



Social Life Cycle Assessment (S-LCA) of Chocolate Beverage in Nglanggeran, Patuk District, Gunung Kidul Regency, Yogyakarta Special Province

Felix David Aritonang, Mochammad Maksum, and Wahyu Supartono*

Department of Agroindustrial Technology – Faculty of Agricultural Technology
Universitas Gadjah Mada
wstono@ugm.ac.id

Abstract. Cacao (*Theobroma cacao*) is one of agricultural commodities in Indonesia and mostly consumed as instant beverages. Some problems in the chocolate beverage production chain existed, such as the low quality of cocoa beans, the lack of knowledge of production technology and the absence of the basic price of cocoa beans. This research aimed to perform efforts to maintain the sustainability of the cocoa industry in Nglanggeran. This study used the Social Life Cycle Assessment method to assess the social aspects during the life cycle of the product. The method for the assessment was based on UNEP/SETAC – Guidelines for Social Life Cycle Assessment for Products. The results showed that there were positive and negative impacts on the sub-systems, namely the material production and the cocoa processing chocolate drinks. The positive impact for the two sub-systems lies in the contribution of the agricultural sector and local employment for the two sectors. While the negative impact was faced by the raw material production sub-system, which was influenced by the price of cocoa beans and the farmers got very little profit. The negative impact occurred in the cocoa processing that contributed the emissions to the environment and the absence of the social benefits was caused by industrial workers. These problems must be improved by the formulated strategy among all parties concerned to maintain the sustainability of the chocolate beverage life cycle and the welfare of the stakeholders.

Keywords: Chocolate Beverage, Nglanggeran, Social Impact, Stakeholder, Social Life Cycle Assessment

1 Introduction

Indonesia is one of the largest cocoa producing countries in the world, supported by several factors including geographical conditions that pass by the equator. The increase in cocoa land area has contributed significantly to the increase in Indonesia's cocoa market share in the world cocoa scene. Indonesia is among the world's top five cocoa producers, alongside Côte d'Ivoire, Ghana, Ecuador and Nigeria (Indonesia Eximbank Institute, 2019).

© The Author(s) 2024

A. Wafa et al. (eds.), *Proceedings of the 8th International Conference of Food, Agriculture and Natural Resources & the 2nd International Conference of Sustainable Industrial Agriculture (IC-FANRes-IC-SIA 2023)*,

Advances in Biological Sciences Research 41,

https://doi.org/10.2991/978-94-6463-451-8_7

cocoa producers, alongside Côte d'Ivoire, Ghana, Ecuador and Nigeria (Indonesia Eximbank Institute, 2019).

Indonesia's cocoa commodity industry has a very rapid increase since the 1980s. In general, the average increase in cocoa area in the period 1980-2016 was 11.48% per year. The largest increase was experienced by smallholder plantations, which contributed the most to Indonesia's cocoa production. In the above period, the largest area occurred in 2012 at 1,774,463 ha. (Nuryati and Yasin, 2016). Its consumption continues to increase in the last 5 years of 9.97% per year with the latest position of 476 thousand metric tonnes. The increase in cocoa consumption is in line with the growth of the domestic cocoa industry since the issuance of export duty (BK) on cocoa bean products in 2010 (Indonesia Eximbank Institute, 2019).

To increase the competitive advantages of cacao some environmental aspects could be considered and one of method to assess the environmental aspect was Life Cycle Assessment (LCA), which was stated in ISO 14040. The scope of the LCA approach is quite broad, covering the entire impact of a product from its raw material production process to its final disposal. At another term, LCA is called ecobalance, which emphasizes the measured balance and inventory of pollution emissions and resources (Jolliet et al 2016).

The implementation of LCA will give some advantages to industries such as saving energy and raw material usage, lower distribution cost, lower waste handling cost, increasing consumer satisfaction and establishment of an industrial improvement framework (Frankl. 2000). But on the other hand Kofi and Rubik (2000) stated that there was an issue on environmental sustainability, where the agricultural sector predicted give contribution of 25-30% of GHG emission.

