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Economics of Smallholder Rubber Production under Different Tapping Arrangements in Delta State, Nigeria

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Abstract
The study examined the Economics of smallholder rubber production under different tapping arrangements in Delta State, Nigeria. The study was carried out in the Central Agricultural Zone of the State. A multistage sampling technique was adopted in the collection of data from 110 respondents. The survey instrument used was a pre-tested structured questionnaire. Both descriptive and inferential statistics and budgetary approach were used in the analysis of the data. The results showed that the rubber farmers were literate and had mean age of about 36 years. Only 3.6% of the tappers owned plantations tapped, while others operated under sharecropping arrangement or leased/rented plantations; and tappers of different categories had, on the average, four years tapping experience. Average plantation size was 1.77 hectares. The mean age of rubber plantations in the area was 35 years. The mean annual output per hectare was found to be 878.92kg of dry rubber (or 2,197.23kg of wet rubber). The mean net income of tappers from tapping per hectare was N288,557.73 per annum (or N9,6185.91 per tapping week of 3 days). The factors found to have significantly accounted for the 76 % variation of yield from the double-logarithmic function were age of tappers, tapping experience, age of plantations, variety planted and size of plantations (number of trees tapped for latex). The study also showed that rubber development was constrained by shortage of tappers, high cost of plantation establishment and long gestation period. The study recommended that unemployed youths should be encouraged to go into rubber tapping to reduce the shortage of tappers and that farmers should be given loans with some period of grace to address the problem of high cost of plantation establishment and the gestation period. Moreover, rubber farmers who lack tapping skills should adopt sharecropping tapping arrangement to ensure their holdings are tapped.

Keywords: Economics, smallholder, rubber, different tapping arrangements, Nigeria

Introduction

Smallholder rubber farmers operating on plantations of ten hectares and below contribute well over 85% of the world's output of natural rubber (IRRDB, 2001; Abolagba *et al*, 2016). In Nigeria, about 62.34% of the total rubber area planted is owned by smallholder farmers (RRIN, 2010 as cited by Agbonkpolor *et al*., 2019). The Board also estimated that some thirty million smallholders and their families are dependent on rubber for their livelihood. Therefore, creating and maintaining a viable smallholder sector will be a critical factor for future production of rubber with attendant benefits to producing countries. From 1983 to 2016, global natural rubber production increased greatly from 4.4 million metric tonnes to about 13 million metric tonnes (International Natural Rubber Study Group, 2017). This global increase in production caused over supply of natural rubber by about 200,000 tonnes per annum for several years (International Natural Rubber Study Group, *ibid*). However, the situation in Nigeria is different; the average annual production between 1995 and 2013 was 73,531.57 metric tonnes (Abolagba *et al.*, 2018) and declined to 53,000 metric tonnes in 2017(International Natural Rubber Study Group, *ibid*). All the same, Nigeria has a great potential to increase output because of the country's favourable agro-climatic condition, existing culture of rubber production and supply of labour (Uche, 2004; Omiji *et al.*, 2016).

Rubber tapping is the process by which latex is collected from rubber trees. The tapping is often carried out under different tapping arrangements: owner tappers who tap their own plantations or employ tappers who tap the trees for a fixed wage, sharecroppers who tap for the plantation owners based on an agreed product sharing formula, and those who rent plantations to tap or operate

under a lease agreement. Giroh and Adebayo (2009) reported that 43% of rubber farmers in Edo and Delta States adopted wage tapping to tap trees for a fixed wage while others adopted sharecropping and rent/lease arrangements. Moreover, Yuniyus, Musa and Yustus' (2020) study on the analysis of improved production practices under smallholder rubber plantation in Nigeria indicated that 57% of the respondents had sharecropping arrangement as the dominant mode of engagement of tappers for latex exploitation.

