Improving the sustainability of cocoa smallholders farming in Aceh, Indonesia

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Abstract. Cocoa is the main plantation commodity in Aceh as Aceh government reinforces Aceh as the national cocoa resource. Various efforts have been performed through many development and training programs for sustainable cocoa production. This study was aimed to identify the sustainability of cocoa smallholder farming based on the ecological, economical, and social aspects. This study was conducted in Aceh Tenggara and Pidie Jaya District. The study method used descriptive-quantitative method by calculating the score range of sustainability level. The result showed that cocoa smallholders challenged sustainability problems based on ecological, economical, and social aspects. The sustainability of cocoa smallholder farming in Aceh Tenggara District achieves a better performance based on the economical, ecological, and social sustainability aspects than in Pidie Jaya District.

1. Introduction
Cocoa is the main commodity places the fourth rank of Aceh plantation production with 101,230 Ha area. Aceh Tenggara and Pidie Jaya District are the greatest cocoa producing regions in Aceh Province that contribute at 40.31% of total cocoa production in Aceh. Moreover, several other districts that become the cocoa production centers in Aceh are Pidie, Aceh Besar, Aceh Utara, Aceh Timur, Aceh Barat Daya, and Aceh Jaya District. Based on the Decree of Indonesian Ministry of Agriculture Number 46/Kpts/PD.300/1/2015 about National Plantation Area Establishment, cocoa has been selected as the main commodity and National Plantation Area covered Pidie and Pidie Jaya District. Therefore, Aceh government reinforces Aceh as the national cocoa production region apart from Sulawesi and West Sumatra as the greatest cocoa producing regions in Indonesia.

The community cocoa agricultural farming development effort has been performed through public and private partnerships in various empowerment and training programs. The empowerment program is Cocoa National Action Program (Gernas Kakao) and Aceh Economical Improvement Program (PEKA) focused on the production and farmer income improvements. In the next program, farmer’s empowerment orientation is improved from the product quality through Cocoa Sustainable Production Program. This program focuses on the dissemination effort and good agricultural practice based on the government regulation presented in the Indonesian Ministry of Agriculture Regulation Number 48 of
2014 about Technical Guidance for Cocoa Culture and Good Agricultural Practices on Cocoa (GAP). This regulation refers to the sustainable agricultural concept that inclines the environmental quality and conserves the natural resource [1].

Sustainable principal is the world’s development issue promoted through the Sustainable Development Goals (SDG’s). The Sustainable Development Goals are sustainable developmental concepts with a universal purpose to sustain the balance of three sustainable development dimensions: environment, social, and economy [2–4]. In other words, sustainable development is an effort to combine environmental problem and socio-economical problem as an answer for the latest and future challenges [3]. A cocoa agricultural farming based on ecological aspect is characterized to have low pest and disease attacks, appropriate land for plant nutrient requirement, reinforced environmental sanitation, implemented land conservation, and sustained biodiversity [5,6]. The economical sustainability can be explained based on the farmer income, productivity, cost efficiency, and product price level [7]. Sustainability based on the social aspect can be identified from agricultural farming benefit for farmers and surrounding community, consist of social management system, worker’s equity, occupational health and safety, and public relation [7].

In sustaining the farming, a holistic approach is required on three sustainability pillars [3,4]. The cocoa sustainability will be achieved when the stewardship of farmer activity and his farming also considers on the social responsibility [8]. Product certification is an effort for sustainable production quality guarantee. Several certification standards regulated by the international cocoa market is the Fairtrade International, Universal Trade Zone (UTZ) Certificate, and Rainforest Alliance Certificate. Production certification achievement simplifies the farmers to perform selling cooperation with good price rate. Since 2016, two cooperatives in the main production regions in Aceh, namely Koka Jaya Cooperative in Pidie Jaya District and Sekata Cooperative in Aceh Tenggara District, have received UTZ certificate facilitated by the private organization. This success is one of the benchmarks that the community cocoa farming in Aceh has fulfilled sustainable principals. However, cocoa productivity in Aceh continuously decreases each year and land use transformation from cocoa to other commodities as considered to obtain more promising production [9].

Previous studies showed that the sustainability status of cocoa farming was achieved through the implementation of Good Agricultural Practices (GAP) on Cocoa. Olutegbe and Sanni [10] stated that farmers’ compliance to the GAP was high. There was a high value of the economic and environmental benefits of cocoa farming due to the implementation of good practices on cocoa [11,12]. Certified farmers who applied a full package of good cocoa practices experienced a significant cocoa productivity and income increases [13]. The adoption and implementation of GAP positively and significantly affect the production of safe and qualified cocoa beans [14].