Furthermore, not only technical LCA was applied to cocoa industries in Indonesia, the social aspects of cocoa production in the village was investigated with Social Life Cycle Assessment and it was conducted at a village in Gunung Kidul Regency, because it was very interesting to see how importance the social aspects of the farmers was.

Gunung Kidul Regency is the region in the Special Region of Yogyakarta that has the highest cocoa productivity. This is evidenced by the fact that Gunungkidul Regency has 1371 ha of cocoa land, with a productivity of 481 kg/ha, which is greater than Kulon Progo. Four sub-districts have the potential for cocoa commodity development in Gunung Kidul Regency, namely Ponjong, Karangmojo, Patuk and Gedangsari

This research on cocoa in Nglanggeran village uses the S-LCA (Social Life Cycle Assessment) method. S-LCA is used as a tool to analyze social and socio-economic aspects throughout the product life cycle, in this case from the cocoa production process to chocolate drinks. Both aspects directly affect the stakeholders involved in the life cycle of a product. The importance of knowing the socio-economic impacts caused by cocoa farms, especially in cocoa producing areas in Yogyakarta, is to assess the positive or negative impacts and potential impacts of social aspects of cocoa products on relevant stakeholders and to provide information to decision makers in order to improve social conditions throughout the cocoa life cycle. This is included in

the general objective of Life Cycle Assessment to develop a sustainability development phase for industry and society.

2 Research Methodology

Social impact assessment starts from the procurement of raw materials from cocoa farmers to be used as raw materials to the production process into chocolate beverage products at the processing industry level. This research was conducted in Kapanewon Patuk, Nglanggeran Village in Gunungkidul Regency.

The data required in this research study is a study of social aspects, both socio-economic and socio-cultural, at each stage of the process carried out in the chocolate beverage production process. The primary data obtained from the location are: 1. raw materials; 2. machinery and equipment; 3. production process; 4. labor; 5. products; and 6. distribution.

The secondary data includes cocoa production policies for both cocoa farmers and the cocoa processing industry, the production process of cocoa into chocolate beverages in two processing industries in Kapanewon Patuk (TTP Nglanggeran and Griya Cokelat), the regional minimum wage and the amount of cocoa production and other rules that become a reference for stakeholders in the cocoa plantation and industry.

The sampling technique used in this study is a non-probability sampling approach, which is used in this study is purposive sampling technique used to determine key informants in local community stakeholders and value chain actors, snowball sampling technique for sampling stakeholder workers in the raw material production sub-system, and saturated sampling technique for workers in the processing sub-system.

The research stages that will be carried out are as follows:

- a. Preliminary study to make initial observations of the condition of the cocoa processing industry into chocolate drinks.
- b. Literature study aimed at providing a theoretical basis that supports the research is UNEP/SETAC literature on Guidelines for Social Life Cycle Assessment of Products (UNEP, 2010).
- c. Definition of Goal and Scope of S-LCA, which is from the cocoa plantation to the processing of chocolate drinks or cradle to gate.
- d. Social Life Cycle Inventory for collecting data used for the process of assessing the social aspects of the cocoa product life cycle.
- e. Social Life Cycle Impact Assessment aims to provide an assessment of the data that has been collected at the product life cycle inventory stage.
- f. Social Life Cycle Interpretation to give the evaluation and to determine conclusions that can meet the objectives of the S-LCA research and can be used as a reference for recommendations for the decision-making process by stakeholders.

- g. Conclusions and suggestions. The final stage of this research is drawing conclusions by answering the research objectives mentioned earlier and providing suggestions for further research.

The instruments used in this S-LCA stage are the categorization of relevant stakeholders and their subcategories and the assessment indicators contained in the Product Social Impact Life Cycle Assessment (PSILCA) Database. This tool is a database containing information about the social aspects of products in their life cycle that can be used in many sectors, which can be used in the calculation and assessment of social impacts (Ciroth and Eisfeldt, 2016).

