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# Postharvest practices and farmers' perception of cocoa bean quality in Cameroon

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## Abstract

**Background:** After the closure of Cameroon's National Produce Marketing Board in 1990, rigorous measures no longer existed to control production of quality cocoa. This study assesses farmers' knowledge of postharvest practices that could influence cocoa bean quality (CBQ), their perception of quality cocoa and the factors that hinder good farming and postharvest practices (GFPHP). We also make suggestions on how quality control can be incorporated in the production chain to improve on CBQ produced.

**Methods:** In a cross-sectional, purposive study in Fako Division, South West Region of Cameroon, 100 farmers were enrolled from 10 villages (10 from each village) which make up the major production area in Agro-ecological Zone IV of Cameroon. Farmers were administered a semi-structured questionnaire in the language they best understood.

**Results:** Cocoa farming in this area is a tradition and our results show that 97 % of farmers are males and acquired farming practices mainly through their family member (43 %) and/or friends (34 %). Farms are self-owned, 76 and 85 %, respectively, are less than 5Ha and have been cultivated for more than 20 years. Only 10 % of farmers could perceive quality cocoa using physical characterization. Although more than 95 % of farmers knew GFPHP, only 48 % undertake these practices. Farmers' focus was on bean weight and not on CBQ and 64 % of farmers think quality has little impact on the price. Most farmers (71 %) sell to "buyam-sellams" who care little about quality. The proportion of respondents who acquired knowledge through formal learning was significantly higher than those who did so from informal learning with regards to both good cocoa production practice ( $p = 0.036$ ) and appreciation of quality attributes ( $p = 0.043$ ). Subsidizing inputs, access to credits, creating cooperatives, regulating price of cocoa and training on postharvest management in decreasing order could enhance practices that will ensure quality cocoa production.

**Conclusion:** GFPHP is important in the production of quality cocoa. Left alone, farmers will not pay attention to these quality attributes especially as premium quality is not rewarded. Organizing farmers into cooperatives will reduce the link between farmers and companies exporting cocoa and alleviate most bottlenecks in the sector.

**Keywords:** Cocoa bean, Perception, Postharvest, Quality

## Background

Cocoa is one of the main cash crops in Cameroon. Cameroon produced 264,077 million tons of cocoa in 2010 [1]. This production dropped to 209,905 million tons in 2013 and rose a little to 232,530 million tons in 2014. This makes Cameroon the fifth world cocoa producing nation after Ivory Coast, Ghana, Indonesia and Nigeria

[2]. Presently, the Government of Cameroon projects that with an increase in availability of planting material and the opening of new farms with the help of National Cocoa Development Board that will assist farmers with acquisition of planting materials and accompany them in planting this amount will swell to 600,000 million tons by 2020. This will increase the overall quantity produced but the amount per hectare still remains low. Despite all these, the cocoa sector in Cameroon is still not fully controlled. In 1990, the National Produce Marketing Board (NPMB) was closed down. This board was a government structure

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that acted in the control of quality and marketing of cocoa beans. After this closure, government involvement was greatly reduced in this sector. Farmers were abandoned to themselves and since they could now sell to anyone ready to buy, stringent measures are no longer taken to guarantee the production of quality cocoa. Licensed Buying Companies (LBC) no longer respected bean quality and buying operations have been left to middlemen (“buyam-sellam”) who most of the time are not trained and always in a haste to meet their required monthly tonnage. These forces have greatly compromised the quality of cocoa leaving Cameroon for foreign markets.

The cocoa tree is cultivated principally for cocoa beans. These beans are the principal raw material for the manufacturing of chocolate and other cocoa-based beverages. Inside the cocoa pod (the fruit) is a mucilaginous pulp which represents approximately 40 % of the fruit fresh weight [3]. It is composed of a spongy mucilaginous tissue containing cell sap.