Hidayanto et al. [5] explained that the community cocoa plantation obtained a sustainable status based on the socio-cultural dimension, while cocoa farming status was less sustainable based on ecological and economical aspects. The economical dimension sustainability of cocoa farming is relatively low identified from high number of cocoa farmers who lives under the poverty line. Relatively small land ownership impacts on low production result and productivity, which farmers only obtain 60% of the world’s cocoa price[6]. The main problem in economical sustainability of cocoa farming is the product instability price and low cocoa farmer income [15]. Low cocoa farmer income is also influenced by low cocoa productivity produced by farmers. Therefore, production level, productivity, and selling price are associated with the economical sustainability in cocoa farming.

This research aimed to analyze the community cocoa farming sustainability level based on the ecological, economical, and social aspects. The sustainability analysis results will be used to formulate a strategy that supports the community cocoa farming in Aceh.

2. Methods
The research was conducted in Aceh Tenggara and Pidie Jaya District as the main cocoa producing regions based on the highest cocoa production and cocoa area in Aceh Province. Moreover, these regions are also the priority regions for cocoa commodity developed by the Aceh Province
Government. The research population were cocoa farmers who joined in farmer groups with the total of 2,958 farmers as 1,441 farmers were from Pidie Jaya District and 1,517 farmers were from Aceh Tenggara District. The number of samples were determined using the Slovin method at 5% error level. Based on the Slovin formula, 352 farmers containing 171 farmers from Pidie Jaya District and 181 farmers from Aceh Tenggara District. The samples of cocoa farmer were selected by simple random sampling method.

This study used a descriptive analysis with quantitative approach. Descriptive statistical analysis is mostly used for explorative studies, as this study aimed to explore the community cocoa farming sustainability level based on ecological, economical, and social aspects. A quantitative approach according to Arikunto [16] is selected due to using numbers, starting from data collection, data definition, and data analysis result interpretation. Descriptive statistic is a statistic that covers the way to collect, prepare, organize, process, present, analyze the numeric data which can provide ordered, simple, and clear description about phenomenon, incident, or condition, which can be defined with certain meaning.

This study used score range analysis to describe the implementation level of sustainable cocoa farming. The research variable consists of economic sustainability i.e total production, production cost and farmer saving; ecological sustainability i.e waste utilization, the use of chemical substances and the level of pest and disease attack; social sustainability i.e partnership capability, house condition, cocoa certification achievement and relationship with the village community. The aspects of sustainability were presented in the form of interval data scores divided into four categories, namely: very low (0.00 - 0.99), low (1.00 - 1.99), high (2.00 - 2.99) and very high 3.00 - 4.00). We calculated the score of sustainability in two conditions; before and after the implementation of the good cocoa practices. Then, we compare both scores to show the condition of sustainability as:

- Increase : if the score after implementation of the good cocoa practices is higher than before the implementation the good cocoa practices
- Equal : if the score after implementation of the good cocoa practices is equal with before the implementation the good cocoa practices
- Decrease : if the score after implementation of the good cocoa practices is lower than before the implementation the good cocoa practices

The results were presented by the percentage of farmers who experience the increasing or decreasing the sustainability aspects. The descriptive analysis was used to describe the sustainability in each aspect and determine the strategies for improving the sustainability of cocoa farming.

3. Results and discussion

The sustainable agricultural farming is the purpose of good agricultural practice implementation in cocoa farming management. The cocoa sustainable farming contains economical, ecological, and social sustainability. The community cocoa farming in Aceh Tenggara District had a better performance in economical, ecological, and social sustainability aspects than in Pidie Jaya District.

3.1. Economical sustainability

The economical sustainability was described from the total production, farming cost, and total farmer saving before and after implementing the good practice on cocoa farming. The economical sustainability of cocoa farming was in a low category, but there was an alteration on cocoa farming performance after the technological implementation. The cocoa productivity increased by 23%, from 630 kg/Ha/year to 810 kg/Ha/year after the implementation of the good cocoa practices. This condition was supported by the use of excellent clone and cocoa maintenance more intensively following the guidance from good cocoa practices introduced by the extension worker. There were 19.30% of Pidie Jaya District farmers and 2.76% of Aceh Tenggara District farmers who suffered from decreased production. Decreased production was mainly due to pest and disease attacks which was unable to be overcome by the farmers. Climate change which caused the environmental condition
change also impacted on the total cocoa production. Table 1 shows the total production, farming cost, and farmer’s income after implementing the good practices on cocoa.

