of the farmers.

METHODOLOGY

The study Area

The study was conducted in selected Local Government Areas of Edo State. Edo State lies between Latitudes 5° 44′ and 7° 34′ N of the equator and between Longitudes 5° 04′ and 6 ° 43′ E of the Greenwich Meridian. It shares boundary to the south by Delta State, in the West by Ondo State and in the East by Kogi and Anambra States (Emokaro and Erhabor, 2006a). The State covers a land area of about 17,902 km^2 with a population of 3,218,332. Edo State is divided into 18 Local Government Areas (NPC, 2006). The State is characterized by a tropical climate which ranges from humid to sub humid at different time of the year. Three distinct vegetation identified in the State are mangrove forest, fresh swamp and Savannah vegetations. The mean annual rainfall in the northern part is 1270 mm to 1520 mm while the southern part of the State receives about 2520 mm to 2540 mm rainfall respectively. Mean temperature in the State ranges from a minimum of 24 ^{0}C to a maximum of 33^0 C. The people of the State are mostly farmers growing a variety of crops such as cassava, rice, yam, plantain, pineapple and tree crops such as rubber, oil palm and cocoa. Other occupations of the State include small and medium scale businesses and jobs done by artisans and civil servants who engage in farming on part time basis (Emokaro and Erhabor, 2006a).

Sampling Techniques

Four Local Government Areas of Edo State were purposively adopted for the study because of their prominent roles in rubber production in the State. The Local Government Areas include Ikpoba Okha, Ovia North East, Ovia South West and Uhunmwode, respectively. The second stage was the compilation of rubber growing villages and farmers involved in rubber production in the selected local government areas. The final stage involved a random selection of 200 rubber Farmers served with interview schedule out of which 160 were returned and used for analysis.

Data Analysis

Data collected were analyzed using descriptive statistics, budgetary technique and the Stochastic Frontier Production Function. The use of the stochastic frontier production function has some conceptual advantage in that it allows for the decomposition of the error term into random error and inefficiency effects rather than attributing all errors to random effects (Xu and Jeffrey, 1998, Ojo, 2008).

It is specified as:

$$Y_i = f(X_i, \beta)\exp(V_i - U_i) \quad \text{(Battese, } et\ al., \text{ 1993)} \qquad (1)$$

Where Y_a = Production of the ith firm X_a = Vector of input quantities of the ith firm β = Vectors of unknown parameters V = Assumed to account for random factors such as weather, risk and measurement error. It has zero mean, constant variance, normally distributed and independent of U. It covers random effects on production outside the control of the decision unit. U = is non negative error term having zero mean, and constant variance(Xu and Jeffrey,1998). It measures the technical inefficiency effects that fall within (because the errors could be controlled with effective and adequate managerial control of the firm), the control of the decision unit (Apezteguia and Garate, 1997). The production technology of the farms was assumed to be specified by the Cobb-Douglas functional form. Bravo-Ureta and Pinheiro(1997) and Ojo (2008) reported that the stochastic frontier models are better estimated using the Cobb- Douglas functional form because of its simplicity and wider use in farm efficiency analyses in both developing and developed countries.

The stochastic frontier production model used is specified as follows:

$$\text{Log } Y_1 = \beta_o + \beta_1 \log X_1 + \beta_2 \log X_2 + \beta_3 \log X_3 + \beta_4 \log X_4 + \beta_5 \log X_5 + V_i - U_i \qquad (2)$$

Where: Y_1 = Output (kg of garri) of the ith farmer, X_1 = Planting materials (number of cassava stems used); X_2 = Agrochemicals (in litres); X_3 = Labour use (in man days); X_4 = Farm size (Hectares); X_5 = Depreciation on fixed cost items (in naira); V and U as previously defined.

The technical efficiency of rubber – cassava intercrop of the ith farm, defined by the ratio of observed production to the corresponding frontier production associated with no technical inefficiency, is expressed by TE = exp $(-u_i)$ so that $0 \leq$ TE $0 \leq 1$ (3)

Variance parameters are: $\sigma^2 = \sigma^2_v + \sigma^2_u$ and $\gamma = \sigma^2_u / \sigma^2$ (4)

so that $0 \leq \gamma\ 0 \leq 1$.

