CHALMERS

From Ghana to Magnum Ice Cream:
Tracking Down the Organisation of Sustainable Cocoa Product Chains

Master of Science Thesis in the Master Degree Programme
Industrial Ecology – for a Sustainable Society

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Cover: Personal photos
Left: Cocoa farming family in Ghana
Upper right: Cocoa pods growing on a tree
Lower right: Farmer mixing sun drying cocoa beans

Gothenburg, Sweden 2012

“It is about supply chain risk and supply chain security as much as it is about doing the right thing”

- *Mercedes Talló, Rainforest Alliance*

Abstract

This master thesis will follow the product chain of cocoa from a sustainability perspective, from the cocoa farms in Ghana to the production of Magnum ice creams. The emphasis is on the organisational structure of the product chain, how it is managed to ensure sustainable sourced cocoa.

The cocoa industry is complex with diverse range of actors. Not least in Ghana with the government as a regulator of the cocoa market. In addition, there are various associations, certification schemes, non-profit organisations, companies and numerous amounts of smallholder farmers that build-up the whole structure of the cocoa industry. There are thus considerable aspects to take into consideration when investigating such a product chain with its various actors and their perceptions of sustainability. The identified product chains in this study are structured with one big multi-national company, Unilever, at one side of the chain and smallholder farmers on the other end. Unilever has high targeted sustainability goals and has claimed that all the cocoa for its Magnum ice creams should be Rainforest Alliance (RA) certified by 2015. It makes the smallholder farming conditions critical to consider ensuring sustainable cocoa production and how the rest of the actors are aligned in their sustainability efforts.

The cocoa farmers are typically facing significant challenges, both socioeconomic and environmental. The socioeconomic aspects consist of inadequate living conditions, low incomes, child labour, lack of knowledge and education among others. Some of the environmental challenges entail deforestation, loss of biodiversity, inappropriate chemical usage and climate change. The observed challenges stated by the farmers are being analysed in relation of what the other actors in the product chain think are of main importance. This is also connected to the industry actors' sustainability driving forces and what sustainability actions they are taking. The main driving forces stated by the majority of the actors are productivity and improved farmer livelihoods. One outcome highlighted in this study is thus that support to the smallholders is of great essence. To enable this many of the actors in the product chain address that further collaborations are needed in excess of the ones already established.

Along with this a comparison of RA certified farms with non-certified ones have been conducted. The focus has been to see what benefits there are for the farmers of being certified as well as other actors' general view of certification schemes. The results show that farmers are very positive to RA, even more than the industry actors. Through education and training the farmers have increased their productivity significantly which has led to improved farmer incomes which in turn can lead to improved farmer livelihoods. The environmental benefits at farm level are also demonstrated through greenhouse gas emission (GHG) calculations. The newly developed GHG emission calculator, the Cool Farm Tool, has been used and assessed. The study proves that the sustainability transformation takes time and patience is required as well as joint efforts within the industry.

Key words: Sustainable product chain management, sustainable agriculture, smallholder farming, cocoa, agri-food industry, Unilever, Cool Farm Tool, greenhouse gas calculator, certification schemes, Rainforest Alliance.

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Table of Content

1 Introduction **1**

1.1 Aim 2

2 Method **3**

2.1 Literature Study 4

2.2 Office Visits 4

2.3 Interviews 5

2.4 Cool Farm Tool (CFT) 6

2.5 Data Analysis 7

3 The Cocoa Industry **8**

3.1 The Global Cocoa Industry 9

3.2 The Cocoa Industry in Ghana 11

4 Findings: The Cocoa Product Chains **13**

5 Findings: Sustainability Management **16**

5.1 Sustainability Driving Forces 18

5.2 Sustainability Actions 19

5.3 Future 19

6 Findings: Sustainability Challenges **20**

7 Findings: Certifications Schemes **23**

7.1 Actors' Opinions of Certification Schemes 23

7.2 Farmers' Experience of Rainforest Alliance 24

7.3 Calculations Assessing Rainforest Alliance Certified Farms 26

8 Findings: Evaluation of the CFT **31**

9 Discussion **32**

10 Conclusions **35**

11 Recommendations **36**

References **37**

Appendix A – The Ghana Cocoa Board (COCOBOD)

Appendix B – The Cool Farm Tool (CFT) Results

List of Tables

Table 1 Overview of actors involved in the study and type of interactions. 5
Table 2 Global production of cocoa (ICCO, 2011) 9
Table 3 Explanation of symbols for product chain figures 15
Table 4 Actors' sustainability management 16
Table 5 Environmental challenges 21
Table 6 Socioeconomic challenges 22
Table 7 Opinions of certification schemes (c.s.) 23
Table 8 Farmers' experiences of environmental improvements of a Rainforest Alliance certificate 25
Table 9 Farmers' experiences of socioeconomic improvements of a Rainforest Alliance certificate 25

List of Figures

Figure 1 An illustration of the relation between PCO and LCA. 3
Figure 2 Cocoa consumption per capita, bean equivalent (ICCO, 2010) 10
Figure 3 Fluctuation on the prices of cocoa beans at the London and New York markets year 2009/2010 (ICCO, 2011e). 11
Figure 4 Ghana's regions. 11
Figure 5 Illustration of the conventional cocoa product chain. 15
Figure 6 Illustration of Unilever's certified cocoa product chain. 15
Figure 7 Average productivity per farm group. 27
Figure 8 Average shade tree density per farm group. 28
Figure 9 Average emissions by production per farm group. 29
Figure 10 Emissions by production per farm 29
Figure 11 Emissions by production per farm excluding shade trees 30

List of Abbreviations

AGL	Armajaro Ghana Ltd
ATL	Armajaro Trading Ltd
BC	Barry Callebaut
CFT	Cool Farm Tool
CMC	Cocoa Marketing Company
COCOBOD	The Ghana Cocoa Board
CPC	Cocoa Processing Company
CRIG	Cocoa Research Institute
FG	Farm Group
GHG	Greenhouse Gases
LBC	Licensed Buying Company
LCA	Lifecycle Assessment
LUC	Land Use Change
PBC	Produce Buying Company
PCO	Product Chain Organisation
RA	Rainforest Alliance
SFL	Sustainable Food Lab
SPCM	Sustainable Product Chain Management
UL	Unilever
WCF	World Cocoa Foundation

1 Introduction

There is a global awakening going on regarding sustainable development including issues such as fair working conditions and climate change. In a world of globalisation, many companies have not only their business areas but also their product chains spread over several continents all around the world. There are significant differences between regions where the companies are active, especially between developed and developing countries. It is argued that companies must take responsibility and develop strategies to minimise their negative environmental impact and reduce social inconsistencies. It is possible for companies to avoid bad reputation and costly scandals created elsewhere in the product chain by having a good understanding of and influence on their product chains as well as good relationships with suppliers and other industry stakeholders. Welford (2002) explains that organisations need to look at the whole product chain because their main environmental or social burden may occur outside their system boundaries, at other stages in the product chain. With the complexity of multi-national companies' organisation of their product chains that can be easier said than done.

Every industry has its own sustainability challenges and the agri-food industry is not an exception. For example, 70% of the global deforestation is caused by agricultural expansion and farms often contribute to problems like water pollution, soil erosion and wildlife extinction (Rainforest Alliance, 2012). Unilever is one of the largest actors on the global agri-food market. The company has high environmental ambitions and is dedicated to meet three major sustainability goals by year 2020: (i) halve the environmental impact of the product portfolio, (ii) 100% sustainable sourcing of agricultural raw materials and (iii) support over 1 billion people in taking action for improved health and well-being. At the same time Unilever has the aim to double its business size (Unilever, 2012a). The company's product chains are spread all over the globe and involve numerous people worldwide. To achieve their high targeted environmental and sustainability goals, a good Sustainable Product Chain Management must be in place.

Unilever buys 1% of the globally produced cocoa and 95% of that is used for the Magnum and Ben&Jerry ice creams. By year 2015, all cocoa used for the Magnum ice creams is targeted to be sourced sustainably and by 2020 all cocoa used by Unilever will be sourced sustainably. To secure the sustainability performance through the cocoa product chain and to communicate the sustainability efforts to customers, Unilever has chosen to certify the cocoa for the Magnum ice creams with Rainforest Alliance (RA). (Unilever, 2012b) RA has a broad sustainability approach with a strong farmer focus, taking both environmental as well as socioeconomic aspects into consideration (Rainforest Alliance, 2012). As a complement to Rainforest Alliance-certifications, Unilever has together with Sustainable Food Lab and the University of Aberdeen developed a Microsoft Excel-based software for calculating greenhouse gas (GHG) emissions on farm level for all crops in any part of the world called the Cool Farm Tool (CFT). It can be used to manage and communicate the GHG emissions on the farms to other actors in the product chain (Sustainable Food Lab, 2012).

The cocoa industry in general is a complex organisation with many stakeholders involved (Ghana Cocoa Board, 2012a). For the world's second largest cocoa producer, Ghana (Ntiamoah & Afrane, 2008), the structure of the industry differs quite a lot compared to other cocoa producing countries. The reason for this is the governmental entity, the Ghana Cocoa Board (COCOBOD), which strongly

influences and controls the market, ensuring the high quality cocoa that Ghana is known for (Ghana Cocoa Board, 2012).

The cocoa industry and its sustainable implications have gained more attention during recent times. There are many more on-going sustainability projects and programs within the cocoa industry besides certification schemes. Issues are raised to better reach out and support the livelihoods of farmers as they are the ones that in the end are providing the industry with cocoa. Efforts are put into managing the cocoa product chains in a more sustainable way. But the big question is: is it possible to achieve sustainable cocoa product chains at all, and if so, how?

1.1 Aim

The main purpose is to examine and provide better understanding of how a sustainable cocoa product chain could be organised and managed. The aim is to highlight and analyse the challenges achieving such a product chain. Related to this are the two aims to compare Rainforest Alliance-certified and non-certified cocoa farms in Ghana, as well as to help Unilever understand how they can measure greenhouse gas emissions from agriculture in developing countries by using and analysing the Cool Farm Tool. Consequently, the research questions that have directed the study are:

How is the cocoa product chain organised?

What are the collaborations within the cocoa product chain? How are the actors interlinked?

What are the main environmental and socioeconomic challenges for the cocoa industry in Ghana according to each actor in the product chain? How are they differing along the chain?

Are all of the actors in the cocoa product chain working in the same direction with their sustainability programs and projects?

What are the sustainability driving forces within the cocoa product chain?

What are the organisational challenges with certification schemes?

What are the benefits to Rainforest Alliance certify cocoa farms in Ghana?

a. Are the benefits changing over time?
b. How are the environmental and socioeconomic conditions improved?
c. What are the differences between Rainforest Alliance certified and non-certified farms regarding greenhouse gas emissions?
d. How is the Rainforest Alliance certification program affecting (i) the productivity of the cocoa farms and (ii) the usage of shade trees of the cocoa farms?

What are the challenges of using the Cool Farm Tool at farm level for calculating the greenhouse gas emissions on cocoa in Ghana?

How is the Cool Farm Tool applicable as a greenhouse gas emission communication and management tool?

2 Method

In this study the chain perspective has been central and resulted in the use of the concept of Sustainable Product Chain Management (SPCM). In the context for this study SPCM has been broadened from supply chain management. The term supply chain is used in the management of a network of production processes involving several steps, including companies and organisations that the specific company under study has interconnections with (Fransson, 2012). Boons (2002) uses the term product chain which includes more steps than supply chain such as retail, use and waste management. The latter is also applied in association with greening of product chains which has an emphasis on the network of actors and their impact on the environmental performance of the product chains. However, since this study is looking at both environmental and socioeconomic aspects of the product chain, the term used throughout this report is Sustainable Product Chain Management (SPCM).

Furthermore, the SPCM approach is similar to the newly developed Product Chain Organisation (PCO) study (Baumann, 2012). The PCO method has connections with the life cycle assessment (LCA) method which is typically looking at the environmental impacts of a product during its life cycle (from cradle to grave) (Baumann & Tillman, 2004). Note here that the term life cycle is more or less synonymous to the term product chain. In the PCO method, focus is instead placed on the organisation and structure of product chains. The differences are the focus areas of the methods: LCA have environmental information structured along the technical processes of the chain and the PCO is structured according to the actors (see Figure 1). It is the actors along the product chain that enables the product flow from its origin to final disposal. The network of actors and their interrelations are of importance to analyse to enable the possibility of proper sustainability management practices for companies to work with sustainable business solutions and to meet targeted sustainability goals. SPCM could thus be seen as a variant of PCO, with a strict focus on organisational issues related to sustainability.

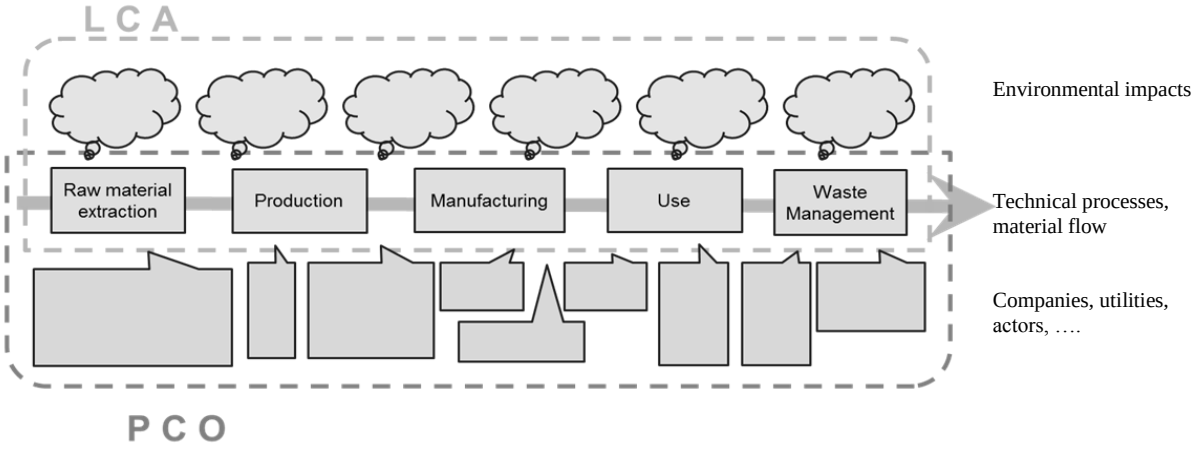

Figure 1 An illustration of the relation between PCO and LCA. Both are following the technical processes but LCA focus on environmental impacts and PCO focus on companies, utilities, actors etc. (Figure modified from Baumann 2012).