**Table 1.** Cocoa farmer distribution based on the economical sustainability before and after the implementation of good cocoa practices in Pidie Jaya and Aceh Tenggara Districts.

| Economical Sustainability Aspects | Pidie Jaya | Aceh Tenggara |
|----------------------------------|------------|---------------|
|                                  | Increase   | Equal         | Decrease   | Increase | Equal   | Decrease |
| Total production                 | 64.91      | 15.79         | 19.30      | 77.35    | 19.89   | 2.76     |
| Production cost                  | 40.35      | 13.45         | 46.20      | 3.31     | 39.78   | 56.91    |
| Farmer saving                    | 53.80      | 36.26         | 9.94       | 65.75    | 29.83   | 4.42     |

The maintenance cost of cocoa decreased by 13% from 2.3 million rupiahs to 2 million rupiahs. The organic fertilizer cost was higher than the other fertilizer types, but fertilizer was also less applicable and uneasily cleaned in soil, which was more efficient to use. Moreover, farmers still bought chemical pesticide to simplify the plantation maintenance. The cocoa production cost was used for purchasing production facilities, equipment maintenance, and worker’s wages. According to Duguma et al. [17], disease-resistant seed development is necessary to decrease management and maintenance costs, which can be more attractive economically for farmers.

Increased saving was influenced by the increased farmer income. Farmer income increased due to increased total production and price level. Cocoa price in farmer level was varied depending on the latest price and farmer’s production quality. Price in farmer level was averagely at Rp 24,000 per kg for dried cocoa seeds. Drying was performed conventionally in one day after the cocoa were ripened for two days in cocoa land. The merchants commonly had certain criteria when accepting the farmer harvesting product. If the farmer was incapable of fulfilling these criteria, then the price was decreased based on the product quality decreased percentage produced by farmers (Table 2). As total production and product quality could increase well, the farmer income intended to increase and could divide the income as a family saving. Before the good practices implementation, the farmer saving was in a low category, then increased to a high category after implementing the good practices.

**Table 2.** Cocoa seed price calculation according to quality.

| Cocoa Seed Requirement | Standard Quality | Example of Quality at Farmer Level | Reduction |
|------------------------|------------------|------------------------------------|-----------|
| Moisture level         | 10%              | 12%                                | -2%       |
| Dirts                  | 5%               | 15%                                | -10%      |
| Moldy seeds            | 3%               | 7%                                 | -4%       |
| Total seeds            | 110/100 g        | 120/100 g                          | -10%      |
| Total reduction        |                  |                                    | -26%      |

The economic performance of cocoa farming in Aceh Tenggara was higher than cocoa farming in Pidie Jaya. The productivity average of cocoa farming in Aceh Tenggara District before implementing the good practices was at 740 kg/ha/year, which increased by 25% to 1000 kg/ha/year after implementing the good practices on cocoa farming. This total was greater than the productivity average of cocoa in Pidie Jaya District at 510 kg/ha/year before implementing the good practices technology, which increased by 19% to 630 kg/ha/year after implementing the good practices. Therefore, the production cost spent by cocoa farmers was also higher in Pidie Jaya District. The production cost difference was due to the difference of total production facility and workers used, as farmers in Pidie Jaya District averagely required a higher production cost in cocoa management.
3.2. Ecological sustainability

The ecological sustainability was described from waste utilization, chemical substance use, and pest and disease attack in cocoa. The most emerging change in land farming after implementing the good practices was plantation waste utilization (Table 3). The 16.96% of farmers in Pidie Jaya and 20.44% of farmers in Aceh Tenggara have increased the waste utilization in their plantations. Cocoa farmers gathered wastes from cocoa leaves and shade tree in rorak. Rorak was a burrow made in plantation land to bury the plant wastes. The rorak made by cocoa farmers in the study area was formed in a rounded shape or line shape among cocoa trees.

| Ecological Sustainability Aspects | District | District |
|----------------------------------|----------|----------|
|                                  | Pidie Jaya | Aceh Tenggara |
| Waste utilization                | Increase  | Equal | Decrease | Increase  | Equal | Decrease |
|                                  | 16.96     | 80.12  | 2.92     | 20.44     | 78.45  | 1.10     |
| Chemical substance use           | 33.33     | 37.43  | 29.24    | 20.99     | 59.67  | 19.34    |
| Pest and disease attack level    | 41.52     | 19.88  | 38.60    | 7.18      | 23.20  | 69.61    |

The chemical substance utilization was still used by farmers, mainly to overcome the weed in cocoa land and pest attack spreading among the cocoa plants. The mechanical protections for cocoa plants, such as weaver ant rearing and cocoa fruit covering, have been performed by several farmers. However, most farmers still used simple and faster way by applying chemical pesticide, which ecologically could increase the environmental pollution risk and decrease the ecosystem biodiversity on the impacted chemical substance used. Increased ecological dimension was found on the efficient use of fertilizer and pesticide that could impact on the economical dimension to decrease the cost. Moreover, the waste utilization of cocoa plantation could become an additional income for farmers or could be used by farmers to fulfil the organic fertilizer requirement [18].