The inefficiency model is defined by:

$$U_i = \delta_0 + \delta_1 Z_1 + \delta_2 Z_2 + \delta_3 Z_3 + \delta_4 Z_4 + \delta_5 Z_5 \qquad (5)$$

Where U_i = Inefficiency effect; Z_1 = Age of farmer (in years); Z_2 = Literacy level (measured in years spent in school); Z_3 = Farming experience (in years); Z_4 = Extension contact (1 contacted, otherwise zero) and Z_5 = Family size (total number of persons in household)

The Stochastic Frontier Cost Function

It is specified as:

$$\text{Ln } C_a = f(P_a, Y_a: \beta) + (V_+ U) \qquad (6)$$

Where C_a = total cost of production of the ith firm P_a = input prices Y_a = Output of the ith firm β = parameters to be estimated V = systematic component which represents random disturbance cost due to factors outside the scope of the firm and U = one sided disturbance term used to represent cost inefficiency and is independent of V. The cost efficiency of an individual firm is defined in terms of the ratio of observed cost (b) to the corresponding minimum cost (c^{min}) under a given technology.

$$CE = \frac{(c^b)}{(c^{min})} = \frac{f(P_a, Y_a: \beta) + (V_+ U)}{f(P_a, Y_a: \beta) + (V)} = \exp(U) \qquad (7)$$

Where CE = Cost efficiency, C^b = the observed cost and represents the actual total production cost and C^{min} = the minimum cost and represents the frontier total production cost or least total production.

Applying Shephard's Lemma, the system of minimum cost input demand equation can be obtained by differentiating the cost frontier with respect to each input price (Bravo-Ureta and Pinheiro, 1997):

$$\frac{\partial C}{\partial P_i} = X_i (P_a, Y_a: \beta) \quad (8)$$

Substituting a farm's input prices and quantity of output in equation (8) yields the economically efficient input vector X_e. With observed levels of output given, the corresponding technically and economically efficient costs of production will be equal to ($X_{it}.P$) and ($X_{ie}.P$) . The cost of farm's actual operating input combination is given by $X_i.P$. The three cost measures can then be used to compute the technical (TE), economic (EE) and allocative efficiency (AE) indices as follows:

$$TE = X_{it}.P / X_i.P \quad (9)$$

$$EE = X_{ie}'.X_i.P \quad (10)$$

$$AE = EE / TE = X_{ie}.P / X_i.P \quad (11)$$

Empirical Stochastic Frontier Cost Production Model

The empirical stochastic frontier cost production model used is specified as follows:

$$LogC_1 = \beta_o + \beta_1 logP_1 + \beta_2 logP_2 + \beta_3 logP_3 + \beta_4 logP_4 + \beta_5 logYi + V_i + U_i \quad (12)$$

Where C_1 = Total production cost (naira) P_1 = Cost of planting stakes (naira) P_2 = Cost of agrochemicals (naira) P_3 = Depreciation cost (naira) P_4 = Cost of labour (naira) Y_1 = Output (kilogramme of garri) of the ith farmer

The inefficiency model is defined by:

$$U_i = \delta_0 + \delta_1 Z_1 + \delta_2 Z_2 + \delta_3 Z_3 + \delta_4 Z_4 + \delta_5 Z_5 \quad (13)$$

Where U_i = Inefficiency effect; Z_1 = Age of farmer (in years); Z_2 = Literacy level (measured in years spent in school); Z_3 = Farming experience (in years); Z_4 = Extension contact (1 contacted, otherwise zero) and Z_5= Family size (total number of persons in household).

The Maximum Likelihood Estimates (MLE) for all the parameters of the stochastic frontier production and cost functions were obtained using the computer program FRONTIER version 4.1c (Coelli, 1996; Ogundari and Ojo, 2007). The model was used to achieve the allocative, technical and economic efficiency intercropping rubber with cassava.

The budgetary technique used for cost and return analysis is the gross margin. The gross margin per hectare, which is the difference between total revenue per hectare and total variable costs per hectare, is expressed by:

$$TR = \sum Q_y P_y - \sum X_i Px_i \quad (14)$$

Where TR= total revenue; G Q_y = output (kg/ha); P_y = unit price of the output (N), Q_yP_y = total revenue derived per hectare, X_i = quantity of the ith input/ ha, Px_i = price per unit of the ith input/ ha, X_iPx_i = total cost associated with ith input /ha and $\sum$= summation sign.