Several researchers (Giroh *et al*., 2011; Ekunwe and Idubor, 2015) have found rubber tapping to be a viable business in Nigeria. For instance, Ekunwe and Idubor (*ibid*) reported that rubber tapping in Edo State, Nigeria was profitable with a gross margin and net farm income of N162,000 and N149,000 per hectare per annum respectively. However, Giroh and Adebayo (2014) concluded in their research on "Optimal plan in rubber tapping in Southern Nigeria" that the gross margin, kilogramme of dry rubber and cost of production under smallholding rubber production did not reach the farmers' desired level. Available literature indicate that previous studies on the economics of rubber tapping (Mesike *et al*., 2009; Giroh *et al*., 2011; Giroh and Adebayo, 2014; Ekunwe and Idubor, 2015) had not focused on the tapping of rubber under different tapping arrangements. It is important to know how output, cost and revenue as well as profitability vary among the different categories of tappers. It is against this background that the study sought to examine the economics of rubber production under different tapping arrangements in Delta State, Nigeria. Specifically, the following questions were addressed: What are the socio-economic characteristics of the rubber tappers? What are the growers/tappers' output and income from tapping and off tapping activities? What are the effects of the tappers' characteristics and the plantations' features on the output of rubber? What are the tappers' perceived problems of the natural rubber industry? It is likely that the results of the study could be beneficial to plantation owners, tappers, rubber research institutes and policy makers in deciding on the most effective and efficient tappers to engage in the exploitation of latex in natural rubber plantation.

Methodology

Study Area

The study was carried out in the Central Agricultural Zone of Delta State of Nigeria. The Zone is made up of eight Local Government Areas (LGAs): Ethiope East, Ethiope West, Okpe, Sapele, Ughelli North, Ughelli South, Udu and Uvwie. The Central Agricultural Zone of Delta State formed a good study area because it accounts for about 59% (69,000 hectares) of improved and unimproved rubber plantations in the State. Delta State is also known to have about 117,300 hectares of rubber holdings out of 265,867 hectares in Nigeria represents 44.1% as at 1998 (NTCDU, 2006). Farming is a major occupation in the rural areas of Delta Central Agricultural Zone. The main cash crops grown are rubber and oil palm. On the average, about 50% of the arable land is under rubber production (Aweto, 2000). But most of the rubber trees were planted between 1950 and 1965, and are owned by individual farmers operating small holdings of less than 10 hectares (Ojemeruaye, 2004).

Sampling Techniques

A multi-stage sampling technique was used in the data collection. Four LGAs (Ughelli North, Ughelli South, Ethiope East and Ethiope West) were purposively selected for the study. The criteria used were dominant functioning rubber plantations, proximity to the nurseries established in two locations in the study area, and geographical distribution in Delta Central Agricultural Zone. From each LGA, four rubber growing communities/villages were randomly selected from the comprehensive list produced at the LGA level. In each village, proportional random sampling was adopted to select the number of growers/tappers who then completed the questionnaire since the selected villages had unequal number of functioning plantations. On the whole, 120 respondents were selected from the study area.

Survey Instrument

Data were collected by means of a well-structured questionnaire on the characteristics of farmers and rubber farming, and plantation development in terms of area under production, new plantings and replanting carried out in the past. The respondents were also required to supply information on: Average number of trees tapped per day and total trees in their holdings in order to determine the proportion of holdings being tapped for latex, average weekly output (in kilogrammes of wet lump) per tapping household, wage payment system of rubber tappers, cost of renting or leasing a plantation, off-farm activities engaged, income from tapping and other activities, price of rubber (previous and current years), and perceived constraints to the development of the rubber small holder sector. The researchers worked with four research assistants, who were staff of the Agriculture Department of the LGAs covered, in administering the questionnaire. The research assistants were given a small sum of money as an incentive and as compensation for the time dedicated to collect data. Out of the 120 copies of the questionnaire administered to the respondents, five were not returned; five were rejected on account of non-completion of some relevant portions, leaving 110 copies as usable for data analysis. The response rate of the respondents to the survey instrument was therefore 91.67%.