The pulp is the substance that is seen immediately after the pod is opened. It is white, juicy and rich in fermentable sugars such as glucose, fructose and sucrose. It also contains salts (8–10 %), pentosans (2–3 % pectin), organic acids (1–2 %) and 0.6 % proteins [3–5]. The pulp has a high concentration of acids, especially citric acid, 2.1–2.4 % (w/w), and also has smaller amounts of other organic acids present such as lactic acid, 0.03 % (w/w) and acetic acid, 0.04 % (w/w) [6, 7]. During on-farm processing, this mucilaginous pulp is degraded by microbial fermentation, producing a running liquid known in the industry as ‘sweating’ [5]. Fermentation, was considered as simply an easy way to remove the pulp to facilitate drying, but its importance to cocoa quality has been well established [4].

The ethanol and acetic acid that diffuse through the seed coat, combined with the heat produced by the exothermic bioconversion of ethanol, causes the death of the seed embryo and marks the end of the fermentation [8, 9]. These changes induce an array of biochemical reactions within the beans and generate the chemical precursors of chocolate flavour, aroma and colour [10–13]. Other factors such as agronomic management, soil and weather characteristics, as well as postharvest technology, also contribute to chocolate flavour [14].

Cocoa bean is the seed found within the fruit pod embedded in the mucilaginous pulp. The bean is whitish when young and turns brown as it gets matured. Raw cocoa beans have an astringent, unpleasant taste and flavour. The final chocolate flavour is influenced by the origin and cultivar of the cocoa beans, on-the-farm fermentation, drying, roasting and further processing performed by the cocoa and chocolate manufacturer [10, 15–18].

Seating in its sixteenth meeting in Berlin in 2008, Consultative Board on the World Cocoa Economy agreed that cocoa of merchant quality must be fermented, thoroughly dry, and free from smoky or broken beans, abnormal or foreign odours and any evidence of adulteration, reasonably uniform in size, reasonably free from broken beans, fragments and pieces of shell, and be virtually free from foreign matter. In Cameroon, because of pressure by “buyam-sellams” on the farmers to sell their produce and the fact that quality is not usually considered when buying and selling is done, farmers hardly respect these norms.

According to previous reports [19] market-determined premiums in commodity markets are based among other factors on quality perceptions. Folayan [20] explained that the root cause of quality anomalies in cocoa could be traced to poor farm management, infestation and other diseases, poor handling, bad fermentation, inadequate drying leading to high moisture content which makes the produce vulnerable to mold and bacterial growth. Other causes of low quality cocoa are poor and long storage time which result in fat degradation and pest infestation in the absence of fumigation and other forms of quality maintaining measures.

In this study, we assess farmers’ knowledge of post-harvest practices that contribute to quality cocoa bean. Their perception of good quality cocoa and the factors that make it difficult for them to practice these technologies have also been examined. Suggestions have also been made on how quality control can be included in the production chain to improve on the quality of cocoa bean produced in the South West Region of Cameroon.

## Methods

This study was conducted in Fako Division of the South West Region, Cameroon. The South West Region is the major production area in Agro-ecological Zone IV characterized by a forest and a mono-modal rainfall pattern. Ten villages (Bafia, Ikata, Likoko Mile 15, Lilale, Malende, Maumu, Muea, Munyenge, Owe and Yoke) were purposively selected for this study. These villages are amongst those with high cocoa production in this production basin and are closer to the Institute of Agricultural Research for Development (IRAD). It is believed that farmers would be more accessible to research and other technologies that have been developed by IRAD.

The questionnaire was designed to collect information on demography, experience and how knowledge of the cocoa production process was acquired, what kind of postharvest practice they carry out, what limitations they have and suggestions to overcome these limitations. One hundred farmers (10 per village) were

randomly enrolled and each of them was administered a semi-structured questionnaire in the language they best understood after an informed consent. Each participant signed a consent form. Authorisation (Ref: 0012/MIN-RESI/RCSR/01/2014) for this study was obtained from Southwest Regional Centre of the Ministry of Scientific Research and Innovation.

The responses were keyed in an MS excel spread sheet and analysed using the Statistical Package for Social Sciences, SPSS software. Results have been presented as frequency and percentages in tables and figures. Categorical comparisons were performed with Chi-square test. Odds ratios (ORs) and nominal 95 % confidence intervals (CIs) were presented. A two-sided  $p$  value  $< 0.05$  was considered significant for all analyses.