To carry out the purpose of the project and to find possible approaches for the achievement of sustainable cocoa product chains, two alternative Unilever product chains have been identified and examined: (i) a Rainforest Alliance (RA) certified cocoa product chain and (ii) a conventional, non-certified product chain. The actors in the product chains have been determined within the scope of this study, all active and/or doing business in Ghana. The main method for the data collection has been through semi-structured interviews with the actors and workshops conducted with farmers. The data collected has been the basis for the analysis of similarities and differences among the actors in the product chains as well as how and why the identified product chains are differing in terms of sustainability. In addition, GHG emission calculations have been done at farm level to compare certified farms with non-certified ones. Data for the calculations have been collected from the field in Ghana through measurements at farms and interviews The Cool Farm Tool (CFT) has been used for the calculations and has been assessed as a communication tool as a way for companies at one end of the chain to reach the origin easier. Its potential as a complement to certifications is being discussed based on its functionality and the results from the GHG calculations.

2.1 Literature Study

A literature study was conducted to obtain a deeper comprehension of the concept of Sustainable Product Chain Management (SPCM), its applicability and approach within this study. This part of the literature study has contributed to a better understanding of the strengths and weaknesses of specific product chains and which benefits there are for involved stakeholders to be more sustainable. The literature study has aimed to investigate how global companies can secure the environmental and sustainable performance through the product chain. This has led to a comprehension of the role of companies and their product chains on a global scale. The outcome is the application of the concept for this specific study of sustainable cocoa product chains.

As another part of the study a literature review was conducted mainly to obtain background knowledge about the agri-food industry. Much time was spent on obtaining an understanding of the cocoa production and industry, what every actor is responsible of and how the production of cocoa is done. A particular focus has been on getting a grip of what is done on the farms and agricultural practices used by the cocoa farmers as well as the function of shade trees. A part of the literature review has been about sustainable agriculture and the strategies of Rainforest Alliance. Since GHG-emission calculations have been done, better knowledge was needed of how the cocoa agriculture is affecting, and is affected by, GHG. The literature study has both been general as well as Ghana-specific and a basic understanding for agriculture in developing countries has been obtained.

2.2 Office Visit

Early in the project, an office visit was arranged to Unilever's Safety and Environment Assurance Centre in Sharnbrook, UK, to specify the aim and scope of this study. This has provided a better insight about the large and complex organisation of Unilever. It has also provided knowledge and understanding of how Unilever works with sustainability and its strategies and goals.

2.3 Interviews

Several interviews have been conducted with representatives from companies, organisations, governmental bodies and one certification body. These are all actors identified for the cocoa product chains within the scope of this study. In addition, there have been considerable interactions with cocoa farmers in different regions in Ghana. As preparation for the field trip to Ghana other organisations have been contacted for planning purposes. See Table 1 for an overview of all involved actors.

The interviews conducted have provided understanding of the build-up of both the cocoa industry in general and for Ghana in specific. The interviews with the actors identified for the studied cocoa product chains are of main importance to enable the analysis of similarities and differences within the cocoa product chains. These were conducted to recognise the actors' different roles, their sustainability efforts, experienced sustainability challenges, how they influence each other and collaborations. Special emphasis has been at farm level comparing Rainforest Alliance (RA) certified farms with non-certified ones as well as the actors' general view on certifications. Knowledge about the effects of RA-certifications has been obtained through briefings of RA's activities on the ground. In addition individual farm interactions and workshops have been conducted to enable the comparison.

Table 1 Overview of actors involved in the study and type of interactions.

Actor	Function	Number of represent-atives	Location	Type of data collection	Type of contact	Data collection
Cocoa Farmers	Private actors	Numerous	Tafo, Assin Fosu and Kumasi, Ghana	Semi-structured interviews	Workshops and individual interactions	Notes
The Ghana Cocoa Board	Governmental body	3	Accra, Ghana	Semi-structured interviews	Meetings	Recording
The Ghana Research Institute	Governmental body	5	Tafo, Ghana	Semi-structured interviews	Meetings and guided tours at cocoa farms	Recording
The Cocoa Marketing Company	Governmental body	1	Accra, Ghana	Semi-structured interview	Meeting	Recording
Armajaro	Licensed Buying Company /Trader	2	Kumasi, Ghana	Semi-structured interviews	Meetings and field visits	Recording
Produce Buying Company	Licensed Buying Company /Trader	2	Accra, Ghana	Semi-structured interviews	Meetings	Recording
Barry Callebaut	Processor	2	Tema, Ghana; Zurich, Switzerland	Semi-structured interviews	Meetings and phone interview	Recording
Cocoa Processing Company	Processor	2	Tema, Ghana	Semi-structured interviews	Meetings and guided tour at factory facilities	Recording and notes

Actor	Function	Number of represent-atives	Location	Type of data collection	Type of contact	Data collection
Unilever	Manufacturer	5	Sharnbrook, UK; Rome, Italy	Semi-structured interviews	Meetings, phone interviews and continuous communication	Recording and notes
Rainforest Alliance	Certification body	3	Cape Coast and Accra, Ghana; London, UK	Semi-structured interviews	Meetings, phone interviews and continuous communication	Recording and notes
World Cocoa Foundation	Association	1	Accra, Ghana	Semi-structured interview	Meeting	Recording
AgroEco	Local NGO	1	Assin Fosu, Ghana	Semi-structured interview	Meetings and farm visits	Notes
Sustainable Food Lab	Global network	2	Hartland, USA	Preparation for field trip	Phone interviews	Recording and notes
SIK, SP	Industry research institution	1	Gothenburg, Sweden	Preparation for field trip	Meeting	Notes
University of Ghana	Educational institution	1	Accra, Ghana	Dialogue	Continuous communication	Notes

2.4 The Cool Farm Tool (CFT)

The Cool Farm Tool (CFT) has been used for GHG-emission calculations. The CFT is a Microsoft Excel based GHG calculator on farm level available on the web for free download and use. Unilever has together with Sustainable Food Lab (SFL) and researchers at the University of Aberdeen, primary Jon Hillier, developed the CFT with the purpose of measuring and understanding the carbon footprint of agricultural crops. The CFT was launched in April 2010 and over two years the CFT has been piloted to enable its development for future refinements and methodological improvements. The goal is to create a single tool for agricultural GHG emissions' measures applicable on multiple crops around the globe. (Sustainable Food Lab, 2012)

The intended benefits with the CFT are its user-friendliness and the scientifically robust empirical data models as basis for the calculations. The data models include IPCC data and other sources with globally aggregated default emission data, in addition to country specific data and empirical models to enable more complex and site specific information. (Sustainable Food Lab, 2012) Included in CFT's GHG emission calculations are general crop data, production area, yield, climate data, soil quality information, crop residues management, information of fertilisers usage and pesticides, land use change (LUC) information over the past 20 years, data of biomass sequestration in for example shade trees, information about livestock, energy use, farm level processing and transportation. The greenhouse gases included in the tool are CO_2, N_2O and CH_4.

The input requirements for the tool are considered to be easy to complete based on farmer's own knowledge making the CFT act as a farmer engagement and management tool. The calculated results

aim to help farmers understand and identify emission reduction possibilities such as testing different farm management scenarios. These aspects together with the results as decision support have brought positive feedback from the industry. (Cool Farm Institute, 2012) The CFT is still at its early development stage, but through SFL a variety of multinational companies such as Unilever, PepsiCo, Tesco and Marks & Spencer's as well as smaller organisations have piloted it in product chain contexts. The companies strive to work with their suppliers and other industry stakeholders to measure, manage and reduce GHGs (Sustainable Food Lab, 2012) but the tool could also provide a medium to better communicate with farmers about GHG emissions.

The CFT has thus been used in this study for two reasons: (i) to the analysis of the differences in GHG emissions between Rainforest Alliance certified and non-certified cocoa farms and (ii) to examine the implementation possibilities of the CFT. To enable this, data for the calculations was collected both through interviews with experts within different research areas, mostly at the Cocoa Research Institute of Ghana (CRIG), and by farm visits. CRIG provided information about the soils, fertilisers and valuable information about shade trees such as names of tree species (from local names to scientific), growth rates etc. This information was for the general input data options in the CFT applicable for all the farms, meanwhile the data collected from the farms were unique for each specific cocoa farm.

On the farms, the cocoa farmers were interviewed about the farm-specific data needed; size of farm, number of shade trees, energy use, productivity, usage of fertilisers and use of pesticides among others. To obtain the diameter of the shade trees on the farms, measuring tape was used to get the circumference of the trees. The farmers' ability to provide the data needed created a basis for the analysis of the implementation possibilities of the CFT.

2.5 Data Analysis

Most of the interviews have been recorded and for the compilation of all the information that has been gathered, transcriptions have been conducted. To pick the material needed for the purpose of the study, the information from the transcriptions was categorised and consolidated into matrices to facilitate sorting. In the matrices, the information and quotations was grouped into relevant themes und sub-themes. The purpose with the matrices was to get an overview of the numerous data that was collected and to find possible relations of subjects among all the actors. The interviews are the primary source of data used in the report and have provided much material for discussion.

3 The Cocoa Industry

This chapter will give the reader necessary background information about the production and industry of cocoa.

The cocoa belongs to the genus *Theobroma* which has its origin millions of years ago to the east of the Andes in South America. Because of a growing demand for chocolate and cocoa, the production spread in Latin America and in the 19th century the crop was introduced to West Africa. (ICCO, 2011a)

The cocoa is a tree crop. Flowers are grown out from the body and branches of the tree and develop into cocoa pods. Inside the pods, there are around 50 cocoa beans surrounded by sweet tasting placenta.[1] Cocoa grows naturally in the rainforest, within 10oN and 10oS of the Equator. The crop is sensitive to climate aspects such as temperature and rainfall; the cocoa tree need a lot of rain and are sensitive to dry spells. A high humidity is important for a high yield. Because of the cocoa's natural habitat, the rainforest, the cocoa tree has developed the ability to maximising the benefits from the sunlight. Therefore, shading is crucial for the cocoa tree's early years and at cocoa farms, it is normally grown under shade. The soil where the cocoa is grown must have both good drainage as well as good water retention properties. (ICCO, 2011a)

The farmer can start harvest the cocoa tree from around the third year and the tree is considered economically productive for 25-30 years before the yield of the tree is declining. It takes about 6 months for the cocoa flower to become a ripe cocoa pod. The colour of an unripe cocoa pod is green but once the colour starts to change to yellow the pod is ripe and it is time to harvest.[2] The harvest is done manually (ICCO, 2011b) with a sharp knife specific for cocoa harvesting[3] by cutting through the stalk. For pods growing out of reach for the harvesting farmer, a pruning tool with a long pole can be used (ICCO, 2011b). During the opening, the farmers crack the pods with a wooden baton and extract the cocoa beans.[4] There are machines developed for cocoa pod opening (ICCO, 2011b) but the smallholder farmers in Ghana carry out the work manually.[5] Inside the pods, there are wet cocoa beans removed by hand. When the pods are opened, the residues are either left in piles[6] or spread out on the fields bringing nutrients back to the soil (ICCO, 2011b).

The fermentation is important for qualities such as colour and taste of the cocoa beans. The process change the colour of the cocoa beans from purple to chocolate brown and the taste from very bitter to tasting like chocolate without any sugar. The whole fermentation process is natural, no artificial products are added. The heap fermentation is the method mostly used by farmers in Ghana. The beans are piled in heaps on banana leaves mats and cover with more leaves. A good cover is important and to get drainage the farmers make holes in the mats. The total time for the fermentation is six days, mixing the beans with 48 hours' intervals.[7]

[1] Researcher 3, Cocoa Research Institute of Ghana, Interview 2012-05-29
[2] ibid
[3] Field visits, Cocoa Farms, Ghana, 2012
[4] Researcher 3, Cocoa Research Institute of Ghana, Interview 2012-05-29
[5] ibid
[6] Field visits, Cocoa Farms, Ghana, 2012
[7] Researcher 3, Cocoa Research Institute of Ghana, Interview 2012-05-29

When the fermentation is done, the cocoa beans are sundried on a plafond of mats. The drying process is made wherever the farmers are; on the farm, in the village or in the society. The mats are flexible on one side and if it starts to rain, the mats are folded with the beans inside and the farmers cover it all with for example banana leaves for protection. The drying takes about 10-14 days depending on the atmospheric conditions. The cocoa beans should be stirred at least every two hours during daytime. The moisture content in the beans after the fermentation is about 40-50 % and should go down to 6-7 % during the drying process.[8]

The cocoa crop can be attacked by diseases. It is estimated that as much as 30-40 % of global production is lost due to diseases (ICCO, 2011c). Good agricultural practices can decrease these numbers. Some of the most common cocoa diseases in Ghana are the Cocoa Swollen Shoot Virus disease, the Black Pod and the mistletoe.[9] 70 % of the global deforestation is due to agricultural expansion. Agriculture is therefore the biggest threat to tropical forests, and is often also causing environmental problems such as soil erosion, water pollution and wildlife habitat destruction (Rainforest Alliance, 2012). One way to get a more sustainable agriculture is through certification schemes. There are several sustainability certification schemes out on the market; the largest ones within the cocoa production are Rainforest Alliance, UTZ, Fairtrade and Organic. Today, around 10% of the global cocoa is certified.[10]

3.1 The Global Cocoa Industry

Globally today, there are around 40 million people earning their living from cocoa. About 14 million of these are farmers (Unilever, 2012b). More than 90 % of today's cocoa comes from smallholder farms with normally up to around five hectares of land (ICCO, 2011d). The production of cocoa is reported in seasons from October to the end of September. Table 2 shows the global production of cocoa per season, country and continent.

Table 2 Global production of cocoa (ICCO, 2011).

[thousand tons]	*2007/08*	*%*	*2008/09*	*%*	*2009/10*	*%*
AFRICA	2693	*71.8*	2518	*69.9*	2458	*68.0*
Ivory Coast	1382		1222		1242	
Ghana	729		662		632	
Nigeria	230		250		240	
Cameroon	185		227		190	
Others	166		158		154	
AMERICA	469	*12.5*	488	*13.5*	522	*14.4*
Brazil	171		157		161	
Ecuador	118		134		160	
Others	180		197		201	
ASIA & OCEANIA	591	*15.8*	599	*16.6*	633	*17.5*
Indonesia	485		490		535	
Papua New Guinea	52		59		50	
Others	55		50		48	
WORLD TOTAL	**3752**	***100.0***	**3605**	***100.0***	**3613**	***100.0***

[8] Researcher 3, Cocoa Research Institute of Ghana, Interview 2012-05-29
[9] Researcher 1, Cocoa Research Institute of Ghana, Interview 2012-05-28
[10] Representative 1, Rainforest Alliance, Interview 2012-06-02

Between the period 2000/01 and 2009/10, the global production of cocoa has had an average annual growth of 2.5 %. The average annual growth rate in Africa has been higher; almost 3 %. The number one processing region is Europe, but where the cocoa processing industry is growing the most is Asia (ICCO, 2010). In the future, the consumption of cocoa is predicted to increase hugely in fast-growing economies like China and India as well as in regions like Eastern Europe and South America. This will lead to an additional demand of one million tonnes by 2020; see Table 2 Global production of cocoa (ICCO, 2011)Table 2 for comparison of today's production levels (Barry Callebaut, 2012a). For the consumption development in some of the largest consumption countries between the seasons 2000/01 and 2008/09, see Figure 2. A current trend in the cocoa consumption pattern is the increasing consumption of "premium" chocolate, especially dark chocolate with high cocoa content (ICCO, 2010). Sustainably produced and certified cocoa products are also getting more popular. Parallel, there is a growing demand for cheap chocolate due to increasing cocoa prices (Barry Callebaut, 2012b).