Data Analysis

Data obtained were collated on a spread sheet and analysed using a variety of analytical tools. Descriptive statistics such as frequency distribution, mean and percentages were used to: (a) describe the socio-economic characteristics of rubber growers/tappers like age, tapping experience, size of farm, average number of trees tapped per day, wage payment, sex distribution, level of education, etc. (b) determine the proportion of plantation holding being tapped for latex. (c) estimate

growers/tappers output and income from tapping and off tapping activities, and (d) describe the constraints of rubber development under small holdings. The budgetary approach involving gross margin analysis as adopted by Ekunwe and Idubor (2015) was used to determine the net income of the respondents from rubber tapping as follows:

Gross Margin (GM) = Total Revenue – Total Variable Cost ..... (1)
Farm Net Income = GM – Total Fixed Cost …. (2)

Various econometric functional forms were employed while carrying out the multiple regression analysis to determine the influence of some characteristics of the farmers and rubber farming on yield of rubber in terms of wet lumps (kg) tapped per week. The dependent variable was output of rubber measured in kilogrammes (kg) of wet rubber lumps; the form in which the product was sold to merchants by the tappers. The yield figures were converted to dry weight based on the average dry rubber content (DRC) value of 40-45% obtained from functioning rubber factories in May, 2016 in the study area. The lower limit was used in the yield estimate for conservative purpose. In estimating the annual yield of the tappers, average weekly production figures were multiplied by 30 (the average number of weeks rubber is tapped per annum after accounting for rainy days and 'rest' period per week) as adopted by Ushadevi and Jayachandran (2001). This was done because the farmers did not have records of annual yields aggregated from weekly production figures. The independent variables for the study were age of farmers, age of the plantations, tappers' experience, variety planted, area of plantation tapped (measured in terms of average number of trees tapped per day), etc. The double-logarithmic function, square-root, semi-logarithmic, quadratic and inverse functions were fitted to the collated data as suggested by Olayemi (2004) for empirical data involving approximation of productivity functional forms. The lead regression equation; Double log, was finally chosen based on the R^2 values of the different models and the signs of the coefficients of the regressors in relation to *a priori* expectation. The postulated linear relationship between the dependent and the explanatory variables based on the double-log function is as expressed thus:

$$LnY = b_0 + b_1 \ln X_1 + b_2 \ln X_2 + b_3 \ln X_3 + b_4 \ln X_4 + b_5 \ln X_5 + b_6 \ln X_6 + ... + In_{10} X_{10} + e \ldots . (3)$$

Where,
Ln = Natural logarithm,
Y = Yield (in kg of wet rubber lump per week,
b_0 = intercept,
b's = the regression coefficients for the equation,
X_1 = Sex (1 = Male, 0=female),
X_2 = Planting material (improved clones = 1; otherwise, 0),
X_3 = Training in tapping (Yes=1; No = 0),
X_4 = Category of Tapper (dummy variable – Sharecropper = 1, otherwise 0),
X_5 = Tapper's experience (in years),
X_6 = Age of plantation trees (in years),
X_7 = Number of trees tapped per day (as a proxy of size of holding),
X_8 = Fertilizer applied(in Kg),
X_9 = Labour utilization (number of persons engaged),
X_{10} = Tapper's age (in years), e = error term.

The computer-based Statistical Package for Social Sciences (SPSS 26.0) was used for the statistical analysis. An F-test was then applied to the fitted equations after regression which provided an overall test of significance of the regression results. This was followed by the test of the individual regressors for statistical significance using the student's t – distribution. Furthermore, the adjusted Coefficient of Multiple Determination (R^2) was calculated which provided explanation on the proportion of the variation in the dependent variable, output of rubber (Y) explained by variations in the independent variables, Xs.

Limitation
The plantation owners/tappers lacked appropriate records on yields, labour utilization, income, etc. The amount of and reliability on information supplied by the respondents therefore depended on their remembering capacity and capability. It is, however, believed that this limitation did not have effect on the result of this study since most information solicited were for operations carried out on weekly basis that the respondents can easily remember or provide estimates close to reality.

