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Assessment of cocoa farms and rehabilitation techniques in Bong, Lofa and Nimba countries (Liberia)

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Abstract

Despite increasing cocoa farms in Liberia, farmers still producing cocoa below expected. Our assessment the influences causing the adoption of cocoa farm rehabilitation techniques in Bong, Lofa, and Nimba countries. Data was collected through interviews using a structured questionnaire and analyzed using descriptive statistics, correlation coefficient, and logistic regression. The result revealed that farmers were old with a mean age of 50 years; 54.7 % have been into cocoa production for at least twenty-five years, while 75.3 % of the cocoa farms more than twenty-five years ago. The correlation coefficient showed that farm size and years of farming experience were significant factors affecting the adoption of cocoa farm rehabilitation techniques. In addition, the source of finance and availability of information were essential factors that determine the probability of adoption.

Results show that cocoa rehabilitation has resulted in more pods per tree but a lower cocoa production for 2021. Regardless, cocoa rehabilitation has resulted in significant increases in the value of cocoa sales for the years 2021, 2020, and 2019 and has not (yet) translated into changes in food security or the estimated value of household assets. The absence of relevant farmers' and non-governmental organizations (NGOs) in providing workshops, credit facilities, and input delivery systems and adopting proven technologies have reduced cocoa production.

Keywords: Rehabilitation Techniques; Cocoa; Bong; Lofa; Nimba; Liberia

1. Introduction

Cocoa (*Theobroma cacao* L) is a significant cash crop source for many smallholder farmers in the forest regions of Liberia. Ninety percent of worldwide cocoa production comes from smallholdings [4], and most of this production occurs in areas of high biodiversity. As a tropical rainforest country endowed with about 50 % of West Africa's natural rainforest, Liberia continues to have a growing number of cocoa farms, especially in the form of smallholder farming. Even though these smallholder cocoa farms continue to be a source of livelihood for many rural households, productivity remains constrained by factors such as the aging of trees, poor statuses of farms, inappropriate agronomic practices [1]. However, in recent years, many institutions, including IFAD, USAID, World Bank, have intervened with supports such as rehabilitating existing farms in major cocoa belts in Liberia, expecting to improve productivity. The government of Liberia (GOL) has also expressed high priorities in improving smallholder cocoa farms in Liberia. For

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instance, based on achievements and lessons learned from the IFAD co-financed Smallholder Tree Crop Revitalization Support Project (STCRSP) in Lofa County, GOL, through the Ministry of Agriculture (MOA), has requested extension projects to support the smallholder cocoa and coffee subsectors, to improve the livelihoods and climate change resilience of rural households [5].

Increased cocoa production must sustain institutional efforts such as the cocoa rehabilitation program and improved chupon regeneration. Although cocoa accounts for less than 5% of Liberia's export earnings, it employs some 10,000 households [3]. Liberia's agricultural sector has contributed immensely to rural development, industrial materials, food security, and consciousness of measures to increase cocoa production, which accounted for a significant contribution to the national export, improved standard of living, and poverty reduction [7]. For sustainable food production and balance of payment surplus, the Liberian government has acknowledged issues of the improvement of the cocoa sector instead of depending solely on rubber production for national development by embarking on institutional efforts, such as the Central Agricultural Research Institute (CARI), cocoa rehabilitation techniques, and among others [2].

2. Material and methods

Our study referenced Bong, Lofa, and Nimba countries and a multistage random sampling technique employed in data collection. We purposively selected three local cocoa areas (LCAs) randomly chosen from the cocoa region known for high cocoa production out of the ten (LCAs) producing cocoa areas in the country. We collected data with the use of a structured questionnaire. The data collected includes, among others, the socio-economic characteristics of the respondents, the level of awareness of cocoa rehabilitation techniques, extension visits, and the level of adoption of cocoa rehabilitation techniques. The understanding and adoption level was measured by considering the number of strategies the farmers were aware of after adoption into low, medium, and high adoption. Adopting not more than two techniques was deemed insufficient; adoption of between three and four is medium, while adoption of more than five techniques was high [6].

Data were analyzed using statistical reference tools such as correlation coefficient and logistic regression. We used descriptive statistics to explore the personal and socio-economic characteristics of the respondents. The correlation coefficient acknowledged the significant relationship between the respondents' socio-economic factors and the level of adoption of cocoa rehabilitation techniques. At the same time, binary logistic stepwise regression determines the probability of adopting cocoa farm rehabilitation techniques.