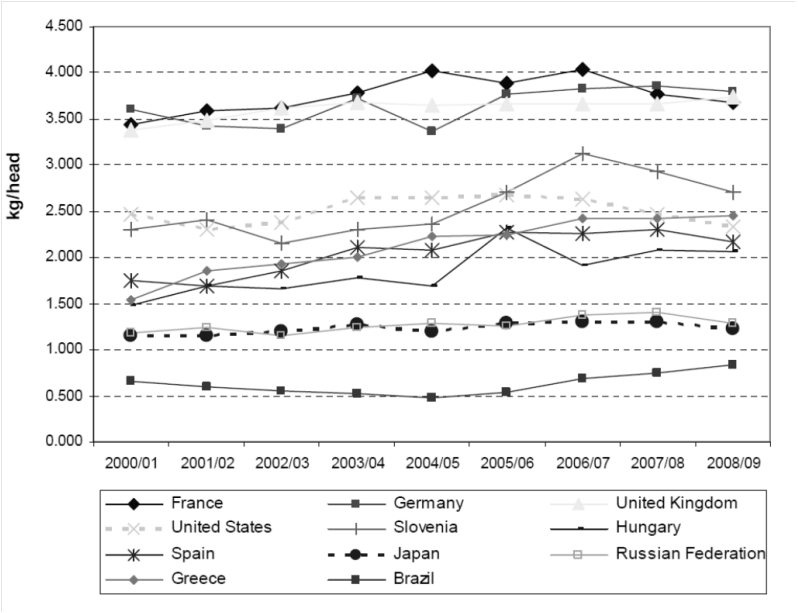

Figure 2 Cocoa consumption per capita, bean equivalent (ICCO, 2010).

The cocoa is traded on the commodity markets of both London and New York.[11] The cocoa daily price is fluctuating, as illustrated in Figure 3. During the time period 2000/01 to 2009/10, the price fluctuated between US$ 774 and US$ 3,637 per tonne (ICCO, 2010).

[11] Manager, Cocoa Marketing Company, Interview 2012-06-27

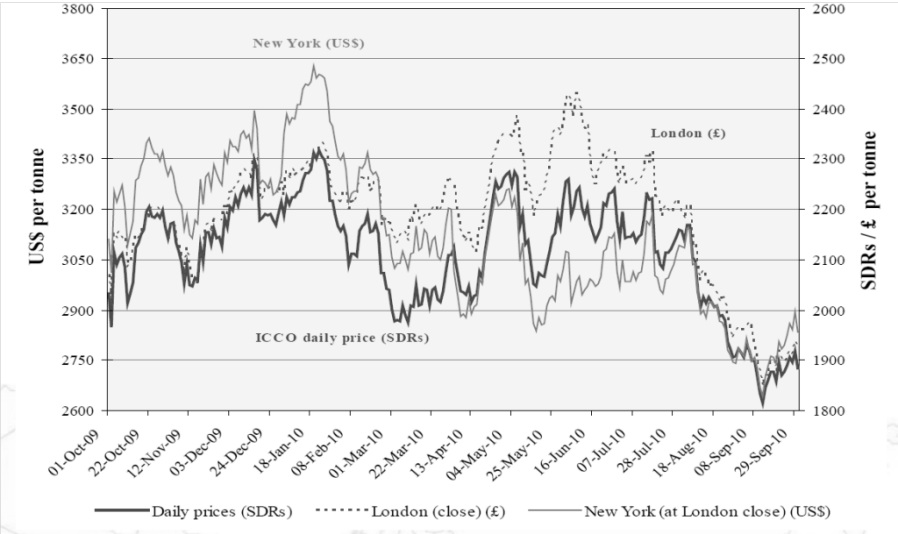

Figure 3 Fluctuation on the prices of cocoa beans at the London and New York markets year 2009/2010 (ICCO, 2011e).

3.2 The Cocoa Industry in Ghana

The cocoa was brought to Ghana from Sao Tome in the 1880's (Ghana Cocoa Board, 2012b). The first export of cocoa beans from Ghana is recorded back to 1891 and ever since the cocoa has been the main export crop and source of foreign exchange and national income. The country was world leading producer of cocoa between the years 1910-1977. (Obeng Adjinah & Opuku) Today, Ghana is divided into six cocoa growing areas (see Figure 4): Ashanti, Brong Ahafo, Eastern, Volta, Central and Western regions (Ghana Cocoa Board, 2012b). Nowadays, Ghana is the world's second largest cocoa producer. Last season, 2010/11, Ghana reached a milestone by producing over one million tonnes of cocoa. This season the production levels are expected to increase.12 On the international market Ghana is known as cocoa for high quality chocolates (Laven, 2007) and the Ghanaian cocoa is slightly more expensive than others with a premium included in its price.[13] Ghana is consuming less than 0.5 % of its produced cocoa. Costs, culture and climate are factors limiting the use of cocoa even though there is a huge market for drinking chocolate.[14]

Figure 4 Ghana's regions.

The cocoa year in Ghana is divided into two seasons; the main crop and the light crop. Between October and June the main crop takes place, followed by a two weeks period without any official harvest as a preparation for the light crop, which lasts until the end of September. It is the amount of rainfall and level of moisture when the cocoa flowers are developed that decided the cocoa season. Therefore the cocoa beans are larger during the main crop bringing more income to the farmer than during the light crop. [15] To protect Ghana's reputation of having good quality cocoa and to give local

[12] Representative 3, The Ghana Cocoa Board, Interview 2012-06-28
[13] Representative 1, Produce Buying Company, Interview 2012-05-21
[14] Representative 2, Cocoa Processing Company, Interview 2012-05-22
[15] Representative 1, The Ghana Cocoa Board, Interview 2012-05-21

manufacturers a chance to buy cheaper cocoa, the produce from the light crop is sold to a reduced price to purchasers within Ghana only.[16]

The cocoa industry in Ghana consists of smallholder farming with an average farm area of approximately 1.2 hectare.[17] The Ghanaian landowner system is complex. One common arrangement is for the landowners to hire caretakers running the farm.[18] The caretaker usually gets one-third of the yield and the owner gets two-thirds. The investment costs are normally a duty of the landowner.[19] In Ghana, companies cannot own any cocoa farms.[20] The farms are most often family properties. The daughters inherit the land from the parents but one or several of the brothers have access and control of the land until his death when the land returns to the sister. Since the land is divided between all sisters, the farm size will reduce for each generation.[21]

Due to the importance of cocoa for the development of Ghana, the Ghana Cocoa Board (COCOBOD) was established in 1947 by the government. The COCOBOD as a central governmental agency was given the main responsibility to develop the industry. (Ghana Cocoa Board, 2012b) The cocoa system in Ghana is today a public private partnership with the COCOBOD in the role of a regulator. The World Bank wanted to fully liberalise the Ghanaian cocoa market but as a compromise the market opened partly up in 1992 and licensed buying companies (LBCs) were established. LBCs are private companies purchasing and collecting the cocoa beans from the farmers.[22] The LBCs are given seed funds from the COCOBOD to purchase the cocoa on behalf of the COCOBOD at a commission.[23] There is a price guarantee for the farmers called the producers' price and is the price per kilogram cocoa beans the COCOBOD will pay the farmers. Currently there are 32 LBCs that are participating in the internal marketing of cocoa in Ghana but about 10 of them are controlling most of the market. The farmers are not restricted to sell their beans to any specific LBCs and can in principal choose how many LBCs they wish.[24] There are no legal contracts so the LBCs have no assurance on getting the farmers to sell them the beans.[25]

[16] Manager, Cocoa Marketing Company, Interview 2012-06-27
[17] Researcher 1, Cocoa Research Institute of Ghana, Interview 2012-05-28
[18] Representative 3, The Ghana Cocoa Board, Interview 2012-06-28
[19] Researcher 2, Cocoa Research Institute of Ghana, Interview 2012-05-29
[20] Representative 2, Cocoa Processing Company, Tema, Ghana, 2012-05-22
[21] Researcher 2, Cocoa Research Institute of Ghana, Interview 2012-05-29
[22] Representative 1, The Ghana Cocoa Board, Interview 2012-05-21
[23] Representative 2, Cocoa Processing Company, in Tema, Ghana, 2012-05-22
[24] Representative 1, The Ghana Cocoa Board, Interview 2012-05-21
[25] Representative 1, Produce Buying Company, Interview 2012-05-21

4 Findings: The Cocoa Product Chains

The identification of the cocoa product chains presented in this chapter is based on information from the interviews conducted with representatives from the different industry actors.

There are many existing, parallel cocoa product chains; in this chapter two alternative ones are presented. Both start with cocoa farmers in Ghana and end with Unilever as the manufacturer of Magnum ice creams. In Figure 5 a conventional, non-certified product chain is illustrated, for an explanation of the symbols see Table 3. The second chain is illustrated in Figure 6. This is a Rainforest Alliance (RA) certified product chain and is Unilever's (UL) response to their sustainability goal of sourcing all Magnum ice cream cocoa sustainably by 2015. The material flow in Figure 5 and Figure 6 is illustrated with grey arrows going from the cocoa farmers in the left to UL in the right end of the figures. Sustainability collaborations between actors are illustrated with black two-way arrows.

The actors and activities taken place in Ghana are marked out with striped boxes in Figure 5 and Figure 6. As described in Chapter 3.2, the structure of the Ghanaian cocoa industry is country specific due to the role of the Ghana Cocoa Board (COCOBOD) who is involved in all cocoa related activities within Ghana. Included in the COCOBOD are several divisions. The Cocoa Marketing Company (CMC) is the part of COCOBOD responsible for sale and export of all Ghanaian cocoa. In Figure 5 and Figure 6 , the linkage between CMC and the COCOBOD illustrates the connection between them. Due to the connection it is indifferent if the black two-way arrows point at COCOBOD or CMC in the figures. The Cocoa Research Institute of Ghana (CRIG) is another division belonging to the COCOBOD. CRIG performs research to develop the Ghanaian cocoa production and industry. In the figures of the two product chains, CRIG is included under the COCOBOD but is presented separately henceforth in the report since its research activities are of essential importance for the cocoa production in Ghana.

All cocoa produce, sun dried cocoa beans, is purchased from the farmers and sold to CMC by Licensed Buying Companies (LBC) explained in Chapter 3.2. In the RA certified product chain, Armajaro Ghana Ltd (AGL) is the active LBC, see Figure 6. In the conventional product chain in Figure 5 both AGL and a domestic competitor, Produce Buying Company (PBC), is presented. This is because for conventional cocoa, a trader or processor buys their beans from CMC without knowing what LBC that has purchased the cocoa from the farmers. When Armajaro Trading Ltd (ATL), the trader that is buying the cocoa beans from CMC in the RA certified product chain, started its traceability program the cocoa industry structure in Ghana had to change. This was because ATL wanted to be able to buy its cocoa from a specific LBC: AGL. This organisational change enables for the traders and processors to know where the cocoa come from, what LBC that has purchased the beans, and allows traceability up to village level. This change was necessary also for certified cocoa.

The processors are transforming the dried cocoa beans into cocoa liquor, cocoa butter, cocoa cake and cocoa powder. Thereafter, chocolate is produced. UL has an agreement with the processor Barry Callebaut (BC) since early 2012 to purchase 70 % of its cocoa from BC. According to UL, one of the reasons for this is to enable UL to reach its targeted sustainability goals. In the RA certified product chain in Figure 6, BC is therefore UL's only processor of cocoa. In Figure 5, the domestic processor Cocoa Processing Company (CPC) is added as a competitor to BC in the conventional product chain. In this chain there are also material flows directly from CMC to the processors since the traceability program of ATL is not needed.

As shown in Figure 6 with black two-way arrows, RA collaborates with most actors along the product chain. This is to ensure that its standards are followed through the whole chain. RA's focus is the farmers but to be able to reach out to as many farmers as possible and to build local competences, RA is often working through local NGOs, as illustrated in the figure. Source Trust is a non-profit organisation set up by ATL engaging several actors and with a mandate to implement sustainability projects such as RA certifications on behalf of ATL.

Seen in the figures are also what actors that have direct contact with the farmers. UL does not have any direct farmer contact but works instead through its processors. Also the processors in both product chains lack direct contact with the farmers but it should be noted that this is only in the specific case of Ghana with the COCOBOD as a regulator. Instead it is the COCOBOD and the LBCs that are the most active in the farmer contacts in the conventional product chain in Figure 5, and with RA added in the certified chain in Figure 6.

The World Cocoa Foundation (WCF) is an external industry agency developing sustainability projects and programs in collaboration with both public authorities and private cocoa companies. UL is not a part of this industry association. WCF has an impact on the global cocoa industry and production but since it is not directly connected to the product chains of UL, it is excluded from the illustrations of the chains but included as an actor hereafter in the report.

To sum up this chapter it is identified that there is a big company at one end of the chain and small-holder farmers on the other end. The bigger actor at one side of the chain might seem to have more power than the farmers but will at the same time not be able to survive without the farmers produce. To be able to achieve the sustainable cocoa product chain UL is striving for, it is of importance to analyse all the actors' sustainability efforts as well.

Table 3 Explanation of symbols for product chain figures.

