CocoaSoils

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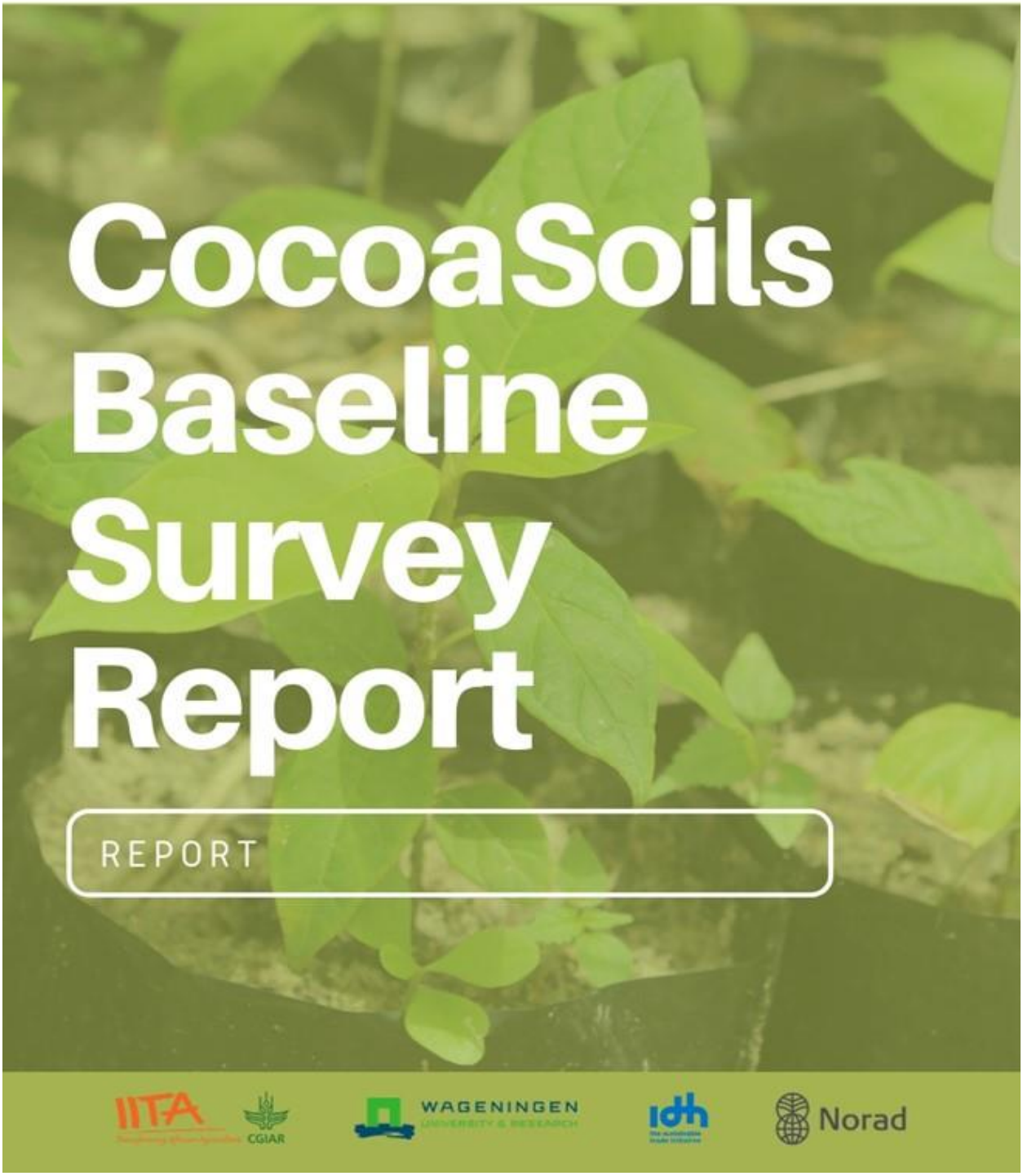

CocoaSoils Baseline Survey Report

REPORT

IITA CGIAR WAGENINGEN UNIVERSITY & RESEARCH idh Norad

Project Website: https://cocoasoils.org/

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ABBREVIATIONS AND ACRONYMS

AEZs	Agroecological Zones
CSC	Climate Smart Cocoa
CBO	Community-based Organization
CNRA	Centre National de Recherche Agronomique
CRIG	Cocoa Research Institute of Ghana
CRIN	Cocoa Research Institute of Nigeria
GPS	Global Positioning System
HDDS	Household Dietary Diversity Score
IDH	The Sustainable Trade Initiative
IITA	International Institute of Tropical Agriculture
IRAD	The Agricultural Research Institute for Development
ISFM	Integrated Soil Fertility Management
MEL	Monitoring, Evaluation and Learning
NDA	Nondisclosure Agreement
NGO	Nongovernmental Organization
Norad	Norwegian Agency for Development Cooperation
ODK	Open Data Kit
PPI	Poverty Probability Index
SPSS	Statistical Package for Social Sciences
WUR	Wageningen University and Research

1 INTRODUCTION

1.1 Project Background

CocoaSoils is a global program supported by the Norwegian Agency for Development Cooperation (Norad) through a 5-year (2017-2022) project in Africa. It is implemented through a consortium of international and national partners led by IITA, IDH, and WUR. The overall objective of the project is to achieve a sustainable cocoa supply sector with increased productivity, efficient use of agricultural inputs and improved rural livelihoods while minimizing the risk of cocoa-driven deforestation.

The project is aimed at developing relevant integrated soil fertility management (ISFM) products and other cocoa production-related tools that are demanded by cocoa stakeholders, including private sector companies, private and public dissemination networks, and policymakers, and making such products available to beneficiaries for use. The project is expected to contribute to increasing incomes and yields among 90,000 cocoa farmers, reduce deforestation, avoid child labour and maintain ecosystem balance through monitoring deforestation and the development of tools to support a more ecosystem service-based approach to cocoa development (at landscape and national levels).

This will be achieved by developing state-of-the-art knowledge and tools on how to enhance cocoa yields in a sustainable way and sharing these tools through training events with extension agents of the project's dissemination partners, who in turn ensure awareness and knowledge gain at the smallholder farmer level. The target countries include Cameroon, Côte d'Ivoire, Ghana, and Nigeria, and the project will be implemented in the operational areas of its dissemination partners within the cocoa-producing areas of these countries.

1.2 Objectives of the Baseline survey

The objective of the baseline survey was to establish a reference point for impact and selected outcome indicators in the project results framework. Emphasis was placed on indicators for which baseline data were not available. These indicators included cocoa yields from smallholder cocoa farmers, income generated from cocoa production, deforestation rates (focusing on previous land use of each cocoa plot), types of labor used/access, and the types of ISFM recommendations/practices in use by target smallholder cocoa farmers. *Table 1* shows the project impact indicators as in the results framework.

In addition, this study documents the range of environmental factors present in existing cocoa systems (e.g., shade cover, weather, soil, management practices, etc) to allow the design of appropriate Satellite Trials to address knowledge gaps. Other specific objectives include:

- Redefining additional and or appropriate interventions (such as training content) for the project beneficiaries to respond to farmers' needs
- Providing justification for revision of targets if and as required during project implementation.

Table 1. Project indicators to be measured at Baseline

Project results	Indicators
Impact. Smallholder cocoa farmers benefit from sustainably increased cocoa productivity and income generated through cocoa production *Sustainability is the continuous increase in cocoa productivity through avoided **deforestation** and **child labor*** ***Avoided deforestation** is not cutting down the forest for purposes of cocoa production and maintaining ecosystem functions*	• Change (%) in cocoa yields for target households (90,000 households)
	• Change (%) in income generated from cocoa production for target households (90,000 households)
	• Change (%) in deforestation rates compared to control sites
	• No evidence for child labor obtained
	• Change in carbon stock, water and biodiversity indexes in cocoa zone of Côte d'Ivoire and Ghana
Outcome 2. Recommendations generated through research products are used by target households	• Number of cocoa-producing households (gender disaggregated) using new recommendations/new knowledge • Types of recommendations being used by the target households

1.3 Scope of the study

The baseline was implemented in the target areas of the project's dissemination partners across four countries (Cameroon, Côte d'Ivoire, Ghana, and Nigeria). The term "target areas" refers to all areas in the four countries where the development partners intend to disseminate the project's recommendations for cocoa management that will be generated through the research activities. Respondents were mainly smallholder cocoa farmers working with the project partners.

With regards to the survey tool for cocoa farmers, the questions focused on socioeconomic factors, assets of participating households, current household incomes from cocoa production, other sources of income, yield levels from farmers' fields, current cocoa production management practices, awareness and knowledge of ISFM recommendations/products, perspectives on child labour, gender equality issues, and land use patterns. Units of observation included farmers and their households and farms. Other spatial data, such as Global Positioning System (GPS) coordinates of respondents' homesteads and location of farms and sizes, were included.

2 METHODOLOGY

2.1 Sampling technique and sample size

Respondents of the survey were smallholder cocoa farmers in the operational areas of participating partners. A sample size of 800 cocoa farmers per country was distributed proportionately across implementing partners based on the number of farmers in their databases.

Farmers in the partner databases served as sample frames from which the 800 farmers were drawn. *Table 2* shows the actual distribution of the sample size across the four countries, and

Table 3 shows the specific partners and number of farmers that formed the baseline sample frame. In all, a total of 3280 (17% female) cocoa farmers were interviewed across the various agroecologies in the four countries, with country distribution as follows: Cameroon (25.6%), Côte d'Ivoire (24.6%), Ghana (25.2%), and Nigeria (24.6%). The actual sample size exceeded the planned sample size as new partners joined the survey a few days after commencement and needed to adjust to accommodate their respective sample frames and sample sizes. New locations were also added by private partners (e.g., Cameroon).

Table 2. Sample size distribution across countries

Country	Planned sample size	Actual sample
Cameroon	800	838
Côte d'Ivoire	800	808
Ghana	800	827
Nigeria	800	807
Total	**3200**	**3280**

Table 3. Sample frame per partner across the countries

Country	Company name	Operational area (Region/State)	Number of farmers
Cameroon	Olam(ofi)	Sud-Ouest, Centre	1,487
Côte d'Ivoire	Cargill	Indénié-Djouablin, Gôh, Nawa, Gbokle Lôh-Djiboua, Guémon, Tonkpi, Haut-Sassandra, Marahoué, Nawa, San-Pédro, Sud-Comoé, Agnébi-Tiassa, Mé, Bélier, Grands Ponts	97,208
	ICRAF/MARS	Nawa	272
Ghana	Kuapa Kokoo	Ashanti, Ahafo, Bono East, Western North, Western, Central	69,092
	Mondelez	Eastern, Ashanti	1,105
	Cargill	Western, Western North	6,583
	Transroyal (Rockwinds)	Central, Ashanti, Eastern	4,572
Nigeria	Olam (Ofi)	Ondo, Osun, Cross River	18,625
TOTAL			**198,949**

The study adopted a multistage stratified random sampling technique to ensure a representative sample of cocoa farmers was selected for the study. First, the study areas were purposively sampled based on partner operational areas, which were stratified according to AEZs, and the sample size was proportionately distributed among partners according to the number of farmers submitted for the survey. The study areas included all the cocoa-growing in the Agro-Ecological Zones (AEZs) where the dissemination partners operate. The country-level AEZs, as submitted by partners, have been aligned to the AEZs demarcated by the various cocoa research institutes in the three counties. Table 4 has a list of country AEZs where the survey was carried out.

Second, the sample size was divided proportionately between the agroecological zones based on the number of farmers present in the area and by each partner (if more than one partner was in the zone).

To select villages/communities within the zones, farmer databases from private partners were reviewed alongside their communities within the various AEZ and randomly selected. The number of farmers per community/village was determined using weights (based on the number of farmers in the selected community). The number of farmers was randomly selected from their groups (with assistance from partner field staff) from each selected village (mainly from cooperatives or farmer associations of the partners). *Table 4* shows the sample size per AEZ across the three countries.

Table 4. Sample size per agroecological zone per country.

Cameroon		Côte d'Ivoire		Ghana		Nigeria	
AEZ	**Frq**	**AEZ**	**Frq**	**AEZ**	**Frq**	**AEZ**	**Frq**
Forest Zone	633	Sudano–Guinean average forest area	546	Dry Semi-Deciduous Inner Zone	9	Humid Forest	154
Forest/Savanna Zone	32	Guinean Forest area	252	Moist evergreen	470	Humid Forest/Derived Savanna	141
Savanna Zone	22	Sudano–Guinean preforest area	10	Moist Semi-Deciduous North West	79	Humid Forest/Derived Savanna	228
Semi- Zone	151			Moist Semi-Deciduous South East	240	Humid Forest/Derived Savanna	284
				Wet Evergreen	29		
TOTAL	**838**		**808**		**827**		**807**

2.2 Data collection, analysis, and reporting

The survey gathered data and information from cocoa farmers on both qualitative and quantitative aspects. An agreed survey tool was programmed in a free and open-source mobile data collection tool known as Open Data Kit (ODK) and used for data collection. The methods of data collection included face-to-face interviews with sampled respondents, geo-tracing of selected plots, and GPS locations of the homestead. All the data were sent directly to the CocoaSoils ODK aggregate platform for quality control and access.

Enumerators were selected among research assistants within the cocoa research Institutes and university graduates who had experience in data collection, could use tablets, and could speak and understand local languages in the participating countries. A four-day training programme (comprising three days of training and one day of refresher training) was organized in each country, including field pretesting of data collection tools to ensure common understanding, usefulness, and logic of the tool by all enumerators.

Data quality checks were done at numerous levels (during and after data collection). Supervisors of enumerators assessed the completeness of survey tools and rectified obvious mistakes

(without changing the actual content of responses). This was done before the data upload. Centralisedcentralire assessed for its completeness and validity by the Monitoring, Evaluation and Learning (MEL) team and feedback shared with the country teams as data collection progressed.

Data was analyzed using Statistical Package for Social Science (SPSS), version 25. A combination of statistical analysis, including descriptive statistics (means, frequencies) and test of significance, using t-test and Pearson regressions, were applied. The descriptive analysis characterized the respondents' households, whereas the regression coefficients were computed to ascertain the relationships among variables such as determinants of use of inputs, the relationship among use of different inputs, age of plantation and yield. The Poverty Probability Index (PPI) Scorecard and the look-up tables were used to analyse the percentage of households within a PPI score range and the probability of households within, above or below poverty lines.

2.3 Limitations and issues encountered

Three significant limitations were faced during the survey implementation across the countries. First, it took much more time than anticipated for the project to receive information on the operational areas of dissemination partners. Several discussions and meetings (including the signing of nondisclosure agreements) had to take place before the project was allowed access to partners' databases.

Second, information on the quantity of cocoa beans harvested was obtained through a memory recall by respondents. This approach had its limitations. There was the possibility that the information obtained may be proxies and may not reflect the exact quantity that was harvested (though it is much easier for cocoa farmers to know the number of bags produced). This limitation notwithstanding, the quality of data generated was reasonably accurate and compared with available secondary data. In addition, a sample of the data has been ground-truthed by the lead baseline coordinators in the countries.

3 RESULTS and DISCUSSION

3.1 Project impact indicators

To ascertain future changes due to contributions by the project interventions, the baseline survey has established a reference point for the project's impact indicators in the project results framework, especially those without baseline data, and to use these as benchmarks for impact. Table 5 shows the various baseline data for each indicator across the countries. Specific analysis of yield, income, labour types, previous land uses across the countries, and gender is discussed under specific sections hereafter.