3 Results and Discussion

3.1 Cocoa and Chocolate Beverages Production

Many people in Nglanggeran village also work as cocoa farmers. The cocoa commodity is utilized as a source of income by the community. The number of cocoa farmers recorded in the data of Gapoktan Kumpul Makaryo (2019) is 764 people. Farmers produce wet cocoa beans from their land and will be sold to five Farmer Groups (Poktan) to be fermented for a week into fermented cocoa beans. The cocoa production of each farmer in each Poktan varies according to the number of trees owned by each farmer in the five hamlets, but the type of output produced is the same, namely fermented cocoa beans. Average weekly production data from each farmer group can be seen in Table 1.

Table 1. Weekly average cocoa production of farmer group

Group farmer	Cocoa Trees	Weekly average production (kg)	
		Wet cocoa bean	Fermented cocoa bean
Hargo Mulyo	7200	80	28
Margo Dadi	5700	75	25
Sido Muncul	7225	95	31
Mugo Dadi	4218	50	17
Ngudi Makmur	4125	45	15

After the raw materials of cocoa beans have been fermented, then the five farmer groups will provide the total fermented cocoa beans that have been produced to the Farmer Group Association (Gapoktan). Gapoktan will carry out the next process, namely sorting cocoa beans according to the demand of the processing industry of TTP Nglanggeran and Griya Cokelat, and the rest that cannot be accepted to the processing industry will be sold to the market.

Fermented cocoa beans will be processed into several processed cocoa products including chocolate drinks. The processing capacity owned by TTP is 50

kg/production and Griya Cokelat with capacity of 12 kg/production. The TTP Nglanggeran itself has 4 main cocoa-based processed products, namely 3 in 1 chocolate drink, chocolate bar "Choger", chocolate candy, and chocolate dodol as well as several other types of variant products such as chocolate ice cream and chocolate dates produced on demand. The Griya Cokelat also has 4 main cocoa products, including "Chocomix" chocolate drink, "Salut" chocolate banana, chocolate dodol, and chocolate bakpia, as well as variant products of chocolate drink.

The production process of chocolate beverages in Nglanggeran village is done in two ways, namely manually and by using machines. The two cocoa processing industries in Nglanggeran village, TTP Nglanggeran and Griya Cokelat, process fermented cocoa beans by combining both methods. The process sequence is almost the same, the difference is the treatment given to the fermented cocoa beans, such as the mixing process, additional ingredients, and treatment in the sieving process. TTP Nglanggeran itself has a longer process flow than Griya Cokelat. This is due to the larger production capacity that requires different treatments in the production process.

These two processing industries only process Grade A and Grade B fermented cocoa beans (under certain conditions) within the cocoa bean SNI. In SNI 2323:2008, fermented cocoa beans are classified into several grades based on bean weight, which is expressed by the number of beans per 100 grams. Grade A contains 86-100 beans/100 gram and Grade B 101-110 beans/100 grams respectively.



Fig 1. Selection of good cacao pod



Fig 2. Dried cocoa beans

3.2 Analysis of Social Life Cycle Assessment

The definition of goal and scope are to implement the method for assessing social effect of the products based on UNEP/SETAC and to identify and to analyze positive and negative impact of LCA of cocoa drink. The scope of the investigation is divided into two categories, namely the sub-system **of raw material production** and

sub-system of processing of fermented cocoa beans to cocoa drinks. In term of LCA this cope is **cradle to gate**.

Social-LCA data inventory aims to identify and to inventory social impact experienced by the stakeholders involved during the valuation chain. Agyekum et al (2016) stated this stage was conducted in three steps; a. Identify the stakeholders involved; b. Identify impact subcategories that contain social indicators; c. Collection of data relevant to stakeholders in accordance with the social indicators being assessed.