The binary logistic regression model stated as follows:

$$\text{Logit}(p) = b_0 + b_1 x_1 + b_2 x_2 + \ldots b_n x_n$$

p = probability of adoption of innovation

$b_1 - b_n$ = logistic regression coefficients.

B_0= constant term.

$x_1 - x_n$ = independent variables.

logit information is defined as the log odds

$$Odds = \frac{p}{1-p} = \frac{\Pr obability\ of\ adoption}{\Pr obability\ of\ non-\ adoption}$$

$$\text{logit}(p) = in\ [\underline{p}]$$

$$[1\text{-}p]$$

Where in = natural logarithm.

3. Results and discussion

3.1. Personal and Socio-Economic Characteristics

Table 1 Socio-economic characteristics of respondents

Age	**Number of respondents**	**Number of %**
21 - 30	8	4.0
31 - 40	20	13.0
41- 50	35	30.0
51 - 60	37	40.0
Above 60	20	13.0
Mean Age: 50 years		
Sex		
Male	100	80.0
Female	20	20.0
Marital status		
Single	4	2.0
Married	112	96.0
Widowed	2	1.0
Separated	2	1.0
Household size		
1 – 5	30	30.0
6 – 10	60	60.0
Above 10	30	30.0
Mean = 8.0		
Education level		
No formal education	50	40.0
Adult literacy school	20	15.0
Primary education	25	20.0
Secondary education	20	15.0
Tertiary education	5	10.0
Cocoa farming experience (years)		
1 - 10	60	50.0
11 - 20	50	40.0
21 - 30	10	10.0

Source: field Survey, 2019.

Table1 showed age groups 41-50 and 51- 60 years were 30.0 and 40.0 percent, respectively. The mean age was 50.0 years, which showed that most respondents were not economically active and productive; hence, there is a low prospect of adopting various cocoa farm rehabilitation techniques. Most of the respondents (80 percent) were males; this situation may benefit cocoa farm rehabilitation techniques as men can cope with strenuous farm management practices. In addition, men are more concentrated in farm work than their female counterparts, who are also involved in off-farm activities such as buying and selling farm produce, storing crops, and packing farm make. This finding agrees with [7], who reported that rural women engaged in off-farm activities. The majority (94.7 percent) were married, indicating that most respondents have family responsibilities that could encourage them to adopt innovations to help them earn more money.

According to the results in table 1, most respondents (76.7 percent) had a household size of 6 members and above, while just 23.3 percent had between 1 and 5 members. The mean household size was 8.0, which means that the household size of the respondents was relatively large. This situation may enhance the level and the rate of adoption of technologies because the more significant the household size, the more farm labor that will be available to promote the practice of various rehabilitation techniques. In addition, this is in line with the finding of [8], who noted that cocoa farmers with large household sizes could readjust to sudden changes in labor supply at peak periods of labor demand.

About 59.3 percent of the respondents were literate, with the most significant proportion (24.0 percent) having primary school education and 14.2 percent adult literacy education, 6.0 percent had tertiary education. In comparison, 40.7 percent of the respondents had no former, and 14.7 percent had secondary education. This distribution favors the adoption of rehabilitation techniques, as farmers can easily understand the ideas behind different techniques introduced by subject matter specialists. Again, the table also showed that 39.4 percent of the respondents had above 30 years of farming experience, 27.3 percent had 1-10 years of farming experience. The mean number of years of farming experience was 22. The implication is that majority of the respondents (56.7) percent had the farming experience of 20-30 years and above, which showed that the farmers have experience in different stages of cocoa management.

3.2. Participants in cocoa rehabilitation awareness

Table 2 showed that significantly sampled farmers from Lofa participated in a cocoa rehabilitation project (40 %) than the sampled farmers from Bong and Nimba (18 % and 16 %, respectively). 21 % (n=161) of sampled farmers in Lofa participated in STCRSP (IFAD/MOA), compared to 0 % in Bong and Nimba counties. A significantly more significant proportion of the sampled farmers in Lofa participated in LIFE (ACDI/VOCA) (10 %) than in Bong and Nimba counties (4 % and 2 %, respectively). None of the sampled farmers in Lofa participated in SOCODEVI, compared to 7 % and 8 % of sampled farmers in Bong and Nimba. Only a tiny percentage of sampled farmers participated in cocoa rehabilitation projects of LAADCO and WIENCO; there were no significant differences in participation rates between counties.