## Results

### Demographic and socioeconomic characteristics of respondents

Cocoa farming in this area is an activity of the middle aged with 70 % of farmers in the age group 31–50. More than 80 % of the farmers are married and have attended school to at least junior secondary (Table 1). The farms are mostly self-owned with, 85 % less than 5Ha. The majority (62 %) have been under cultivation for more than 10 years. Cocoa farming in study area is a tradition and results show that they learned farming practices mainly from their family (43 %) or friends (34 %).

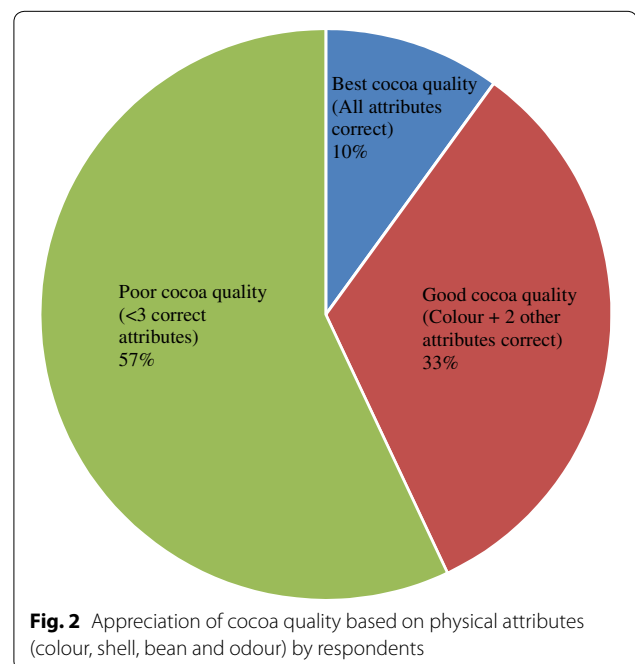
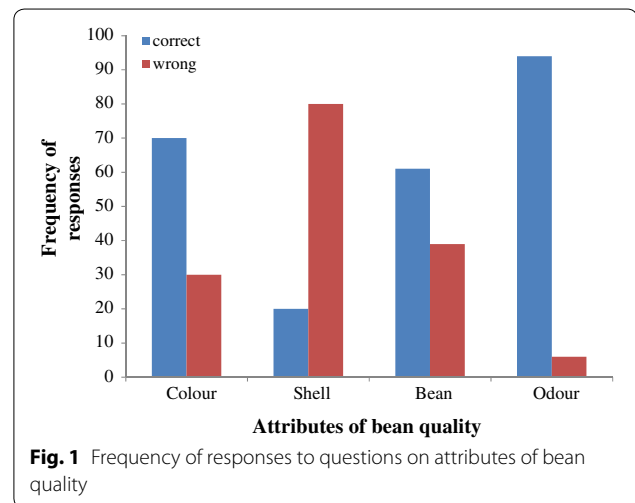
### Perception of quality cocoa based on physical characteristics

Farmers were asked to describe the characteristics based on what they know to be quality cocoa. For each quality attribute (Colour, shell, bean and odour) a table with correct and incorrect responses was provided for them to choose. Based on the present understanding of what is required for the physical characterization of CBQ, most farmers concentrate on the colour, the bean and odour (whether it is smoky). Farmers easily could tell the odour (94 %), external colour (70 %) and internal colour (64 %) of good quality bean but only 20 % could appreciate the quality of the shell as shown in Fig. 1.

To perceive quality cocoa bean, all these attributes are supposed to be correct. When they were put together, only 10 % (Fig. 2) would come out with premium quality beans. Fifty-seven (57) percent had less than three attributes correct (poor bean).

### Good farming practices to ensure quality cocoa

Some of the cultural practices were listed and farmers asked to comment on their level of importance to obtaining quality cocoa. Based on their responses as shown in Table 2, apart from use of fertilizer, all of the practices



were very important to ensure the production of quality cocoa bean.