Table 5. Baseline values for project impact indicators

Project results	Indicator	Baseline
Impact 1. Smallholder cocoa farmers benefit from sustainably increased cocoa productivity and income generated through cocoa production *Sustainability is the continuous increase in cocoa productivity through avoided **deforestation** and **child labor*** ***Avoided deforestation** is not cutting down the forest for purposes of cocoa production and maintaining ecosystem functions*	• Change (%) in cocoa yields for target households (90,000 households)	• Current cocoa yields (kg/ha): • Cameroon:429 • Côte d'Ivoire: 391 • Ghana: 526 • Nigeria: 369
	• Change (%) in income generated from cocoa production for target households (90,000 households)	• Current income (value of production) generated from cocoa production (USD/year/Household) • Cameroon: 2768 • Côte d'Ivoire: 1491 • Ghana: 1392 • Nigeria:1172
	• Change (%) in deforestation rates compared to control sites	• Current Deforestation rates (using terra-I) • Refer to maps on current deforestation rates (pg 43–47) • Previous land use[1] • Cameroon: 66% forest • Côte d'Ivoire:50% forest and 17% fallow • Ghana: 39% and 34% forest and fallow, respectively, • Nigeria: 70% forest
	• No evidence for child labor obtained	• Current forms of labour used by households • Cameroon: Family labor (55%–74%), the rest vary between temporary hire and all year round • Côte d'Ivoire: Family labor (93%–98%) and the rest vary between temporary hire and all year round • Ghana: Family labor (55%–89%), the rest vary between temporary hire and all year round • Nigeria: Family labor (45%–60% of respondents), the rest vary between temporary hire and all year round • % Children in school
	• Change in carbon stock, water and biodiversity indexes in cocoa zone of Côte d'Ivoire and Ghana	• Current carbon stock, water and biodiversity indexes in cocoa zone of Côte d'Ivoire and Ghana • Refer to pages 47–50

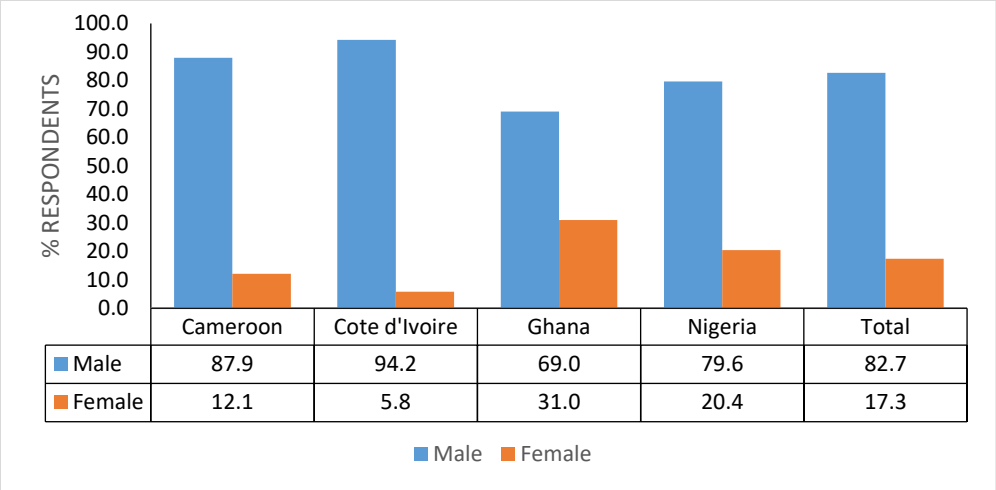
Source: Survey data, 2019

[1] Considers only cocoa plot or first two plots of a respondent

3.2 Descriptive analysis of household characteristics

This section presents the demographic characteristics of the households covered in the baseline survey. These characteristics include household composition, age, sex, marital status, educational status, cocoa farming experience, access and control of productive resources, access and sources of credit, and types of crops grown.

The majority (82.7%) of respondents for this survey were male (Figure 1). Côte d'Ivoire had the highest proportion of male respondents (94.2%), with Cameroon, Nigeria, and Ghana having 87.9 %, 79.6%, and 69%, respectively. Female respondents constituted 5.8%, 12.1%, 31%, and 20.4% of respondents for Côte d'Ivoire, Cameroon, Ghana, and Nigeria, respectively.



	Cameroon	Cote d'Ivoire	Ghana	Nigeria	Total
Male	87.9	94.2	69.0	79.6	82.7
Female	12.1	5.8	31.0	20.4	17.3

Figure 1. Sex distribution of survey respondents

3.2.1 Distribution of household heads by sex

Household heads constituted 91.8% of the total respondents, with the majority being males (80.9%) (*Table 6*). Côte d'Ivoire had the highest number (92.7%) of households being headed by males, followed by Cameroon (86.7%), Nigeria (78.4%), and Ghana (66%). This implies that Ghana had the highest number of female household heads (18.7%).

3.2.2 Age distribution of respondents

The age of a household head has a positive correlation with how active and productive the household would be and the adoption of new and innovative technologies, among other factors. To ascertain the actual age and be able to use this parameter to establish further interrelationships, data on the age of the respondents was analyzed (of whom 82.7% were male).

Figure 2 shows the distribution of respondents by age. Age distribution was similar across the four countries. On average, about 64% of respondents were between 35 years and 60 years old. A similar trend was found between the average ages of males and females, with Cameroon and Côte d'Ivoire having the lowest average age of 47. The proportion of the lowest age range (18–35-year-old youth) was about 14% across the countries. The high percentage of active

respondents has a direct positive bearing on labour, ease of adoption of innovations, and reduction in the degree of risk aversion.

Table 6. Sex distribution of households (HH) heads interviewed

Variable	Sex	Cameroon N = 835		Côte d'Ivoire N = 803		Ghana N = 817		Nigeria N = 805		Total N = 3260	
		Freq.	Percent	Freq.	Percent	Freq.	Percent	Freq.	Percent	Freq.	Percent
HH head	Male	724	86.7	743	92.7	539	66.0	631	78.4	2637	80.9
	Female	79	9.5	23	2.9	153	18.7	101	12.5	356	10.9
	Total	**803**	**96.2**	**766**	95.6	**692**	**84.7**	**732**	**90.9**	2993	91.8
Not HH head	Male	10	1.2	14	1.5	25	3.1	10	1.2	59	1.8
	Female	22	2.6	23	2.9	100	12.2	63	7.8	208	6.4
	Total	**32**	**3.8**	**35**	4.4	**125**	**15.3**	**73**	**9.1**	267	8.2

Source: Survey data, 2019

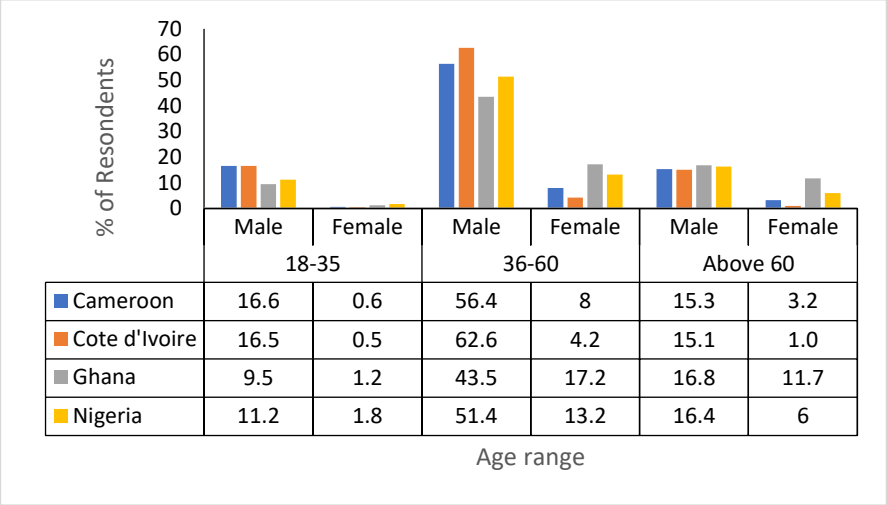


Figure 2. Age distribution of respondents

3.2.3 Education level of respondents

The educational level of respondents differs across the four countries (Table 7). The highest level of education in Cameroon was primary (41%); in Ghana, junior high school (42.9%); in Nigeria, secondary (34.6); and in Côte d'Ivoire, most farmers had no formal education (48.4%). In total, 43.6% of respondents had primary and secondary education across the three countries. Most female respondents had a low education level, with the majority being at the primary level (4.6%). In relative terms, female respondents are less educated.

3.2.4 Marital status of respondents

The significance of marital status on agricultural production can be explained in terms of the supply of agricultural family labour. *Table 8* shows the marital status of respondents across the four countries. There was a similarity in the distribution of respondents' marital status across the countries, especially in Ghana and Nigeria, with over 80% and 90% of respondents, respectively,

being married. Côte d'Ivoire had about 78% of respondents married, and Cameroon had a little over 50% of respondents being married. In all, about 75% of respondents were currently married, while about 5% (males 3.8%, females 1%) were single (never married). In contrast, 1.5% of males and 5.5% of females were widowed.

Table 7. Educational level of respondents

Educational level	Sex	Cameroon N=835		Côte d'Ivoire N=803		Ghana N=807		Nigeria N=794		Total N=3250	
		Freq	Percent	Freq	Percent	Freq	Percent	Freq	Percent	Freq	Percent
No formal education	Male	25	3.0	371	46.2	91	11.3	80	10.1	567	17.4
	Female	15	1.8	18	2.2	78	9.7	45	5.7	156	4.8
	Total	**40**	**4.8**	**389**	**48.4**	**169**	**20.9**	**125**	**15.7**	723	22.2
Adult education	Male	2	0.2	5	0.6	3	0.4	4	0.5	14	0.4
	Female	0	0.0	0	0.0	0	0.0	1	0.1	1	0.0
	Total	**2**	**0.2**	**5**	**0.6**	**3**	**0.4**	**5**	**0.6**	15	0.5
Primary	Male	292	34.9	199	24.8	84	10.4	194	24.4	769	23.7
	Female	51	6.1	11	1.4	46	5.7	60	7.6	168	5.2
	Total	**343**	**41.0**	**210**	**26.2**	**130**	**16.1**	**254**	**32.0**	937	28.8
Junior high school	Male	99	11.8	134	16.7	268	33.2	42	5.3	543	16.7
	Female	7	0.8	10	1.2	78	9.7	6	0.8	101	3.1
	Total	**106**	**12.7**	**144**	**17.9**	**346**	**42.9**	**48**	**6.0**	644	19.8
Secondary	Male	273	32.7	41	5.1	93	11.5	238	30.0	645	19.8
	Female	23	2.8	7	0.9	26	3.2	37	4.7	93	2.9
	Total	**296**	**35.4**	**48**	**6.0**	**119**	**14.7**	**275**	**34.6**	738	22.7
Post-secondary	Male	48	5.7	7	0.9	28	3.5	86	10.8	169	5.2
	Female	3	0.4	0	0.0	15	1.9	6	0.8	24	0.7
	Total	**51**	**6.1**	**7**	**0.9**	**43**	**5.3**	**92**	**11.6**	567	17.4

Source: Survey data, 2019

3.2.5 Household size and composition

Table 9 presents the average household size and the distribution of household members by selected age groups. The results show a high similarity of average household size across the four countries of about eight persons per household. The results further indicate that between 60% and 67% of respondents have household members within the age ranges of 4–10, 18–35, and 36–60 across the countries, suggesting that most families are predominantly youthful, although the 4–10 group constitute the highest (about 68%). Cameroon and Nigeria have the highest household members (65%) within the age brackets of 36–60 years, suggesting high family labour for production, whereas Ghana has 57% of household members within this age group. Households with persons aged above 60 years constituted about 39%. This indicates an ageing farming labour, which could affect the labour force required for farm operations.

From *Table 10,* about 89% of respondents belonged to a farmer association, 70% in Cameroon, 92% in Côte d'Ivoire, and 97% in Ghana and Nigeria. Overall, about 15% of respondents who belonged to farmer groups were females, and 75% of total female respondents were members of farmer groups. Côte d'Ivoire has the least number of female respondents who were members of farmer groups (4.9%). Respondents could be targeted using their groups as entry points. However, female respondents will probably require additional strategies to be reached with critical information.

Table 8. Marital status of the respondents

Marital status	Sex	Cameroon N = 824		Côte d'Ivoire N = 803		Ghana N = 789		Nigeria N = 798		Total N = 3214	
		Freq.	Percent	Freq.	Percent	Freq.	Percent	Freq.	Percent	Freq.	Percent
Single	Male	56	6.8	29	3.6	18	2.3	18	2.3	121	3.8
	Female	15	1.8	5	0.6	7	0.9	1	0.1	28	0.9
	Total	**71**	**8.6**	**34**	**4.2**	**25**	**3.2**	**19**	**2.4**	**149**	**4.6**
Married	Male	417	50.6	600	74.7	513	65.0	618	77.4	2148	66.8
	Female	26	3.2	23	2.9	122	15.5	102	12.8	273	8.5
	Total	**443**	**53.8**	**623**	**77.6**	**635**	**80.5**	**720**	**90.2**	**2421**	**75.3**
Divorced	Male	13	1.6	3	0.4	21	2.7	1	0.1	38	1.2
	Female	5	0.6	4	0.5	38	4.8	1	0.1	48	1.5
	Total	**5**	**0.6**	**7**	**0.9**	**38**	**4.8**	**1**	**0.1**	**51**	**1.6**
Widowed	Male	25	3.0	11	1.4	12	1.5	1	0.1	49	1.5
	Female	45	5.5	10	1.2	72	9.1	51	6.4	178	5.5
	Total	**70**	**8.5**	**21**	**2.6**	**84**	**10.6**	**52**	**6.5**	**227**	**7.1**
Partner	Male	227	27.5	114	14.2	4	0.5	5	0.6	350	10.9
	Female	8	1.0	4	0.5	3	0.4	1	0.1	16	0.5
	Total	**235**	**28.5**	**118**	**14.7**	**7**	**0.9**	**6**	**0.8**	**366**	**11.4**

Source: Survey data, 2019

Table 9. Household size and composition

Age (years)	Sex	Cameroon N = 838 (4278)		Côte d'Ivoire N = 803 (7016)		Ghana N = 817 (3974)		Nigeria N = 805 (3869)		Total N = 3263 (19,137)	
		Freq.	Percent	Freq.	Percent	Freq.	Percent	Freq.	Percent	Freq.	Percent
Under 4	Male/female	456	54.3	785	11.2	313	38.3	304	37.8	1858	9.7
4–10	Male/female	611	72.7	1507	21.5	545	66.7	511	63.5	3174	16.6
11–17	Male	447	53.2	787	11.2	409	50.1	452	56.1	2095	10.9
	Female	399	47.5	653	9.3	384	47.0	351	43.6	1787	9.3
18–35	Male	513	61.1	951	13.6	506	61.9	473	58.8	2443	12.8
	Female	556	66.2	904	12.9	500	61.2	464	57.6	2424	12.7
36–60	Male	547	65.1	633	9.0	472	57.8	525	65.2	2177	11.4
	Female	450	53.6	564	8.0	500	61.2	482	59.9	1996	10.4
Above 60	Male	163	19.4	139	2.0	177	21.7	180	22.4	659	3.4
	Female	136	16.2	93	1.3	168	20.6	127	15.8	524	2.7
Ave. HH size	Male/female	8		9		7		7		7	

Table 10. Group membership

Group membership	Sex	Cameroon N = 837		Côte d'Ivoire N = 803		Ghana N = 809		Nigeria N = 799		Total N = 3248	
		Freq.	Percent	Freq.	Percent	Freq.	Percent	Freq.	Percent	Freq.	Percent
Yes	Male	523	62.5	706	87.9	561	69.3	633	79.2	2423	74.6
	Female	68	8.1	39	4.9	225	27.8	149	18.6	481	14.8
	Total	**591**	**70.6**	**745**	**92.8**	**786**	**97.2**	**782**	97.9	**2904**	**89.4**
No	Male	215	25.7	51	6.4	7	0.9	10	1.3	283	8.7
	Female	31	3.7	7	0.9	16	2.0	7	0.9	61	1.9
	Total	**246**	**29.4**	**58**	**7.2**	**23**	**2.8**	**17**	2.1	**344**	**10.6**

Source: Survey data, 2019

3.2.6 Assets and control of productive resources

The respondents' access and control of productive resources is presented in *Table 11.* On average, respondents had over 22 years of cocoa farming experience, with Cameroon the shortest (about 20 years) and Nigeria the longest (26 years). With regards to the number of farm plots, an average of two plots per farmer was established across the countries and across genders (male/female). On the average farm size, a minimum of two hectares per household was recorded across Cameroon, Ghana and Nigeria, with Côte d'Ivoire recording about three hectares. Ghana had the lowest average farm size of about 1.4% for female respondents, whereas Côte d'Ivoire, Cameroon, and Nigeria have two or over two hectares for females.