Results and Discussion
Socioeconomic characteristics of rubber tappers
About 86.0% of the tappers were males, indicating that rubber tapping was dominated by males. On the average, a typical rubber tapper is about 35 years. The finding about the average age of tappers agrees with those of Giroh *et al*. (2006) indicating an average age of 36 years for non-resident tappers in the Rubber Research Institute of Nigeria's rubber estate. Both rubber growers and tappers were literate; about 87% of tappers had at least Junior School Leaving Certificate. This is consistent with the findings of Giroh *et al* (*ibid*) as well as Giroh *et al*. (2011) which indicated that a typical rubber grower or tapper was literate. Furthermore, about 36.4% of the tappers were engaged in tapping alone; others (63.63%) combined different activities with tapping. The tappers must be engaging in activities other than tapping to enhance their earning capabilities to have improved standard of living. Therefore, encouraging tappers to be involved in off-tapping activities is necessary, though some may argue that such strategy might compound the problem of low supply of tappers since enhanced income from other sources might facilitate tappers' withdrawal from tapping. This may be true, but under proper guidance, off-tapping income could be channeled into plantation establishment as it is the case with income diversification strategies of rubber farmers in Indonesia (Penot, 2004). Three categories of tappers were found to

exist in the study area, though majority (55.5%) was share-croppers. Owner tappers constituted 7.3% while about 37% were tappers on rented or leased plantations. The sharing ratio between the grower and tapper was mostly 1:1 which was adopted by majority of the growers. However, the ratio of 3:2 to the tappers and the plantation owners respectively was common in some localities. The finding about the prevalent sharing ratio of about 1:1 is in agreement with the results of other studies (Chew, 2001; Uche, 2004; Yuniyus, Musa and Yustus, 2020) which indicated a sharing percentage of about 50 between growers and tappers. This means that majority of the plantations may remain untapped whenever the share croppers withdraw their services. On **a**verage, plantation size was 1.77 hectares, with 98% being less than two hectares.

The average age of the rubber trees was 35 years. This means that majority of the smallholdings were over-aged and therefore due for replanting since the economic life of rubber trees is between 25 and 30 years (Uche, 2004). The finding about the average age of rubber trees in the study area was not surprising. Socfinco (1989), based on the data from the rubber sector survey of 1988, estimated that 72% of the rubber small holder plantings in the then Bendel State were over 30 years. Only about 44.5% of the plantations of sampled growers were planted with improved varieties. Others were planted with unimproved clonal materials. This agrees with the observations of the Giroh and Adebayo (2014) that most of the smallholders' plantings in Nigeria had been with unselected seedlings giving low yields of about 300 - 500kg per hectares per annum.

Tapping System Adopted

The results of the analysis of the tapping system adopted by the tappers indicated that only 8.2% of the tappers adopted the improved tapping system like third daily as recommended by the International Rubber Research Development Board (2001). Majority of the tappers (87.3%) adopted alternate daily system. This differs from the findings of Giroh *et al*. (2011) which indicated that 37% of the respondents adopted alternate daily tapping. The system of tapping adopted possibly came out of the tappers' experience that rubber trees tapped daily do not produce as much latex as the ones tapped every other day. Only about 49% of the tappers had received formal training on tapping from estate plantations where they had once worked (Table 1).

Latex Processing

All the tappers processed the latex obtained into wet lumps. The latex was usually mixed with rubber scraps and allowed to coagulate in a large bowl to form rubber lumps. This process is called "dishing" by the tappers in the study area. The tappers did not roll the coagulated latex to form rubber sheets, nor smoked the rubber lumps before selling. The lumps were usually gathered and sold after 3 or 4 tapping days to rubber processors via rubber merchants. The average time taken for tapping and related works by a tapper was estimated as follows: Tapping took 2 hours 30 minutes, collection of latex was one hour 30 minutes and about 30 minutes was used for 'dishing'.