Thus,

$$GM = TR - TVC \quad (15)$$

$$NFI = GM - TFC \quad (16)$$

Where TR = total revenue (₦/ha), TVC = total variable cost (₦ /ha); TFC= total fixed cost (₦ /ha) and NFI= net farm income(₦ /ha)

RESULTS AND DISCUSSION

Cost and Returns to Rubber – Cassava Intercropping

Intercropping of immature rubber plantation may not be for the purpose of only satisfying the household food need or subsistence. The farmers may be interested in selling their outputs to raise income. Thus the farmers' like any other entrepreneur would be interested in the profitability of the intercrop enterprise. For this reason, efforts were made to determine the cost associated with rubber based intercrop and also revenue that accrues to the farmers' efforts. Only the variable cost of production was considered while profitability was measured as the gross margin. Result in Table 1 shows that the per hectare analysis reveals an average total cost of ₦93,350($583.44) with ₦169,560($1,059.75) accrues to the farmer as revenue and ₦76,210($476.31) is left as gross margin with a net farm income of ₦70,710($441.94 . The rate of return (ROR) is the ratio of total revenue to total cost of production. It is similar or identical to the discounted benefit/ cost ratio of a project. This indicates that for ₦1 invested rubber based intercrop, ₦1.82 is made as revenue. The rate of return per capital invested (RORCI) gives the ratio of profit to total cost of production. It indicates what is earned per capital outlay. This is ₦ 0.82 in this study. Both indicators can be multiplied by 100 to convert them to percentage. The RORCI in percentage is then compared with the prime lending rate which stood at 22% to determine the desirability of this venture. The results showed that RORCI is greater than the bank lending rate implying that intercropping rubber saplings with cassava is a profitable business and thus rubber based intercrop is a profitable venture. This result support both viability and profitability of this venture. The result is line with earlier studies conducted in Sri- Lanka, Indonesia and Nigeria (Esekhade et *al.*, 1996; Rodrigo *et al.*, 2001a; Emokaro *et al.*, 2010).

Productivity analysis

The Maximum Likelihood Estimate (MLE) of the parameters of the stochastic frontier production function of the respondents shown in Table 2 which contained the estimates of the parameters for the frontier production function, the inefficiency model and the variance parameters of the model. The variance parameters of the stochastic frontier production function are represented by sigma squared (δ^2) and gamma (γ). The sigma squared in Table 2 is 0.710 and significantly different from zero at one percent level. This indicated a good fit and correctness of the distributional form assumed for the composite error term. Gamma indicates that the systematic influence that are unexplained by the production function are the dominant sources of random error .The gamma estimate which is 0.762 shows the amount of variation resulting from the technical inefficiencies of the tappers. This means that 76.20 percent of the variation in farmers output is due to difference in technical efficiency. This implies that the ordinary least squares estimate (OLS) will not be adequate in explaining the inefficiencies on rubber latex production thereby justifying the specification of a stochastic frontier production. Typical of the Cobb-Douglas production function, the estimated coefficients for the specified function can be explained as the elasticities of the explanatory variables. The sign of the slope coefficients of the stochastic frontier production function are positive. The return to scale (RTS) was found to be 1.655(increasing return to scale) indicating that production is in stage one of the production frontier.

Table 1: Average Cost and return in rubber – cassava based intercropping/ hectare

Variable	Value(₦)	Percentage of Total cost
Cassava stem	9,000.00	9.64
Labour planting	5,000.00	5.36
Weeding	18,000.00	19.28
Cost of implement	5,500.00	5.89
Land clearing	37,500.00	40.17
Harvesting/ processing	7,500.00	8.03
Cost of empty bags	3,000.00	3.21
Transportation	7,850.00	8.41
Total cost	93,350.00	100
Total revenue	169,560.00	
GM(TR- TVC)	76,210.00	
NFI(GM- TFC)	70,710.00	
ROR	1.82(182%)	
RORCI	0.82(82%)	

