(RESEARCH ARTICLE)

Strategic revamping of natural rubber (*Hevea brasiliensis*) production system: Implications for livelihood sustainability in Delta state, Nigeria

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Abstract

Rubber industry in Nigeria is a source of livelihood to many people (producers and marketers)but a recent trend shows a fast disappearing rubber industry. The economic risks associated with disappearing rubber plantations is a serious challenge to individuals and societies as the natural, social and economic benefits of the industry are gradually eroded. Revamping the rubber plantation will restore and sustain the livelihood of the stakeholders in the industry. This study therefore examined the strategic revamping of the disappearing rubber industry and implications for livelihood sustainability in Delta State, Nigeria. A multi-stage sampling procedure was adopted in selecting 480 respondents for the study. Structured questionnaire was used to collect primary data. Collected data were analyzed with parametric and non- parametric statistical tools. Such as mean percentage, standard deviation, frequency distribution table. Logit regression model was used to analyze the factors that influence farmers' probability to revamp natural rubber production. The finding shows that majority of the rubber farmers (85.38%) were old (51 – 70 years), cultivated between 0.5 and 1.0 hectares (small-scale production with large family size (above 5 persons) About 76.70% of rubber farmers expressed willingness to revamp rubber plantations. Identified livelihood capitals could significantly enhance the possibility of revamping rubber production system. Subsidizing the cost of relevant inputs (seedlings), discovery of foreign markets for rubber and large scale acquisition of land by corporate organization for rubber farming were the significant strategies identified and recommended for revamping rubber industry in Delta state, Nigeria. This study has expanded the frontier of literature on rubber by emphasizing that revamping rubber production has implications for livelihood sustainability for rubber farmers and marketers in Nigeria.

Keywords: Strategies; Revamping; Rubber Farming; Livelihood sustainability

1. Introduction

Rubber (*Hevea brasiliensis*) is a perennial dicotyledonous plant which belongs to the family Euphorbiaceae. It is grown for commercial purpose. It can be harvested for 35 years (Aghimen, et. al 1997). Natural rubber is also called the India Rubber.

It is commonly produced for its latex, a milky colloid (Fig. 1) extracted from rubber tree for industrial uses.Due to its macroeconomic importance, rubber producing nations particularly China,have set their national objective to revamp their rubber sub-sector in order to satisfy their domestic and foreign demands for natural rubber products (Statistica, 2018).

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Global output of natural rubber was 6.8 million metric tons as at 2018 with an increase of more than 13.5 million metric tons over the 2017 figure (Statistica, 2018). Japan ranked fifth in natural rubber production whilethe United States is the world's third largest consumer of natural rubber.

China has a variety of industrial uses of natural rubber such as automobile tyre. China however produces only a portion (1/4) of their natural rubber consumption and import 3/4from other countries. China was expected to scale up the production of natural rubber to 1.4 million metric tons by 2020 (Statistica, 2018).

Figure 1 A natural rubber tree

In Nigeria, rubber estates were established in Delta state, Ondo, Ogun, Abia, Anambra, AkwaIbom, Cross River, Rivers, Ebonyi, Bayelsa States Edo state, Cross River state, Rubber is an important cash crop contributed substantially to the Nigerian economy prior to the oil boom (Aghimien, 1997.Aigbekaen, et. al. 2000; Abolagba, et. al. 2003.). The products serve not only as raw materials for local and foreign industries but also as a source of local revenue and foreign exchange (Ogowewo 1987). Nigeria was the biggest producer of natural rubber in Africa and ranked sixth in the world contributing about 159,264 tons annually (3 percent of the world output) (FAOSTAT, 2017). According to Achoja and Esumai (2019) economic growth and livelihood sustainability are the core objectives for the establishment of rubber industry in Nigeria.Consequently it contributed immensely to the Nigeria economy.Rubber is one of the main agricultural commodities boosting Nigeria's agricultural exports. However there has been a general decline in rubber production in Nigeria over the past two decades both in terms of hectres under cultivation and total output.