	Governmental bodies
	Industry actors (Unilever suppliers)
	Non-profit organisations
	Flow of the cocoa produce
	Collaborations
	Within Ghana

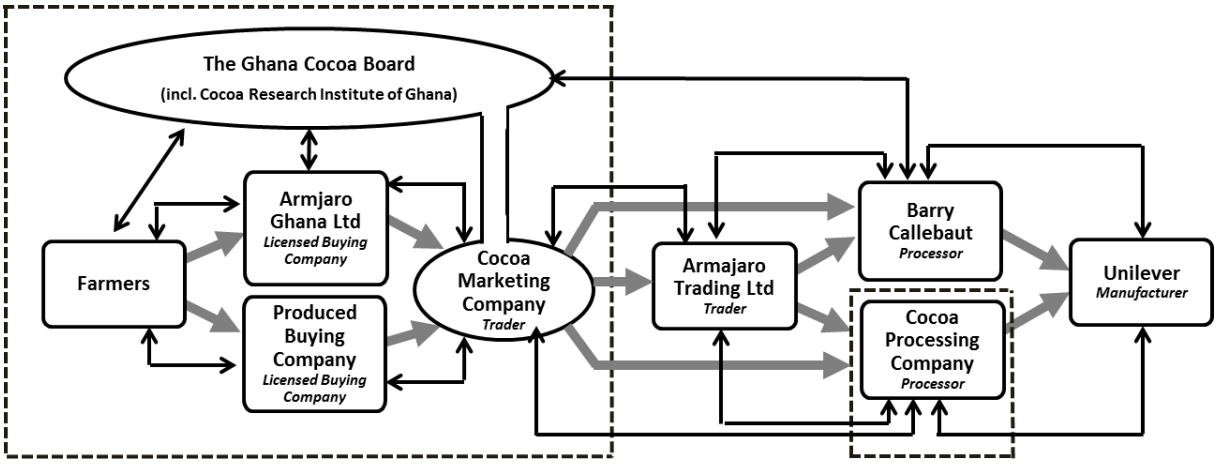

Figure 5 Illustration of the conventional cocoa product chain.

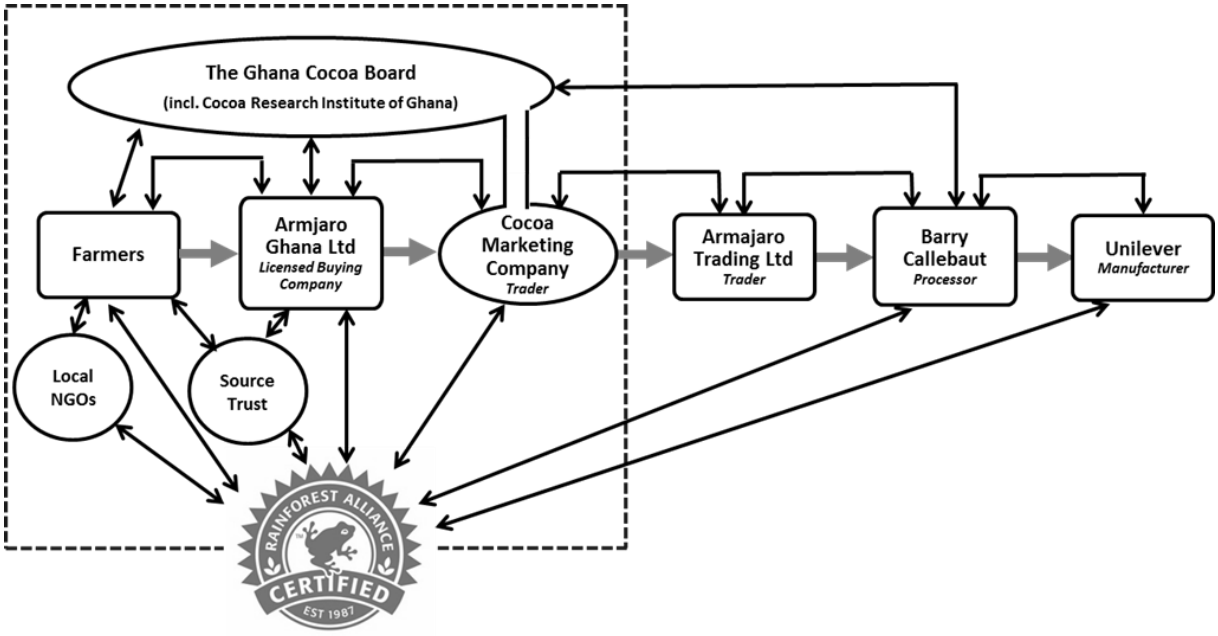

Figure 6 Illustration of Unilever's certified cocoa product chain.

5 Findings: Sustainability Management

This chapter includes analysis of the sustainability management conducted by the different actors identified in the product chains presented in Chapter 4. All the information is compiled from the interviews carried out with the representatives from the organisations. The actors included in the cocoa product chains have different roles. Their roles and market positions influence their sustainability efforts which are crucial to analyse to see how they are aligned. The actors' sustainability efforts are summarised in Table 4 divided into actors' role, their sustainability driving forces, actions taken, and their future predictions about the cocoa industry.

Table 4 Actors' sustainability management.

	Role	Sustainability Driving Forces	Sustainability Actions	Future
COCOBOD	**Governmental body** Regulate Ghana cocoa industry	• Economic sustainability • Productivity • Sustainable cocoa production • Improve farmer livelihoods	• Sustainability investments • Farmer training and education • Improve agricultural practices • Promote pesticide and fertiliser usage • Control of quality • Intensification instead expansion of land • Secure future labour	• Good social conditions are the future of the cocoa industry
CRIG	**Research Institute** Research on cocoa	• Productivity • Sustainable agricultural practices • Protect ecosystems • Secure cocoa production • Prevent climate change consequences • Secure future labour	• Sustainability research • Disease control • Capacity building • 2-way communication with farmers • Approve and recommend chemicals	• Increased demand of environmentally friendly production methods
CMC	**Trader** Mediate cocoa produce from production to the market	• Respond to market trends	• Collaboration and communication with other actors • Enable traceability and certification schemes	• Increased demand of sustainability and traceability as well as organic
Armajaro	**Licensed Buying Company/Trader** Purchase cocoa beans from farmers and resell the produce	• Improve farmer livelihoods • First mover's advantages • Productivity • Better control of farm activities • Create awareness among farmers • Sustainable agricultural practices	• Collaboration with other actors • Farmer interventions • Provide support services to farmers • Farmer training and education • Develop together with existing clients • Sustainability investments • Traceability • Certificate holder	• Increased demand of sustainable cocoa
Barry Callebaut	**Processor** Transform cocoa produce into cocoa liquor, powder and butter as preparation for the end products:	• Improve farmer livelihoods • Ensure sustainable cocoa product chains and	• Collaborations with other actors • Financial and resource support helping the	• Increased demand of certified cocoa

	chocolate, cocoa powder and compound	responsible business • Productivity • Satisfy customer demands • Reduce costs • Modernisation of cocoa production • Secure future labour • Secure future cocoa demand	COCOBOD's sustainability work • Increased emphasis on management practices	
Unilever	**Manufacturer** Use chocolate for the manufacturing of ice creams	• Productivity • Secure future cocoa demand • Create a balanced product chain • Reach the origin easier • Improve farmer livelihoods • Reduce costs	• Sourcing strategy based on sustainability • Prepare for increased demand • Collaboration with other actors • Certification schemes • Ambitious sustainability goals	• There will no non-sustainable cocoa available on the market in ten years' time
RA	**Certification Body** Certify farms	• Drive the demand for sustainable produced goods • Sustainable agriculture • Productivity • Protect ecosystems • Improve farmer livelihoods • Continuous improvements of agricultural practices • Give benefits to all actors • Secure future sustainable cocoa demand	• Certify farms • Direct and comprehensive interaction with farmers • Farmer training and education • Promote sustainable agricultural practices • Traceability • Build up local capacity • Engage private sector • Data collection and measurements	• Increased demand of certified and sustainable cocoa
WCF	**Cocoa industry association** Connect public and private sector	• Productivity • Improve farmer livelihoods • Improve the collaboration between industry actors • Sustainable cocoa production • Secure future labour • Improve information flows to farmers	• Implement public private partnerships • Developed farmer training programs overtaken by the COCOBOD • Sustainability programs directly targeting farmers and communities • Promote and develop sustainable production	• Increased demand of certified cocoa
PBC	**Licensed Buying Company/Trader** Purchase cocoa beans from farmers and resell the produce	• Follow customer demands	• Limited sustainability effort • Traceability • Occasional farmer training • Collaboration with the COCOBOD	*No opinion*
CPC	**Processor** Transform cocoa produce into cocoa liquor, powder and butter as preparation for the end products: chocolate, cocoa powder and compound	• Follow customer demands	• Sustainability goals on the drawing board • No customer demand for traceability	*No opinion*

5.1 Sustainability Driving Forces

The main sustainability driving forces identified in Table 4 are productivity and to improve farmer livelihoods. 7 out of 10 actors promote productivity which is seen to be critical to sustain the cocoa industry. All the actors can benefit of increased productivity in terms of higher yields at farm level that will lead to more cocoa beans available and the possibility to increased sales volumes for the companies within the product chain. This is especially due since increased demand of cocoa is predicted in the future. In line with increased productivity, 6 out of 10 actors are promoting improved farmer livelihoods. Farmer livelihood include improved working conditions, farmer income and community development among others. Common for the actors and their driving forces is that they all have farm focus in one way or another. Many of the actors are also addressing sustainable cocoa production or sustainable agricultural practices.

The focus of the driving forces is mainly on socioeconomic aspects. Environmental aspects are addressed in term of protection of ecosystems and indirectly through sustainable agricultural practices but are not as strongly addressed as the socioeconomic perspectives. As an example, the COCOBOD brings up economic sustainability. According to them, the focus should be to improve the economic situation for the farmers before the other issues can be tackled in a greater extent. Many of the actors thus emphasise the socioeconomic aspects for development.

The actors have different roles in the cocoa product chain, giving altered sustainability driving forces. For example, the CMC, which only respond to market trends and acts as a trader has not the ability to promote sustainability more than through communication to other actors. The CMC's sustainability driving forces are thus seen to be limited. Along with this the different actors, mainly Armajaro and BC, have diverse ways of positioning themselves on the market. Armajaro's strategy is to be a sustainability market leader of traceable, certified and sustainably produced cocoa. By being first the company can benefit of first mover advantages which imply the ability to gain competitive advantage and increased market shares. BC on the other hand offers more flexibility and follows customer demands, if costumers demand certified or sustainably produced cocoa BC responds to it. This gives BC possibility to gain market shares.

As seen in Table 4 most of the actors are having several and strong sustainability driving forces except the two domestic companies; PBC and CPC (as well as CMC already mentioned). Their business activities are lacking international presence and result in limited awareness or interest of the market trends in the global cocoa industry. Their common driving force identified is to follow customer demands. WCF working with both private and public actors is claiming that the sustainability awareness is becoming more and more widespread within the cocoa industry. However, what is seen in Table 4 is that the domestic actors are not there yet.

5.2 Sustainability Actions

The main sustainability action among the actors is collaboration with others in the cocoa industry. It is the global actors that address the importance of collaboration and how they are trying to find sustainability solutions together. The domestic companies, PBC and CPC, do not have any sustainability work at this point in time.

The sustainability actions seen in Table 4 show that environmental and socioeconomic aspects are brought up. In comparison with the sustainability driving forces the actors are actually doing more environmental favourable activities than they are expressing. These are to promote sustainable agriculture through farm interventions. The farmers are given training and education in good agricultural practices such as farm management and given recommendation of amounts of shade trees and chemical usage. What is seen as key among many of the actors is to improve farmer knowledge. The education and training is a sustainable way to promote development in many terms such as to improve farmer livelihoods through increased farmer incomes and improved yields. In addition the farmers are able to forward knowledge to next generations.

5.3 Future

It is clear that most of the actors' predictions about the future are about sustainable and/or certified cocoa. The actors doing more business-related activities address that there will actually be an increased demand of sustainable and/or certified cocoa. Meanwhile the COCOBOD and CRIG say that social and environmental conditions are the future of the cocoa industry. PBC and CPC have no opinions mainly because they are not following the global market trends.

6 Findings: Sustainability Challenges

To get an overview of the environmental and socioeconomic challenges brought up by the different actors, summaries by categories and actors are made in Table 5 and Table 6. The C's indicate noticed challenges considered by the actors during conducted interviews. The C's in brackets under "Child Labour" indicates complications, that it is a challenge but not as severe as others might think or that the problem has already been taken care of, see further down in the text for more information. Since both farmer groups consider "Climate Change" to be the most difficult environmental challenge and "Farmers' Income" the biggest socioeconomic issue, they are market with a larger C in the tables.

Within the challenges brought up by the actors, three different categories can be seen: (i) challenges agreed upon, (ii) challenges with diverse interest among the actors and (iii) challenges with conflicting opinions.

The challenges agreed upon is the ones most likely to be assessed and worked on since everyone involved is prioritising those as major challenges. The risk with challenges with diverse interest among the actors is that even if some actors think those are challenges and others do not they tend to fall back on the agenda. Challenges with conflicted opinions are the ones which are most difficult to improve since the actors cannot agree on anything concerning those issues. Examples of challenges that the actors agree upon is environmental challenges such as "Deforestation" and "Soil Depletion" and socioeconomic challenges such as "Farmers' Income", "Productivity", "Community Development" and "Lack of Knowledge & Education". Most actors find these challenges major and point them out as important to work with and to improve.

When it comes to challenges with diverse interest among the actors, these are challenges that some actors find it very important to put effort into improving while others do not think of them as a major problem. In this category, "Climate Change" is a good example. Both of the two farmer groups see this as the most difficult environmental challenge while many other actors do not bring it up as a challenge at all.

The best example of a challenge with conflicted opinions about is "Child Labour". There are two different types of child labour brought up among the actors. The first kind is a form of trafficking where children are taken from other villages and even from neighbouring countries to work on cocoa farms under slavery resembling conditions. The actors bringing this up are considering this to be a very severe problem. Other actors deny this problem's even existence. The other form of child labour is what many of the actors explain as a cultural difference and a misunderstanding between developed and developing countries e.g. when children are helping their parents out on the farm. Many actors think that the best way of meeting this challenge is by educating and informing the farmers of boundaries of which work is acceptable for the children to help out with on weekends and school holidays, and which they should avoid completely – provided that the children are sent to school at all. Some actors suggest that this "milder" form of child labour is a problem, others that this is now under control after the effort of the COCOBOD and others to reduce it since the issue was brought up a few years ago. Hence, they suggest that the effort should be put on other sustainability challenges. There are those actors who think that both forms of child labour exist and constitute problems, those who believe that the only real challenge is the cultural one and those who believe that the child labour issue is overrated and is not a big challenge at all.

Table 5 Environmental challenges. The C's indicate noticed challenges and the bold C's are the most difficult environmental challenges.