The identification of stakeholders is based on Guideline for Social Life Cycle Assessment for Products (UNEP, 2010) and it consisted of five stakeholders; a. Workers, b. Local Community, c. Society, d. Consumers and 3. Value Chain Actors. The workers were the people who worked for cocoa farming and processing, they were divided into regular and occasional workers. The local community was determined by geographical place where the research was conducted (Couture et al, 2015) and it included people or community dealing with chocolate beverages directly or indirectly and normally in distance of 10 km from the production center (Manik, 2013). These communities are indirectly affected by the lifecycle of chocolate beverages produced in Nglangeran village. The value chain actors are those who take part in the value chain of the chocolate beverage life cycle, including the managers of the Griya Cokelat cocoa processing industry and Nglangeran TTP and the Kumpul Makaryo Farmer Association (Gapoktan).

The identification of impact sub-categories include social indicator is done in accordance with the objectives and scope of the research and can be relevant to the circumstances in the field such as data availability, the relationship of social issues with field conditions and different social indications. Manik et al (2013) and Putri (2017) conducted similar researches on SLCA on agroindustrial products, based on cradle to gate and used no geographical specification, so that this research did not need to be adjusted (Wu et al, 2014).

The data collection relevant to stakeholders in accordance with the social indicators being assessed was conducted based on the defined social indicators and referred to The Methodological Sheets for Subcategories in Social Life Cycle Assessment (S-LCA) by the UNEP/SETAC (2013). Each social indicator to be studied has its own data collection method according to the type of data, namely in the form of qualitative, quantitative data. Data collection is done through field studies (observations and interviews) and literature studies related to secondary data, both for generic data and site-specific data.

3.3 Results of Social Life Cycle Assessment

The workers aspects showed that no child labor and no forced labor worked in this business. They received fair salary, although it depended on the national standard price of cocoa bean and the quality of beans. Over all they have salary within the region standard salary of Gunung Kidul. Furthermore, they worked freely and no discrimination occurred. Their working time depended actually on their daily working

plan, but in general they worked in cocoa system for 6-7 hours per day. The health and safety system in the working place were maintained in their owned standard and tried to minimize the accidents. The health insurance for the workers in the field or the production should be applied for comprehensive individual health services, including promotive, preventive, curative and rehabilitative services including drugs and medical materials (Kurniawati and Rachmayanti, 2018).

For **the local community** who lived in distance 10 km from the cocoa center, the environment was in good for safe and healthy living condition. The farmers used the natural and organic pesticide and fertilizers for maintaining their cocoa trees. The fermentation process was controlled and it produced the low emission (table 2).

Table 2. Emission from the cocoa bean fermentation process

Unit	CO ₂	NO ₂	CH ₄	CO
Kg/kg fermented cocoa beans	3.524×10^{-1}	7.525×10^{-4}	5.897×10^{-4}	2.687×10^{-4}

The employee or the farmers came from the local area and they owned their land and their cocoa trees. The number of farmers was 764 and they came from different villages such as Karang Sari, Doga, Nglanggeran Kulon, Nglanggeran Wetan and Gunung Butak.

The contribution to economic development was explained as follow; the cocoa commodity in Gunungkidul Regency is classified into the Agriculture, Forestry and Fisheries sector. In 2017, the Gross Regional Domestic Product (GRDP) of Gunungkidul Regency reached Rp 16,207,041 and increased from 2016 which was 14.98 million rupiah or 1.22% (BPS, 2018). Based on BPS data (2018), this sector has increased even though it is very small. In 2017-2018, the contribution of the Agriculture, Forestry and Fisheries sector to the GRDP of Gunung Kidul Regency was 2.27%. In national term, the value of cocoa-based Gross Domestic Product (GDP) in 2017 reached 3.47% decreased from 2016 by 3.57%.