We went ahead and asked farmers whether they carry out these practices in their farms to ensure that they always have quality cocoa at the end of each cycle. From the responses we realized that more than 95 % of farmers always spray the pods, prune the branches, ferment and dry their beans. However, 31 % of farmers will not plant improved varieties either because they do not yet have access to these varieties, do not have new land, no knowledge, or the fact that these improved varieties fall after 3 years due to a production that cannot be supported by

**Table 1 Demographic and socioeconomic characteristics of respondents**

Characteristics	Category	Frequency	Valid percent
Marital status	Married	84	86.6
	Single	13	13.4
Age group (years)	21–30	7	7.1
	31–40	35	35.7
	41–50	35	35.7
	50–60	12	12.2
	>60	9	9.2
Level of education (years of school)	<7	6	6.0
	7–11	64	64.0
	12–16	24	24.0
	>16	6	6.0
Size of farm (hectares, Ha)	<5 Ha	85	85.0
	>5 Ha	15	15.0
Farm owner	Family	14	14.0
	Landlord	10	10.0
	Self	76	76.0
Occupation	Applicant	1	1.0
	Business	8	8.0
	Civil servant	2	2.0
	Farming	89	89.0
Age of farm (years)	≤10	22	22.4
	11–20	39	39.8
	21–30	28	28.6
	>30	9	9.2
Duration in farming (years)	<5	8	8.0
	5–10	30	30.0
	>10	62	62.0
Acquisition of farming know-how	Cooperative	17	17.0
	Family	43	43.0
	Farmers field	5	5.0
	School	34	34.0
	Friend	1	1.0
Formal training on postharvest technology	No	49	49.0
	Yes	51	51.0

the root system. Of the 74 % of farmers who do not use fertilizers in their farms more than half (62 %) attribute it to the high cost and 18 % think that it is of no use since their soil is fertile.

Due to the fact that quality is not checked, some farmers (10 %) will not remove diseased pods from the pile. They explained that diseased beans contribute to weight during sales and they do not sort them out as this process is laborious. Whether sorting is done or not does not affect the price, they explained.

Survey data indicate that more than half (52 %) of farmers do not ferment their bean. Fermentation, when done, is mostly carried out for 4–6 days in bags. To achieve

this, the pods are opened and pod content filled in 50 kg bags. This permits farmers to easily transfer them from the field on motorbikes to either their homes or to ovens for drying. Some farmers (7 %) carry out fermentation for less than 4 days either because of their turn to use the oven or to get the beans out quickly to a waiting buyer.

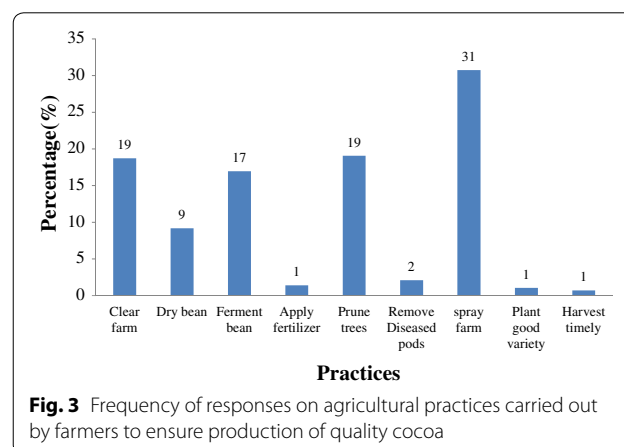
Farmers were further asked to list in order of importance three things that would allow them obtain good quality cocoa. According to the results (Fig. 3), farmers would prefer to spray, prune trees and clear their farms in that order. Fermentation and drying only comes afterwards. Upon further questioning (not included in the questionnaire), they indicated that their intention is to have a good harvest and high weighted beans and not how good looking these beans are. Of all the respondents, 64 % said quality will not affect price while only 11 % considered quality cocoa to attract a higher price.

Most farmers (71 %) market their beans to middlemen while very few (5 %) sell directly to exporters. In some of the areas, cooperatives have been developed and 24 % of the respondents now sell directly to their cooperatives. This contributed to the fact that 52 % of farmers would not grade their cocoa due to the fact that buyam–sellams do not have a grading scheme and they propose the same price irrespective of. However, 35 % would always grade to check humidity and 13 % will do so only sometimes.