	COCOBOD	CRIG	CMC	Farmers 1 (Non-RA)	Farmers 2 (Non-RA)	Armajaro	Barry Callebaut	Unilever	RA	WCF	PBC	CPC
Usage of Non-Approved Chemicals & Products	**C**	**C**				**C**				**C**		
Incorrect Usage of Chemicals & Fertilisers	**C**	**C**	**C**			**C**	**C**			**C**		**C**
Climate Change	**C**			**C**	**C**		**C**					
Deforestation	**C**	**C**		**C**			**C**	**C**	**C**	**C**	**C**	
Loss of Biodiversity		**C**		**C**	**C**				**C**			
Illegal Logging	**C**				**C**	**C**						
Illegal Mining						**C**						
Slash-and-Burn	**C**	**C**										
Soil Depletion	**C**	**C**		**C**	**C**		**C**			**C**		
Water & Soil Pollution /Contamination		**C**										
Cocoa Diseases		**C**										

Table 6 Socioeconomic challenges. The C's indicate noticed challenges, the bold C's are the most difficult socioeconomic challenges meanwhile the ones in brackets indicate complications, either being an already tackled problem or it is considered a challenge of less importance.

	COCOBOD	CRIG	CMC	Farmers 1 (Non-RA)	Farmers 2 (Non-RA)	Armajaro	Barry Callebaut	Unilever	RA	WCF	PBC	CPC
Farmers' Income	**C**	**C**		**C**	**C**	**C**	**C**	**C**	**C**	**C**		**C**
Productivity	**C**	**C**				**C**	**C**	**C**	**C**		**C**	
Financial Support					**C**							
Fluctuating World market Prices	**C**											
Getting Labour	**C**	**C**		**C**			**C**			**C**		
Landowner System	**C**											
Conflict of Land			**C**									
Community Development	**C**	**C**		**C**	**C**	**C**	**C**	**C**	**C**	**C**		
Lack of Knowledge & Education	**C**	**C**		**C**		**C**	**C**	**C**		**C**	**C**	
Difficulties Reaching All Farmers		**C**					**C**				**C**	
Farmers' Attitude						**C**				**C**		
Food Safety						**C**				**C**		
Lack of Documentation											**C**	
Lack of Contracts: LBC-Farmers						**C**					**C**	
Child Labour	**(C)**	**(C)**		**(C)**	**(C)**	**C**	**C**	**C**		**(C)**		

7 Findings: Certification Schemes

This chapter includes an assessment of how certification scheme affects the cocoa industry and the actors involved with a focus on Rainforest Alliance.

7.1 Actors' Opinions of Certification Schemes

If a farm becomes certified, all actors involved in the product chain of that crop will be affected. Therefore, the opinions of certification schemes in general are presented in Table 7 for each actor in the product chains. Farmers and Rainforest Alliance (RA) are excluded from this comparison; the opinions of the farmers are presented in Chapter 7.2. Meanwhile, RA as a certification scheme is excluded because their opinions do not make a fair fit in the analysis. The opinions are divided into "Advantages" and "Disadvantages" of certification schemes.

Table 7 Opinions of certification schemes (c.s.).

	Advantages	Disadvantages
COCOBOD	• Securing good quality cocoa • Protecting the soil quality • Securing future labour	• Harmonisation is needed • Control mechanisms are needed • COCOBOD could do the sustainability work on its own • C.s. are businesses
CRIG	• Giving assurance to the customers	• More collaboration is needed • Harmonisation is needed • Control mechanisms are needed • Cannot reach all farmers
CMC	• Positive for the market • Giving assurance to the customers • Marketing tool • The premium is good	• Harmonisation is needed • More collaboration is needed • Not reaching all farmers • The timeline is too ambitious • COCOBOD is threatened • Limited financial returns for farmers • Unclear legal frames • Uncertain future • C.s. are businesses
Armajaro	• Positive for the whole industry	• Risk of physical and financial burden on farmers • Potential risk for company brand
Barry Callebaut		• More collaboration is needed • Harmonisation is needed • Risk increasing too fast • Costs • Not reaching all farmers • Takes time to implement • Western standards forgetting farmers' reality • More flexible standards are needed • C.s. are businesses
Unilever	• Education and reduced environmental impacts	• Harmonisation is needed • Many programs go beyond c.s.
WCF	• Sceptic farmers become positive	• More collaboration is needed • Control mechanisms are needed • It is not enough • Risk increasing too fast • Not reaching all farmers
PBC	*No opinion*	*No opinion*
CPC	*No opinion*	*No opinion*

The actors in the product chains are pointing out more disadvantages than advantages of using certification schemes. The main positive effect of certifying farms is according to involved actors that there are improvements of the sustainability performance of the cocoa production; mainly socioeconomically but also environmentally. Certification schemes as an assurance to customers of the sustainability efforts and performance of the cocoa industry is also seen as an important benefit.

According to the actors involved, there are many aspects of certification schemes to take into consideration and to improve. There are many competing schemes such as RA, UTZ, Fairtrade and Organic creating confusion, harmonisation between these is much asked for within the industry. To secure the farmers get what they are promised by the certification schemes and make sure the customer can trust the system, control mechanisms are needed. For some actors the costs of certification schemes are the number one disadvantage; the money spent on administration, audits and other external costs could instead be spent directly on the farmers and sustainability improvements. Actors in the product chains argue that certification schemes cannot reach all farmers, discriminating those that do not get a chance to become certified. Only certification schemes are not enough – they cannot make the cocoa industry sustainable on their own. Other sustainability initiative, projects and collaborations are therefore also needed. The COCOBOD experiences itself to be threatened by certification bodies coming into their territory without considering existing structure and involved actors. They believe that they could do the necessary sustainability efforts without certification schemes but rather in collaboration with other actors.

Overall the actors think that certifications schemes improve the sustainability performance of the cocoa industry but there are a number of disadvantages and possible improvements to consider. They are generally unsure whether it is the most effective way to make the industry sustainable.

7.2 Farmers' Experience of Rainforest Alliance

Since Rainforest Alliance (RA) has farm focus with their sustainability efforts, an analysis of the farmers' experienced sustainability improvements has been made. In Chapter 7.1 the challenges identified by the actors were discussed. In Table 8 and Table 9, the terms "Farmers 1" and "Farmers 2" represent workshops held with non-certified farmers presented in Chapter 6 discussing environmental and socioeconomic challenges within cocoa agriculture. For comparison, "Farmers 3" and "Farmers 4" are representing workshops with RA certified farmers discussing sustainability challenges as well as potential improvements since becoming certified. These farmers have been working with sustainability as an industry project since 2008 and became certified in 2010. The brackets seen in Table 9 indicate challenges that are mentioned by the farmers but not really considered of such an importance as the other ones.

Table 8 Farmers' experiences of environmental improvements of a Rainforest Alliance certificate.

	Farmers 1 (Non-RA)	**Farmers 2** (Non-RA)	**Farmers 3** (RA)	**Farmers 4** (RA)
Climate Change	**Challenge**	**Challenge**	**Still a challenge**	**Still a challenge**
Deforestation	Challenge			
Loss of Biodiversity	Challenge	Challenge	Improved	Improved
Illegal Logging		Challenge		
Slash-and-Burn			Improved	Improved
Soil Depletion	Challenge	Challenge	Improved	Improved
Cocoa Diseases			Improved	Improved

Table 9 Farmers' experiences of socioeconomic improvements of a Rainforest Alliance certificate.

	Farmers 1 (Non-RA)	**Farmers 2** (Non-RA)	**Farmers 3** (RA)	**Farmers 4** (RA)
Farmers' Income	**Challenge**	**Challenge**	(Improved)	(Improved)
Productivity			Improved	*New challenge: Harvest all!*
Financial Support		Challenge	Improved	
Getting Labour	Challenge			Improved
Community Development	Challenge	Challenge	Improved	
Collaboration Farmers			Improved	Improved
Lack of Knowledge & Education	Challenge		Improved	Improved
Family Planning			Challenge	
Child Labour	(Challenge)	(Challenge)	Improved	

Since their farms got RA certified, large environmental and socioeconomic improvements have been experienced by the farmers. The biggest socioeconomic challenge pointed out by the farmers is their incomes. The certified farmers believe their incomes have increased due to the certifications even if they are still low-paid and not satisfied with the financial situation they are experiencing. The non-certified farmers are not discussing productivity as a challenge but the certified farmers acknowledge improved productivity as an important improvement. Farmers in group number four even explain that having time to harvesting all cocoa has become a new challenge since the yield has increased heavily. Climate change is perceived to be the biggest challenge among all four farmer groups, both certified and non-certified.

7.3 Calculations Assessing Rainforest Alliance Certified Farms

To make an assessment of the sustainability impact of the certification scheme Rainforest Alliance (RA) from a GHG point of view, annual farm level GHG emission calculations have been made. In addition, productivity and density of shade trees have been calculated and are analysed in this chapter.

As calculation tool, the Cool Farm Tool (CFT) has been used. Since the CFT as a tool has its limitations and several assumptions and simplifications have been made, one should be careful when examining the results of the CFT. Therefore, the results of the calculations should only be used as a comparison between different farm groups, not as exact emission levels. As explained in Chapter 2.4 of what is included in the CFT's GHG emission calculations are general crop data, production area, yield, climate data, soil quality information, crop residues management, information of fertilisers usage and pesticides, land use change (LUC) information over the past 20 years, data of biomass sequestration in for example shade trees, information about livestock, energy use, farm level processing and transportation. For more information about the tool see Chapter 2.4 and 8. See also Appendix B for tables with detailed CFT data used for the calculations.

When executing the CFT calculations, simplifications and assumptions have been made. To calculate the biomass sequestration in the shade trees, the diameters of the trees are measured in breast height. Considering the geometry of some of the trees, especially the older ones, the measure of the diameters risk give a too large carbon sequestration. Therefore, these numbers have been adjusted. The growth rates of the trees given by researchers at the Cocoa Research institute of Ghana (CRIG) are specific for each species but do not take the age of the trees into consideration. Because of this, adjustments of the growth rates relative to the diameter of the shade trees have been made. Even if the correlation between the age of the tree and its diameter is not absolute, this leads to more correct results than without the adjustments. When calculating the GHG emissions from the LUC, simplifications were necessary since the options in the CFT not were corresponding to the case of cocoa in Ghana. All fertilisers were not possible to find among the options in the CFT and similar fertilisers have been used instead. The soil has been assumed to have the same quality over all the cocoa producing regions in Ghana and the climate is held to be same. No intercropping has been included in the calculations since the other crops existing on the farms only was in small scale, giving the farmer family some extra food. Also the livestock has been excluded from the calculations since the animals on the farms not are used in any businesses but mostly only walking around on the farms beyond any control from the farmers. On all examined farms, all transportations made on the farms are done by foot, carrying the cocoa beans, and all on farm processing is sun driven.

The GHG calculations were made on 18 farms divided into three different groups depending on their certification status:

Farm group 1 (FG1) consists of 8 farms and are all RA certified in the district Assin Fosu, marked with black in the diagrams. This group of farmers have been working with sustainability as a project since 2008 but became RA certified in 2010.

Farm group 2 (FG2) marked with white, is 6 farms from the districts Assin Fosu and Nyinahin. These farms are not certified but are located in connection to RA certified farms.

The grey-coloured farm group 3 (FG3) is located in the Nyinahin district and consists of 4 farms. These farms are RA certified since 2010. They had no experience of sustainability before they became certified.

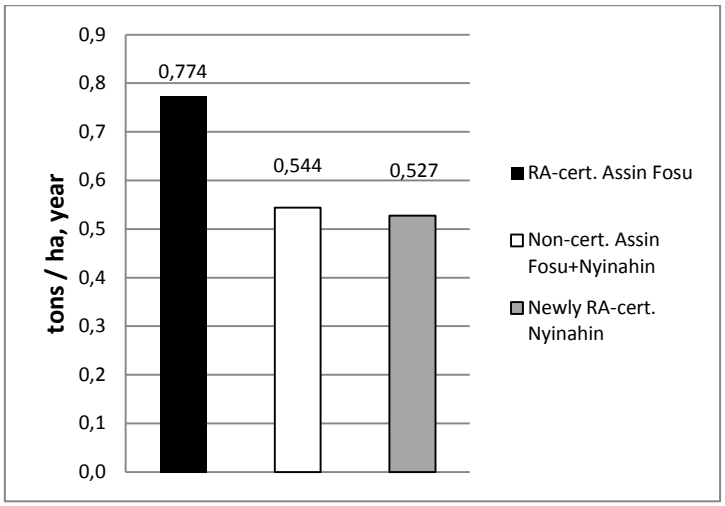

Figure 7 Average productivity per farm group.

In Figure 7, the average productivity for each of the three farm groups are presented as finished tons per hectare and year. Finished produce is the dried cocoa beans. This can be compared with the average productivity of all cocoa farmers in Ghana: 0.4 tons per hectare.[26] All of the three farm groups are above the national average. FG1 has a higher productivity than the other two groups, which in turn have similar productivity.

Shade trees are important from a sustainability point of view and a high shade tree density is preferable. Increased biodiversity, increased productivity and improved soil quality are examples of sustainability benefits of using shade trees within the cocoa production.[27] The GHG emission calculations below show that the shade trees affect the results by sequestrating carbon. Figure 8 illustrates that the average shade tree density is much higher in the RA certified farm group that has worked with sustainability the longest than for the other groups. The farm group being certified since 2010 has the lowest density, lower than the non-certified group. As comparison, the COCOBOD has recommendations for the Ghanaian farmers to have 2.430-3.645 shade trees per hectare (corresponds to 6-9 trees per acre) while the RA requires 3.24 shade trees per hectare (or 8 trees per acre) as a minimum.[28]

To keep in mind is that it takes some time to grow new shade trees. That is why RA gives the farmers five years to reach the required shade tree density. FG3 has not worked with sustainability as long as FG1, which could be one reason for why they have so much lower shade tree density. An example of difficulties that can emerge is what happened to the newly RA certified group in Nyinahin: the supplier of the shade trees could not deliver on time, so many trees were planted too late resulting in a failure of the planting.[29] This has probably contributed to the low density seen in the graph. In

[26] Researcher 1, Cocoa Research Institute of Ghana, Interview 2012-05-28
[27] ibid
[28] Representative 1, Rainforest Alliance, Interview 2012-06-02
[29] Representative 2, Armajaro, Interview 2012-06-13

addition, regional differences could be an explanation with for example varying conditions when it comes to soil quality etcetera as well as what has been done with shade trees historically in the area.

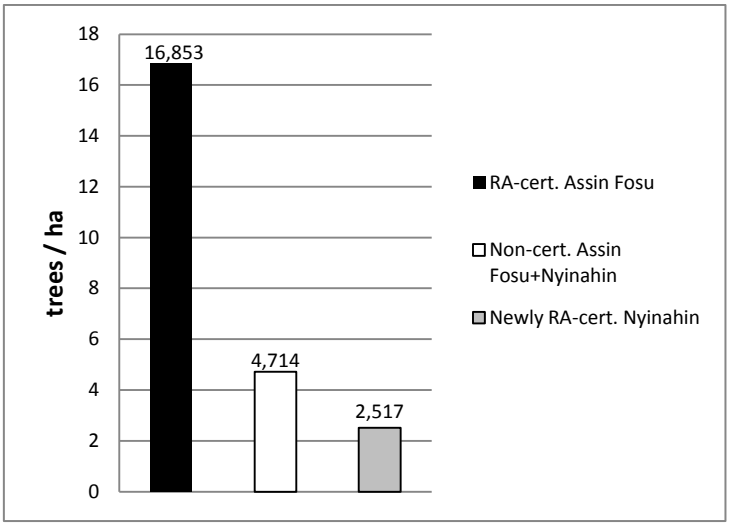

Figure 8 Average shade tree density per farm group.