Table 11. Access and control of productive resources

Variable	Sex	Cameroon (N = 838)	Côte d'Ivoire (N = 801)	Ghana (N = 827)	Nigeria (N = 807)
Average number of plots (No.)	Male	1.72	2.42	2.43	1.80
	Female	1.71	2.15	2.18	1.97
Average size of Plot (estimated) (ha/household)	Male	2.60	3.03	1.75	2.31
	Female	2.43	2.16	1.38	1.64
Mean farming experience (years)	Male	19.6	19.18	20.5	24.08
	Female	19.9	18.3	22.3	25.7

Source: Survey data, 2019

Table 12 presents a T-test analysis to show the level of significance between male and female farmers in terms of age, cocoa farming experience, and land size. In Cameroon, there is a significant difference between the age of male and female farmers, which indicates that female farmers are relatively older than male farmers. In Côte d'Ivoire, there is a significant difference between the age and land size of male and female farmers; this shows that female farmers are relatively older than male farmers, and male farmers have access to bigger land sizes than female farmers. In Ghana, there is a significant difference between age, cocoa farming experience, and land size of male and female farmers; hence, female farmers are relatively older than male farmers and have relatively higher cocoa farming experience than male farmers but have access to lesser sizes of land compared to male farmers. In Nigeria, there is a significant

difference between the age and land size of male and female cocoa farmers; female farmers are older compared to male farmers and have access to smaller sizes of land for cocoa farming.

Table 12. Test of significance between mean values of male and female farmers

	Variable	Mean (female)	Mean (Male)	T-statistics
Cameroon	Age of farmer	53.12	46.48	0.005**
	Cocoa farming experience	19.99	19.6	0.78
	Land size	2.4	2.66	0.41
Côte d'Ivoire	Age of farmer	51.52	47.39	0.03**
	Cocoa farming experience	18.13	19.04	−0.596
	Land size	2.16	3.03	0.001**
Ghana	Age of farmer	53.79	50.24	0.004**
	Cocoa farming experience	22.47	20.46	0.018**
	Land size	1.38	1.75	0.03**
Nigeria	Age of farmer	53.79	50.24	0.003**
	Cocoa farming experience	25.77	24.07	0.12
	Land size	1.64	2.31	0.01**

Source: Survey data, 2019, ** Significant at 5%

3.2.6.1 Land ownership status

Obtaining insight into the land tenure system and ownership of cocoa farmlands is key for the establishment of the CocoaSoils satellite trials. To understand this, respondents were asked about their ownership of the cocoa-cultivated lands. Table 13 shows that about 51% of the respondents inherited their main farms, and 28% bought theirs, while about 7% were sharecroppers across the countries. However, there were slight differences in the countries regarding other forms of ownership status. About 37% and 38% of respondents in Cameroon and Nigeria, respectively, bought their main cocoa farmlands, whereas Ghana was split between sharecropping (19%) and gift (14); in Côte d'Ivoire, about 63% of respondents inherited their lands. These ownership statuses should be considered in the selection and implementation of the research trials to enable continuity and avoid conflicts.

3.2.6.2 Labor types per ISFM practice used by respondents

The labour types available to respondents for cocoa production based on the major activities being conducted on their farms were assessed. *Table 14* shows that respondents have used similar labour types across the countries for common farm activities. These include family labour, temporary hires (daily), year-round paid labour, and farmers' helping groups. However, the intensity of using a type of labour depends on the activity in question.

Family labour is, however, the most commonly used for all types of farm activities across the four countries. Nigeria used, to some extent, temporary hire (daily) as the second most used type of labour. Although the majority of respondents (68% and 50%) indicated having children between the ages of 4 and 0 and 11–17, respectively, which may have a perception of child labour, the PPI score showed that most of these children are enrolled in school. This suggests

that family labour could be provided by other age categories (18–60), of which 61% of respondents indicated having family members (including themselves) within this group.

3.2.6.3 Segmentation of respondents using climate smart cocoa (CSC) implementer

The Climate Smart Cocoa Implementer is an app that segments farmers into various resource endowment groups using parameters such as land and household sizes, age of farms, contact with extension or numbers of training, etc. This section seeks to segment the baseline farmers using the key questions from the CSC Implementer app. This is to assist in identifying the kind of farmers and how they relate to the uptake of practices in the four countries.

Table 13. Land ownership status[2]

Status	Sex	Cameroon N = 832		Côte d'Ivoire N = 803		Ghana N = 814		Nigeria N = 792		Total N = 3241	
		Freq	Percent	Freq	Percent	Freq	Percent	Freq	Percent	Freq	Percent
Bought	Male	276	33.2	202	25.2	59	7.2	241	30.4	576	23.6
	Female	32	3.8	4	0.5	16	2.0	63	8.0	111	4.6
	Total	**308**	**37.0**	206	25.7	**75**	**9.2**	**304**	**38.4**	**687**	**28.2**
Caretaker	Male	5	0.6	5	0.6	59	7.2	34	4.3	98	4.0
	Female	3	0.4	0	0.0	5	0.6	7	0.9	15	0.6
	Total	**8**	**1.0**	5	0.6	**64**	**7.9**	**41**	**5.2**	**113**	**4.6**
Gift	Male	44	5.3	32	4.0	63	7.7	64	8.1	171	7.0
	Female	8	1.0	5	0.6	47	5.8	5	0.6	60	2.5
	Total	**52**	**6.3**	37	4.6	**110**	**13.5**	**69**	**8.7**	**231**	**9.5**
Inherited	Male	405	48.7	468	58.3	262	32.2	281	35.5	948	38.9
	Female	56	6.7	34	4.2	149	18.3	83	10.5	288	11.8
	Total	**461**	**55.4**	502	62.5	**411**	**50.5**	**364**	**46.0**	**1236**	**50.7**
Sharecropping	Male	2	0.2	50	6.2	118	14.5	12	1.5	132	5.4
	Female	1	0.1	3	0.4	36	4.4	2	0.3	39	1.6
	Total	**3**	**0.3**	53	6.6	**154**	**18.9**	**14**	**1.8**	**171**	**7**

Source: Survey data, 2019

Table 15 presents a distribution of responses to key questions from the CSC Implementer app. Analysis across the four countries shows that most farmers received extension contact/training less than ten times in the 2017/18 cocoa cropping season. Most respondents have household sizes below 15, and most cocoa farms are within the age range of mature and adult cocoa, except in Nigeria, where old cocoa farms dominate them. Most farm sizes in Cameroon, Côte d'Ivoire, Ghana, and Nigeria are below 2 ha.

[2] Land ownership is based on plot 1 of the respondents

Table 14. Frequency distribution of access to labour[3] by gender

Type of Practice	Labor Type	Cameroon			Côte d'Ivoire			Ghana				Nigeria		
		Gender distribution of labor type used		%			%	Gender distribution of labor type used		%		Gender distribution of labor type used		%
		Male	Female		Male	Female		Male	Female			Male	Female	
Land preparation	Family labor	693	81	64.8	698	39	93.1	113	56	67.3		548	116	45.7
	Temporary hires (daily)	122	14	11.3	37	3	5	24	15	15.5		376	88	31.9
	Year-round paid labor	152	26	14.9	11	3	1.7	1	2	1.2		241	58	20.6
Crop management *(pruning, weeding, disease management, fertilizer application)*	Family labor	671	74	54.6	658	38	94.1	889	365	54.8		590	127	48.2
	Farmers' helping groups	158	13	12.5	8	0	1.1	228	72	13.1		28	5	2.2
	Temporary hires (daily)	207	18	16.5	20	2	2.9	367	178	23.8		362	89	30.3
	Year-round paid labor	189	34	16.2	11	3	1.9	15	9	1.0		224	52	18.5
Shade management	Family labor	672	67	74.1	746	43	98.5	356	146	89.2		618	121	60.0
	Farmers' helping groups	63	5	6.8	3	0	0.4	22	8	5.3		28	7	2.8
	Temporary hires (daily)	29	4	3.4	4	2	0.7	10	10	3.5		183	58	19.6
	Year-round paid labor	124	27	15.1	2	1	0.4	1	3	0.7		90	13	8.4

Source: Survey data, 2019

3.3 Poverty Probability Index

3.3.1 Distribution of households along the PPI scale

The Poverty Probability Index (PPI), also referred to as the "Progress out of Poverty Index", was used to determine the likelihood that respondents' households were living below the poverty line. The survey used the ten (10) PPI questions specific for each country on household characteristics and asset ownership to score the likelihood that the household is living below the poverty line. The individual household scores were used to compute the average score for the entire sample. This section allows us to measure the poverty outreach (i.e., the portion of households who live below a chosen poverty line), improve the performance of the intervention among the resource-poor, and track poverty over time (https://www.povertyindex.org/about-us). This is also relevant to assess the probability of adoption of the ISFM components being introduced to households and mechanisms or strategies based on the score of participating households.

Table 15. Segmentation of respondents using CSC

CSC Implementer parameter	Cameroon		Côte d'Ivoire		Ghana		Nigeria	
	Freq.	%	Freq.	%	Freq.	%	Freq.	%
Number of extension contacts/training								
0	510	61.2	187	23.8	111	13.7	74	9.3
1–5	272	32.6	545	69.2	563	69.4	384	48.2
6–10	29	3.5	50	6.4	122	15	170	21.4
11–15	9	1.1	3	0.4	13	1.6	77	9.7
16–20	8	1	1	0.1	0	0	65	8.2
21–25	1	0.1	0	0	2	0.2	14	1.8
26–30	0	0	0	0	0	0	5	0.6
31–35	1	0.1	0	0	0	0	1	0.1
36–40	1	0.1	0	0	0	0	4	0.5
41–45	0	0	0	0	0	0	1	0.1
46–50	1	0.1	0	0	1	0.1	0	0
51–55	1	0.1	0	0	0	0	1	0.1
56–60	0	0	1	0.1	0	0	0	0
61–65	1	0.1	0	0	0	0	0	0
66–70	0	0	0	0	0	0	0	0
Total	**834**	**100**	**787**	**100**	**812**	**100**	**796**	100
Household size								
1–5	262	31.3	194	24.7	263	32.4	256	32.2
6–10	396	47.3	377	48	456	56.2	419	52.6
11–15	132	15.8	151	19.1	72	8.8	98	12.3
16–20	37	4.4	44	5.6	17	2.1	19	2.4
21–25	7	0.8	13	1.7	4	0.5	3	0.4
26–30	3	0.4	4	0.5	0	0	1	0.1
31–35	0	0	2	0.3	0	0	0	0
36–40	0	0	1	0.1	0	0	0	0
Total	**837**	**100**	**786**	**100**	**812**	**100**	**796**	100

CSC Implementer parameter	Cameroon		Côte d'Ivoire		Ghana		Nigeria	
	Freq.	%	Freq.	%	Freq.	%	Freq.	%
Age of cocoa								
1–3	37	4.4	45	5.7	13	1.6	19	2.4
4–13	288	34.4	254	32.3	241	29.7	120	14.9
14–25	282	33.6	308	39.1	355	43.7	235	29.2
>25	231	27.6	180	22.9	203	25	431	53.5
Total	**838**	**100**	**787**	**100**	**812**	**100**	**805**	**100**
Farm size								
0–2	485	57.9	441	56.1	684	84.2	561	70.5
3–5	244	29.1	268	34.1	106	13.1	172	21.6
6–8	56	6.7	64	8.1	14	1.7	39	4.9
9–10	19	2.3	7	0.9	5	0.6	8	1
>10	34	4	6	0.8	3	0.4	16	2
	838	**100**	**786**	**100**	**812**	**100**	**796**	**100**

The number of extension contacts is used to replace the number of years of training received in cocoa since the latter is not a question in the baseline survey.

Figure 3 shows the distribution of households along the PPI scale. It shows that different percentages of households fall within different PPI scales. This indicates that poverty rates were varied among the sampled households. Considering the peak points for the distributions, the results indicate that about 26% of households in Cameroon fall within the PPI scale of 15–19 and 35–39, whereas a greater part of the population falls within the 5–9 and 70–74 scales (Figure 3). Due to the complete lack of a look-up table for Cameroon, their probability rates were not computed. Côte d'Ivoire, Ghana, and Nigeria had the most households falling within 15–19 and 75–74.

3.3.2 Poverty probability scores across countries

Using the average[4] of the PPI scores, Cameroon had an average of 41% poverty rate among the sampled households. With a confidence level of 99% and a margin of error of 5%, it can be estimated that the poverty rate among households in Cameroon lies between 36% and 46%. Also, Côte d'Ivoire had an average poverty rate of 32.6% among its respondents, putting its households in the poverty percentage range of 30% to 40%. Similarly, Ghana had an average poverty rate of 24.9% among its sampled households, and this indicates Ghana's poverty rate among sampled farmers lies between 20% and 30%, whereas Nigeria lies between 32% and 42% using the international poverty line of $1.25/day (2005 PPP lines).

3.4 Awareness and use of Integrated soil fertility management (ISFM) practices

This section presents respondents' access to training and extension services, access to credit and sources, awareness and use of the various components of ISFM, and their major determinants (drivers of use) across the three countries. The section also presents the relationship between awareness levels and the use of the various ISFM components.

Integrated soil fertility management (ISFM) is defined as a set of soil fertility management practices that necessarily include the use of fertilizer, organic inputs, and improved germplasm

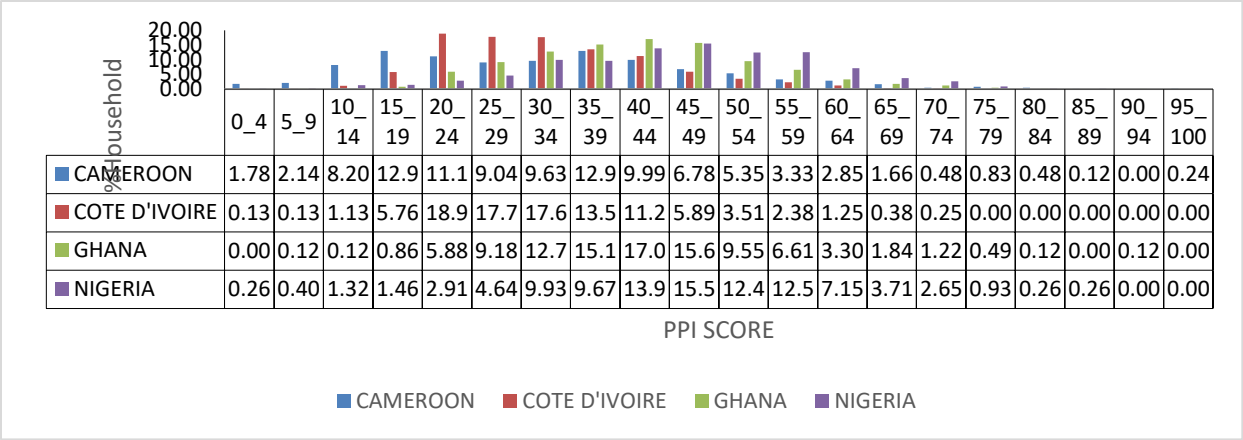
[4] Averages for countries computed using PPI scorecards, data analysis tool

combined with the knowledge of how to adapt these practices to local conditions, aiming at maximizing agronomic use efficiency of the applied nutrients and improving crop productivity (Vanlauwe et al., 2015). As such, ISFM is not a single technology but a set of technology components that are ideally co-applied in the same plot (referred to as "complete ISFM"). These components need to be applied correctly, hence the reference to "good agronomic practices".