Source: Field survey, 2011

The production elasticity with respect to planting materials (0.332) is statistically significant at one percent and a critical factor in cassava production. Improved planting materials have the potentials for high yield, early maturity and disease resistance. This result is in line with earlier studies conducted by Eze and Akpa (2010) who reported increase in output of food crops farmers when improved seeds were used. Emokaro and Erhabor(2006b) also reported a significant relationship between improved planting materials and yield among cassava farmers in Edo State. The coefficient for agrochemicals is 0.671 and is statistically significant at significant at one percent. This implies that agrochemicals have a positive and significant influence on the output of cassava. An increase of one percent in the application of agrochemical will result to an increase in output by 0.671 *ceteris paribus*. Labour is also statistically significant at one percent implying that a one percent increase in the coefficient of labour will lead to a 0.226% increase in output. The result of the study is in line with studies conducted which show that labour has been a critical factor in rubber production in Nigeria where production is done manually (Mesike *et al.*, 2009). Farm size measured in hectares has an estimated coefficient of 0.305 and statistically significant at one percent level and a critical factor in rubber – cassava production. A unit in crease in hectare will lead to an increase of 0.305 kg. Farm size has been found to be one of the most important factor of production and critical in the adoption of innovations in agriculture (Awotide and Adejobi, 2006; Ogundari and Ojo, 2007; Mesike *et al.*, 2009).

Determinants of Technical inefficiency among Respondents

The signs and coefficients in the inefficiency model are interpreted in the opposite way such that a negative sign means the variable increases efficiency while positive signs indicated that the variables decrease efficiency. The result of the inefficiency model shows that the coefficients of the efficiency variables with the exception of age, farming experience and family size had the expected signs (Table 2). The coefficients for education and extension contact were statistically significant at one percent respectively while implying that it affected efficiency significantly. Extension contact will lead to increase in the efficiency of the farmers. The implication of this is that increasing the number of contact with extension agents through efficient extension delivery system can bridge the gap between the efficient and inefficient rubber farmers in the study area. Such approaches stimulate farmers' adoption of agricultural technologies which in the long run shifts the farmers' production frontier upward. This result is consistent with the findings of Rahman (2003) and Binam *et al.,* (2004). The estimated coefficient for the age of farmers is positive to inefficiency and is statistically significant at ten percent. This implies that as the farmer gets older, will lead to declining productivity and a reduction in efficiency. Many studies conducted on rubber production revealed the elderly population dominates rubber production in Nigeria. Similarly, the coefficient for farming experience variable is estimated to be positive (0.127) and statistically not significant. A plausible reason for this is that old age and experience are synonymously related leading to a reduction in efficiency

Table 2: Maximum Likelihood Estimate of parameters of Cobb- Douglas Stochastic Frontier Production function for rubber- cassava farming system

Variable	Parameter	Coefficient	T. value
Stochastic frontier			
Constant	β_0	0.081	0.97
Planting materials	β_1	0.332	5.70
Agrochemicals (litres)	β_2	0.671***	3.87
Labour(SMD)	β_3	0. 226***	7.88
Farm size(ha)	β_4	0. 905***	3.62
Depreciation on fixed cost items	β_5	0. 121	1.58
Inefficiency model			
Constant	δ_0	0.309	1.47
Age	δ_1	0.403*	1.72
Education	δ_2	-0.278***	- 9.16
Farming experience	δ_3	0.127**	5.79
Extension contact	δ_4	-0.684*	- 3.78
Family size	δ_5	0.192	- 1.09
Variance parameters			
Sigma squared	δ^2	0.710***	16.73
Gamma	γ	0.762***	17.18

Source: Computer Print Out *** Significant at 1 percent ** Significant at 5 percent

Allocative Efficiency of rubber – cassava production

The Maximum Likelihood Estimate (MLE) of the parameters of the stochastic cost frontier model of the sampled farmers is presented in Table 3. The Table contained the estimates of the parameters for the frontier cost function, the inefficiency model and the variance parameters of the model. The variance parameters of the stochastic frontier cost function are represented by sigma squared (δ^2) and gamma (γ). The sigma squared is 0.146 and significantly different from zero at one percent level. This indicated a good fit and correctness of the distributional form assumed for the composite error term. Gamma indicates that the systematic influences that are unexplained by the cost function are the dominant sources of random error. The gamma estimate which is 0.875 shows the amount of variation resulting from the allocative inefficiencies of the rubber farmers. This means that about 88 percent of the variation among the sampled farmers is due to differences in allocative efficiency. This implies that the ordinary least squares estimate (OLS) will not be adequate in explaining the allocative inefficiencies among rubber farmers thereby justifying the specification of a stochastic frontier cost function.