Output distribution according to categories of tappers

Table 3 shows that the yield of the tappers ranged between 50kg and 150kg of wet rubber lump per week, with a mean of 98.14kg. This translates to an annual yield per tapper of 2,944. kg (based on 30 tapping weeks) or mean annual dry rubber output per tapper of 1177.68kg. This was satisfactory compared with the average annual yield of 1073.7kg dry rubber (or 2,684.25 of wet rubber) obtained from non-resident tappers in RRIN estate plantation near Benin City, Nigeria (Giroh *et al* , 2006). However, the mean output per week varied according to the category of tappers. The tappers leased or rented plantations produced most, followed by the share croppers, with the yield of 113.72kg and 91.10kg per week respectively. The average *owner* tapper had an output of 72.0kg per week of wet rubber lump.

Productivity of Rubber Tappers

The productivity of the tappers was considered in terms of number of trees tapped per day, proportion of the plantation tapped and output per tapper per hectare.

***Number of trees tapped per day*:** The number of rubber trees tapped per tapper per tapping day ranged between150 and 400 with a mean of 251. About 79 % of the sampled tappers tapped between 200 and 300 trees per day. The tappers tapping less than 200 trees and more than 300 trees constituted 11.8% and 9.1 % of the respondents respectively (Table, 4).

***Proportion of area of holdings tapped*:** Only about 1.34 hectares out of the mean rubber holdings size of about 1.77 hectares were tapped weekly. This represents about 77% of the size of the functioning holdings. Therefore, about 23 % of the plantations' size in the study area was left untapped.

***Output per hectare*:** The mean output of the tappers per hectare per week was 73.24kg of wet lump (Table 3), equivalent to 18.31kg of dry rubber per week of 3 tapping days or about 6.0kg per tapping day. The yearly mean output was 878.9kg of dry rubber per hectare per farmer.

Rubber Farm Gate Price, other Costs and Farmers' Income

***Farm gate price and other costs*:** The farm gate price of wet rubber lump as at May, 2016 ranged between N225 and N240 per kilogramme, with a mean of N 232.50. This was found to be higher than the farm gate price for the product in the preceding year which ranged between N180 and N210 per kilogramme. In almost all the cases, the nature of wage payment was share-cropping arrangement. The mean cost of renting or leasing a plantation from growers by tappers was N75,894.74 per annum. Payment could be made monthly or annually but the latter was more prevalent. The yearly payment was preferred by growers since it guaranteed the annual

income from their rubber holdings. But it limits the number of holdings that could come under tapping since many tappers may have difficulty in raising such money. The researchers observed that the holdings of some growers were abandoned and left untapped because of high cost of renting plantations.

***Annual Net income from rubber tapping*:** Table 5 shows the rubber production economics on per annum basis. On average, a rubber tapper earned a total revenue and net revenue of N510, 855.98 and N288,557.73 per hectare per annum respectively from rubber tapping. However, mean annual income per hectare varied according to the category of tappers. The tappers on rented or leased plantations had the highest mean annual net income per hectare of N319,027.01 followed by the sharecroppers. The owner-tappers had the least mean annual net income per hectare of N177,776.05.

***Relative Share of Different Sources of Tappers' Income*:** The relative share of different sources of tappers' income is presented on Table 6. A large portion of the tappers' average weekly income (65.3%) was obtained from rubber tapping. The second major contributor was the tertiary sector made up of bike riding and trading (18.1 %). The contributions of arable/livestock farming and causal labour were 9.7% and 6.9 % respectively. The data presented indicated that the higher the income group, the lower the share of tapping in the total weekly gross income of tappers with enterprise combination.