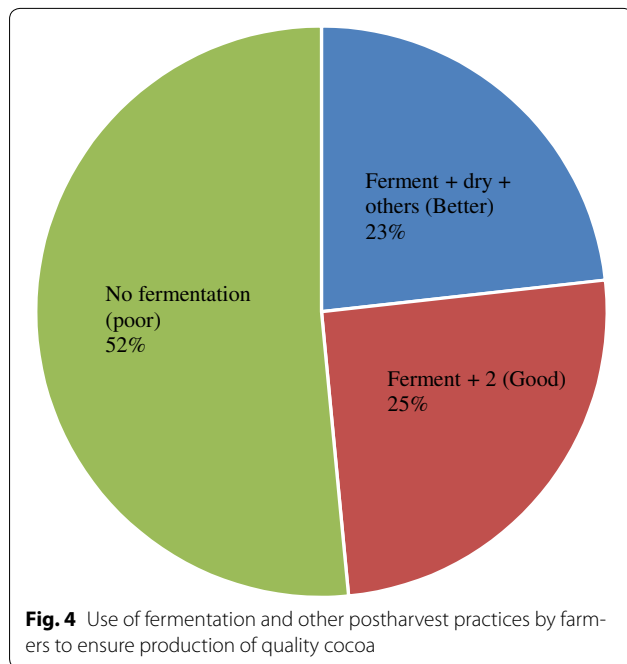
Based on farmers' responses, we could observe that only 48 % undertake practices that could ensure quality cocoa bean as shown in Fig. 4.

#### Factors that influence good cocoa practices and appreciation of quality attributes

The proportion of respondents who acquired knowledge through formal [cooperatives and Farmer Field School (FFS)] learning was significantly higher than those who did so from informal (family, friends and self) learning with regards to both good cocoa practice (OR 2.86, 95 %



**Fig. 3** Frequency of responses on agricultural practices carried out by farmers to ensure production of quality cocoa



**Table 2** Appreciation of agricultural practice to ensure production of quality cocoa

Practice	Frequency of category		
	Not important	Not so important	Very important
Plant good variety	2	8	90
Use of fertilizer	9	20	71
Spray farm	0	1	99
Prune farm	0	0	100
Remove diseased pods	1	4	95
Ferment bean	0	0	100
Dry bean	0	0	100

CI 1.05–7.80,  $p = 0.036$ ) and quality attributes (OR 2.68, 95 % CI 1.10–7.06,  $p = 0.043$ ) as shown in Table 3. This was observed when a farmer is under a landlord/family land as opposed to when farm was self-owned (OR 2.70, 95 % CI 1.02–7.14,  $p = 0.041$ ) and when training on postharvest techniques was formal as to informal (OR 2.86, 95 % CI 1.05–7.80,  $p = 0.036$ ). While the other factors did not show a significant difference, only farm ownership significantly influenced good cocoa practice.

**Farmers’ recommendations to ameliorate cocoa production**

Farmers were finally asked to make recommendations as to what they think could be done to permit them produce quality cocoa all the time. The most prominent suggestions were that there be subsidies for inputs (33.85 %),

access to credit (18.08 %) and the formation of cooperatives (10.77 %) (Fig. 5).