Table 3 shows that Bong farmers participating in cocoa rehabilitation on feeder roads are further away from cocoa cooperatives than farmers not participating in cocoa rehabilitation. The distance between the cocoa farm and cooperative is significantly more considerable for farmers participating in cocoa rehabilitation (on average, 73 minutes travel time) than for farmers not participating in cocoa rehabilitation (46 minutes). The distance between the homestead and nearest feeder road is significantly smaller for farmers participating in cocoa rehabilitation (on average 25 minutes travel time) than farmers not participating in cocoa rehabilitation (on average 38 minutes).

In Lofa, farmers participating in cocoa rehabilitation are closer to facilities and roads than farmers not participating in the cocoa rehabilitation process. Distance between the cocoa farm and cooperative is significantly smaller for farmers participating in cocoa rehabilitation (on average 69 minutes travel time) than for farmers not participating in cocoa rehabilitation (on average 81 minutes). The distance between the homestead and nearest local market is significantly smaller for farmers participating in cocoa rehabilitation (on average, 46 minutes travel time) than for farmers not participating in cocoa rehabilitation (56 minutes). The distance between the homestead and nearest district market is significantly smaller for farmers participating in cocoa rehabilitation (on average 61 minutes travel time) than for farmers not participating in cocoa rehabilitation (on average 72 minutes). The distance between the homestead and nearest tarmac road is significantly smaller for farmers participating in cocoa rehabilitation (on average 501 minutes travel time) than for farmers not participating in cocoa rehabilitation (on average 583 minutes). The distance between the homestead and nearest secondary school is significantly smaller for farmers participating in cocoa rehabilitation (on average 56 minutes travel time) than for farmers not participating in cocoa rehabilitation (on average 71 minutes).

In Nimba, farmers participating in cocoa rehabilitation are closer to facilities and roads than farmers not participating in cocoa rehabilitation. Distance between the homestead and cocoa farm is significantly smaller for farmers participating in cocoa rehabilitation (on average 36 minutes travel time) than for farmers not participating in cocoa rehabilitation (on average 42 minutes). The distance between the homestead and cocoa cooperative is significantly smaller for farmers participating in cocoa rehabilitation (on average 42 minutes travel time) than for farmers not participating in cocoa rehabilitation (on average 65 minutes). The distance between the cocoa farm and cooperative is significantly smaller for farmers participating in cocoa rehabilitation (on average 57 minutes travel time) than for farmers not participating in cocoa rehabilitation (on average 98 minutes). The distance between the homestead and nearest district market is significantly smaller for farmers participating in cocoa rehabilitation (on average 75 minutes travel time) than for farmers not participating in cocoa rehabilitation (on average 100 minutes). The distance between the homestead and nearest feeder road is significantly smaller for farmers participating in cocoa rehabilitation (on average 45 minutes travel time) than for farmers not participating in cocoa rehabilitation (on average 64 minutes). The

distance between the homestead and nearest tarmac road is significantly smaller for farmers participating in cocoa rehabilitation (on average 180 minutes travel time) than for farmers not participating in cocoa rehabilitation (on average 204 minutes). The distance between the homestead and nearest secondary school is significantly smaller for farmers participating in cocoa rehabilitation (on average 63 minutes travel time) than for farmers not participating in cocoa rehabilitation (on average 83 minutes).

Table 2 Participation in cocoa rehabilitation projects

Participation	Bong		Lofa		Nimba		P-value
	Freq	Perc	Freq	Perc	Freq	Perc	
Cocoa rehabilitation	141	18.3%	298	39.5%	122	16.1%	0.0001
STCRSP (WB / MoA)	3	0.4%	7	0.9%	12	1.6%	0.9213
STCRSP (IFAD / MoA)	5	0.7%	161	21.3%	1	0.1%	0.0001
LIFE (ACDI/VOCA)	34	4.4%	73	9.7%	16	2.1%	0.0334
LAADCO	1	0.1%	17	2.3%	0	0.0%	0.6956
WIENCO	29	3.8%	14	1.9%	9	1.2%	0.6624
SOCODEVI	52	6.8%	0	0.0%	58	7.7%	0.0001
STCP (IITA)	24	3.1%	10	1.3%	18	2.4%	0.8304
USAID project	1	0.1%	3	0.4%	0	0.0%	0.9906
other	15	2.0%	8	1.1%	3	0.4%	0.8700

Source: field Survey, 2019.