Figure 9 present the average GHG emissions for each farm group. The difference between FG1 that has worked longer with sustainability and FG3 that is newly certified is considerable. The non-certified group's average emissions are between the two certified groups. Figure 10 shows the variations between farms within each farm group.

Comparing Figure 10, showing the emissions for each farm with all aspects included, and Figure 11 showing the emissions when the sequestration from the shade trees is excluded, the impact of the shade trees' carbon sequestration is shown. This explains FG1's negative number in Figure 10 as well as the differences between them and the other two groups. The results indicate the importance of shade trees as carbon restorer.

To understand the high average emissions of FG3, Figure 9 should be examined. The three farms with the highest emissions (farm number 14, 16 and 17) are also the only farms with historical land use changes (LUC). Since both farm 16 and 17 are found in FG3, their LUC have a considerable impact on the total average of that group. In the calculations, LUC made the last 20 years are included. Both farm 16 and 17 had made their LUC before becoming certified but their historical decisions will still affect the GHG emission calculations of today deteriorating the average of the whole group. This shows the GHG emission impacts of deforestation.

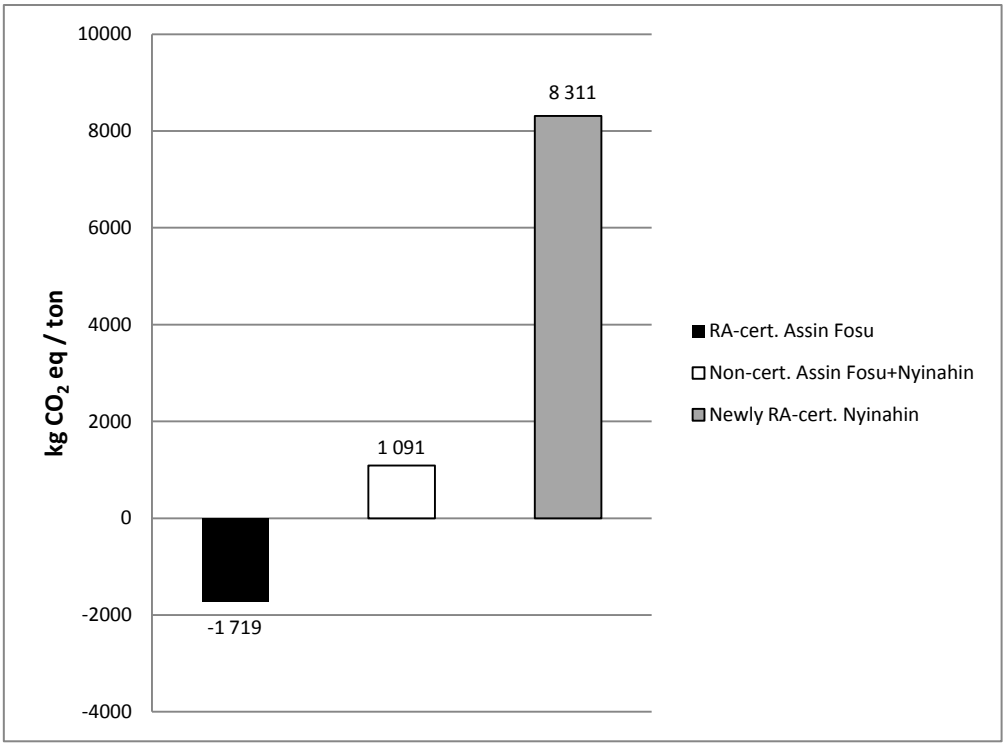

Figure 9 Average emissions by production per farm group.

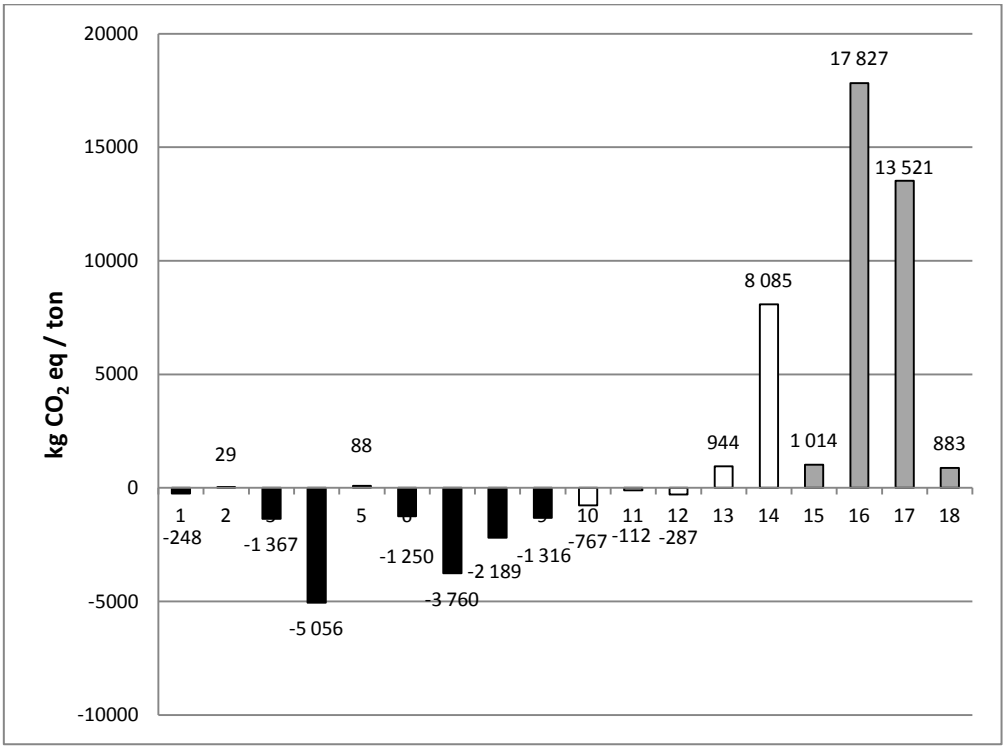

Figure 10 Emissions by production per farm.

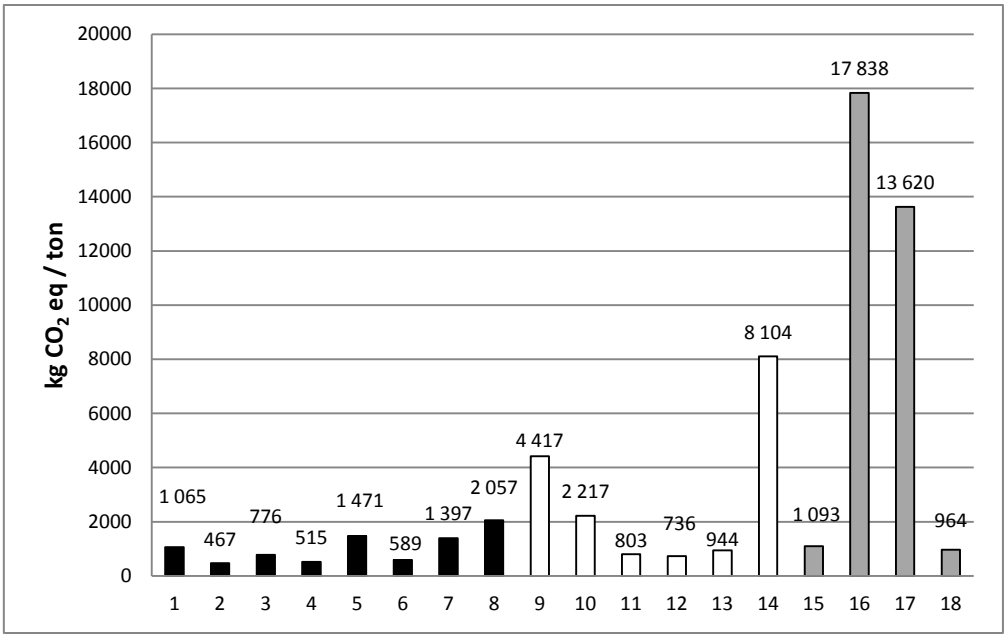

Figure 11 Emissions by production per farm excluding shade trees.

8 Findings: Evaluation of the CFT

Unilever (UL) plans to use the farm level greenhouse gases (GHG) emission calculator the Cool Farm Tool (CFT) in their sustainability work as a complement to certification schemes to examine and reduce its farmers' greenhouse gas (GHG) emissions. This chapter includes an evaluation of the tool and an analysis of the potential implementation possibilities of the CFT for cocoa production in Ghana. The information is based on field studies and the authors' first handed experiences of using the CFT on cocoa in Ghana. For more information about the CFT, see Chapter 2.4 and 7.3.

According to the Cool Farm Institute (2012) is one of the purposes to enable for the farmers themselves to find their GHG emission hot spots and thereby reduce their emissions. Most cocoa farmers in Ghana are illiterate without electricity and running water on the farms and in the villages. Their education level is low and they have no computer skills. Teaching them the CFT is not a realistic vision. It is also a matter of priorities; there are other challenges more important for the farmers to overcome than to learn how to perform GHG emission calculations. The farmers' lack awareness is also a challenge when gathering data for calculations; many farmers have limited knowledge about their farms. The size of the farm and number of shade trees are basic data causing troubles for some farmers. To know details about for example the soil quality is too complicated. Despite access to Ghana's leading cocoa researchers, some data needed for the CFT were not possible to get hold on. One examples of this is the amount of residues that varies with the shade tree density.

The plan with the CFT is for the agri-food industry to use it on all crops on any continent to get comparable GHG emission comparisons. The tool is relatively new resulting in a limited number of options in categories such as fertilisers, tree species for the biomass sequestration and land use changes (LUC). These limitations make the user of the tool use assumptions and simplifications to work around the limitations of the CFT. To get the biomass sequestration for the shade trees correct, the diameters of the body of the trees must be measured in breast height. Many of the shade trees found on the cocoa farms in Ghana are many decades old meaning that they are often not round and well formed, especially not in their lowest parts. This will lead to an over dimensioned carbon sequestration in the calculations compared to the real case.

Even if there are significant improvement and development possibilities for the CFT, the calculations were executed and results came out. This means that even if guidance and help from expertise were needed and the results are not completely confident due to simplifications and assumptions made, the tool can be used. But more resources are needed both to develop the CFT further as well as to perform the data collection and the actual calculations.

9 Discussion

The actors within the cocoa industry have productivity and improved farmer livelihood as main sustainability driving forces in their sustainability management. They are interlinked since increased productivity will increase the farmers' income and thereby also their livelihood. Looking at what challenges the actors state as key to see whether they are aligned with the actors' sustainability driving forces or not will give a better understanding of how thought through the actors' sustainability management are. Due to increased demand of cocoa, risk of deforestation and a need for improved farmer livelihood, productivity is discussed as key challenge by a majority of the actors even if the farmers rather talk about their incomes. Interesting is that the Rainforest Alliance (RA) certified farmers stress that their productivity has increased significantly since they started to work with sustainability and became certified. In addition, the Cool Farm Tool (CFT) results indicate also that the RA certified farmers working the longest with sustainability have increased productivity compared to the non-certified group and the group of RA certified farmers working shorter time with sustainability. Improved farmer livelihood is not a challenge on its own but divided into several of the challenges discussed among the actors. Two of them are farmer income and community development. Both are stressed as main challenges among most actors, the farmers think their low income is their number one socioeconomic challenge.

Considering the sustainability actions, collaborations with other actors is a main activity. Despite that, the actors' views of certification schemes indicate that more communication and collaboration within the industry is asked for. The actors stress that certification schemes are not enough to make the cocoa industry sustainable, other projects and programs must be done as well; joint efforts are needed. The fact that there are several competing certification schemes on the market is also used by many actors as an argument for more collaboration, harmonisation is asked for. Shown in the two alternative product chains, the transition from conventional to traceable and certified cocoa has changed the structure of the cocoa industry in Ghana. The COCOBOD feels threatened by this change and wonders how far this change will go and what their role will be in the future. The COCOBOD is a key player for enabling sustainability improvements of the Ghanaian cocoa industry since they are the regulator and all farmer projects must go through them. This indicates further the importance of collaboration and communication to get the whole industry on board of the changes and to work in the same direction.

In the sustainability management as well as the sustainability challenges chapters it is clear that even if both environmental and socioeconomic aspects are considered, the focus is from most actors on socioeconomic sustainability. This could be related to the fact that all actors have farm level focus in their sustainability efforts, shown in the same chapters. Even if the farmers do consider environmental aspects, direct or indirect, their livelihood and issues like electricity and other things included in community development are generally ranked as larger problems. This also shows that improved farmer livelihood is critical partly to enable conditions for the farmers to manage their jobs and partly to attract and keep future labour in the cocoa farming. The number one environmental challenge addressed by the farmers is the climate change, both local due to for example deforestation as well as global climate change.

Different actors are using different positioning strategies with their sustainability management. Armajaro's strategy is to gain first mover's advantage by being the market leader on traceable and certified cocoa. Barry Callebaut (BC) is mainly following the demand of their customers even if they have development projects on their own; if the customers are asking for certified cocoa, BC purchases and trades certified cocoa. Concerning sustainable sourcing, Unilever (UL) has high targeted sustainability goals. In the case of cocoa, UL seems to have put most of the responsibility on BC by sourcing 70 % of its cocoa from them. Considering geographic aspects, it is clear that some of the domestic actors lack awareness of global trends such as sustainable and certified cocoa. Their sustainability management is not as developed as the global actors and they do not consider sustainability aspects and challenges in any considerable way.

RA certified farmers are more positive to certification schemes than most other actors in the product chains. The workshops with farmers and the CFT results show that there are possible sustainability benefits of a RA certificate but it has to be done with a good supporting organisation surrounding it and with some patience, it does take some time to see the results. Examples of potential sustainability benefits are increased productivity, shade tree density and farmer income. With increased shade tree density come reduced greenhouse gas (GHG) emissions. An important aspect of certification schemes from a sustainability point of view is the training and education the farmers get through the RA certificate. Even if the farmers for some reasons would lose their certificate, the knowledge can be passed on to future generation keeping the productivity increase. Despite sustainability benefits of certification schemes, some actors think that the financial costs of the schemes are too high and keep resources away from the farmers. They argue that the same improvements could be made by existing actors in other projects and programs. Important to remember is that the labels of certification schemes are used as a marketing tool. Customers demand a guarantee that the farmers of the cocoa they buy really have been reached by the claimed sustainability efforts and investments.