Its impact on the fringe communities (neighboring communities) has been noted in different articles, publications and debates (Mihirlal et al. 2014; Abhik et al. 2014; Okuneye et al.1998). Achoja and Esumai (2019), found out that provision of educational facilities (p<0.05)mass influx of people into the host communities (p<0.01) were as a result of establishment of rubber estates. Economic impact of rubber estate on fringe communities were, establishment of auxiliary industries (p<0.01) and provision of employment (p<0.05). The employment and income multiplier index of the rubber estate on fringe communities were computed to be 30.53% and 45.84% respectively (Achoja and Esumai, 2019),.

The shift from rubber production to alternative agricultural enterprises is becoming more pronounced with the ever changing economic and climatic environments that influence agricultural production.

Strategic thinking process leverages on the understanding of the threat of farming business, leading to the identification of the core competencies and capabilities to adequately respond to the opportunities provided by the external environment. The livelihood potentials of natural rubber industry to alleviate poverty of the direct and indirect operators depend on the cumulative effect of livelihood asset pentagon as exemplified by Shivakoti and Shrestha (2005a); and Choudhury*et al* (2005) andShivakoti and Shrestha, (2005b).

This is presented in conceptual framework of Choudhurym *et al* (2005) with certain modifications to suit the specific context of rubber farming systems.
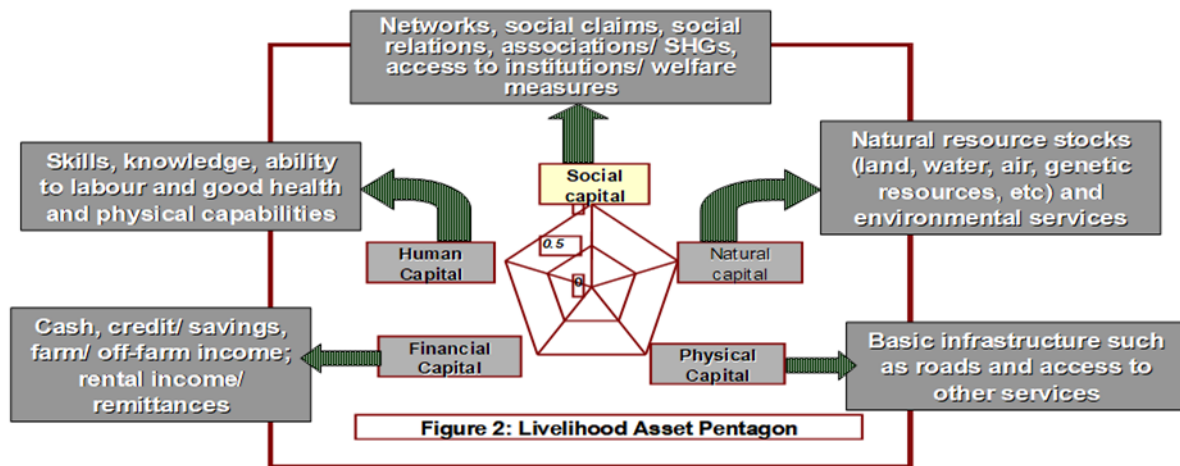
Figure 2 Livelihood Asset Pentagaon

Livelihood sustainability of operators in the natural rubber industry is hinged on 5 pillars of the Livelihood Asset Pentagon(LAP): i.natural capital (stock of natural resources such as land/environmental services for rubber production); ii.physical capital (available basic infrastructures such as marketing facilities for natural rubber products); iii.financial capital (credit/saving institutions for rubber farming systems); iv.human capital (education, skill, health); v.social capital (social relation, Self Help Groups/associations).

Research experts should develop the capacity to investigate livelihood sustainable capitals/factors that are associated with the revamping of the rubber production systems. The ultimate goal is to harmonize with national objective of sourcing for development strategies and programmes to resuscitate the disappearing rubber production systems in Delta State, Nigeria.

Achoja,(2015). has advocated for the sustainability of the natural rubber sub- sector. Despite the fact that much attention and efforts are being devoted to diversification of agriculture, much of the effort is neither sharply focused nor capable of generating a systematic body of knowledge necessary for revamping varnishing enterprises such as rubber plantations (Dabbert and Madden, 1986). adoption of some recommended agronomic practices of natural rubber (Aigbekan *et al*, 2000; Giroh *et al,* 2006 and quality analysis of natural rubber products (Giroh et al, 2007). However, not many studies have addressed the issue of revamping natural rubber plantation, hence the need for the present study.