The estimates of the parameters of stochastic cost frontier model of the rubber farmers as contained in Table 3 were all positive implying that the variables used in the stochastic cost frontier analysis have direct relationship with total cost of cassava production. The cost of cassava production increases by the value of each of the coefficient as the quantity of each variable is increased by one. Also, the estimated coefficients for the specified function can be explained as the elasticities of the explanatory variables which are typical of the Cobb-Douglas production function. The return to scale (RTS) was found to be 1.281 (increasing return to scale) for production cost among the sampled farmers. This suggests that a proportionate increase in all the inputs given their respective prices would result to more than proportionate increase in the production cost of the farmers. The estimated coefficient for cost of planting materials was statistically significant at one percent level. This implies that the variable is a positive and significant factor that influences cost of production among farmers. An increase of one percent in the cost of planting materials will result to an increase in the total cost by 0.127 percent. The coefficient for cost of labour was 0.574 and the highest and statistically significant at one percent. This means that farmers incur more cost of labour in production. Studies conducted by Abolagba and Giroh (2006) identified labour as a major factor in rubber production. The scarcity and high cost of labour was as a result of the fact that the rubber belt corresponds with oil block of Nigeria that offers fat and attractive youths than the rubber industry. The coefficient for cassava output (0.062) is statistically significant at one percent. The implication of this is that rubber farmers incur more cost as output or production of cassava increases. This result is in conformity with the works of Amaefula *et al.*(2010) who found out that

farmers incur more cost when they produce more and result is consistent with apriori expectation. Similarly cost of depreciation and cost of agrochemical were statistically significant and positively related to production among the respondents

Determinants of Allocative inefficiency

The determinants of allocative inefficiency among the farmers are presented in Table 3. The variations in allocative inefficiency of the farmers may arise from managerial decisions, farmers' characteristics, existing technology and other factors. The result of the inefficiency model shows that all the coefficients of the inefficiency variables have the expected signs. The coefficient for family size affects efficiency but not significantly. The estimated coefficient for age of farmers (- 0.187) was negative to inefficiency and is statistically significant at one percent. This implies that as the farmers get older, they become efficient in the allocation of resources in the rubber- cassava production activities. The result is in line with the works of Asogwa *et al.*, (2007) and Asogwa *et al.* (2011a) who found out that older farmers exhibited allocative efficiency in agricultural production in Nigeria. Farming experience (-0.784) and statistically significant at five percent level. The implication is that the more experienced the farmer is, the higher his level of allocative efficiency. This is consistent with the works of Egwu *et al.* (2010) who found positive impacts of farm experience on the efficiency of farmers. The computed value for extension contact was – 0.287 and is statistically significant at one percent and a critical factor that increases farmers' allocative efficiency. Increasing the number of contact with extension agents can bridge the gap between the efficient and inefficient rubber farmers. Regularity in extension visits has been found to enhance farmers' adoption of agricultural technologies which in the long run shifts the farmers' production efficiency upward. This result is in agreement with the findings of Onyeweaku *et al.* (2005) who reported a considerable improvement in the efficiency of farmers when extension visit is regular.

Table 3: Maximum Likelihood Estimate of parameters of Cobb- Douglas Stochastic Frontier cost function for Rubber farmers

Variable	Parameter	Coefficient	T.value
Stochastic frontier			
Constant	β_0	0.241**	2.7
Cost of safety kits	β_1	0.127***	9.80
Fuel and other operational cost	β_2	0.203**	1.89
Depreciation	β_3	0.174***	15.58
Cost of labour	β_4	0.574***	6.64
Output	β_5	0.062***	4.25
Inefficiency model			
Constant	δ_0	0.286***	3.35
Age	δ_1	-0.187	- 11.09
Education	δ_2	- 0.234	- 5.80
Farming experience	δ_3	-0.784**	-2.55
Extension contact	δ_4	-0.287	-6.19
Family size	δ_5	-0.496	- 1.54
Variance parameters			
Sigma squared	δ^2	0.146***	7.42
Gamma	γ	0.875***	4.25

Source: Computer Print Out *** Significant at 1 percent ** Significant at 5 percent.