Table 3 Differences in distances between treatment (T) and control (C) group, by county

Variable	Bong			Lofa			Nimba		
	T	C	P	T	C	P	T	C	P
Distance house to cocoa farm (min)	36.0	38.3	0.5054	51.6	43.4	0.4123	35.5	42.2	0.0318
Distance house to coop (min)	38.2	26.1	0.1423	45.2	51.8	0.2533	41.9	65.1	0.0332
Distance farm to coop (min)	72.8	45.9	0.0109	68.8	81.3	0.0407	57.1	98.3	0.0004
Distance to local market (min)	43.3	43.8	0.9178	45.9	55.8	0.0327	37.2	47.2	0.0830
Distance to district market (min)	73.6	79.9	0.3388	60.5	71.6	0.0085	74.9	99.6	0.0007
Distance to feeder road (min)	24.8	37.8	0.0116	38.5	37.4	0.7785	44.6	63.8	0.0026
Distance to the tarmac road (min)	114.6	130.5	0.0598	501.0	582.7	0.0466	179.7	203.5	0.0265
Distance to primary school (min)	15.0	14.9	0.9985	15.1	18.5	0.0879	11.1	11.8	0.6560
Distance to secondary school (min)	80.1	81.4	0.8809	55.6	70.6	0.0015	63.1	82.7	0.0032
Distance to the health centre (min)	45.5	51.5	0.2081	42.7	53.0	0.0058	54.8	60.2	0.3420

Source: field Survey, 2019.

3.3. Cocoa production

Table 4 Cocoa productions

Variable	Treatment	Control	P-value
Estimated cocoa harvest 2021 (kg dry weight) [a]	238	232	0.6142
Estimated cocoa harvest 2020 (kg dry weight) [a]	218	195	0.0471
Estimated cocoa harvest 2019 (kg dry weight) [a]	184	190	0.6737
Estimated total value cocoa harvest 2021 (USD) [a]	282	233	0.0018
Estimated total value cocoa harvest 2020 (USD) [a]	202	186	0.2064
Estimated total value cocoa harvest 2019 (USD) [a]	160	160	0.9808
Detailed production data 2021			
Estimated quantity (kg) sold as grade 1 in 2021 [a]	532	256	0.3982
Estimated percentage of cocoa harvest sold as grade 1 in 2021 [a]	66%	65%	0.8182
Price (USD) for grade 1 in 2021 [a]	69	63	0.4634
Estimated value (USD) of cocoa sold as grade 1 in 2021 [a]	311	245	0.0922
Estimated quantity (kg) sold as grade 2 in 2021[a]	54	53	0.8785
Estimated percentage of cocoa harvest sold as grade 2 in 2021 [a]	26%	24%	0.4508
Price (USD) for grade 2 in 2021 [a]	48	38	0.1132
Estimated value (USD) of cocoa sold as grade 2 in 2021[a]	77	72	0.6312
Estimated quantity (kg) sold as grade 3 in 2021 [a]	4	8	0.0473
Estimated percentage of cocoa harvest sold as grade 3 in 2021 [a]	5%	8%	0.1146
Price (USD) for grade 3 in 2021 [a]	24	22	0.7493
Estimated value (USD) of cocoa sold as grade 3 in 2021 [a]	36	34	0.8599
Estimated quantity (kg) sold as dry in 2021 [a]	230	218	0.4533
Estimated percentage of cocoa harvest sold as dry in 2021 [a]	97%	97%	0.9164
Price (USD) for dry in 2021 [a]	56	58	0.7139
Estimated value (USD) of cocoa sold as dry in 2021 [a]	246	221	0.1406
Estimated quantity (kg) sold as wet in 2021 [a]	-	-	-
Estimated percentage of cocoa harvest sold as wet in 2021 [a]	1%	1%	0.2770
Price (USD) for wet in 2021 [a]	0.03	0.13	0.0851
Estimated value (USD) of cocoa sold as wet in 2021 [a]	-	-	-
Detailed production data 2020			
Estimated quantity (kg) sold as grade 1 in 2020 [a]	156	144	0.6021
Estimated percentage of cocoa harvest sold as grade 1 in 2020 [a]	61%	64%	0.5082
Price (USD) for grade 1 in 2020[a]	49	46	0.7551
Estimated value (USD) of cocoa sold as grade 1 in 2020 [a]	164	122	0.0559
Estimated quantity (kg) sold as grade 2 in 2020 [a]	67	58	0.4178
Estimated percentage of cocoa harvest sold as grade 2 in 2020 [a]	30%	28%	0.5180
Price (USD) for grade 2 in 2020 [a]	37	39	0.7377
Estimated value (USD) of cocoa sold as grade 2 in 2020 [a]	89	63	0.0998