Given the prevailing poor situation of natural rubber sector in Nigeria, and in Delta state in particular, there is need to carry out comprehensive study that is focused on revamping of natural rubber production by engaging in activities that can to reverse the ugly trend in the rubber industry for the purpose of sustainable livelihood systems -in Delta State, Nigeria. There is virtual absence of empirical information on this all important development issue.

The present study attempts to fill this information gap in Delta state, Nigeria. The study is a useful guide to the government and agricultural policy makers to revamp the rubber industry.

The rubber sub-sector is one of the keys to economic growth and development in Nigeria in terms of employment creation, income generation and poverty reduction. There is no sufficient information that would guide the farmer towards revamping of rubber production systems. The finding of this study is expected to improve the rubber enterprise in Nigeria. The study will be a useful guide to research students and agricultural policy makers in Nigeria (Achoja, 2015).

Thus, investigating the strategies for revamping natural rubber plantation is warranted in view of the potential economic benefits to famers as well as climatic change mitigation.

The main thrust of this paper is to investigate the strategies for revamping natural rubber production system in Delta State, Nigeria.

The specific objectives set for the study were to:

- Describe the socioeconomic characteristics of natural rubber farmers in Delta State, Nigeria;
- examine the willingness of rubber plantation farmers to revamp rubber production systems;
- evaluate the effect of livelihood capitals on the expansion capacity of rubber farmers' in Delta State;
- identify strategies for revamping natural rubber plantation in Delta State; and

The following null hypotheses were tested to guide the study.

- **H_01:** The selected socio-economic factors do not significantly influence farmers' decision to revamp rubber production in Delta State, Nigeria.
- $H_0 2$: Livelihood capital – based strategies have no significant effect on the expansion capacity of rubber farmers' in Delta State, Nigeria

2. Materials and methods

2.1. Area of Study, Sampling Techniques and Data Collection

This study was carried out in Delta State, Nigeria. The area has rainforest vegetation which makes it to be classified as natural rubber production belt of Nigeria. The major occupation of the people is fishing and farming, including rubber farming, while others are involved in petty trading. The area is also suitable for livestock and crop production. Crops grown include: rubber, oil palm, cassava, yam, plantain, maize and vegetables.

A multi-stage sampling procedure was adopted in selecting 240 respondents for the study.. Firstly, the simple random sampling technique was adopted in selecting six (6) local government areas. Second stage involved the selection of four (4) communities in each local government area. Third stage involved the selection of twenty (10) farmers in every selected community. This gave a total of 480 respondents that participated in the survey. However, only LGAs where rubber is produced were purposively sampled for better representation and generalization of the results..Primary data were collected using structured questionnaire which was personally administered to rubber plantation owners in the study area.

Collected data were analyzed with parametric and non- parametric statistical tools. Descriptive statistical tools (mean percentage, standard deviation and frequency distribution table) and Logit regression model were used to analyze the factors that influence farmers' propensity to revamp Rubber revamp decision of farmers was achieved using conditional Logic regression model.

2.2. Data Analysis Techniques

Collected data were analyzed with parametric and non- parametric statistical tools.Descriptive statistical tools (mean percentage, standard deviation and frequency distribution table) and Logit regression model were used to analyze the factors that influence farmers' propensity to revamp to rubber production. The essence of this is that once these factors are identified and managed, they are likely translate to growth in the rubber sub- sector, over time. Direction of preference and the speed of shift towards rubber production, was analyzed, following McFadden and Train, (2000) and Train, (2003) specifications. The probability that the selected farmer would shift to rubber production, was determined by using Discrete Choice Model (DCM).

2.3. Model Specification

Objective 3: determinant of entrepreneurial shift decision was achieved using conditional Logic model with variable that vary over alternative enterprises this is presented below:

$$Pd^k_j = C/(i+e - zij)$$

Where: d_j^k is the dummy variable that identifies alternatives k.