Regression analysis of determinants of rubber yield

The estimates of the variables and the R^2 value for the lead regression equation (Double log) are presented in Table 7. The regression results indicated that all the independent variables in the function were statistically significant except sex of the respondent and labour input (in man-days). The adjusted Coefficient of Multiple Determination (R^2) was about 72% and significant at 1% level. The R^2 value of 0.7168 for the double-log function implies that about 72% of the total variation in rubber output in the study area was explained by the explanatory variables - age of tappers, tapping experience, etc. The variables were therefore influential in the determination of output level under small rubber holdings in the study area. The remaining 28% was residual and this could have been due to sampling error and other factors not investigated. The testing of the coefficients of regressors showed four variables: age of tappers, age of plantations, tapping experience and quantity of fertilizer applied, to be statistically significant at 1%. Other variables, number of trees tapped per day, variety planted, being a share cropper were significant at 5%. This meant that the variables used in the analysis played a significant role in explaining the variation of rubber output in the study area. The coefficients of age of plantations and age of tappers were both negative. This indicated an inverse relationship between the independent variables and rubber output implying that output per hectare decreased with the age of the trees in the plantations. This is consistent with production theory which puts the economic life of rubber trees between 25 and 30 years, beyond which output become reduced (Uche, 2004). Therefore, old plantations should be replanted with improved materials so as to increase plantation yield. The inverse relationship between age of tappers and output meant that the productivity of rubber tappers decreased with age, as tappers grew older, their output deceased. This result is consistent with the findings of other researchers in Nigeria which indicated a declining productivity of aging farmers (Onyenweaku and Nwaru, 2005; Giroh and Adebayo, 2009). The coefficient of tappers' experience was positive. This indicated a direct relationship between tapping experience and output, and is in consonance with a priori expectations that farmers with more years of farming experience are more efficient. The result also agrees with the works of Giroh and Adebayo (2009) whose study showed a positive relationship between farming experience and technical efficiency in rubber latex production in Edo State of Nigeria.

Constraints to the development of rubber industry in the study area

What the rubber farmers considered to be the main constraints to the development of the small holdings are presented in Table 8. About 82% of the respondents considered shortage of tappers as the greatest constraint to the development of the small rubber holdings in the study area. Other constraints identified include high cost of plantation establishment and unwillingness of family members to support the replanting of old plantations with new improved clones, possibly due to the desire to put such land to the cultivation of arable crops. These results agree with the work of Abolagba *et al*. (2016) as well as Agbokpolor *et al*. (2019) on the perceived constraints of the rubber industry by rubber farmers in Nigeria.

Conclusion

The results of the study indicated that rubber tapping in the study area was profitable. Overall, tappers had net revenue of N288,557.73 per hectare. However, tappers operating under lease arrangement had net revenue of N319,027.01 higher by about 11% than the average tapper, followed by those under sharecropping deal. The owner tappers had the least revenue per hectare. The relative share of income from different sources showed that tapping of rubber contributed about 65%. Rubber plantation development was constrained by shortage of tappers, high cost of plantation and unwillingness of family members to support replanting of over-aged trees. It is recommended that unemployed youths should be trained and encouraged to go into rubber tapping, especially under lease arrangement or sharecropping to reduce the shortage of tappers and that farmers should be given loans with reasonable moratorium to address the problem of high cost of plantation establishment and the long gestation period, considered to their major constraints.

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Table 1: Socioeconomic characteristics of rubber tappers

Variable	No	%	Mean	Min.	Max.
Sex(Male)	94	85.45			
Tappers' age(years)			35.08(7.85)	18	52
Experience in tapping (years)			4.16(2.12)	1	11
Education up to Junior School	96	87			
Qty. of fertilizer applied(kg)			5.13(4.00)	1	10
Area of holding(hectares)			1.77(0.51)	0.5	3.2
Area tapped (hectares)			1.34(0.47)	0.2	1.7
Labourers engaged			1.45(0.42)	1	3
No of trees tapped/day			251(53.45)	150	400
Man-days /annum			197.57(51.4)	196	200
Age of trees tapped (years)			34.91(8.29)	10	50
Tappers with formal training (Yes)	54	49.10			
Holdings with improved varieties	49	44.45			
Enterprise Combination(Yes)	70	63.63			
Categories of tappers:					
Owner	8	7.27			
Share cropper	61	55.45			
Renter/Leasee	41	37.28			