The CFT could be used by UL for GHG emission calculations on farm level for cocoa in Ghana if significantly more resources are put into these calculations. The tool needs to be developed further for it to match cocoa production better and to include options relevant for each crop. In the case of cocoa in Ghana, it is unrealistic to believe that the farmers would be able to execute the calculations themselves. Either a third body, UL itself or some of the other already existing actors in the product chains could be responsible for this.

Regarding the credibility of the results of this report, some aspects should be touched upon. Large amount of the information used is taken from firsthand sources. It could always be discussed how transparent and honest the interviewed people are. In some cultures it is polite to answer what one thinks the interviewer want to hear. On some of the interviews, other people in excess of the authors and the interviewed representatives were joining the interviews. This could be because these people were the contact between the two parties. When interacting with farmers, there was another reason for having other people joining the discussions. Even if English is an official language of Ghana, most farmers are only speaking local languages. Therefore, local interpreters were needed. The interpreters used were not official ones but rather some contacts involved in the project. It could be debated whether the discussion got affected by having other people joining the interviews. Also the quality and neutrality of the interpreters could be a question for discussion. There are hundreds of thousands of cocoa farmers in all of Ghana, many with no or limited contact with other actors within

the cocoa industry. When the farmers in the study were chosen, both for the workshops and the CFT calculations, this was made through other actors involved in the product chains. This means that the farmers in the study might not be completely representative for the average cocoa farmer in Ghana. Due to assumptions and simplifications done in the CFT calculations, the results should be seen as what they were meant for; to enable a comparison between different farm groups, not for exact emission numbers.

10 Conclusions

Within this project, many aspects could be discussed and many conclusions drawn. The authors have chosen to point out some conclusions for them considered to be the main, but the reader could find other conclusions to be the most interesting.

The focus of the cocoa industry is on socioeconomic rather than on environmental sustainability. For the farmers, the main socioeconomic challenge is their income and the number one environmental challenge is local and global climate change. Due to an increasing global demand and a need for improved farmer livelihood, productivity is the main driver for the cocoa industry to make the production more sustainable. The certification scheme Rainforest Alliance (RA) can with the right circumstances increase the productivity within the cocoa production in Ghana. According to certified farmers, RA does also improve environmental aspects such as biodiversity and soil quality as well as socioeconomic aspects such as farmers' income and education. Greenhouse gases (GHG) emission calculations made with the Cool Farm Tool (CFT) indicate that emission reductions are made on RA certified cocoa farms, mostly by an increased shade tree density, but the improvements do take time.

Farmers are more positive to RA than most other actors within the cocoa industry are to certification schemes in general. Too many competing schemes, lack of control mechanisms, discrimination of farmers and high costs are the main disadvantages brought up by the industry. Despite the improvement possibilities of the system with certification schemes, the industry actors acknowledge sustainability improvements and that it does give the customers assurance of what sustainability efforts have been made. More collaboration within the product chains is needed to make all actors strive towards the same goals also because only certifying the cocoa is not enough; other programs and joint efforts is a must to make the cocoa industry more sustainable.

The CFT could be a good complement to certification schemes for calculating GHG emissions on farm level. For cocoa in Ghana, a lot more resources are needed to enable a large scale use of the CFT. The tool needs to be developed and adjusted to local conditions. Having professionals to execute the calculations is a must since it is unrealistic to believe that illiterate cocoa farmers in Ghana will be able to perform the calculations themselves.

11 Recommendations

There is a lack of these types of studies conducted with the concept of Sustainable Product Chain Management and further ones are recommended. There are as well very few studies taking greenhouse gas emission calculations into consideration at farm level, not least for cocoa production. Many actors are interested to have this type of data and to develop such a tool in the right way could be very beneficial. Important is thus to have right resources to enable such calculations and farm level evaluations.

This organisational study with a sustainability approach has touched upon various different and interesting topics. It is important to point out that there are more topics that could have been addressed in this study but due to the scope and limited resources it has been constricted to the ones highlighted here. This study could thus lead to further work with different sustainability approaches, for example bring up more of the challenges in a detailed study or a more in-depth analysis of the different sustainability perceptions among actors. In further studies, it would be interesting to make a more detailed study of each actor within the cocoa industry. It would also be interesting to study more actors and meet additional representatives from the different organisations to get a broader perspective.

This study has showed great interest among cocoa industry actors. Sustainability topics that are up-to-date have been discussed and many have addressed that there is an absence of this type of sustainability mapping. Hopefully this is just one of many more to come for the achievement of a sustainable cocoa industry. There are great potentials but further work is needed.

References

Baumann, H. (2012). Using the life cycle approach for structuring organizational studies of product chains. 18th Greening of Industry Network conference (https://gin.confex.com/gin/2012/webprogram/start.html), 21-24 October 2012, Linköping, Sweden.

Baumann, H. and A.-M. Tillman (2004). *The Hitchhiker's Guide to LCA: An Orientation in Life Cycle Assessment Methodology and Application*. Lund: Studentlitteratur.

Barry Callebaut (2012a). *Sustainable cocoa*. [Online] Available from: http://www.barry-callebaut.com/8109 [Accessed: 2012-09-20]

Barry Callebaut (2012b). *1900 - today*. [Online] Available from: http://www.barry-callebaut.com/1593 [Accessed: 2012-09-14]

Boons, F. (2002). Greening products: a framework for product chain management. *Journal of Cleaner Production*, vol. 10, pp. 495-505.

Cool Farm Institute (2012). *Cool Farm Tool*. [Online] Available from: http://www.coolfarmtool.org/CoolFarmTool [Accessed: 2012-12-10]

Fransson, K. (2012). *Chemical Risk Information in Product Chains, the cases of paint and textile.* Thesis for the degree of Licentiate of Engineering, Chalmers University of Technology, Gothenburg, Sweden. ESA report no 2012:5. ISSN 1404-8167.

Ghana Cocoa Board (2012a). [Online] Available from: http://www.cocobod.gh/index.php [Accessed: 2012-11-09]

Ghana Cocoa Board (2012b). *The history of cocoa and its production in Ghana.* [Online] Available from: http://www.cocobod.gh/history.php [Accessed: 2012-09-14]

ICCO (2010). *The World Cocoa Economy: Past and Present.* (EX/142/6) [Online] Available from: http://www.icco.org/about-us/international-cocoa-agreements/cat_view/30-related-documents/45-statistics-other-statistics.html [Accessed: 2012-12-10]

ICCO (2011a). *Origins of cocoa and its spread around the world*. [Online] Available from: http://www.icco.org/about/growing.aspx [Accessed: 2012-05-03]

ICCO (2011b). *Harvesting & post-harvest processing*. [Online] Available from: http://www.icco.org/about/Harvesting.aspx [Accessed: 2012-05-03]

ICCO (2011c). *Pests & Diseases*. [Online] Available from: http://www.icco.org/about-cocoa/pest-a-diseases.html [Accessed: 2012-11-23]

ICCO (2011d). *Production*. [Online] Available from: http://www.icco.org/economy/production.html [Accessed: 2012-09-14]

ICCO (2011e). *Annual Report 2009/2010.* [Online] Available from: http://www.icco.org/about-us/icco-annual-report.html [Accessed: 2012-12-10]

Laven, A. (2007). *Who is interested in good quality cocoa from Ghana?*, in R. Ruben, M. van Boekel, A. van Tilburg and J. Trienekens (eds) Tropical food chains, governance regimes for quality management, pp. 189-211. Wageningen: Academic Publishers. ISBN: 978-90-8686-027-2

Ntiamoah, A. and Afrane, G. (2008). Environmental impacts of cocoa production and processing in Ghana: life cycle assessment approach. *Journal of Cleaner Production*, vol. 16, pp. 1735-1740.

Obeng Adjinah, K. & Opuku, I.Y.. [Online]: "*The national cocoa diseases and pests control (CODAPEC): achievments and challenges."* [Accessed: 2012-09-28]

Rainforest Alliance (2012). Our Work in Sustainable Agriculture. [Online] Available from: http://rainforestalliance.com/work/agriculture [Accessed: 2012-11-09]

Sustainable Food Lab (2012), Cool Farming Options, [Online] http://sustainablefoodlab.org/index.php?option=com_content&view=article&id=117:gaca-home&catid=18&Itemid=53 [Accessed: 2012-11-06]

Unilever (2012a). *Unilever Sustainable Living Plan*. [Online] Available from: http://www.sustainable-living.unilever.com/ [Accessed: 2012-02-24]

Unilever (2012b). *Sustainable Cocoa & Sugar*. [Online] Available from: http://unilever.com/sustainable-living/sustainablesourcing/cocoa-sugar/ [Accessed: 2012-11-08]

Welford, R. (2002). *Beyond Systems: A vision for corporate environmental management for the future.* Key note paper, Science days for the Studia Economia lecture series, Helsinki School of Economics, 2003.

Interviews

Armajaro:

Representative 1, Kumasi, Ghana, Interview 2012-06-12
Representative 2, Kumasi, Ghana, Interview 2012-06-13

Barry Callebaut:

Representative 1, Tema, Ghana, Interview 2012-06-26
Representative 2, Zurich, Switzerland, Interview 2012-09-07

Cocoa Marketing Company:

Manager, Accra, Ghana, Interview 2012-06-27

Cocoa Processing Company:

Representative 1, Tema, Ghana, Interview 2012-05-22
Representative 2, Tema, Ghana, Interview 2012-05-22

Cocoa Research Institute of Ghana:

Researcher 1, Tafo, Ghana, Interview 2012-05-28
Researcher 2, Tafo, Ghana, Interview 2012-05-29
Researcher 3, Tafo, Ghana, Interview 2012-05-30

Field visits, Cocoa Farms, Ghana, May-June 2012

Ghana Cocoa Board:

Representative 1, Accra, Ghana, Interview 2012-05-21
Representative 2, Accra, Ghana, Interview
Representative 3, Accra, Ghana, Interview 2012-06-28

Produce Buying Company:

Representative 1, Accra, Ghana, Interview 2012-05-21
Representative 2, Accra, Ghana, Interview 2012-05-21

Rainforest Alliance:

Representative 1, Ghana, Continuous communication
Representative 2, London, UK, Interview 2012-08-02
Representative 3, London, UK, Interview 2012-09-04

Unilever:

Representative 1, Rome, Italy, Interview 2012-09-03
Representative 2, Continuous communication
Representative 3, Continuous communication

World Cocoa Foundation:

Representative, Accra, Ghana, Interview 2012-06-29

Appendix A - The Ghana Cocoa Board (COCOBOD)

The Ghana Cocoa Board (COCOBOD) was established in 1947 with the main mission to in a cost efficient and productive way boost and facilitate the production, processing and marketing of quality cocoa, coffee and sheanut. The COCOBOD answers for the structure of the Ghanaian cocoa industry and is conducted by a Board of Directors constituted of bankers, economists, worker's representatives and cocoa farmers. The operations run by the COCOBOD and its subsidiaries have great impact not only in the cocoa industry but also for the national economy as the main governmental agency with the responsibility to develop the industry (Ghana Cocoa Board, 2012a). The COCOBOD operates at zero profit. The work force at the COCOBOD is about 6000-7000 employees working within the different divisions and subsidiaries.[30]

The Cocoa Board is divided into two main sectors; pre-harvest and post-harvest, taking issues at farm-gate level into consideration respectively steps further down the product chain.

- Pre-harvest: Cocoa Research Institute of Ghana (CRIG), the Seed Production Unit (SPU) and the Cocoa Swollen Virus Disease Control Unit (CSSVDCU).
- Post-harvest: Quality Control Division (QCD) and the Cocoa Marketing Company (CMC).[31]

These divisions are in turn broken down into different functionalities of the Board, the main ones being production, research, extension, internal and external marketing and quality control. CRIG is a fully owned subsidiary performing research and acts proactively to find ways to develop the Ghana cocoa and its productivity such as production of hybrid varieties and improved varieties for farmers. The CSSVDCU of the COCOBOD provides extension functions and education at farm level meanwhile the SPU unit after the production of hybrid varieties multiplies them. The cocoa seed and pest control program, CODAPEC, is a separate program developed under the COCOBOD. CODAPEC is a high tech unit that is into control of diseases and viruses and carry out fertiliser programs. The division of QCD is doing all the quality tests at different levels within the cocoa product chain in Ghana. For the public partnership the COCOBOD is involved as a regulator and also perform external marketing through its subsidiary; the CMC.[32]

Cocoa Research Institute of Ghana (CRIG)

The Cocoa Research Institute of Ghana (CRIG) was established in June 1938 and is located in Tafo. CRIG has the mandate to research on the crops cocoa, coffee, kola, sheanut, and cashew with fats similar to cocoa butter. The core activities are "to develop environmentally friendly, economically viable and sustainable research packages to the mandated crops for farmers". The aim is to generate good agricultural information to be used by farmers to enable increased productivity. The research is looking at areas to limit the spread of diseases from affected to non-affected areas and at the same time gain better understanding of the diseases and develop strategies and interventions. This implies early detection and understanding on how viruses are transferred and identification of them such as weaknesses and strengths.[33] One of CRIG's main functions is also to produce hybrid varieties for

[30] Representative 1, Ghana Cocoa Board, Interview 2012-05-21
[31] Researcher 1, Cocoa Research Institute of Ghana, Interview 2012-05-28
[32] Representative 1, Ghana Cocoa Board, Interview 2012-05-21
[33] Researcher 1, Cocoa Research Institute of Ghana, Interview 2012-05-28

duplication and currently due to the climate change drought resistance varieties are being developed. CRIG also decides which fertilisers and pesticides to use in the market and certify them.[34] The areas of research are divided into seven scientific divisions: Agronomy/Soil Science, Plant Breeding, Entomology, Plant Pathology, Physiology/Biochemistry, Social Science and Statistics and New Products Development (Ghana Cocoa Board, 2012b). CRIG is furthermore structured with directors at the top of the hierarchy that control all activities on station. Subsequently in the hierarchy comes the research scientists that are purely technical people e.g. pathologists and agronomists specialised in main activities and manages research programs and initiates research projects. Under each research scientist are the technical officers with technical background of what research that is being conducted and take instructions of research scientists. The technical officers in turn have technical assistants and at last the field assistants. All the employees in Tafo have their accommodation provided on the CRIG area that also has its own water supply and health clinic.[35]

Seed Production Unit (SPU)

The Seed Production Unit (SPU) has the mandate to produce disease tolerant hybrid seedlings for farmers. The varieties that are developed and come out at CRIG are given to the SPU who multiply it as seedlings for the farmers to come and pick them up and can be planted on their farms to boost production.[36] There are a lot of SPU centres across the country[37].