$dj^k = $ 1, if $\begin{cases} j=k \\ \\ 0, \end{cases}$ otherwise

P_{ij} = the probability that a rubber plantation owner will choose to shift to permanent crop (j) or annual crop (i) enterprises. Given the information embodied by index, Zi, C is a constant index.

$$ZIJ = \beta_0 + \beta_I X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 \qquad - \qquad \text{equ. (4)}$$

Where XI........... X6 are the factors influencing farmers revamping of rubber plantation enterprises

Following Bamire and Ola (2004) specification the Logic model further be specified as:

$$\text{Ln } (Pij/CI - Pij) = \beta_1 X_1 + \beta_2 X_2 + \dots\dots\dots\dots\dots + \beta_k X_k \qquad \text{-equ. (5)}$$

2.4. Effect of Livelihood capital – based strategies on the revamping of rubber plantations' in Delta State, Nigeria

Table 1 Description of Symbols of Livelihood capital Variables in Models

Symbols	Description	Measurement
P_{ij}	Decision/willingness to revamp rubber plantation	1, if yes
X_i	enterprises (i)	0, otherwise
X_2	Natural Capital	Likert scale of 1 to 4
X_3	Social Capital	Likert scale of 1 to 4
X_4	Financial Capital	Likert scale of 1 to 4
X_5	Human Capital	Likert scale of 1 to 4
X_6	Physical Capital	Likert scale of 1 to 4

3. Results and discussion

3.1. Socio-economic Characteristics of Rubber Plantation Owners

Table 1 revealed that majority of the respondents (85.38%) who were actively involved in rubber farming were within the age brackets of 51-70 years implying that the farmers are old. This result agrees with the views of Abolagba et al. (2003) who noted that rubber farmers consisted mainly of the aged category. The preponderance of older people in rubber farming profession means that adoption of innovation may be difficult. Labour output of the old farmers might be low due to their declining productivity. The region lies within the oil belt with scare labour resources, with young and energetic youths seeking for jobs in the oil and gas companies in the area.

Table 2 Socio-economic characteristics of rubber farmers (N=84)

Socioeconomic Characteristics	Frequency	Percentage
Age (years)		
21-30	7	3.85
31-40	3	3.46
41-50	4	3.46
51-60	28	56.15
61-70	24	29.23
>70	20	3.85
Gender		
Male	84	100.00
Female	0	0.00

Marital Status		
Married	48	93.85
Single	29	4.62
Widower	6	1.52
Farm Size (ha)		
1-2	40	79.23
3-4	10	15.38
5-6	27	3.08
7-8	7	2.31
Family Size		
1-2	13	13.48
3-4	29	34.52
5-6	37	44.05
7-8	1	0.01
9 and above	4	0.05
Experience (years)		
<10	4	3.85
10-19	36	42.30
20-29	24	28.46
30-39	6	2.31
40 and above	14	3.08
Educational Attainment		
No formal Education	0	0.00
Primary	64	75.38
Secondary	12	17.69
Tertiary	8	6.29

(Source: Field survey data, 2022)

3.2. Gender

Finding in Table 2 shows that all the rubber farmers surveyed (100%) were male and married (93.78%) This is because culture of the people encourages rubber farm inheritance by males. This finding support the earlier report of Swanker (1998) who asserted that non-participation of women in agricultural production activities is based on cultural factors.

Farm size Result in Table 2   reveals that rubber plantations wereon small scale (between 0.5 and 1.0 hectares). Delabarre and Serier (2000) has earlier reported that rubber production in Nigeria is predominantly operated by small-scale farmers. The small hectares might be a disincentive to farmers willingness to revamp rubber production.

3.3. Family Size

About 89.23% of the respondents had a family size 5 people and above. The relatively large family size could be a good source of family labour for the improvement of rubber production systemin Delta State.

3.4. Years of Experience

About 50.77% of the surveyed respondents had a range of 16-35 years of experience in rubber production. This result revealed that rubber farmers in the study areas had long years of experience in rubber production. This finding corroborates Abolagba et al. (2003) and Giroh et al. (2007) that rubber farmers have acquired long years of experience in rubber farming.