Technical, Allocative and Economic Efficiencies of Respondents

Efficiency indices derived from the analysis of the stochastic frontier function in respect of the respondents is presented in Table 4. From the Table, the technical efficiency indices showed that 1.87 percent of the respondents fall to the range of ≤ 0.50, 1.25 percent were in the range of 0.51 - 0.60 followed by 4.37 percent (0.61 – 0.70), 16. 25 percent were in the range of 0.71 – 0.80. Majority of the respondents (58.13 percent) had TE in the range of 0.81 – 0.90 while 18.12 percent attained TE from 0.91 – 1.00. Analysis further showed that 31.87 percent of the farmers have technical efficiency (TE) index below the mean figure of 0.82 while majority (68.13 percent) attained TE above the mean. The allocative efficiency (AE) as contained in the table also revealed that 10.63 percent of the respondents fall to the range of ≤0.50, 19.38 percent were in the range of 0.51 - 0.60 followed by 23.13 percent were in the range of 0.61 – 0.70), 31.87 percent were in the range of 0.71 – 0.80 while 14.37 percent (0.81- 0.90). Analysis further showed that 63.75 percent of the farmers have allocative efficiency (AE) index below the mean figure of 0.67 while few (36.25 percent) attained AE above the mean. Further more, the economic efficiency(EE) which is a product of technical and allocative efficiency also revealed majority of the respondents (70%) were in the range of ≤0.50 to 0.70 while the balance of 30 percent (0.71- 0.90). Further more, the analysis showed that 47.50 percent of the farmers have economic efficiency (EE) index below the

farmers incur more cost when they produce more and result is consistent with apriori expectation. Similarly cost of depreciation and cost of agrochemical were statistically significant and positively related to production among the respondents

Determinants of Allocative inefficiency

The determinants of allocative inefficiency among the farmers are presented in Table 3. The variations in allocative inefficiency of the farmers may arise from managerial decisions, farmers' characteristics, existing technology and other factors. The result of the inefficiency model shows that all the coefficients of the inefficiency variables have the expected signs. The coefficient for family size affects efficiency but not significantly. The estimated coefficient for age of farmers (- 0.187) was negative to inefficiency and is statistically significant at one percent. This implies that as the farmers get older, they become efficient in the allocation of resources in the rubber- cassava production activities. The result is in line with the works of Asogwa *et al.*, (2007) and Asogwa *et al.* (2011a) who found out that older farmers exhibited allocative efficiency in agricultural production in Nigeria. Farming experience (-0.784) and statistically significant at five percent level. The implication is that the more experienced the farmer is, the higher his level of allocative efficiency. This is consistent with the works of Egwu *et al.* (2010) who found positive impacts of farm experience on the efficiency of farmers. The computed value for extension contact was – 0.287 and is statistically significant at one percent and a critical factor that increases farmers' allocative efficiency. Increasing the number of contact with extension agents can bridge the gap between the efficient and inefficient rubber farmers. Regularity in extension visits has been found to enhance farmers' adoption of agricultural technologies which in the long run shifts the farmers' production efficiency upward. This result is in agreement with the findings of Onyeweaku *et al.* (2005) who reported a considerable improvement in the efficiency of farmers when extension visit is regular.