**Discussion**

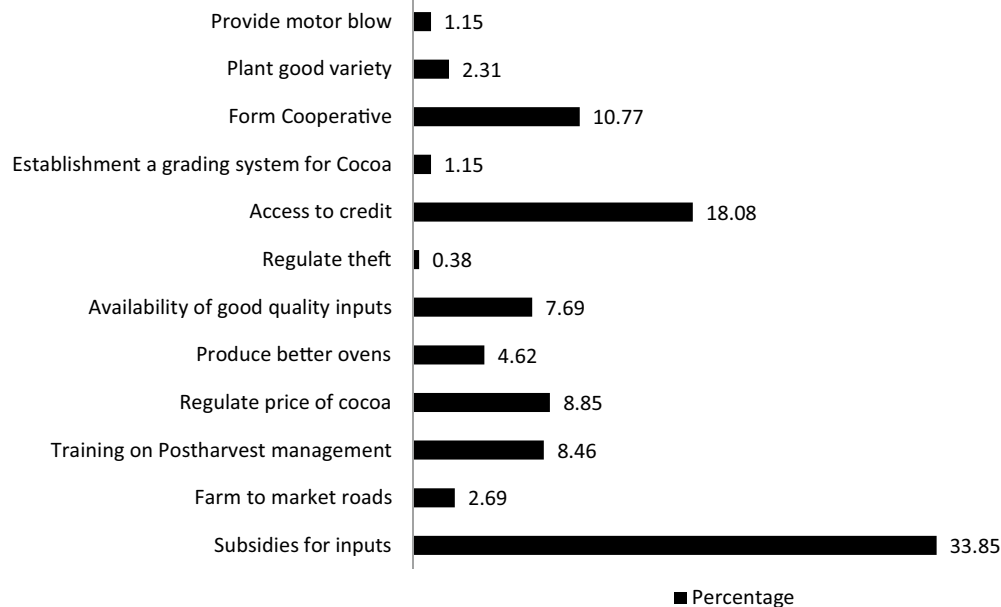
The dream of every cocoa farmer is to sell their bean at a price that enables them to make maximum gain. This is only possible in a system that is well organized and where premium quality is rewarded. This is presently not the situation that prevails in the cocoa sector in Cameroon. There is available information at the level of IRAD that permits farmers to produce quality cocoa. The process continues to be conducted in a traditional manner as has been noticed in earlier studies [7]. Some of the reasons that hinder them to exploit these technologies have been highlighted in this study.

Fermentation is best conducted in trays, cages or on leaves for 6–7 days [15]. This allows for a single turning of the beans during the second or third day to allow for a proper diffusion of heat and acids. This guarantees a more uniform fermentation and quality bean. In study area, fermentation is carried out in bags and the beans are not turned. Beans from such fermentations are usually not homogenous. Those from the middle of the bag are usually over-fermented while those at the surface are less fermented. This is attributed to the fact that the heat generated during fermentation is less at the surface of the bag and the beans at that location are exposed to acids produced during fermentation only for a short while.

From the responses, we observed that most of the farmers lacked a financial base because production demands a lot in terms of availability and timely application of inputs. With the increase in subsidies and/or availability of credit facilities, more than 50 % of the bottlenecks involved in production can be overcome. These subsidies can be provided to farmers as either production inputs that ranked first (33.85 %) and/or access to credits that ranked second (18.08 %).

To achieve this, farmers themselves have realized that they need to create cooperatives. Cooperatives on the one hand will reduce the long chain that exist between producers and exporters and on the other hand put in place a valid control system for monitoring production of cocoa bean. If this is done, grading of bean can be instituted such that premium quality bean can thus fetch higher prices.

In the days of the NPMB, production capacity of farms of affiliated members could be evaluated and farmers given loans in terms of inputs and/or credit (mostly as inputs) and this amount deducted from their sales. The board could equally assist the farmers when they needed money at very low or no interest and keep their produce to sell when market prices are good because they had good storage facilities. When the NPMB closed down, most farmers fell their trees as it was no longer profitable to farm cocoa.



**Fig. 5** Recommended factors that could ameliorate cocoa production

When middlemen are involved, the marketing chain is long. This places the farmer far from the LBCs and reduces their bargaining power. These middlemen are interested in getting their tonnage for the required LBC as fast as possible and they would hurry the farmers not to even ferment or properly dry beans. Poor resource farmers equally want to make fast money and solve problems or repay an outstanding loan. Faced with this pressure from the middlemen, they heed and this affects the quality that gets to the market.

Lack of training on postharvest technologies was equally raised as a factor that affects the quality of cocoa produced. We noticed that 52 % (Fig. 4) of the farmers we interviewed do not ferment their beans. When fermentation is carried out, it is done in bags and this does not allow for turning of the beans thus some end up over-fermented (in the middle of the bag) and some poorly fermented (close to the surface of the bag). The recommended process is to carry out the fermentation either on the ground or in cages or trays covered with banana leaves for 6–7 days. Farmers use 3–5 days when they ferment as equally noticed by Takrama [21] and Bariah [22]. Duration of fermentation is also influenced by the turn of the farmer to use the oven for drying or the pressure to sell to a waiting buyam–sellam.