3.5. Level of Education

Most of the respondents had attained first school-leaving certificate. And education is a catalyst to the adoption of improved production practices. Thus revamping rubber production systems may be easier as rubber farmers can read and understand technologies easily. The process of rubber production transformation will be easier when farmers are educated. van den Ban and Hawkins 1996) had earlier reported that there is positive correlation between education and adoption of innovation.

3.6. Distribution of Farmers Decision/Willingness to revamp rubber plantation

The distribution of farmers' decision/willingness to revamp rubber plantation is presented in Table .3

Table 3 Farmers Decision/Willingness to revamp rubber plantation

Decision/willingness	Frequency	Percentage
Yes	64	76.7
No	20	23.3
Total	84	100

(Source: Field Survey 2022)

The result shows that majority 76.7% of rubber plantation owners expressed willingness to revamp rubber plantations while minority 23.3% indicated decision to do otherwise.

Table 4 Logit regression of the effect of farmers' socio-economic characteristics on the Revamping of rubber plantation

Variable	Coefficients	Standard errors	Wald	Significance
EXPR	3.1932	1.6323	3.827	0.050*
CST	-4.0658	1.4610	7.744	0.005*
AVL	0.0542	0.4911	0.012	0.912
RSKL	-3.9647	1.2878	9.378	0.002*
MKT	1.1877	1.4775	0.646	0.042*
CLM	-0.6389	1.3122	0.237	0.626
CONSTANT	6.5315	2.5134	6.753	0.009*

Sig* is significant at P< 0.05

$R^2 = 0.824$

The coefficient of determination of 0.834 means that 83.4% change in revamping of rubber plantation is accounted for by the exogenous factors in the model (Table 4).

3.7. Existence of Market (MKT)

Table 4 above there is positive and significant relationship (P ≤ 0.05) between the existence of market for rubber product and the possibility of revamping rubber production system in Delta State, Nigeria.

3.8. Cost of Production (CST)

The cost of required inputs for rubber production has a negative and significant relationship the revamping of rubber production system in the study area, This finding implies that rising cost of factors of rubber production will discourage the revamping of rubber production systems in Delta State, Nigeria.

3.9. Test of Hypothesis

- Farmers willingness to revamp rubber production 76% as shown in Table 2 and the significant relationship socioeconomic factors with their willingness to revamp rubber production, the null hypothesis was rejected and the alternative which states that there is significant relationship between socioeconomic variables of rubber farmers (farming experience, age education and the existence of market) and the revamping of rubber production system, was accepted.
- The alternative hypothesis which state that the identified livelihood capital have individual significant effect on revamping of rubber plantation was accepted.

Indicate the extent to which the following livelihood capitals/assets can influence your (farmers) decision to revamp rubber enterprise in Delta State, Nigeria

Table 5 The extent to which livelihood capitals can influence the revamping of rubber production

Livelihood capital for revamping rubber plantation	Very high extent (4)	High extent (3)	Low extent (2)	Very low extent (1)	Total score	Mean Score	Remarks
Natural capital (land & climate)	140(4) = 560	60(3) = 180	35(2)= 70	5(1) =10	820	3.42	significant
Financial capital (access to credit/savings & off-farm income)	138(4) = 552	50(3) = 150	12(2) = 24\	26(1) = 26	752	3.13	significant
Human capital (labour, health & education)	125(4) = 500	45(3) = 135	40(2) = 80	30(1) =30	745	3.10	significant
Physical capital (basic infra structures such as roads & markets)	120(4) = 480	59(3) = 177	41(2) =82	30(1) = 30	769	3.20	significant
Social capital (membership of cooperative society)	80(4) = 320	50(3) = 150	100(2) = 200	10(1) = 10	680	2.83	significant

(Source : 2022 Survey Data)Note: Mean value ≥ 2.50 is significant extent

The result in Table 5 shows the responses of respondents as to whether the identified livelihood capitals/assets can influence farmers decision/willingness to revamp rubber enterprise in Delta State, Nigeria. The result shows that all the identified livelihood capitals has a mean score that is greater than 2.50. This finding implies that the identified livelihood capitals/assets can influence farmers decision/willingness to revamp rubber production to a significant extent in Delta State, Nigeria. The livelihood assets include access to social capital (belonging to cooperative society), physical capital and investment for improving the human capital asset base rubber farmers. Every livelihood activity including rubber production requires the support of wealth creating assets (livelihood assets or capital). This finding is in agreement with Choudhurym *et al* (2005).This necessarily calls for policy and institutional interventions for ensuring that rubber industry is revamped in Nigeria.