Table 3: Maximum Likelihood Estimate of parameters of Cobb- Douglas Stochastic Frontier cost function for Rubber farmers

Variable	Parameter	Coefficient	T.value
Stochastic frontier			
Constant	β_0	0.241**	2.7
Cost of safety kits	β_1	0.127***	9.80
Fuel and other operational cost	β_2	0.203**	1.89
Depreciation	β_3	0.174***	15.58
Cost of labour	β_4	0.574***	6.64
Output	β_5	0.062***	4.25
Inefficiency model			
Constant	δ_0	0.286***	3.35
Age	δ_1	-0.187	- 11.09
Education	δ_2	- 0.234	- 5.80
Farming experience	δ_3	-0.784**	-2.55
Extension contact	δ_4	-0.287	-6.19
Family size	δ_5	-0.496	- 1.54
Variance parameters			
Sigma squared	δ^2	0.146***	7.42
Gamma	γ	0.875***	4.25

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A substantial variation was observed among respondents' technical, allocative and economic efficiencies. The TE ranged between 0.35 and 0.94, with a mean (TE) of 0.82. The implication is that the over all technical efficiency of the sampled farmers could be increased by 18 percent (i.e. 1.00- 0.82) through improvement in the factors that enhance their efficiency like education and extension contact. Also, the allocative efficiency ranges between 0.23 and 0.91 with a mean of 0.67. Allocative efficiency could be improved by 33 percent (1-0.67). Similarly, the economic efficiency indices as contained in Table 4 also revealed wide variation amongst respondents and ranged between 0.18 and 0.85 with a mean of 0.55.These figures indicate that if the average farmer in the sample were to reach the economic efficiency level of its most efficient counterpart, then the average farmer could experience a cost savings of 67.27 percent [i.e. 1-(.18/.55)]. The result suggests that the farmers in the study area are not able to minimize the cost of production as 45 percent of the production costs were wasted relative to the best practiced farms producing the same output facing the same technology in the study area. The implication is that the over all economic efficiency of the rubber farmers could be increased by 45 percent (i.e. 1.00-0.55) through the reduction in production costs that would occur if production were to occur at the allocatively and technically efficient point in the short – run under a given technology. This would enable the farmers to minimize production costs, hence maximizing income and profit. The result is in line with the findings of Amaza and Olayemi (2002) and Asogwa *et al.*, (2011b) who observed in their studies wide variations in farmer- specific efficiency level as a common feature in the developing countries agriculture.

CONCLUSION AND RECOMMENDATION

The study revealed that intercropping of immature rubber with cassava is profitable in the short run as indicated by positive profit margin. The Maximum Likelihood Estimate (MLE) of the parameters of the stochastic frontier production function of the sampled farmers revealed that planting materials, agrochemicals, labour and farm size were significantly related with cassava output while the mean technical efficiency of 0.82. Education and extension contact were the significant factors that increase the technical efficiency of farmers. The estimates of the parameters of stochastic cost frontier also showed that the cost of planting materials, agrochemicals, depreciation, cost of labour and output were significantly related with cost of production with mean allocative efficiency (AE) of 0.67. Age, education, farming experience and extension contact enhance the allocative efficiency of rubber farmers. Considerable variations were also noted in the economic efficiency index ranging from 0.18 to 0.85 with the mean of 0.55 indicating wide differentials between the least and efficient farmer with the scope of improving economic efficiency among rubber farmers by 45%.

Based on the findings in the study it is hereby recommended that government should provide support for extension and training to improve the efficiency of the farmers. Farmers are encouraged to form cooperative societies to enable them access production credit from agricultural and other commercial banks. Government should fund the production of improved planting materials at subsidized rates to promote the adoption of rubber - cassava and other crops combination to encourage farmers' in the production of rubber. Provision of price incentives for cassava should be encouraged by the government through guaranteed minimum price (GMP) to boost production.

Table 4: Frequency Distribution of Efficiency Ratios of Respondents

Efficiency range	Technical Efficiency Freq.	Technical Efficiency Percentage	Allocative efficiency Freq.	Allocative efficiency Percentage	Economic Efficiency Freq.	Economic Efficiency Percentage
≤0.50	3	1.87	17	10.63	54	33.75
0.51 – 0.60	2	1.25	31	19.38	58	36.25
0.61 – 0.70	7	4.37	37	23.13	29	18.12
0.71 – 0.80	26	16.25	51	31.87	17	10.63
0.81 – 0.90	93	58.13	23	14.37	2	1.25
0.91 – 1.00	29	18.12	1	0.63		
Total	**160**	**100**	**160**	**100**	**160**	**100**
Mean	0.82		0.67		0.55	
Maximum	0.94		0.91		0.85	
Minimum	0.35		0.23		0.18	

Source: Computer print out

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