3.4.1 Access to extension services, training, and credit services

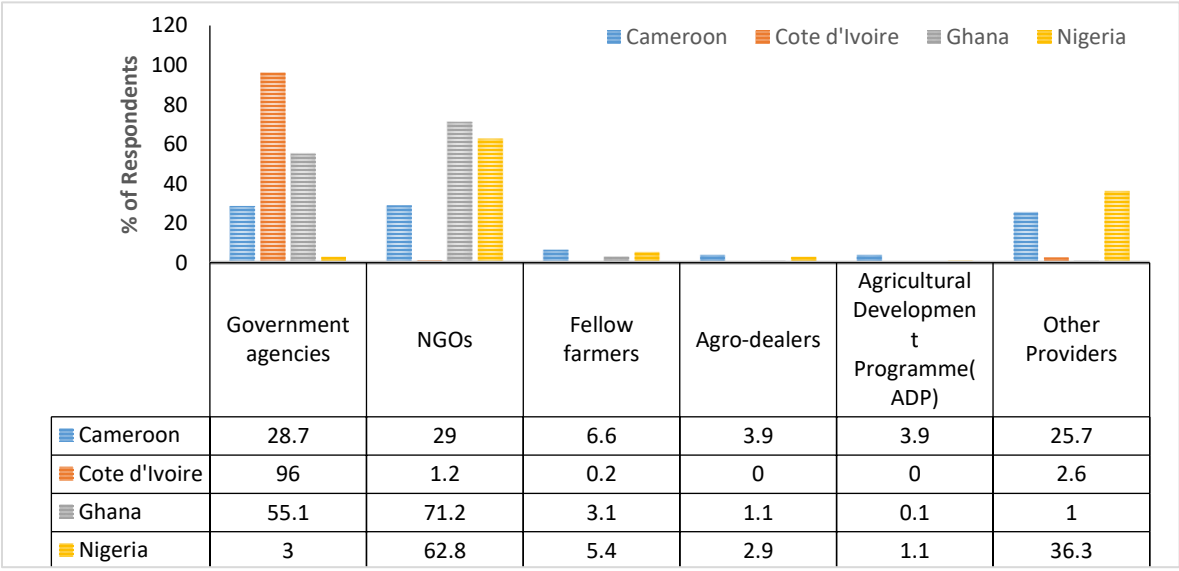
Access to information is a key element of awareness. Respondents' access to training and extension services is presented in *Table 16.* Generally, an average of 73% of farmers had participated and or received extension services across the four countries, the majority of whom were male (60%). Though there were slight country differences between 77% and 92%, a majority of those who had not had access to training and extension services (27%) were females (15%). Ghana and Nigeria have 30% and 20% female participation in training and access to extension services, respectively, whereas Cameroon and Côte d'Ivoire have about 7.5% and 2.3%, respectively. The training focused on pre-planting practices such as nursery and land preparation, agronomic practices, and input use, including organic and inorganic fertilizers, husk management, pruning and postharvest processing, including pod breaking, fermentation and bean drying, and marketing and financial management.

Table 17, which focuses on the respondents who have received training and extension services, shows the number of respondents per training component. The results indicate 100% access to training and extension services within the last year across Ghana and Nigeria in Farm management and agronomic practices, Postharvest processing, and Marketing/Financial management, whereas Côte d'Ivoire and Cameroon had slightly less access. In all, Ghana has the highest female participation in all training and extension services (30%). With regards to sources of the training and extension services, farmers obtained information on the various ISFM components from diverse sources, including government/public extension agencies, agricultural NGOs, private companies, fellow farmers, agricultural development programs (ADPs), and other extension providers (*Figure 4*). The analysis shows that government extension agencies, agricultural NGOs /private companies, and other extension providers were the widely accessed sources of knowledge. The main sources/providers of training and extension services are government extension agencies, NGOs, and private companies in the cocoa industry across the four countries. In addition, Ghana had Government agencies as the second most important service provider, with Côte d'Ivoire, Cameroon, and Nigeria having other providers as the second highest. Though farmers receive extension services and information from other sources, such as other farmers, agro-input dealers within their communities, and ADPs, these are minimal.



	0_4	5_9	10_14	15_19	20_24	25_29	30_34	35_39	40_44	45_49	50_54	55_59	60_64	65_69	70_74	75_79	80_84	85_89	90_94	95_100
CAMEROON	1.78	2.14	8.20	12.9	11.1	9.04	9.63	12.9	9.99	6.78	5.35	3.33	2.85	1.66	0.48	0.83	0.48	0.12	0.00	0.24
COTE D'IVOIRE	0.13	0.13	1.13	5.76	18.9	17.7	17.6	13.5	11.2	5.89	3.51	2.38	1.25	0.38	0.25	0.00	0.00	0.00	0.00	0.00
GHANA	0.00	0.12	0.12	0.86	5.88	9.18	12.7	15.1	17.0	15.6	9.55	6.61	3.30	1.84	1.22	0.49	0.12	0.00	0.12	0.00
NIGERIA	0.26	0.40	1.32	1.46	2.91	4.64	9.93	9.67	13.9	15.5	12.4	12.5	7.15	3.71	2.65	0.93	0.26	0.26	0.00	0.00

Figure 3. Distribution of household along the Poverty Probability index scale



	Government agencies	NGOs	Fellow farmers	Agro-dealers	Agricultural Development Programme(ADP)	Other Providers
Cameroon	28.7	29	6.6	3.9	3.9	25.7
Cote d'Ivoire	96	1.2	0.2	0	0	2.6
Ghana	55.1	71.2	3.1	1.1	0.1	1
Nigeria	3	62.8	5.4	2.9	1.1	36.3

Figure 4. Sources of training and extension services

Table 16. Access to training and extension services

Ext./ training	Sex	Cameroon (829)		Côte d'Ivoire (778)		Ghana (817)		Nigeria (793)		Total (3225	
		Freq.	%	Freq.	%	Freq.	%	Freq.	%	Freq.	%
Yes	Male	306	36.9	566	72.7	493	60.3	585	73.8	1950	60.4
	Female	25	3.0	30	3.9	213	26.1	143	18.0	411	12.7
	Total	**331**	**39.9**	**596**	**76.6**	**706**	**86.4**	**728**	**91.8**	**2361**	**73.0**
No	Male	74	8.9	165	21.2	71	8.7	46	5.8	356	11.0
	Female	424	51.1	17	2.2	40	4.9	19	2.4	500	15.5
	Total	**498**	**60.1**	**182**	**23.4**	**111**	**13.6**	**65**	**8.2**	**856**	**27.0**

Source: Survey data, 2019

3.4.2 Access to credit

Access to credit mostly plays a significant role in agricultural production, especially the production of cash crops. The frequency distribution of farmers who requested and received credit compared with the sample size is presented in *Figure 5*.

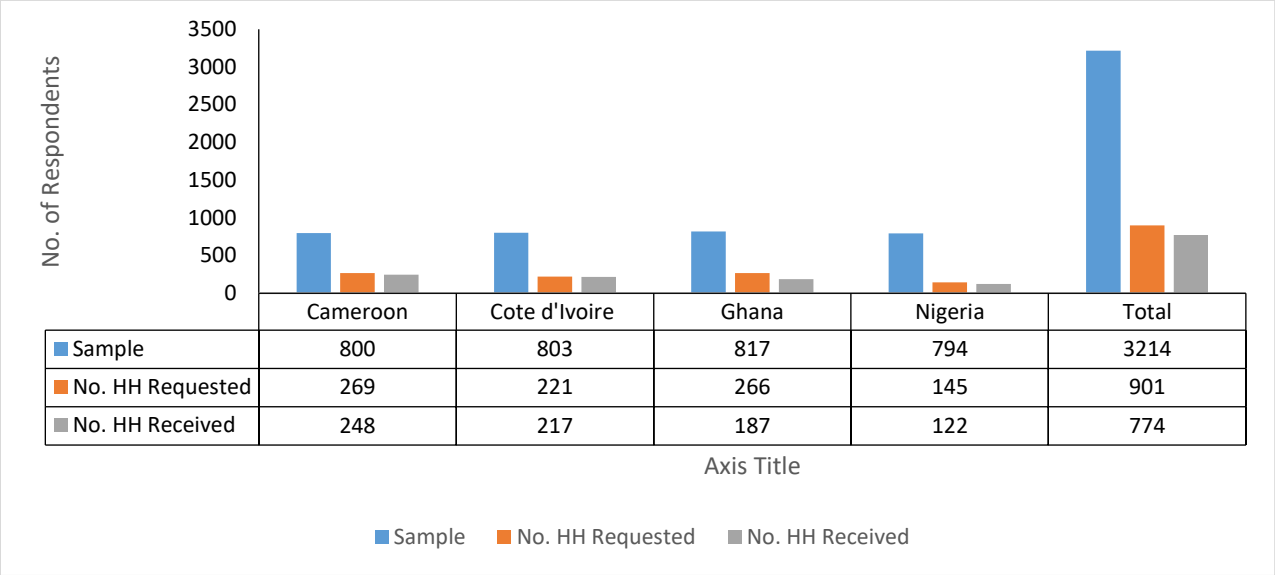
About one-third of respondents across the countries requested credit (cash) in the last year with good access *(Table 18)*. The percentage of respondents who received credit was far higher among male farmers than female farmers *(Table 19*). However, several respondents did not request credit and gave several reasons why (*Figure 6*).

Respondents received credit from diverse sources, including CBOs, friends, banks/microfinance institutions, NGOs, private lenders, self-help, and others. Friends and other sources provide the most access to credit. About 41% of credit was utilized on farm input, seeds, and fertilizer, and about 22% was utilised on school fees. The rest was used on other household expenditure items (*Table 20*). This suggests that an increased request and access to credit could facilitate the purchase and use of farm inputs, seed, and fertilizer, including ISFM components.

Table 17. Summary of type of training and extension services received

Type of Practice/Activity	Sex	Cameroon N = 331 (1580)		Côte d'Ivoire N = 778 (5444)		Ghana N = 706 (3526)		Nigeria N = 728 (3629)		Total N = 2543(14179)	
		Freq.	%	Freq.	%	Freq.	%	Freq.	%	Freq.	%
Preplanting practices	Male	297	89.7	485	62.3	491	69.5	582	79.9	1855	72.9
	Female	25	7.6	21	2.7	212	30.0	143	19.6	401	15.8
	Total	**322**	**97.3**	**506**	**65.0**	**703**	**99.6**	**725**	**99.6**	**2256**	**88.7**
Farm management and agronomic practices	Male	264	79.8	560	72.0	493	69.8	585	80.4	1902	74.8
	Female	27	8.2	29	3.7	213	30.2	143	19.6	412	16.2
	Total	**291**	**87.9**	**589**	**75.7**	**706**	**100.0**	**728**	**100.0**	**2314**	**91.0**
Postharvest processing	Male	298	90.0	549	70.6	493	69.8	585	80.4	1925	75.7
	Female	25	7.6	26	3.3	213	30.2	143	19.6	407	16.0
	Total	**323**	**97.6**	**575**	**73.9**	**706**	**100.0**	**728**	**100.0**	**2332**	**91.7**
Marketing/financial management	Male	298	90.0	25	3.2	493	69.8	585	80.4	1401	55.1
	Female	25	7.6	1	0.1	213	30.2	143	19.6	382	15.0
	Total	**323**	**97.6**	**26**	**3.3**	**706**	**100.0**	**728**	**100.0**	**1783**	**70.1**
Processing and transformation of beans	Male	296	89.4	5	0.6	492	69.7	577	79.3	1370	53.9
	Female	25	7.6	0	0.0	213	30.2	143	19.6	381	15.0
	Total	**321**	**97.0**	**5**	**0.6**	**705**	**99.9**	**720**	**98.9**	**1751**	**68.9**

Source: Survey data, 2019; *Numbers in brackets are N for multiple responses by respondents



	Cameroon	Cote d'Ivoire	Ghana	Nigeria	Total
Sample	800	803	817	794	3214
No. HH Requested	269	221	266	145	901
No. HH Received	248	217	187	122	774

Figure 5. Request and access to credit

Table 18. Request for credit by gender

Access	Sex	Cameroon (269)		Côte d'Ivoire (221)		Ghana (266)		Nigeria (145)		Total (901)	
		Freq	%	Freq	%	Freq.	%	Freq	%	Freq	%
Yes	Male	221	82.2	206	93.2	137	16.8	99	12.5	663	73.6
	Female	27	10	11	5	50	6.1	23	2.9	111	12.4
	Total	**248**	**92.2**	**217**	**98.2**	**187**	**22.9**	**122**	**15.4**	**774**	**86**
No	Male	21	7.8	4	1.8	56	6.9	18	2.3	99	11
	Female	0	0	0	0	23	2.8	4	0.5	27	3
	Total	**21**	**7.8**	**4**	**1.8**	**79**	**9.7**	**22**	**2.8**	**126**	**14**

Table 19. Access to credit by gender

Request	Sex	Cameroon (827)		Côte d'Ivoire (779)		Ghana (817)		Nigeria (790)		Total (3213)	
		Freq	%	Freq	%	Freq.	%	Freq	%	Freq	%
Yes	Male	242	29.3	210	27	193	8.9	27	3.4	552	17.2
	Female	27	3.3	11	1.4	73	23.6	118	14.9	349	10.9
	Total	**269**	**32.5**	**221**	**28.4**	**266**	**32.6**	**145**	**18.3**	**891**	**28**
No	Male	486	58.8	522	67	371	45.4	514	64.7	1893	58.9
	Female	72	8.7	36	4.6	180	22	135	17	423	13.2
	Total	**558**	**67.5**	**558**	**71.6**	**551**	**67.4**	**649**	**81.7**	**2316**	**72**

Table 20. Use of credit received

Use of credit	Cameroon (248)		Côte d'Ivoire (217)		Ghana (187)		Nigeria (122)		Total (774)	
	Freq.	Percent.	Freq.	Percent.	Freq.	Percent.	Freq.	Percent.	Freq.	Percent.
Buy/hire land	1	0.4	3	1.4	5	2.7	3	3.1	12	1.6
Buy fertilizer	9	3.6	69	31.8	25	13.3	1	1	104	13.4
Buy seeds	2	0.8	2	0.9	0	0	1	1	5	0.6
Buy farm inputs	86	34.7	7	3.2	55	29.3	65	66.3	213	27.5
Medical expenses	21	8.5	32	14.7	18	9.6	0	0	71	9.7
School fees	40	16.1	62	28.6	45	23.9	20	20.4	167	21.6
Trade	4	1.6	4	1.8	15	8	2	2	25	3.2
Other uses	85	34.3	38	17.6	25	13.3	30	6.1	173	22.4

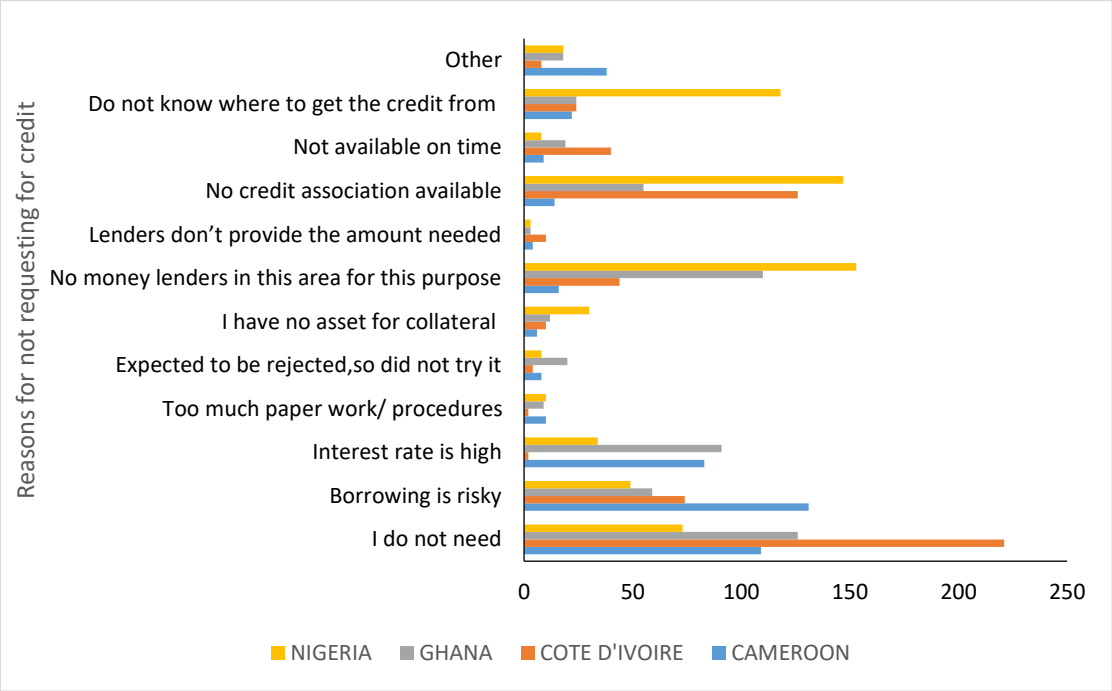


Figure 6. Reasons for not requesting credit

3.4.3 Awareness and use of ISFM practices

3.4.3.1 Awareness of ISFM practices

Over the years and as indicated by the high percentage of respondents with access to training and extension services, several ISFM components have been introduced, and farmers have been trained in their application in the study areas across the countries. In this study, respondents were asked to provide information about their knowledge of the various ISFM components that they knew. This section focuses on farmers' awareness of the various components of ISFM and their use of such components.