4. Conclusion

The focus of this study was the analysis of strategic revamping of disappearing rubber plantation and implications for livelihood sustainability in Delta State, Nigeria. It was concluded that the rubber plantation owners were mostly the aged people (51 and 70 years) with very few young people to sustain the natural rubber industry. Revamping the

disappearing rubber enterprise will call for the creation of awareness on rubber production among the youths with respect to profit derivable from natural rubber production as an incentive. High Cost of seedlings had negative relationship with decision to revamp rubber plantation in Delta State, Nigeria Expected profit showed positive relationship with the willingness to revamp rubber plantation.

Strategies such as converting the swamps to rubber production, community ownership of rubber estates for rent, government establishment of rubber estates for rent and effective lease arrangement between rubber tappers and rubber plantation owners could revamp natural rubber production in Delta State, Nigeria. The outcome of the study has the potential to bring about improvement to the rubber sub- sector by way of jobs provision for young people thereby helping to solve unemployment and poverty reduction and increase in Gross Domestic Product (GDP) in Nigeria.

Policy recommendations

The following policy recommendations were made:

- Young and educated people should be encouraged to participate in the rubber production system.
- The manual for improved rubber management practices should be made available to interested rubber farmers.
- Government should establish large scale rubber estates and rent same to the youths for management.
- Government policy on revamping of rubber industry should encapsulate livelihood assets such as land, infra structures, education / workshops, credit.

Compliance with ethical standards

Disclosure of conflict of interest

There is no conflict of interest among the authors of this paper.

Statement of informed consent

Informed consent was obtained from all individual participants included in the study."

References

[1]   Abolagba E.O, Aigbekaen E.O, Omokhafe K.O (2003). Farm gate marketing of natural rubber in the southeast rubber growing zone of Nigeria.*Nigeria Journal Agriculture and Rural Development, 6:40-48.*

[2]   Achoja, F.O. and Esumai R.C. (2019)Development Impact of Rubber Estates on Fringe Communities in Nigeria,*Journal of Bartin Faculty of Forestry,* 21(2): 466-477.

[3]   Aghimien C.I (1997). Small Holder Rubber Exploitation: Implication for the Rubber Industry in Edo State Nigeria M.Sc. Thesis, Unpublished University of Benin, Nigeria.

[4]   Mgbekaen E.O, Imarffiagbe E.O, Omothafe K.O (2000). Adoption of some - j recommended agronomic practic9 of natural rubber in Nigeria; *Journal of Agriculture and Fisheries*, l & (2)51, pp.51- 56.

[5]   Dabbert S. and P. Madden (1986): the Transition to organic Agriculture, a Multi-year simulation model of a pennsylicania a farm"; *American Journal of Alternative Agriculture 1*(3) 99-107.

[6]   Giroh D.Y, Abubakar M, Balogun F.E, V Wuranti, Ogbebor O. I. (2006). Adoption of rubber quality innovations among small-holder rubber farmers in two farm settlements of delta state, Nigeria.*Journal of Sustainable Development Agriculture and Environment,* 2:74-79.

[7]   Giroh DY, Ephraim I.J, Fannap D, Igbinosun F.O, Ogwuche P (2007). A qualitative analysis of adoption of natural rubber production technologies among farmers in southern Nigeria; *Journal of Sustainable Tropical Agriculture and Resource, 21,* 11-18.

[8]   McFadden U. and Tram .K (2000) "Mixed MNL models for discrete response (htp:elsa. brekeley. edu/wp/rncfadden/1 98/rn cfaddenhl98.pdj2 "Journal of Applied Econometric voL. 15(5), 447-470.

[9]   Ogowewo, NT.O.C. Ndubizu and A.A Eubuomwakn, (1987); Discussion paper, IRSG London.

[10]   Train, K. (2003) *Discrete Choice Methods with Simulation,* Massachusetts: Cambridge University Press.