Estimated quantity (kg) sold as grade 3 in 2020 [a]	13	15	0.6847
Estimated percentage of cocoa harvest sold as grade 3 in 2020 [a]	5%	6%	0.6373
Price (USD) for grade 3 in 2020 [a]	19	23	0.5274
Estimated value (USD) of cocoa sold as grade 3 in 2020 [a]	24	28	0.6229
Estimated quantity (kg) sold as dry in 2020 [a]	189	183	0.6218
Estimated percentage of cocoa harvest sold as dry in 2020 [a]	97%	98%	0.1671
Price (USD) for dry in 2020 [a]	49	51	0.6042
Estimated value (USD) of cocoa sold as dry in 2020 [a]	200	188	0.4412
Estimated quantity (kg) sold as wet in 2020 [a]	0	0	-
Estimated percentage of cocoa harvest sold as wet in 2020 [a]	1%	1%	0.2957
Price (USD) for wet in 2020 [a]	0	0	-
Estimated value (USD) of cocoa sold as wet in 2020 [a]	0	0	-
Detailed production data 2019			
Estimated quantity (kg) sold as grade 1 in 2019 [a]	95	139	0.0322
Estimated percentage of cocoa harvest sold as grade 1 in 2019 [a]	55%	64%	0.1102
Price (USD) for grade 1 in 2019 [a]	42	36	0.3173
Estimated value (USD) of cocoa sold as grade 1 in 2019 [a]	122	93	0.1335
Estimated quantity (kg) sold as grade 2 in 2019 [a]	74	80	0.7582
Estimated percentage of cocoa harvest sold as grade 2 in 2019 [a]	32%	24%	0.1071
Price (USD) for grade 2 in 2019 [a]	35	35	0.9912
Estimated value (USD) of cocoa sold as grade 2 in 2019 [a]	78	62	0.3370
Estimated quantity (kg) sold as grade 3 in 2019 [a]	8	8	0.9249
Estimated percentage of cocoa harvest sold as grade 3 in 2019 [a]	6%	6%	0.9476
Price (USD) for grade 3 in 2019 [a]	10	30	0.0561
Estimated value (USD) of cocoa sold as grade 3 in 2019 [a]	14	33	0.0801
Estimated quantity (kg) sold as dry in 2019 [a]	165	171	0.6176
Estimated percentage of cocoa harvest sold as dry in 2019 [a]	96%	98%	0.0303
Price (USD) for dry in 2019 [a]	42	45	0.4744
Estimated value (USD) of cocoa sold as dry in 2019 [a]	162	162	0.9839
Estimated quantity (kg) sold as wet in 2019 [a]	0	0	-
Estimated percentage of cocoa harvest sold as wet in 2019 [a]	1%	1%	0.5610
Price (USD) for wet in 2019 [a]	0	0	0.3936
Estimated value (USD) of cocoa sold as wet in 2019 [a]	0	0	1

Source: field Survey, 2019. a Nova test to determine whether differences in means between variable and detailed production data are significant.

Table 4 showed that most farmers do not use external inputs for cocoa production. However, the percentage of farmers participating in cocoa rehabilitation (84 %) is significantly smaller than the proportion of not participating (96 %). The result in Table 4 showed that production data on cocoa for 2021, 2020, and 2019 seems unreliable and inaccurate considering a large number of missing data and high variation in data. Outliers (values outside the 4x standard deviation interval) have from the dataset. Because of the high variation, it was not easy to detect any significant differences between the treatment and control groups, acknowledging most cocoa produce has as dry cocoa beans without grading. Most of the cocoa is sold as grade one if grading is applied. Although small quantities on average for both, farmers who participated in cocoa rehabilitation sold significantly less cocoa as grade 3 in 2021 than farmers not participating in

cocoa rehabilitation. The estimated total value of cocoa sold in 2021 was substantially higher for farmers participating in cocoa rehabilitation (282 USD on average) than for farmers not participating in cocoa rehabilitation (233 USD on average).

4. Conclusion

Farmers in the study area have a low level of adoption of cocoa rehabilitation techniques. However, farm size and distance to the local market affect adoption. Henceforth, farmers regularly visited, and extension activities intensified to encourage the adoption of cocoa rehabilitation techniques.

Compliance with ethical standards

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Statement of informed consent

All of the study's participants gave their informed consent.

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