Cocoa Swollen Shoot Virus Disease Control Unit (CSSVDCU)

The Cocoa Swollen Shoot Virus Disease Control Unit (CSSVDCU) has broad based and multi-faceted operations such as disease control and extension services going to the field to help and educate farmers in good agricultural practices on their farms. The CSSVDCU has the mandate to control particular diseases, mainly the Cocoa Swollen Shoot Virus disease (CSSV), and CRIG has a supportive role to this unit.[38] The head office is in Accra with regional offices in the cocoa growing regions and operations in 41 cocoa districts. Apart from the disease control the CSSVDCU remove and destruct swollen shoot diseased cocoa trees from farms and provide the infested farmers with resistant hybrid varieties for replantation. CSSVDCU has a college, the Bunso Cocoa College that serves as a training center for the field staff (Ghana Cocoa Board, 2012c). Since CSSVDCU through the extensions have direct contact with farmers it acts as a source of information flow. Previous CRIG had its own extension but it collapsed and emerged into CSSVDCU instead to carry out information from research to farmers.[39]

CODAPEC

For Ghana to maintain the position as one of the world leading cocoa producers and as a result of the decline in production during the 1980's the COCOBOD, as a drive from the government, started off a National Cocoa Diseases and Pest Control (CODAPEC) program. The purpose was to aid farmers to handle common diseases of Capsid/Mirid and Black Pod that attacked their farms through mass spraying. This also constituted training for farmers and technical personnel on methods to control pests and diseases but also to educate local pesticide sprayers in safety matters, to enable income increase for farmers and as a way to create jobs for people in rural communities (Obeng Adjinah K. &

[34] Representative 1, Ghana Cocoa Board, Interview 2012-05-21
[35] Researcher 1, Cocoa Research Institute of Ghana, Interview 2012-05-28
[36] ibid
[37] Representative 1, Ghana Cocoa Board, Interview 2012-05-21
[38] Researcher 1, Cocoa Research Institute of Ghana, Interview 2012-05-28
[39] ibid

Opuku I.Y.). All the chemicals that are used in the CODAPEC program are certified by CRIG and for each product yearly assessments and reviews are done[40]. The CODAPEC program is supposed to cover every farm but currently it reaches out to 90%[41].

The mass spraying program was introduced during the cocoa season in 2001/02, at that time the cocoa production level was at the low level of 350,000 tonnes. A lot of intervention methods were explored but without any positive outcome. To give some examples insecticides were given to farmers to do spraying on their own but the economic situation did not allow this. The common situation was often that the farmers were hiding the products given to them for free at home and they did not apply them. Another attempt was to give the farmers input on credit for spraying machines but the farmers took the money instead and would not pay. This led to the decision that small portions of the cocoa were taken to enable the mass spraying that was needed. The CODAPEC program resulted in increasing productivity and last year (2011) the production levels exceeded one million tonnes.[42] The program also shows reduced levels of black pod and mirid infestations (Obeng Adjinah K. & Opuku I.Y.).

Each season starts with training sessions for farmers consisting of pesticide application methods covering aspects on dosages, dangers of exposure, importance of protective clothing, handling of spraying machines, personal hygiene, environmental safety issues, first aid, application techniques, handling and disposal of empty containers. During the training also the roles and responsibilities of stakeholders are explained. (Obeng Adjinah K. & Opuku I.Y.)

Quality Control Division (QCD)

According to the International Cocoa Standards there are certain requirements of cocoa quality that need to be met. Since Ghana is known for high quality cocoa and to maintain the status quality control of the produce are being conducted by the Quality Control Division (QCD) (Ghana Cocoa Board, 2012d). The QCD performs quality checks three times through the product chain of cocoa within the country. The quality checks begin at the society level, thereafter at the district level and finally at the take-over centres at the ports. These three quality checks together with the extension system are considered to make the Ghana's cocoa quality the best. The quality checks are compulsory and as soon as one purchases cocoa the QCD must be conducted to grade it and cocoa of poor quality will be rejected.[43]

Cocoa Marketing Company (CMC)

The Cocoa Marketing Company (CMC) is responsible for the sale and export of Ghana cocoa beans. The purpose of the CMC is to act as a mediator of the supply chain of cocoa from production to the market.[44] The main office is located in Accra but the company also has a branch office in London where the trading of cocoa beans takes part (Ghana Cocoa Board, 2012e). The trading of the cocoa, where buyers and sellers meet, is done on the London and New York stock market.[45]

[40] Researcher 1, Cocoa Research Institute of Ghana, Interview 2012-05-28
[41] Representative 3, Ghana Cocoa Board, Interview 2012-05-21
[42] ibid
[43] Representative 1, Ghana Cocoa Board, Interview 2012-05-21
[44] Manager, Cocoa Marketing Company, Interview 2012-06-27
[45] ibid

Historically the company only worked with the trading but with time other activities have been included such as inbound logistics. The main logistic operations consist of the management of the receiving of cocoa purchased upcountry, planning the shipments, port operations and to manage the overall distribution chain. When the cocoa beans arrive to the take-over points sample checks are done by QCD port staff and all the approved cocoa gets a certificate issued by CMC that allows the cocoa to enter the port warehouses. Despite the trading of cocoa and the logistic operations associated the CMC also have a marketing side both from local and global perspectives. The drive is to respond to market trends such as the growing demand of sustainability and traceability within the cocoa industry.[46]

References

Cocoa Marketing Company:

Manager, Accra, Ghana, Interview 2012-06-27

Cocoa Research Institute of Ghana:

Researcher 1, Tafo, Ghana, Interview 2012-05-28

Ghana Cocoa Board:

Representative 1, Accra, Ghana, Interview 2012-05-21

Ghana Cocoa Board (2012a). *About us*. [Online] Available from: http://www.cocobod.gh/about.php [Accessed: 2012-09-14]

Ghana Cocoa Board (2012b). *Cocoa Research Institute of Ghana (CRIG)*. [Online] Available from: http://www.cocobod.gh/cocoa_research.php [Accessed: 2012-09-17]

Ghana Cocoa Board (2012c). *Cocoa swollen shoot virus disease control unit*. [Online] Available from: http://www.cocobod.gh/cocoa_swollen.php [Accessed: 2012-09-17]

Ghana Cocoa Board (2012d). *Quality control division*. [Online] Available from: http://www.cocobod.gh/quality.php [Accessed: 2012-09-18]

Ghana Cocoa Board (2012e). *Cocoa Marketing Company Ghana Limited*. [Online] Available from: http://www.cocobod.gh/cocoa_marketing.php [Accessed: 2012-09-12]

Obeng Adjinah, K. & Opuku, I.Y.. [Online]: "*The national cocoa diseases and pests control (CODAPEC): achievments and challenges."* [Accessed: 2012-09-28]

[46] Manager, Cocoa Marketing Company, Interview 2012-06-27

Appendix B - The Cool Farm Tool (CFT) Results

Table 1 Farm specific information for the CFT calculations.

Farm Number	District	Village	Certified	Area (ha)	Finished Product (bags/year)	Finished Product (tonnes/year)	Fresh Product (tonnes/year)	Productivity (finished tonnes/ha, year)
1	Assin Fosu	Atentan	RA	0,972	12,000	0,750	12,150	0,772
2	Assin Fosu	Atentan	RA	1,620	32,000	2,000	32,400	1,235
3	Assin Fosu	Atentan	RA	1,215	15,000	0,938	15,188	0,772
4	Assin Fosu	Agave	RA	0,810	15,000	0,938	15,188	1,157
5	Assin Fosu	Agave	RA	1,620	11,000	0,688	11,138	0,424
6	Assin Fosu	Agave	RA	1,215	20,000	1,250	20,250	1,029
7	Assin Fosu	Nkranfum	RA	0,810	6,000	0,375	6,075	0,463
8	Assin Fosu	Nkranfum	RA	1,823	10,000	0,625	10,125	0,343
9	Assin Fosu	Gold Coast Camp	-	2,430	5,500	0,344	5,569	0,141
10	Assin Fosu	Gold Coast Camp	-	2,025	9,000	0,563	9,113	0,278
11	Assin Fosu	Agave	-	0,810	10,000	0,625	10,125	0,772
12	Assin Fosu	Agave	-	0,405	5,000	0,313	5,063	0,772
13	Assin Fosu	Agave	-	0,405	4,000	0,250	4,050	0,617
14	Nyinahin	Kyereyaso	-	3,645	40,000	2,500	40,500	0,686
15	Nyinahin	Nzema	RA	3,848	42,000	2,625	42,525	0,682
16	Nyinahin	Nzema	RA	4,050	20,000	1,250	20,250	0,309
17	Nyinahin	Kyereyaso	RA	3,038	20,000	1,250	20,250	0,412
18	Nyinahin	Kyereyaso	RA	4,860	55,000	3,438	55,688	0,707

Table 2 Farm specific shade tree data.

Farm Number	Shade Trees: In Total	Shade Trees: Density (total trees/ha)	Shade Trees: Hard Wood	Shade Trees: Density (Hard Wood/ha)	Hard Wood Average Diameter This Year (cm)	Hard Wood Average Annual Growth Rate (cm/year)	Hard Wood Average Diameter Last Year (cm)	Shade Trees: Soft Wood	Shade Trees: Density (Soft Wood/ha)	Soft Wood Average Diameter This Year (cm)	Soft Wood Average Annual Growth Rate (cm/year)	Soft Wood Average Diameter Last Year (cm)
1	20,000	20,576	19	19,547	45,946	1,847	45,358	1	1,029	272,006	0,675	271,792
2	19,000	11,728	12	7,407	76,890	0,839	76,622	7	4,321	76,106	1,140	75,743
3	27,000	22,222	21	17,284	83,520	1,262	83,119	6	4,938	123,106	1,260	122,705
4	18,000	22,222	14	17,284	171,672	2,048	171,021	4	4,938	448,324	0,900	448,037
5	17,000	10,494	14	8,642	55,388	1,968	54,762	3	1,852	113,366	0,750	113,127
6	22,000	18,107	16	13,169	53,656	2,132	52,978	6	4,938	178,978	1,119	178,621
7	39,000	48,148	34	41,975	51,769	1,872	51,173	5	6,173	66,450	1,691	65,912
8	23,000	12,620	16	8,779	31,592	1,256	31,192	7	3,841	224,761	1,131	224,401
9	12,000	4,938	3	1,235	344,968	2,800	344,077	9	3,704	83,454	0,823	83,192
10	12,000	5,926	8	3,951	136,837	2,126	136,161	4	1,975	102,611	1,418	102,160
11	7,000	8,642	4	4,938	37,338	0,600	37,147	3	3,704	173,161	0,850	172,890
12	3,000	7,407	1	2,469	48,701	0,800	48,447	2	4,938	135,011	1,035	134,682
13	-	-	-	-	-	-	-	-	-	-	-	-
14	5,000	1,372	-	-	-	-	-	5	1,372	27,597	0,682	27,380
15	21,000	5,458	14	3,639	32,114	0,585	31,928	7	1,819	43,058	0,486	42,904
16	3,000	0,741	-	-	-	-	-	3	0,741	20,112	0,500	19,953
17	8,000	2,634	1	0,329	46,266	0,500	46,107	7	2,305	35,830	0,766	35,586
18	6,000	1,235	3	0,617	60,967	0,760	60,725	3	0,617	76,840	1,103	76,489

Table 3 Farm specific data of residue amount, fertilisers, pesticides, land use changes and energy utilisation.

Farm Number	Residue Amount (tonnes/ha, year)	Fertilisers	Fertilisers (kg/ha, year)	Pesticides (number of applications/year)	Land Use Changes	Petrol (litres/year)	Diesel (litres/year)	Pesticides Petrol + Diesel (litres/spray, ha)	Electricity
1	2,200	Cocofeed	308,642	3,000	-	9,092	-	3,118	-
2	2,600	-	-	1,000	-	1,000	-	0,617	-
3	2,200	-	-	3,000	-	6,000	-	1,646	-
4	2,200	-	-	3,000	-	3,000	-	1,235	-
5	2,600	-	-	3,000	-	6,000	-	1,235	-
6	2,300	-	-	3,000	-	6,000	-	1,646	-
7	2,000	Asaase Wura	123,457	2,000	-	3,000	-	1,852	-
8	2,500	Asaase Wura	164,610	2,000	-	3,000	-	0,823	-
9	2,900	-	-	2,000	-	9,000	-	1,852	-
10	2,800	-	-	2,000	-	6,000	-	1,481	-
11	2,700	-	-	2,000	-	6,000	-	3,704	-
12	2,800	-	-	-	-	-	-	-	-
13	3,000	-	-	-	-	-	-	-	-
14	3,000	Cocofeed	41,153	6,000	Yes	27,276	-	1,247	-
15	2,800	Cocofeed	103,963	4,000	-	18,184	18,184	1,182	-
16	3,000	-	-	5,000	Yes	22,730	-	1,122	-
17	2,900	Asaase Wura	82,304	6,000	Yes	54,552	-	2,993	-
18	3,000	-	-	4,000	-	36,368	-	1,871	-

Table 4 Farms specific CFT results with and without shade trees. LUC indicates Land Use Changes.

Farm Number	CFT-RESULT: Emissions by Land Area (kg CO2 eq/ha, year)	CFT-RESULT: Emissions by Production (kg CO2 eq/tonne)	CFT-RESULT: No Shade: Emissions by Land Area (kg CO2 eq/ha, year)	CFT-RESULT: No Shade: Emissions by Production (kg CO2 eq/tonne)	CFT-RESULT: No LUC but With Shade: Emissions by Production (kg CO2 eq/tonne)
1	-191,100	-247,600	821,400	1064,500	-
2	35,800	29,000	576,400	466,900	-
3	-1055,100	-1366,700	599,200	776,200	-
4	-5855,100	-5056,100	596,400	515,000	-
5	37,500	88,300	624,600	1470,700	-
6	-1286,100	-1250,100	606,300	589,300	-
7	-1740,900	-3760,400	646,500	1396,500	-
8	-750,600	-2189,200	705,300	2057,200	-
9	-186,200	-1315,500	625,200	4416,700	-
10	-213,100	-766,600	616,500	2217,300	-
11	-86,200	-111,700	619,700	803,200	-
12	-221,600	-286,700	568,600	735,700	-
13	582,700	944,000	582,700	944,000	-
14	5545,100	8084,700	5558,500	8104,300	1075,800
15	692,000	1014,400	745,600	1093,000	-
16	5502,100	17826,900	5505,400	17837,600	2251,500
17	5563,200	13520,700	5604,000	13620,000	1837,300
18	624,700	883,000	682,100	964,200	-