Source: Survey data, 2016. Figures in parentheses are standard deviations

Table 2: Distribution of tappers according to adopted tapping system

Type of Tapping	Number of Tappers	%
Daily	5	4.5
Alternate daily	96	87.3
Third daily	9	8.2
Total	110	100.0

Source: Field survey, 2016

Table 3: Output of rubber according to nature of tapper

Output	Owner		Share-cropper		Renter/lease		All	
(kg)/week	No	%	No	%	No	%	No	%
50-75	4	50	22	36.07	0	0.00	26	23.64
76-100	4	50	31	50.82	25	60.98	60	54.55
101-125	0	0.0	5	8.20	7	11.48	12	10/91
126-150	0	0.0	3	4.92	9	21.95	12	10.91
Total	8	100.0	61	100.00	41	100.00	110	100.00
Mean /tapper/wk	72.00		91.10		113.72		98.14	
Mean/hectare	53.73		67.99		84.87		73.24	

Source: Field survey, 2016

Table 4: Frequency distribution of trees tapped per day

Number of trees	Number of tappers	%
Less than 200	13	11.8
200 – 300	87	79.1
Above 300	10	9.1
Total	110	100.0

Source: Field survey, 2016

Table 5: Rubber production economics (Per Annum)

Variable	Owner tapper	Sharecropper	Leasee/Renter	All
Wet Rubber output(Kg)/tapper	2,160.00	2,733.12	3,411.51	2,944.29
Wet Rubber Output(Kg)/Ha	1,611.94	2,039.64	2,545.90	2,197.23
Price(₦)/Kg	232.50	232.50	232.50	232.50
Total Revenue(₦)/ Ha	374,776.05	474,216.30	591,921.75	510,855.98
Cost/ Hectare				
Labour	147,000.00	147,000.00	147,000.00	147,000.00
Others	50,000.00	50,000.00	125,894.74	75,298.25
Total Cost	197,000.00	197,000.00	272,894.74	222,298.25
Net Revenue (₦)/ha	177,776.05	277.216.30	319,027.01	288,557.73

Source: Computed from survey data, 2016

Table 6: The relative share of different sources of income (percentage)

Income Range (₦)	Tapping	Arable Farming	Casual Labour	Trading	Bike Riding	Total
Less than 10,000	70.9	29.1	0.0	0.0	0.0	100
11000 - 15,000	65.7	13.6	13.1	3.1	4.5	100
16,000 - 20,000	64.5	4.5	0.0	18.7	12.3	100
Share of Total	65.3	9.7	6.9	10.1	8.0	100

Source: Computed from Survey Data, 2016

Table 7: Regression estimates of the Determinants of Rubber Yield

Variable	Coefficient	St. Error	t	P>|t|
Sex	-0.0451	0.0432	-1.04	0.300
Variety planted	0.0613	0.0281	2.18	0.032**
Training	0.0605	0.0362	1.67	0.097*
Share cropper	0.1176	0.0603	1.95	0.050**
Tapper's experience	0.2177	0.0651	3.34	0.001***
Tree age	-0.1578	0.0541	-2.91	0.004***
Trees tapped	0.1656	0.0811	2.04	0.044**
Fertilizer	0.1081	0.0190	5.69	0.000***
Labour utilisation	0.0343	0.0466	0.74	0.464
Tapper's age	-0.1442	0.0357	-4.03	0.000***
Constant	4.6261	0.2217	20.86	0.000***
Diagnostics statistics			F(9,100)=31.65	Prob>F=0.000
R-squared				
D-W Statistic	0.7168			
	1.761			

Source: Computed from survey data, 2016. * Significant at 10 % level; **Significant at 5 % level, *** Significant at 1 % level

Table 8: Constraints to the development of small rubber holdings in the study area

Constraints	Number of respondents	%
Shortage of tappers	90	81.8
Unwillingness of family members to Support replanting of holdings	85	77.3
High cost of establishment	85	77.3
Long gestation period	82	74.5

Source: Survey data, 2016