About 65% of the respondents are aware of at least one component of ISFM, as outlined in Table 21, across the four countries (based on the overall sample size of the survey). The average awareness levels per country stand at 58% in Cameroon, 83% in Côte d'Ivoire, 75% in Ghana, and 59% in Nigeria. Knowledge of the use of mineral fertilizer, pest management, manual weeding, and intercropping in young cocoa is higher, ranging between 80% and 98% in Cameroon and Ghana. In Côte d'Ivoire, as well, knowledge of structural pruning, sanitary pruning, pest management, and manual weeding is very high. Whereas manual weeding had the highest awareness level in Nigeria (91%) and site selection (88%). Knowledge of the use of organic fertilizer was much less in Cameroon and Nigeria except Ghana, whereas awareness of weeding by herbicides was rare in Nigeria (10%) and highest in Ghana (60%). Knowledge of the use of organic fertilizer, use of improved seeds, intercropping in mature cocoa, and use of herbicide was low in Côte d'Ivoire. With the country difference across the different ISFM components, it will require specific review and adjustment to any training content to be delivered to farmers in the study area.

Table 21. Awareness of ISFM practices in cocoa production

ISFM Component	Cameroon N = 838		Côte d'Ivoire N = 803		Ghana N = 827		Nigeria N = 807		Total N = 3275	
	Freq.	%	Freq.	%	Freq.	%	Freq.	%	Freq.	%
Mineral fertilizer	667	79.6	714	88.9	814	98.4	460	57	3369	82.6
Organic fertilizer	292	34.8	469	58.4	721	87.2	475	58.9	2426	59.5
Structural pruning	560	66.8	735	91.5	658	79.6	475	58.9	3163	77.6
Sanitary pruning	535	63.8	803	100	750	90.7	588	72.9	3479	85.3
Pest management	575	68.6	800	99.6	809	97.8	559	69.3	3543	86.9
Weeding using herbicides	322	38.4	489	60.9	493	59.6	80	9.9	1873	45.9
Manual weeding	633	75.5	803	100	822	99.4	738	91.4	3799	93.2
Presence of shade	524	62.5	493	61.4	408	49.3	511	63.3	2429	59.6
Use of improved varieties	475	56.7	101	12.6	553	66.9	268	33.2	1397	34.3
Site selection	488	58.2	694	86.4	654	79.1	711	88.1	2547	62.5
Intercropping in young cocoa	566	67.5	449	55.9	669	80.9	601	74.5	2285	56.03
Intercropping in mature cocoa	226	27	127	15.8	185	22.4	265	32.8	803	18.9

Source: Survey data, 2019

3.4.3.2 Use of ISFM practices

The use of the various ISFM components was computed based on the number of respondents who knew and were aware of such components and being applied or used in one plot or more than one. Table 22 shows the level of use (by frequency and percentage) of each ISFM component per country. The table indicates that there is a strong relationship between awareness and use of the various components except for a few components.

In all, structural pruning, sanitary pruning, pest management, manual weeding, improved varieties, and site selection were the most used practices across the countries. With regards to mineral fertilizer, 78%. 89% and 84% of respondents who were aware in Cameroon, Côte d'Ivoire, and Ghana were using this component, but in Nigeria, only 17% out of 57% who were aware were using this component. Pest management is a component with high awareness and use levels across the countries. Between 80% and 97% of respondents who were aware were using this component as well. Nigeria, however, has the highest use of herbicides (94%) among the 10% of respondents who knew about it. This suggests that an increased awareness level among respondents can increase the level of use as well.

In Cameroon, fertilizer is applied mostly on the first two plots of the respondents (68% of plot 1 and 73% of plot 2), and the most commonly used fertilizers are Agrovert, Folivert, Banzai, Urea, and NPK 20-10-10, which are mainly applied by ring placement and spraying. Fungicides were primarily used to manage blackpod disease, as indicated by respondents. In Côte d'Ivoire, the commonly used fertilizer is NPK 0-23-19, which is mostly applied through ring placement. In Ghana, fertilizer application is done on 85% of the first two plots of respondents. The most commonly used fertilizers are Sidalco, Cocofeed, and Asaasewura, which are mostly applied by ring placement, spraying, and broadcasting. In Nigeria, fertilizer application is done on 6% of plots. The most commonly used fertilizers are NPK 15 -15 -15 and Super Gro, mainly applied by ring placement and spraying.

The sequence of application of these ISFM components was also assessed using the frequency and period of application. For fertilizer application, most respondents applied from January to December, in most cases, across the three countries. In Cameroon, about 22% of respondents applied fertilizer every month of the year regardless of the recommendation to apply in May–June when the rains have stabilized. Pruning is similarly done outside the recommended periods of February and July–November. A similar story exists across Ghana and Nigeria, where fertilizer application is done between March and December. In Côte d'Ivoire, fertilizer application is done between March and June, and from January to December in Nigeria. These inconsistencies could affect the yield levels through these inputs and practices being used by respondents.

Table 22. Use of ISFM practices

ISFM Component	Cameroon			Côte d'Ivoire			Ghana			Nigeria			Total	
	Freq.	%		Freq.	%		Freq.	%		Freq.	%		Freq.	%
Mineral fertilizer	518	77.7		548	76.8		680	83.5		80	17.4		2374	70.5
Organic fertilizer	207	70.9		179	38.3		306	42.4		249	52.4		1120	46.2
Structural pruning	424	75.7		568	70.7		573	87.1		399	84		2532	80.1
Sanitary pruning	386	72.1		733	91.3		709	94.5		468	79.6		3029	87.1
Pest management	460	80		570	71		781	96.5		534	95.5		2915	82.3
Weeding using herbicides	150	46.6		59	7.3		273	55.4		75	93.8		616	32.9
Manual weeding	607	95.9		783	97.5		822	100		734	99.5		3729	98.2
Importance/presence of shade trees	389	74.2		659	82.1		154	37.7		439	85.9		2300	94.7
Use of improved varieties	419	88.2		20	19.8		408	73.8		268	100		1115	79.8
Site selection	392	80.3		379	54.6		566	86.5		598	84.1		1935	76
Intercropping in young cocoa	429	75.8		436	97.1		261	39		508	84.5		1634	71.5
Intercropping in mature cocoa	153	67.7		94	74		81	43.8		233	87.9		561	72.9

Source: Survey data, 2019. ***Percentages are based on the total number of respondents that are aware of each practice.*

3.4.3.3 Correlation between awareness and use of ISFM practices

From *Table 23*, results show a high correlation between awareness and use of the ISFM components. The majority of respondents who were aware of the various ISFM components also used such components.

Table 24 presents a correlation between household characteristics and ISFM components across the four countries. Results show that, in Cameroon, there is a high and positive relationship between the age of farmers and their use of improved planting material; older farmers have a higher demand for improved planting materials, and this may be a result of their quest to benefit from their investments as quickly as possible. In Côte d'Ivoire, there is a positive and significant relationship between education and the use of improved planting material; the more educated farmers tend to have a higher affinity for the use of improved planting material, and this may be explained by their superior knowledge of its benefit.

Table 23. Correlation between awareness and use of ISFM practices

	Cameroon	Côte d'Ivoire	Ghana	Nigeria
Awareness	**Use of ISFM practices**			
Mineral fertilizer	0.340**	0.515**	0.272**	0.288**
Organic fertilizer	0.438**	0.454**	0.294**	0.558**
Structural Pruning	0.552**	0.802**	0.729**	0.676**
Sanitary Pruning	0.485**	0.835**	0.750**	0.435**
Pest management	0.555**	0.683**	0.398**	0.727**
Weeding using herbicides	0.522**	0.468**	0.541**	0.356**
Manual weeding	0.709**	0.705**	0.255**	0.475**
Shade management	0.575**	0.813**	0.447**	0.614**
Use of improved varieties	0.723**	0.397**	0.669**	0.388**
Site selection	0.701**	0.328**	0.700**	0.473**
Intercropping in young cocoa	0.512**	0.677**	0.297**	0.581**
Intercropping in matured cocoa	0.587**	0.637**	0.546**	0.608**

Source: Survey data, 2019. **correlation is significant at 0.01 level (2-tailed).

BOX I: ***Reasons for low fertilizer use in Nigeria (nonedited responses)***

Reasons	***Frequencies***		
	Male	***Female***	***Total***
Limited technical knowledge	*42*	*6*	*48*
Non availability of the input	*59*	*10*	*69*
Lack of cash/credit to buy input	*70*	*13*	*83*
Incompatibility of technology /susceptibility to diseases/ pests	*3*	*0*	*3*
Additional input expensive	*34*	*10*	*44*
Poor taste of new variety	*1*	*2*	*3*
Low yielding after used	*4*	*0*	*4*
Low market prices of output	*1*	*0*	*1*
No market for surplus output	*1*	*1*	*2*
Requires high skills	*3*	*0*	*3*
Content with current practices/variety	*4*	*0*	*4*
Low market demand	*0*	*0*	*0*
Not aware of it	*4*	*1*	*5*
Don't need it (soil is already fertile)	*12*	*2*	*14*
Total	***238***	***45***	***283***

Table 24. Correlation between household and characteristics and ISFM components

Country	Education	Sex	Age of Farmer	No. of Extension Contacts	Household Size	Size of Farm	Cocoa Farming Experience	Credit Access
Use of improved planting material								
Cameroon	0.04	−0.023	0.063	0.041	0.042	0.031	0.045	0.048
Côte d'Ivoire	0.097**	0.007	−0.023	−0.017	−0.028	−0.073*	−0.065	0.045
Ghana	0.035	0.101**	−0.031	0.044	0.038	0.004	−0.043	0.074*
Nigeria	0.06	0.009	−0.02	0.101**	0.031	0.119**	−0.058	−0.002
Fertilizer application								
Cameroon	0.077*	0.005	−0.004	0.143**	−0.014	−0.082*	−0.033	0.073*
Côte d'Ivoire	−0.064	0.102**	0.018	0.085*	0.058	0.170**	0.055	0.103**
Ghana	0.095	0.185**	0.018	0.019	0.047	0.056	0.132**	0.101**
Nigeria	0.088	0.059	−0.038	−0.084*	0.128**	0.05	−0.016	0.03
Punning								
Cameroon	0.048	0	0.019	−0.011	0.117**	−0.072*	−0.072	−0.078*
Côte d'Ivoire	−0.055	0.101**	0.031	0.126**	0.068	0.049	−0.039	−0.029
Ghana	−0.033	0.053	0.02	−0.063	−0.061	−0.042	−0.016	0.058
Nigeria	0.042	0.139	−0.035	0.042	−0.055	−0.006	−0.026	0.134**
Weed management								
Cameroon	−0.033	0.035	0.047	0.057	0.04	−0.004	0.028	−0.014
Côte d'Ivoire	0.016	0.135**	0.01	0.07	0.014	0.053	0	0.034
Ghana	0.015	0.015	−0.001	−0.006	−0.041	0.01	−0.017	0.043
Nigeria	0.015	0.001	−0.028	−0.008	0.024	−0.002	−0.03	0.041
Shade management								
Cameroon	0.044	−0.011	0.056	0.059	0.132**	−0.093**	−0.007	−0.057
Côte d'Ivoire	0.015	0.037	0.022	0.036	0.007	−0.047	−0.097**	0.077**
Ghana	0.03	−0.006	0.026	−0.075	−0.005	0.023	−0.075*	−0.031
Nigeria	−0.011	0.0047	−0.027	0.034	0.05	−0.002	−0.05	0.064
Intercropping in young cocoa								
Cameroon	0.067	−0.077*	0.077*	0.074*	0.112**	−0.097*	−0.047	−0.004
Côte d'Ivoire	−0.012	0.022	−0.078*	0.101**	0.041	0.012	0.008	0.067
Ghana	0.035	−0.031	0.017	−0.008	0.065	−0.017	−0.076*	0.009
Nigeria	0.014	0.034	−0.012	0.114**	0.008	−0.022	0.016	−0.065
Pest management								
Cameroon	0.069*	0.006	0.079	0.072*	0.068*	0.02	0.027	0.01
Côte d'Ivoire	−0.057	0.053	0.035	0.029	0.028	0.065	0.089*	0.014
Ghana	0.025	0.098**	0.009	0.006	−0.024	0.041	−0.009	0.043
Nigeria	−0.007	0.044	−0.039	0.086	−0.02	−0.067	0.03	0.119

Source: Survey data, 2019. **correlation is significant at 0.01 level (2-tailed).

Sex has a positive and significant relationship with the use of improved planting material in Ghana, which means male farmers use improved planting materials more than female farmers; this can be explained by their greater involvement in extension programs than female farmers. In Nigeria, the number of extension contacts has a positive and significant relation with the use of improved variety; this means extension education has a good influence on farmers' use of improved planting material.

Education and number of extension contacts have a positive and significant relationship with fertilizer application in Cameroon; hence the more educated a farmer is, the higher the chance of applying fertilizer, and the more extension delivered to a farmer also shows a higher chance

of application of fertilizer. In Côte d'Ivoire, the sex of the farmer, number of extension contacts, size of farm, and credit access all have a positive and significant relationship on the application of fertilizer. This means male farmers have a higher chance of applying fertilizer which can be explained by their better economic standards as compared to female farmers. The number of extension contacts also means more education on the use of fertilizer, which will influence positively the use of fertilizer. Farmers with higher plot sizes are applying fertilizer more because most are likely to be more resourced and will have better experience with fertilizer application. Credit access means more money for a farmer which means they are better positioned to purchase and use more fertilizer on the farm. In Ghana, sex, cocoa farming experience, and credit access have a positive and significant relationship with fertilizer application, this means more male farmers are applying fertilizer, and this can be supported by them being relatively more resourced than female farmers. More experienced cocoa farmers have tried various ways of increasing their yield, so they have a higher tendency to use fertilizer on their farms. Credit access also means more money for the farmer so they can invest in the purchase of fertilizer for application. The larger size of farmers has a positive and significant relationship with farmers' fertiliser application in Nigeria; this might be explained by the availability of labour on their end during application.

In Cameroon, household size has a positive and significant relationship with pruning; since pruning is a labour-intensive activity, the availability of more hands to assist will enhance its practice. In Côte d'Ivoire, sex and number of extension contacts have a positive and significant relationship with pruning, meaning more male farmers tend to carry out pruning than females, and this can be explained by its labour intensiveness. Furthermore, the higher extension contacts a farmer receives means there is more monitoring on his farm, so they will be under compulsion to prune and keep their farm well pruned. In Ghana, the sex of the farmer and credit access have a positive relationship with pruning practices. This means male farmers who can carry out more labour-intensive activities have a higher chance of pruning, and farmers who have access to credit have the capital to hire more labourers to help prune their farms. In Nigeria, credit access has a positive and significant relationship with pruning; this means that the availability of capital will enhance farmers' ability to engage more labourers on the farm to prune.

The number of extension contacts has a positive and significant relationship with weed management in Cameroon; this means that farmers will carry out weed management with more monitoring from extension officers. In d'Ivoire, sex has a positive and significant relationship with weed management. This means male farmers are more likely to carry out weed management activities, and this is explained by its labour intensiveness. Credit access by farmers in Ghana and Nigeria has a positive relationship with weed management; this means with more money, these farmers are able to engage labourers to carry out weeding on their farms.

Household size has a positive and significant relationship with shade management in Cameroon; farmers with a larger household size may be prone to grow more trees on their farms due to available labour. In Côte d'Ivoire and Nigeria, credit access has a positive and significant relationship with shade management; this means farmers have money to purchase and plant shade trees of their choice and in the correct quantity on their farms. In Ghana, the education and age of a farmer have a positive relationship with shade management; hence, more educated

farmers appreciate the benefit of shade management and tend to practice it. Also, older farmers with more experience may have benefited from shade management over the years, hence their practice of shade management.