The value chain actors were described into fair competition and supplier relationship in providing cocoa beans. The farmers and farmer association played important roles in this stage. The farmers harvested the cocoa pods then processed into the beans, then they could sell to the farmer association in which the beans were fermented or they sold to the market. Normally the price at farmer association was higher than the market, and the price at market depended on quality of cocoa beans and no price guarantee.

The positive impacts of chocolate beverages industry in Nglanggeran were described as follow:

- a. The workers came from local community and it was no child labor, no forced labor and no discrimination between men and women in term of salary.

- b. The cultural heritage was prevented, because the farmers came from surrounding areas and they maintained the land and heritage of the ancient volcano Nglanggeran.
- c. The cocoa contributed to the economic development of the region.

Beside the positive impacts **some negative ones** were occurred in the following aspects:

- a. The cocoa market is oligopsony in nature. This is due to several factors such as the fluctuating selling price of cocoa beans depending on the season. depending on the season, in addition to limitations in the quality and production capacity of fermented cocoa beans by Poktan and Gapoktan.
- b. The social benefits, which should be the right of workers, are not applied in the industry. This is due to the labor recruitment system is still simple, still based on kinship and does not have a standard contract. Therefore, the bond between workers and the industry is still quite weak.
- c. Both industries take fermented cocoa beans as their main raw material from Gapoktan Kumpul Makaryo. Limitations in quality and production capacity mean that rejection of fermented cocoa beans that do not meet the standard often occurs

3.4 Social Life Cycle Assessment Interpretation

The most dominant impact category is the governance impact category related to supplier relationships between cocoa farmers, Poktan and Gapoktan with the Nglanggeran TTP and Griya Cokelat industries. This problem is related to the rejection of fermented cocoa beans sold to the industry because they do not meet the predetermined quality standards. This is due to traditional cocoa planting technology and natural conditions such as soil and seasonal factors. These factors will eventually impact the low selling price of fermented cocoa beans.

The government is an important actor in the development of cocoa commodities in Indonesia. This is because the government has great control over the flow of production from upstream to downstream. One of the government policies is the implementation of cocoa export duties to ensure the availability of raw materials and increase the competitiveness of the national downstream cocoa industry (Hasibuan et al., 2012). The implementation of export duties only benefits the industry, while farmers, who are the largest component of the cocoa agribusiness system, suffer losses (Permani et al., 2011).

In 2009-2012, the National Cocoa Movement (GERNAS) program was implemented. This policy aims to increase domestic cocoa production and quality through three methods, namely rejuvenation, rehabilitation and intensification of cocoa plants, especially smallholder plantations. But this program stopped and no continuity was implemented by the government.

Not only on-farm and off-farm cocoa production played important roles for developing cocoa industry in Indonesia, but also **human resources** who have very

critical factor that have to be improved, so that they have skill, knowledge and competency in cocoa business. The assistance from the government in the form of worker training program and production technology assistance will further improve the performance of the cocoa processing industry.

4 CONCLUSION

The conclusion of this research was as follow:

- a. The indicator of social impact assessment in the life cycle chocolate beverages industries, which was started from cocoa plantation to the beverages production, in Nglanggeran village was the stakeholders, which consisted of workers, local community, society, consumers and value chain factors.
- b. Based the results of Social Life Cycle Assessment there were two impacts occurred, namely the positive and negative ones. The positive impacts were; the workers came from the local community, the cultural heritage was prevented and the cocoa contributed to economic development of the region.
- c. The negative impacts were; the cocoa market is oligopsony, the rights of workers were not applied in the industry and both industries take fermented cocoa beans from the same Gapoktan, which sometimes did not produce the good quality cocoa beans.