Farmers have learned over the past few years to carry out fermentation in bags from their families (43 %) and friends (34 %) Table 3. Most of those who are close to cooperatives and FFS of the Ministry of Agriculture and Rural

Development (MINADER) have started using these structures. There was a significant difference in the way the farmers who used the service of formal structures would appreciate and undertake GFPH when compared to others. It is therefore important that the government through MINADER multiplies these FFS to be close to or present in production basins. Most of the farmers have farming as their principal activity (89 %) and with more than 90 % being able to read and write, the transfer of technologies becomes easier with the use of technical bulletins and practical knowledge in FFS. When farmers were recruited in the Cocoa High Technology Programme in Ghana, 88 % applied the good cocoa practice in their farms to produce quality beans [23].

The fact that farmers always need some form of control was confirmed by the fact that those who worked in farms that they did not own, significantly ( $p = 0.041$ ) undertake good production practices as opposed to those working on their farms (Table 3). This can be explained by the fact that farm owners controlled the way the cocoa production was carried out.

## Conclusion

Good farming and postharvest practice is important in the production of quality cocoa. Left on their own, farmers will not pay attention to these quality attributes especially as premium quality is not rewarded. Organizing farmers into cooperatives is important in reducing the chain that exists between farmers and LBCs that export cocoa.

**Table 3 Factors that influence good cocoa practices and appreciation of quality attributes among farmers**

Characteristics	Categories	Good cocoa practice (%)		Odds ratios (CI, p value)	Quality attributes (%)		Odds ratios (CI, p value)
		Good	Poor		All 4 correct	Less than 4 correct	
Age group (years)	<40	16 (39.0)	25 (61.0)	0.56 (0.25–1.26, 0.156)	18 (45.0)	22 (55.0)	1.30 (0.57–2.96, 0.528)
	≥40	30 (53.6)	26 (46.4)	1	22 (38.6)	35 (61.4)	1
Level of education (years of formal education)	≤12	31 (44.9)	38 (55.1)	0.62 (0.263–1.48, 0.283)	31 (44.9)	38 (55.1)	1.90 (0.76–4.75, 0.164)
	>12	17 (56.7)	13 (43.3)	1	9 (30.0)	21 (70.0)	1
Farm ownership	Others (Landlord and family)	16 (66.7)	8 (33.3)	2.70 (1.02–7.14, 0.041)	12 (52.2)	11 (47.8)	0.54 (0.21–1.37, 0.189)
	Self	32 (42.7)	43 (57.3)	1	28 (36.8)	48 (63.2)	1
Duration in farming (years)	≤10	17 (44.7)	21 (55.3)	0.78 (0.35–1.77, 0.556)	16 (43.2)	21 (56.8)	1.21 (0.53–2.76, 0.657)
	>10	31 (50.8)	30 (49.2)	1	24 (38.7)	38 (61.3)	1
Acquisition of farming knowledge	Formal	15 (68.2)	7 (31.8)	2.86 (1.05–7.80, 0.036)	13 (59.1)	9 (40.9)	2.68 (1.01–7.06, 0.043)
	Informal	33 (42.9)	44 (57.1)	1	27 (35.1)	50 (64.9)	1
Formal training on postharvest	Yes	25 (48.1)	27 (51.9)	1.04 (0.47–2.28, 0.932)	19 (36.5)	33 (63.5)	1.40 (0.63–3.14, 0.410)
	No	23 (48.9)	24 (51.1)	1	21 (44.7)	26 (55.3)	1

These cooperatives when established will help alleviate the majority of bottlenecks that exist in the sector and restore quality cocoa production in the cocoa farming sector.

#### Abbreviations

CBQ: cocoa bean quality; FFS: farmer field school; GFFPH: good farming and postharvest practices; IRAD: Institute of Agricultural Research for Development; LBC: Licensed Buying Companies; MINADER: Ministry of Agriculture and Rural Development; NPMB: National Produce Marketing Board.

#### Authors' contributions

LDL, HDM, AA and SAM did the conception and design, data collection and analysis and manuscript writing. JFK and VKPT participated in the critical revision of the manuscript. All authors read and approved the final manuscript.

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#### Competing interests

The authors declare that they have no competing interests.

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