The number of extension contacts, age of the farmer, and household size have a positive and significant relationship with intercropping in cocoa in Cameroon. The increased interaction with extension officers tends to increase farmers' interest in planting crops in their cocoa farms. Aged farmers and households with a higher population have high labour available and will need more of these crops to supplement food at home. In Côte d'Ivoire, the number of extension contacts has a positive and significant relationship with intercropping in cocoa; this means more extension visits are likely to increase farmers' interest in planting other crops with cocoa. Household size has a positive and significant relationship with intercropping among Ghanaian farmers. This means the higher the household size, the more labour tends to be available to be engaged, and more people need to be fed at home; hence, the motivation is high for growing supplementary foods.

Among Cameroon farmers, the number of extension contacts and household size have a positive and significant relationship with pest management. Extension agents' frequent visits ensure farmers conform to good practices, and a larger household size provides extra labour to farm activities. In Côte d'Ivoire, cocoa farming experience has a positive and significant relationship with pest management; more experienced cocoa farmers who might have experienced the effect of pests on their cocoa yield will be forced to take measures against it more. The sex of the farmer has a positive and significant relationship with pest management in Ghana; male farmers tend to engage in pest management more than females, and this may be explained by them being better resourced. In Nigeria, the number of extension contacts has a positive and significant relationship with pest management; hence, the more extension visits, the more farmers are likely to practice pest management activities.

3.4.4 Productivity of cocoa plantations

3.4.4.1 Age of plantations surveyed

Available studies show that the age of a cocoa plantation determines, to a larger extent, the productive nature of the farm. Productive farms are categorized as mature and adult between the ages of 4 and 13 years and 14 and 25 years, respectively (Asare et al., 2018).

Table 25 shows the age categories of the first plots (plot 1) of each respondent. Côte d'Ivoire, Cameroon, and Ghana have 71%, 68%, and 73% of first plots within the mature and adult categories respectively. Nigeria has about 44% of the first plots within the mature and adult categories, and about 54% falls within the old category. This suggests that more farms are old in Nigeria.

The second plot (plot 2) of the respondents indicates a similar trend of 60%, 71%, and 74% for Cameroon, Côte d'Ivoire, and Ghana, respectively, as being in the mature and adult categories, whereas, in Nigeria, most second plots are within the old age category.

Table 25. Age of cocoa plantation

Country	1–3 years		4–13 years		14–25 years		> 25 years	
	Freq.	%*	Freq.	%*	Freq.	%*	Freq.	%*
Cameroon	37	4.4	288	34.4	282	33.6	231	27.6
Côte d'Ivoire	45	5.7	254	32.3	308	39.1	180	22.9
Ghana	13	1.6	241	29.7	355	43.7	203	25.0
Nigeria	19	2.4	120	14.9	235	29.2	431	53.5

Source: Survey data, 2019; * percentage per country

3.4.4.2 Previous land use of plantations surveyed

Previous land use is a household factor in the survey to ascertain the use of forests for cocoa establishment. The previous land use of the first two plots was assessed for all respondents. *Table 26* shows that 66%, 50%, and 70% of the first two plots of respondents were previously forests in Cameroon, Côte d'Ivoire, and Nigeria, respectively. In contrast, Ghana has an almost equal distribution between fallow and forest (39% and 34%, respectively) and about 18% old cocoa trees. Having previous land uses as forest and fallow suggests a possible expansion of plots into such areas (if available) and needs to be monitored.

3.5 Yield distribution and average yield estimate

Yields are computed at the farm level, using the total production of cocoa beans as reported by farmers in the last three years against the estimated land area. Table 27 indicates that about 50% to 77% of respondents produce below 200 kg/ha and up to 600 kg/ha, with an average of about 429 kg/ha in Cameroon, about 391 kg/ha in Côte d'Ivoire, about 526 kg/ha in Ghana, and 369 kg/ha in Nigeria (Table 28). About 32.4 % of respondents also have yields above 2000 kg/ha, with Cameroon having over 15% of these respondents.

These data exclude outliers. Though the yield estimates are close in Cameroon, Côte d'Ivoire, and Nigeria, there are slight differences between genders, with male respondents having slightly higher yields than their female counterparts.

3.6 Understanding the yield differences—below and above potential yields

To understand the causes of the yield differences, the management practices carried out by respondents whose yields are above the potential yield level were analyzed in *Figure 7*, which suggests what such respondents are doing differently.

Table 30 shows the test of significance between the various ISFM components used and the yields computed. The use of fertilizer has a positive relationship with yield in Cameroon, Côte d'Ivoire, and Ghana. In Nigeria, this has a negative relation; however, the low use of fertilizer and at inappropriate periods in Nigeria might have accounted for this.

The use of fungicides also has a positive relationship with yields in Cameroon, Côte d'Ivoire, Ghana, and Nigeria. In Cameroon, Côte d'Ivoire, and Ghana, this relationship is significant as well.

Pruning, use of improved variety, and shade management have a positive relationship with yield in Cameroon, Côte d'Ivoire, and Ghana; however, in Nigeria, these relationships are negative.

The age of cocoa farms has a positive and significant relationship with yield in Cameroon, Côte d'Ivoire, Ghana, and Nigeria.

Table 26. Previous land use[5]

Type of land use	Cameroon		Côte d'Ivoire		Ghana		Nigeria	
	No. of Plots	%	No. of Plots	%	No. of Plots	%	No. of Plots	%
Cultivated_Annual	16	1.3	8	0.9	79	5.9	51	4.9
Cultivated_ Perennial	53	4.4	198	22.9	28	2.1	79	7.7
Fallow	40	3.3	150	17.4	521	39.1	73	7.1
Forest	800	66.3	432	50.1	447	33.6	721	69.9
Homestead	15	1.2	0	0	2	0.1	0	0
Old_cocoa_trees	115	9.5	73	8.5	244	18.4	103	10
Rented_out	6	0.5	0	0	2	0.1	2	0.2
Savanna	161	13.4	2	0.2	9	0.7	2	0.2
Wood	1	0.1	0	0	0	0	1	0.1
Total Plots (1 and 2)	1207	100	863	100	1332	100	1032	100

Source: Survey data, 2019

The average yields of respondents across the countries were analyzed using the potential yields of 500 kg/ha as the benchmark. Table 28 shows the average yield across the four countries and the yearly yields using a potential yield cap of 500 kg/ha. Table 29 presents average yields of respondents using uncapped raw responses from respondents.

Table 27. Yield distribution

Yield distribution (kg/ha)	Cameroon		Côte d'Ivoire		Ghana		Nigeria	
	Freq.	%	Freq.	%	Freq.	%	Freq.	%
0–200	157	**18.7**	220	**28**	147	**18.1**	293	**36.8**
201–400	145	**17.3**	179	**22.8**	179	**22**	212	**26.6**
401–600	113	13.5	153	**19.5**	129	**15.9**	106	13.3
601–800	116	13.8	92	11.7	90	11.1	60	7.5
801–1000	66	7.9	60	7.6	73	9	34	4.3
1001–1200	45	5.4	22	2.8	55	6.8	21	2.6
1201–1400	29	3.5	17	2.2	25	3.1	7	0.9
1401–1600	14	1.7	7	0.9	22	2.7	5	0.6
1601–1800	12	1.4	3	0.4	19	2.3	5	0.6
1801–1900	4	0.5	2	0.2	6	0.7	2	0.3
1901–2000	9	1.1	1	0.1	7	0.9	3	0.4
>2000	128	**15.2**	30	3.8	60	7.3	48	6.1
TOTAL	838	100	786	100	812	100	796	100

Source: Survey data, 2019

[5] The previous land use was assessed using both plots 1 and plot 2 of the respondents

Table 28. Average yield (kg/ha) — potential yield

Avg. plot size (ha)	Cameroon			Côte d'Ivoire			Ghana			Nigeria		
	Male	Female	Avg.	Male	Female	Avg.	Male	Female	Avg.	Male	Female	Avg.
	2.6	2.4	2.5	2.7	2.2	2.5	1.8	1.4	1.6	2.3	1.6	2
Yield 2015/16	432.9	370.7	401.8	432.5	343.2	387.9	606.1	473.7	539.9	400.9	340.7	370.8
Yield 2016/17	461.4	397.5	429.5	437.4	377.1	407.3	593.1	450.6	521.9	403.9	330.3	367.1
Yield 2017/18	432.9	403.8	454.9	426	330.7	378.3	592.6	438.7	515.7	403.5	335.3	369.4
Avg. 3 Yrs	466.8	390.7	428.8	432	350.3	391.2	597.3	454.3	525.8	402.8	335.4	369.1

Table 29. Average yield (kg/ha) — raw yield data

Avg. plot size (ha)	Cameroon			Côte d'Ivoire			Ghana			Nigeria		
	Male	Female	Average	Male	Female	Average	Male	Female	Average	Male	Female	Average
	2.60	2.43	2.5	2.72	2.20	2.46	1.75	1.38	1.6	2.31	1.64	2
Yield 2015/16	893.7	728.9	811.3	503.5	343.2	423.4	891.4	616.6	754.0	571.6	409.2	490.4
Yield 2016/17	978.5	735.2	856.9	527.1	377.1	452.1	873.6	611.5	742.6	556.9	451.5	504.2
Yield 2017/18	2928.5	735.7	1832.1	469.5	735.7	602.6	844.8	598.5	721.7	444.0	286.4	365.2
Avg. 3 Yrs	1600.2	733.3	1166.8	500.0	485.3	492.7	869.9	608.9	739.4	524.2	382.4	453.3

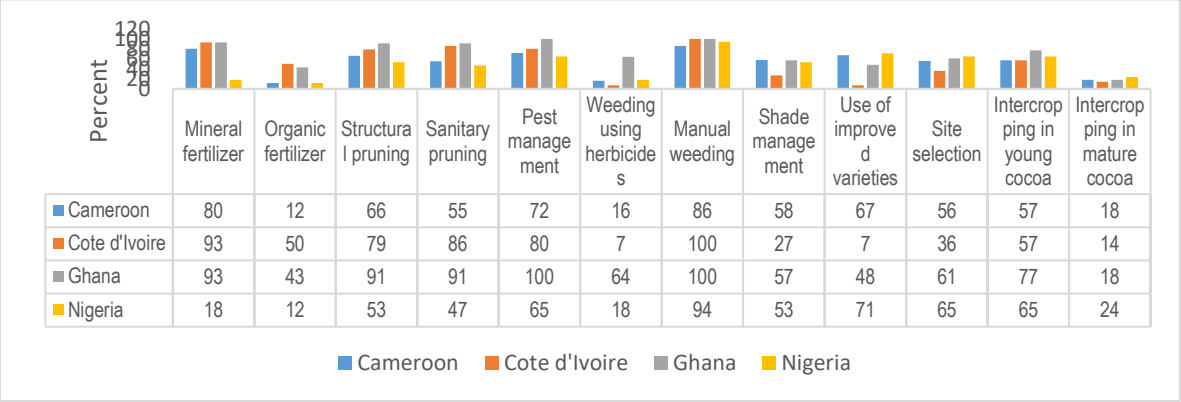


Figure 7. Management practices carried out by respondents whose yields are above the potential and ISFM components

Table 31 shows the relationship and test of significance between the various ISFM components used and the yields above potential computed. Pruning has a positive relationship with yield in

Cameroon, Côte d'Ivoire, Ghana and Nigeria. The application of fungicide has a positive relation with yield in Cameroon, Côte d'Ivoire and Nigeria but a negative one in Ghana.

Shade management has a positive relationship with yield in Cameroon, Côte d'Ivoire, Ghana and Nigeria. Fertilizer application has a positive relationship with yield in Cameroon and Côte d'Ivoire but a negative one in Ghana and Nigeria. The use of improved variety has a positive relationship with yield in Cameroon and Nigeria. The age of cocoa has a positive relationship with yield in Cote d'Ivoire only.

Table 30. Correlation between yield below potential and ISFM components

Parameter	Cameroon	Côte d'Ivoire	Ghana	Nigeria
Improved variety (Hybrid)	0.016	–0.103**	0.046*	–0.033
Fertilizer	0.021	0.151**	0.154**	0.021
Fungicide use	–0.048	0.122**	0.093*	0.047
Pruning	0.035	0.218**	–0.048	–0.057
Weed management	–0.075	0.077*	0.022*	–0.046
Blackpod management	–0.048	0.122**	0.093*	0.047
Shade	0.078	0.076**	–0.058	0.026
Age of cocoa farm	0.035	0.271**	0.049	0.140**

Source: Survey data, 2019. ** significant at 0.01 level and *significant at 0.05 level

Table 31. Correlation between yield above potential and ISFM components

Parameter	Cameroon	Côte d'Ivoire	Ghana	Nigeria
Improved variety (Hybrid)	0.059	–0.117	–0.196	0.168
Fertilizer	0.044	0.575*	–0.274	–0.121
Fungicide use	0.055	0.169	–0.440**	0.185
Pruning	0.065	0.218	0.115	0.240
Weed management	–0.218*	0.117	–0.172	0.067
Blackpod management	0.055	0.169	–0.440**	0.185
Shade	0.075	0.127	0.107	–0.265
Age of cocoa farm	–0.060	0.436	–0.139	–0.115

Source: Survey data, 2019. ** significant at 0.01 level and *significant at 0.05 level

3.7 Total household income and expenditure

3.7.1 Total household income

The survey assessed the various sources of household income and the contribution of these sources to the overall household income. The income in this analysis is the gross income obtained from each source.

From *Table 32*, the surveyed households had four main sources of income: cocoa, livestock, other crops, and off-farm income. Gross income from cocoa is the highest for almost all respondents (male/female) except female respondents in Ghana who rather had off-farm income as their highest source of income.

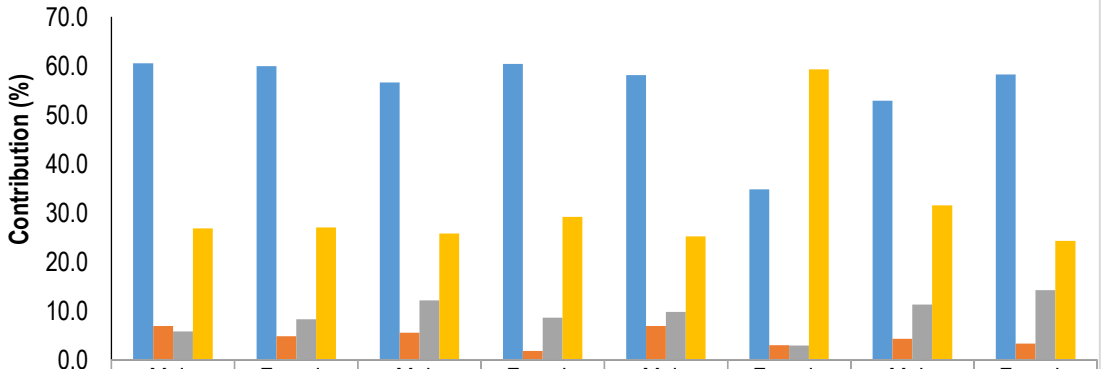
There are also differences in incomes between males and females across the four countries. From Figure 8, cocoa contributes between 53% and 61% to household incomes (both male and female) in the four countries, except for female respondents in Ghana, who had 35% of income from cocoa and 59% from off-farm activities. Off-farm income was the second highest source of income for all other respondents across the four countries.

Table 32. Gross income ($) per annum per household

Source of income	Cameroon (N = 838)			Côte d'Ivoire (N = 803)			Ghana (N = 817)			Nigeria (N = 805)		
	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total
Cocoa	3321	2215	5536	2046	935	2981	1782	1002	2785	1439	904	2343
Livestock	377	177	554	198	28	226	211	86.87	298	116	52	168
Other crops	318	305	623	436	133	569	300	82.23	382	307	220	527
Off-farm Income	1474	998	2472	937	453	1390	772	1712	2484	858	378	1236
Total gross income	5490	3695	4592	3617	1549	5166	3066	2883	2975	2720	1554	2137

3.7.2 Household expenditure

The expenditure patterns of households can determine their investment in technologies. The survey assessed the various types of expenditure items at each household level and the average amount spent on each item. From *Table 33,* household expenditure items are food, farm inputs, labour costs, and other household expenditures such as education, medical expenses, clothing, social events, airtime, taxes, and energy.