References

1. Anonymous. Nglanggeran Village Monograph 2019. <https://nglanggeran-patuk.desa.id/first/artikel/512>, last accessed 2019/08/15.
2. Agyekum, Eric Ofori, K.P.J., Fortuin, Eugenie van der Harst. Environmental and Social Life Cycle Assessment of Bamboo Bicycle Frames Made in Ghana. In: *Cleaner Production* 143: 1069-1080. (2016).
3. Central Bureau of Statistics (BPDS). Indonesia's Gross Domestic Product at Current Prices 2015-2017. Jakarta (2018).
4. Ciroth, Andreas, dan Eisfeldt, Franziska. PSILCA: A Product Social Impact Life Cycle Assessment Database. Green DeltaTC GmbH: New Delhi (2016)
5. Couture, Jean-Michel, Reveret, Jean-Pierre, Parent, Julie. Environmental and Socioeconomic LCA of Milk Production in Canada. Quantis-Ageco- Ciraig-Uqam, Canada (2015).
6. Frankl, P. and Rubik, F.. *Life Cycle Assessment in Industry and Business: Adoption Patterns, Applications and Implications*. Springer. Berlin (2000).
7. Hasibuan, A.M., Nurmalina, R., Wahyudi, A. Analysis of Performance and Competitiveness of Indonesian Cocoa Beans and Processed Cocoa Products Trade in International Markets. In: *Buletin RISTRI* 3: 57 – 70 (2012).
8. Indonesia Eximbank Institute. *Export Projections by Industry: Leading Commodities*. Indonesia Eximbank, Jakarta (2019).

9. Jolliet, O., Saade-Sbeih, M., Shaked, S., Jolliet, A., and Crettaz, P. *Environmental Life Cycle Assessment*. CRC Press. New York (2016).
10. Kurniawati, W dan Rachmayanti, R.D. Identifying the Causes of Low JKN Participation Among Informal Sector Workers in Rural Areas. In *Jurnal Administrasi Kesehatan Indonesia* 6: 33-39 (2018)
11. Kofi, A. B. Y., Duca, D., Pedretti, E. F., and Ilari, A.. *Environmental Performance of Chocolate Produced in Ghana Using Life Cycle Assessment*. MDPI, 14(6155), 1-20 (2021).
12. Manik, Y., Leahy, J., Halog, A. *Social Life Cycle Assessment of Palm Oil Biodiesel: A Case Study in Jambi Province of Indonesia*. In: *International Journal of Life Cycle Assessment* 18:1386–1392 (2013).
13. Nuryati, Leli dan Yasin, Akbar. *Outlook Kakao*. Center for Data and Information Ministry of Agriculture, Jakarta (2016).
14. Permani, R, Vanzetti, D, Setyoko, N. R. Optimum level and welfare effects of export taxes for cocoa beans in Indonesia: A partial equilibrium approach. *AARES Annual Conference*, Melbourne (2011).
15. Putri, Ika Fajriah Gama. *Social Life Cycle Assessment (S-LCA) of Consumption Salt in Pati Regency, Central Java* Skripsi. Program Studi Sarjana Fakultas Teknologi Pertanian. Universitas Gadjah Mada (2018).
16. UNEP (United Nations Environment Programme). *ABC Of SCP-Clarifying Concepts on Sustainable Consumption and Production*. United Nations Environment Programme, Paris (2010).
17. UNEP (United Nations Environment Programme). *The Methodological Sheets For Subcategories In Social Life Cycle Assessment (S-LCA)*. United Nations Environment Programme, Sweden (2013).
18. Wu, Ruqun, Yang, Dan, Chen, J. *Social Life Cycle Assessment Revisited*. *Sustainability* 6: 4200-4226 (2014)

Open Access This chapter is licensed under the terms of the Creative Commons Attribution-NonCommercial 4.0 International License (<http://creativecommons.org/licenses/by-nc/4.0/>), which permits any noncommercial use, sharing, adaptation, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons license and indicate if changes were made.

The images or other third party material in this chapter are included in the chapter's Creative Commons license, unless indicated otherwise in a credit line to the material. If material is not included in the chapter's Creative Commons license and your intended use is not permitted by statutory regulation or exceeds the permitted use, you will need to obtain permission directly from the copyright holder.