	Male	Female	Male	Female	Male	Female	Male	Female
	Cameroon		Cote d'Ivoire		Ghana		Nigeria	
Cocoa	60.5	59.9	56.6	60.4	58.1	34.8	52.9	58.2
Livestock	6.9	4.8	5.5	1.8	6.9	3.0	4.3	3.3
Other Crops	5.8	8.3	12.1	8.6	9.8	2.9	11.3	14.2
Off-Farm Income	26.8	27.0	25.8	29.2	25.2	59.3	31.5	24.3

Figure 8. Contribution of sources of income to total HH income

3.8 Food security and food access

3.8.1 Food availability and access at the household level

This section presents the results of the household food availability and access, which is defined in this survey as households having food at their disposal all year round and being able to afford it.

The study collected information about household food production and availability all year round, in which respondents had to indicate whether they had food all year round or if there were shortages

From Figure 9, between 72% and 91% of respondents indicated that they have food available all year round across the four countries. About 28% in Ghana and 9% in Côte d'Ivoire indicated shortages, whereas between 14% to 16% in Cameroon and Nigeria indicated shortages, respectively. Most food items were bought, and this suggests that food expenditure could increase during these shortages and could affect farm investments.

Among the coping strategies used by households during these periods included borrowing, reduced number of meals per day, modified cooking methods, and substituting with cheaper meals *(Figure 10*).

Table 33. Total household expenditure

Expenditure Item/Avg. Amount	Average Expenditure			
	Cameroon	Côte d'Ivoire	Ghana	Nigeria
Food per week ($)	14.27 (742)	9.59(786)	22.43 (1166)	26.52 (1379)
Fertilizer per annum ($)	41	38	56	51
Fungicide per annum ($)	86	42	55	75
Insecticide per annum ($)	75	35	69	83
Average labor cost per annum	407	200	444	439
Long-term expenditure ($)[1]	1951	1689	999	1473
Total expenditure	3302	2004	2789	3500

Source: Survey data, 2019. *Numbers in brackets are the amounts spent on food per annum

3.8.2 Household dietary diversity score (HDDS)

Dietary diversity is a qualitative measure of food consumption that reflects household access to a variety of foods and is also a proxy for nutrient adequacy of the diet of individuals (FAO Guidelines, 2011). The dietary diversity scores in this survey consist of 12 food groups that a household has consumed over a 24-hour period. The data collected was analyzed at the household level to indicate the average household dietary diversity score and the percentage of different food groups being consumed by the groups. It shows the economic capability of a household to access a variety of foods. Studies have shown that an increase in dietary diversity is associated with socioeconomic status and household food security (Hoddinot and Yohannes, 2002). The average HDDS per country as indicated in *Table 34* shows that between seven and nine food groups were consumed by the surveyed households during the 24-hour period

preceding the survey across the four countries, with Ghana consuming the least food groups. *Table 35* shows the percentage of households consuming the different food groups. Among the limited consumed food groups are eggs and milk products across the three countries, meat in Cameroon and Ghana, and legumes and nuts in Ghana.

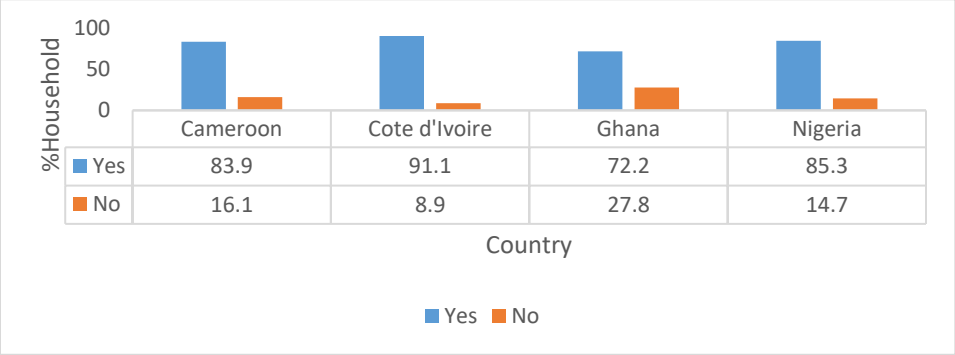
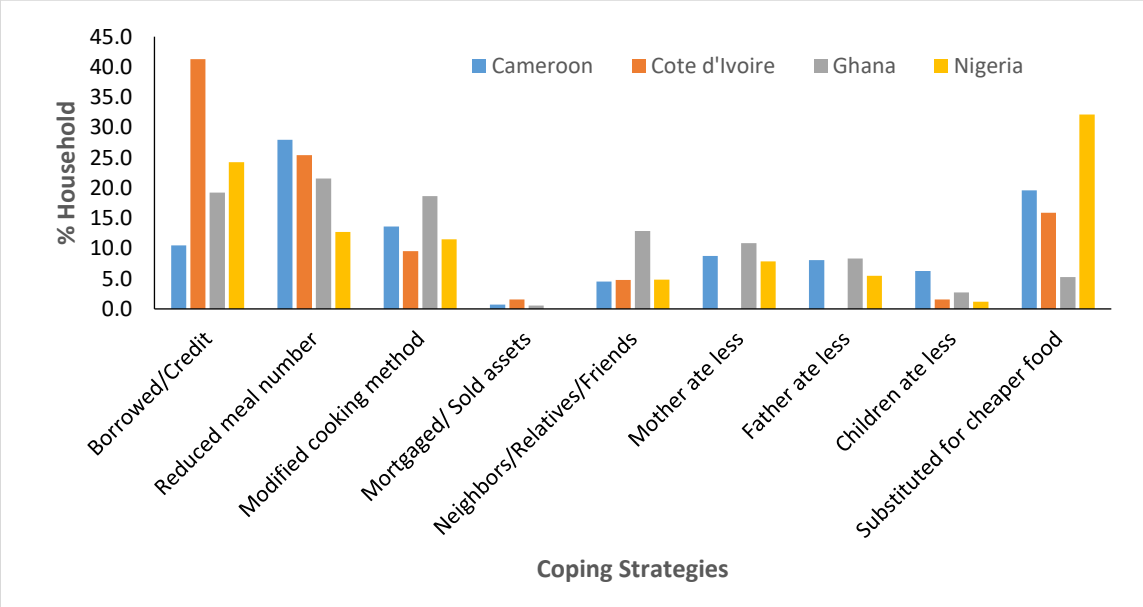


Figure 9. Availability of food all year round



Source: Survey data, 2019. *HDDS Scale: 0-12. Used 12 food groups based on FAO/FANTA

Figure 10. Coping strategies for food shortages

Table 34. Average household dietary score (HDDS)

	Cameroon	Côte d' Ivoire	Ghana	Nigeria
Average Household Dietary Diversity Score (HDDS)	7.9	7.2	7.2	8.7

Source: Survey data, 2019. *HDDS Scale: 0-12. Used 12 food groups based on FAO/FANTA

Table 35. Consumption of different food groups (%)

Food Product	Cameroon (N = 838) %	Côte d'Ivoire (N = 803) %	Ghana (N = 817) %	Nigeria (N = 805) %
Cereals and products	65.36	85.09	86.05	84.46
Vegetable	94.15	98.39	99.02	97.26
White root and tubers	67.50	65.84	85.06	93.29
Fruits	75.54	58.01	61.20	62.73
Meat	43.91	20.87	30.72	62.98
Legumes, nuts, and seeds	76.25	29.57	34.02	81.61
Eggs	26.79	7.83	16.03	32.55
Fish and other sea foods	74.16	92.55	87.64	77.89
Milk and milk products	27.26	17.27	9.79	32.05
Oils and fats (added to food or used for Cooking)	91.67	77.76	71.85	87.83
Sweets	47.14	61.49	39.53	43.98
Spices, condiments, beverages	96.67	98.88	99.51	95.16

Source: Survey data, 2019

4 DEFORESTATION, BIODIVERSITY, and ECOSYSTEM SERVICES

4.1 Baseline of ecosystem services and biodiversity in the cocoa zone of West Africa

4.1.1 Ecosystem services in the cocoa zone: Baseline

Aim: identify areas currently important for the delivery of ecosystem services within areas currently suitable for cocoa.

Methods: Baseline ecosystem services were assessed using the web-based spatially explicit ecosystem services assessment tool Co$tingNature V3 (www.policysupport.org). This tool maps 13 ecosystem services: timber, fuelwood, grazing and fodder, non-wood forest products, water, fisheries, carbon, natural hazard mitigation, culture and nature-based tourism, environmental and aesthetic quality, and wildlife services (pollination). Each ecosystem service was mapped individually and ranked between 0 and 1 for the whole region. Finally, these maps were combined and normalized to present a map of total ecosystem services.

Results: The total realized ecosystem services for the cocoa zone *(Figure 11*) shows high values of ecosystem service provision on the border between Sierra Leone and Liberia (Gola rainforest), in Ghana in the Awura forest reserve, Nigeria downstream along the Niger River, and on the border with Cameroon where several national parks are located. The key services in these areas are carbon sequestration and other forest-related services such as timber and fuelwood.

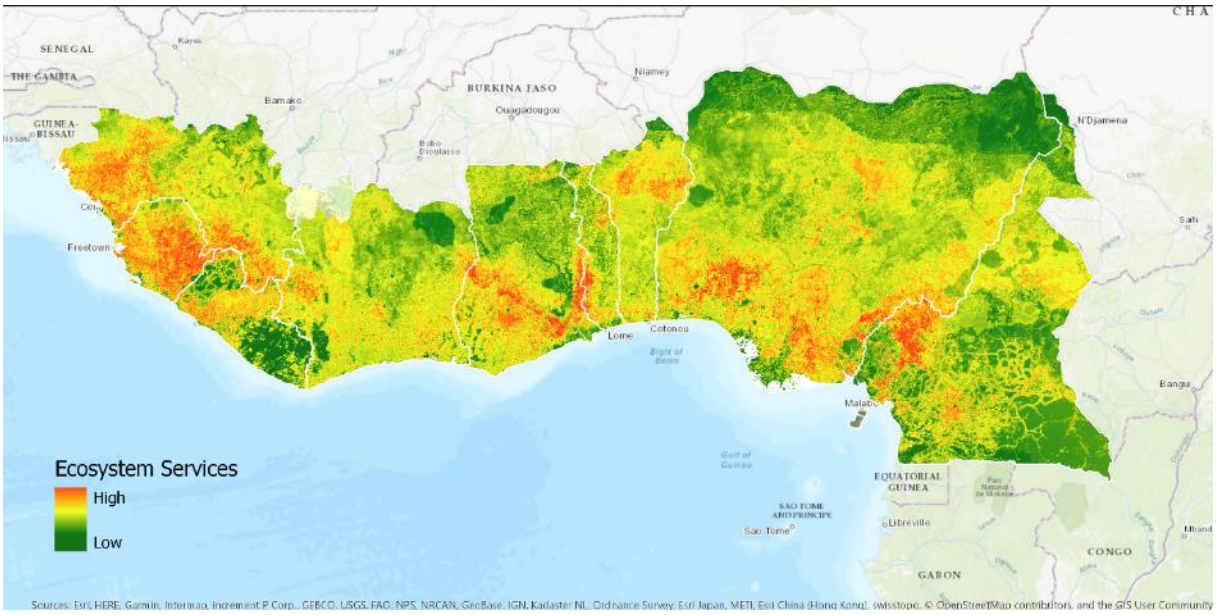


Figure 11. Baseline total realised ecosystem services in the cocoa zone

4.1.2 Biodiversity in the cocoa zone: Baseline

Aim: Identify areas currently important for biodiversity with high suitability for cocoa potentially leading to deforestation.

Methods: To provide an indication of how 'important' a given area is for biodiversity, a metric based on range size-rarity (i.e., endemism) was used, and scores were aggregated for all species. The underlying data was based on the IUCN range data (Parra *et al.*, 2017) for all available species of mammals, amphibians, and birds and refined to include only areas of suitable habitat. Refinement was carried out using data on species' altitudinal limits bontem and habitat affiliations from IUCN, linked to ESA CCI Land Cover (Bontemps *et al.*, 2013) for 2015 and GMTED2010 (Danielson and Gesch, 2011) elevation data.

Results:

Areas of high importance for biodiversity in the cocoa zone are shown in Figure 12 (in dark blue). These areas are focused in parts of Cameroon and Liberia, with more scattered patches in Côte d'Ivoire, Ghana, Togo, and Nigeria.

This dataset includes areas of importance based on all land cover classes. A few areas of high biodiversity importance are present in the northern areas of the cocoa zone and are typically clustered in remaining protected areas of forest or in mountainous forest areas (such as in Cameroon). The latter likely reflects natural endemism from isolation by geographic barriers, whereas elsewhere, this may be due, in part, to land use change (such as seen in the remaining forest patches in Ghana).

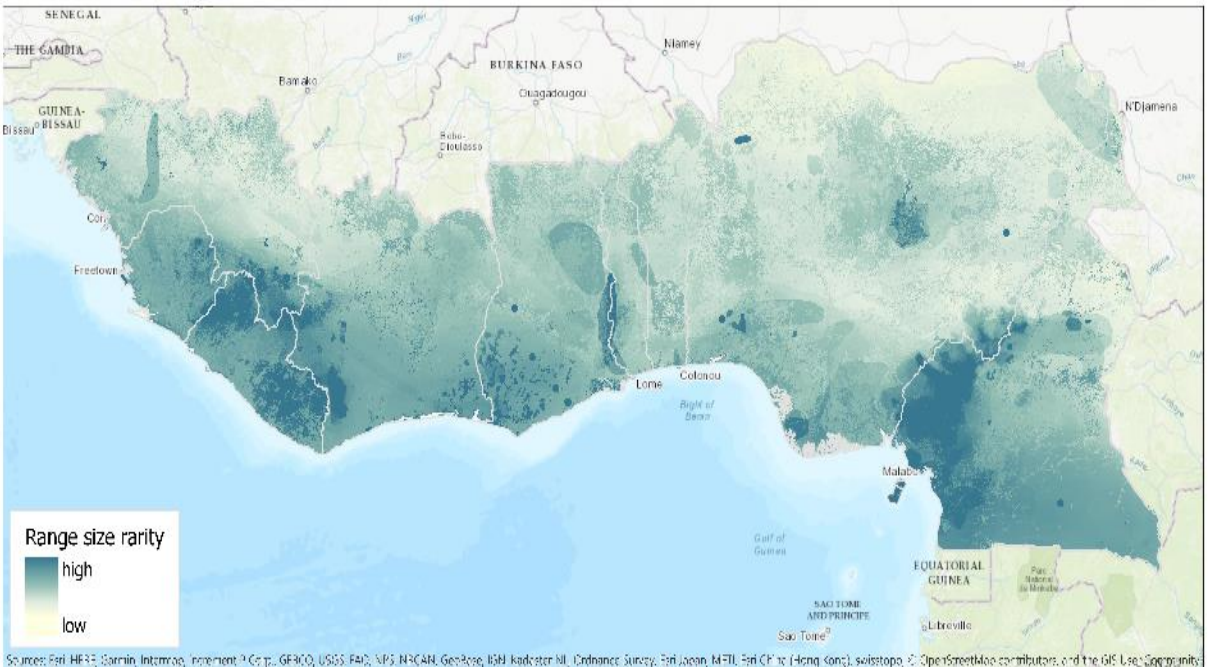


Figure 12. Baseline biodiversity importance in the cocoa zone based on range-size rarity for mammals, amphibians, and birds.

4.2 Baseline current risk to biodiversity and ecosystem services from cocoa

Aim: Investigate the potential risk to biodiversity and ecosystem services (ES) from cocoa expansion under the current climate.

Current suitability categories and broad areas of current cocoa production (Schroth et al. 2016) are used as a proxy for the likelihood of cocoa currently occurring — as maps of actual cocoa cultivation at a national scale are not available — but also as a proxy for the likelihood of cocoa expansion. We focus mainly on potential cocoa expansion into the forest.

4.2.1 Risks to ecosystem services under current suitability

Areas of high suitability are assumed to already be cocoa, except if they are in protected areas (including forest reserves) or if we have other data saying this is most likely not cocoa (e.g. land cover data shows no trees). Risks and potential outcomes for ES will be different for each situation. For areas under forest, conversion to cocoa will have a strong impact on certain ES, though we have to consider how cocoa affects ES over time. When mature, it can behave like a forest (more a plantation, really), but young cocoa is probably not very different from other crops in terms of impacts on various ES. *Methods:* The normalized ecosystem services layer for the region was combined with modeled cocoa suitability based on Schroth et al. (2016) using a bivariate map (Figure 13).

Results: The combined map shows areas that are currently very important in the delivery of ecosystem services and highly suitable for cocoa production (Figure 13). These areas are mostly forests, as forests are important for the delivery of multiple ES. The map also shows that large areas in Liberia are highly suitable for cocoa production but are low in ecosystem services delivery.

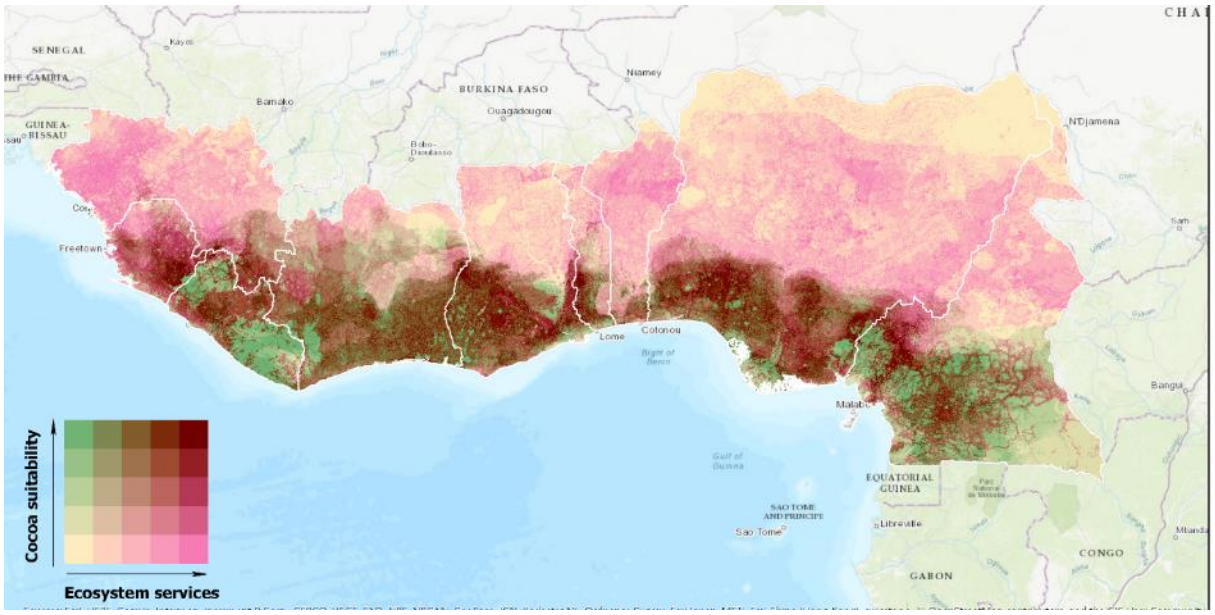


Figure 13. Bivariate map showing modeled cocoa suitability against ecosystem service delivery. Dark red colours are very suitable for cocoa growing as well as high in ecosystem service delivery.

4.2.2 Risks to biodiversity under current suitability

Methods: This biodiversity significance layer was compared with modeled cocoa suitability for the region (Schroth et al. 2016), using a series of bivariate maps. These aim to highlight possible areas of high biodiversity that might be most at risk from cocoa production, and so focus on forests (see Figure 14) and unprotected forests (see Figure 15), based on removing non-forest classes and protected areas (UNEP-WCMC and IUCN, 2018).

Results

The results show areas of high risk to biodiversity from cocoa-driven deforestation in defined patches in the south of Ghana and west of Côte d'Ivoire (e.g., the Tai Forest). Large tracts of such areas are also present in Liberia and northeast Cameroon (*See Figure 14*, areas in dark brown).

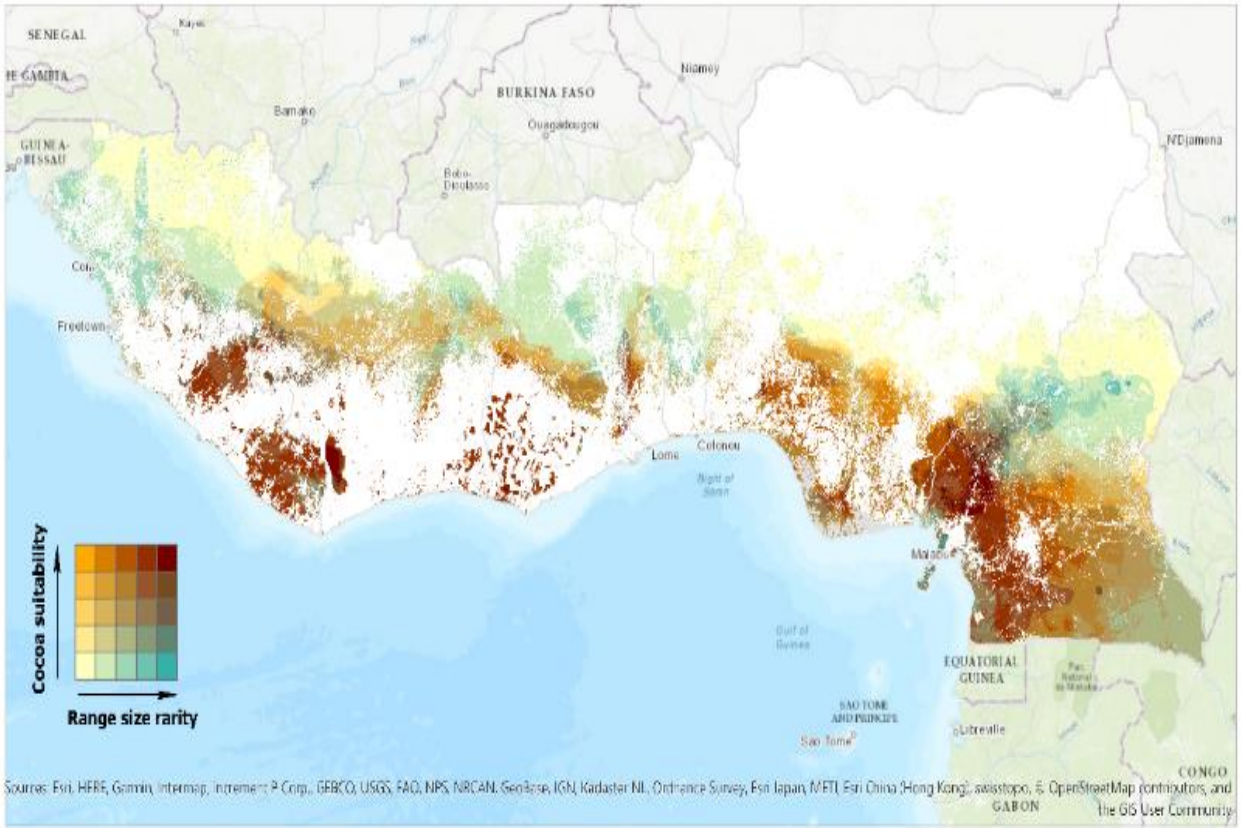


Figure 14. Bivariate map showing modeled cocoa suitability against biodiversity importance (based on range-size rarity) in forests. Dark brown areas have biodiversity and high risk from cocoa-driven forestation.

However, when protected areas are removed from the visualization, the unprotected forest that remains in both Ghana and Côte d'Ivoire is limited to small, scattered patches. Thus, in terms of the highest risk to forest biodiversity from cocoa-driven deforestation, the frontiers appear more concentrated in Liberia and Cameroon. This highlights the need for careful land use planning to limit potential impacts on species of high conservation concern (such as endemics) in these areas.

4.3 Deforestation

Aim: Maps recent deforestation in the area suitable for cocoa in West Africa
Method: This analysis uses recent rates of deforestation based on Terra-I spatial deforestation data.

Result: The mean deforestation rate between 2010 and 2017 for the whole region is 1.1% but 100% for some pixels, mainly in Ghana and Sierra Leone *(See Figure 16)*. This is within the current suitable zone for cocoa with a cutoff of 25% (i.e., good and upwards).

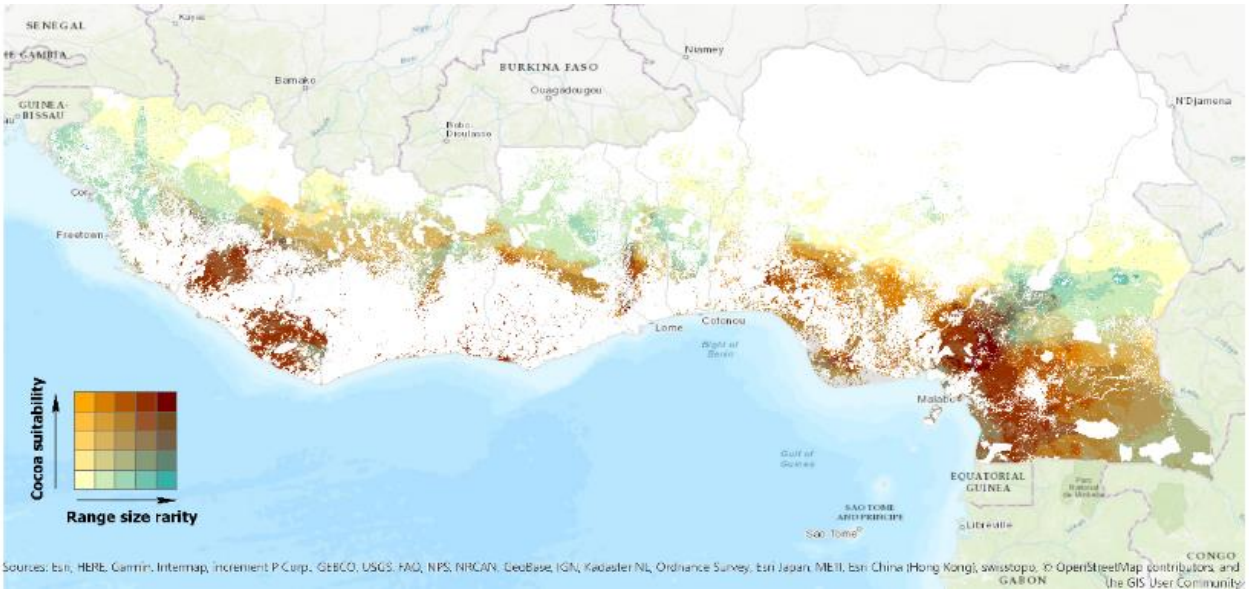


Figure 15.Bivariate map showing modeled cocoa suitability against biodiversity importance (based on range-size rarity) in forests outside protected areas. Dark brown areas have high biodiversity and high risk from cocoa forestation.

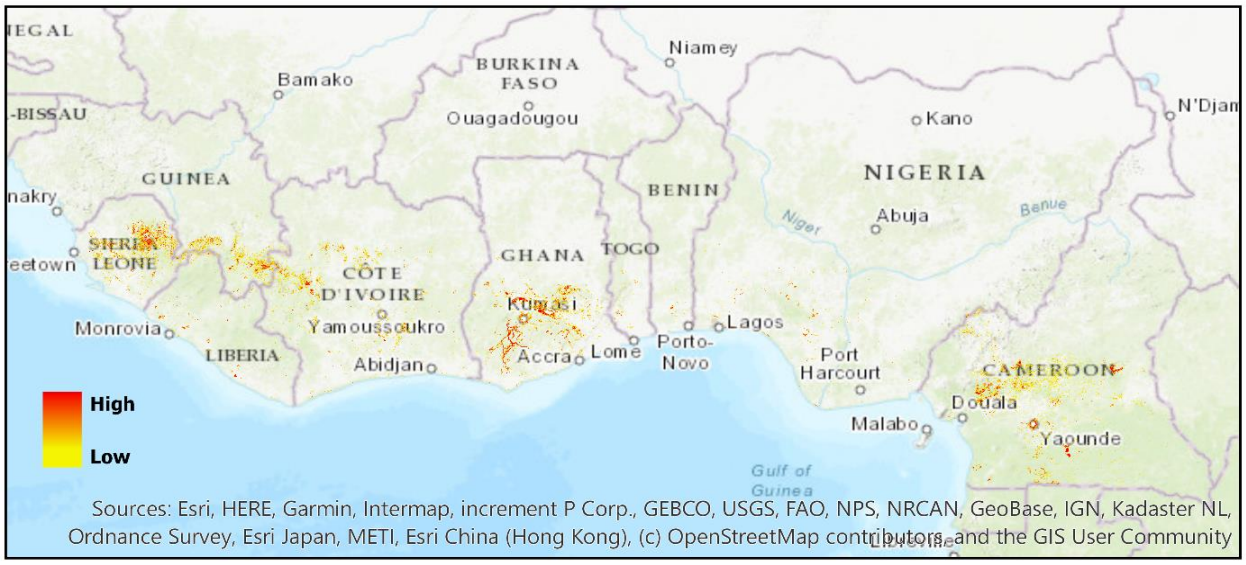


Figure 16. Deforestation between 2010 and 2017 (Terra-i) in the current suitable zone for cocoa with a cutoff of 25% (i.e., good and upwards). (Schroth et al. 2016).

5 SUMMARY AND CONCLUSIONS

This report establishes a reference point for the project's impact and some selected outcome indicators in the project results framework, which include current cocoa yields from smallholder cocoa farmers, income generated from cocoa production, deforestation rates, types of labour used/access, and the types of ISFM recommendations/practices currently used by target smallholder cocoa farmers. It also details some social characteristics required to inform a focused dissemination of technologies among the surveyed respondents.

Awareness and use of ISFM components among respondents are high. The use of mineral fertilizer is found to be high in Cameroon, Côte d'Ivoire, and Ghana but not in Nigeria, where awareness and use are about 57% and 20%, respectively. The high degree of awareness is partly attributed to the diverse sources of information accessible by respondents. Most of the information was disseminated through government agencies, private companies, and NGOs. However, yields are still very low and way below the potential (Cameroon, Côte d'Ivoire and Ghana), ranging between 294 kg/ha and 408 kg/ha. Improvements in yields will, therefore, not require much awareness creation about the existence and importance of the ISFM components but the right application of the components and the gaps in the various training contents based on assessments.

The application of the ISFM components is inconsistent with the country-level recommendations. Fertilizers are applied as and when most farmers prefer or have access to them and with limited quantities, not up to the quantities recommended per hectare (e.g., mostly two bags of 50 kg of NPK 15-15-15 applied on an average plot of 2 hectares in Nigeria). This could be due to inadequate funds as the majority indicate no sources and lenders as key reasons for lack of credit. The barriers to high yield are the insufficient and inconsistent use of fertilizers (including organic fertilizers) and other ISFM practices.

Most plantations in Cameron and Ghana are between the ages of 4 and 25 years (mature and adult), with about 19–28% being over 25 years (old). Over 50% of plantations in Nigeria are over 25 years old. This indicated a highly significant relationship between the age of the plantations and the yields. This could suggest the need for a rehabilitation investment option for most respondents in Nigeria.

Most respondents use family labour for most farm activities, with temporary hires to supplement. The introduction of any technology component needs to consider the labour requirements and investments and develop appropriate strategies to support households, for example, enhanced access to credit, which the analysis showed limited access by especially female farmers.

The mean income from cocoa is the highest among the other sources of income, accounting for over 60% across the countries. This significance of income from cocoa suggests the overdependence of households on cocoa production and an increase in yield could have a direct relationship with income, with linkages to appropriate output markets. The disaggregated income from cocoa revealed that male farmers earned relatively more income than females (20% to 40%).

The household dietary diversity score reveals that households consumed between 7 and 9 food groups out of 12 food groups. This suggests that households in the study area are economically able to access, to some extent, different food groups.

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