The lowest value in ecological sustainability was due to high pest and disease attack in cocoa plants. Climate change and pest resistance influences on the chemical control performed by farmers became the main cause of high pest and disease attack. The biodiversity in cocoa farming ecosystem can be sustained by performing a biological control, but this activity has not been performed by the farmers. Plant pest and disease has been lately become the main problem for farmers in maintaining cocoa plantation, even becoming the main cause of cocoa land use transformation into other commodities that are considered to be more promising. The ecological sustainability value of cocoa farming in Aceh Tenggara District was significantly higher than in Pidie Jaya District. Based on the observation results, farmers in the research location have performed the cocoa plantation waste utilization well. However, cocoa farmers in Pidie Jaya District had a higher intensity in using chemical fertilizer and drugs triggered by the increased pest and disease attacks in cocoa plants.

3.3. Social sustainability

Social sustainability was described from the farmer capability in developing partnerships, joining a relation to other community, increasing the prosperity, and farmers’ ability to achieve the product certification. Low social sustainability level in the research location was characterized by low farmer livelihood improvement, low partnership with other parties, and limited access for gaining a guarantee for the product produced through the production certification process (Table 4). There were the increasing number of farmers that achieved the product certification. The cocoa product certification was retrieved by farmers from the extension workers’ facilitation. By retrieving a certificate, farmers have a higher opportunity to gain cooperation or partnership with other parties with quality guarantee presented on the certificate.
Table 4. Cocoa farmer distribution based on social sustainability before and after the implementation of good cocoa practices in Pidie Jaya and Aceh Tenggara Districts.

| Social Sustainability Aspects       | Pidie Jaya |         | Aceh Tenggara |         |
|-------------------------------------|------------|---------|---------------|---------|
|                                     | Increase   | Equal   | Decrease      | Increase| Equal | Decrease |
| Partnership capability              | 58.48      | 33.33   | 8.19          | 50.83   | 47.51 | 1.66     |
| House condition                     | 46.78      | 48.54   | 4.68          | 62.43   | 34.25 | 3.31     |
| Cocoa certification achievement     | 34.50      | 60.23   | 5.26          | 46.96   | 53.04 | 0.00     |
| Village community relationship      | 26.32      | 71.35   | 2.34          | 46.41   | 53.59 | 0.00     |

The extension and community assistance activities succeeded in facilitating 25.28% of farmers to retrieve the UTZ (Universal Trade Zone) certificate. The UTZ certification is a standard developed by the independent organization to ensure that the product produced through series of activities that can accountable professionally, socially, and environmentally. In certification process, the cocoa plantation land was visited and assessed its eligibility by auditors from accredited organization as social certification organization. The certification retrieval was varied in 2012 to 2019. However, many product certifications retrieved by farmers were postponed as farmers were incapable of sustaining the farming management standard and maintaining the certificate elongation. This condition also becomes the extension workers’ challenge to perform an assistance after certificate retrieval, so farmers can preserve their achievements that are successfully retrieved in sustainable way.

Increased farmer income and saving improve the cocoa farmer prosperity. This condition was marked by the house condition improvement which indicated that the cocoa farmers could fulfil the eligible house requirement standard. The cocoa farmer houses were commonly permanent and semi-permanent houses. Permanent houses were made of rocks, while semi-permanent houses were made of woods. The house condition had available bathroom facility and sanitation, although there were several farmers still had minimum house facility separated from the main house. In social life, farmers could communicate with their social environment. There were no conflicts among farmers and other village community, mainly dealing with cocoa farming management. Cocoa farmers were open for advices offered by the village community, so harmonization could still be preserved. The cocoa farmers tended to be active in their environmental activities, even several farmer groups were part of the village government entrusted to maintain several programs in their villages. Moreover, farmers could obtain a recognition over the production process performed through production certification achievement. The production certificate achievement confirmed the farmer’s concern in the surrounding environmental reservation by preserving the environmentally production process concept. This certificate could also be used by farmers to help improve their prosperity through adding their income in premium fee obtained from the product selling.

The farmer capability development to retrieve cocoa product certificate requires more intensive attention. The cocoa product certification facilitations performed mainly on new certification submission had less product certification elongation concern or re-submission process. This condition impacted on the cancellation of certificate validity period due to not being re-submitted, which caused the product purchase cancellation and premium allocation from the giant companies who purchased the production result from farmers. Moreover, partnership among farmers and traders or industrial companies were rarely found in both study locations, which required a facility to develop a partnership with other parties, mainly in product purchase. The social sustainability level of cocoa farming was shown by the harmonized social relationship among farmers and community around the cocoa farming
area. The social sustainability was also shown by the improvement condition of cocoa farmer livelihood through the increased prosperity.

3.4. Strategy to support the community cocoa farming sustainability

In supporting the community cocoa farming sustainability effort, all stakeholder involvements to support the sustainable production system implementation by farmers can be started from input availability, production process, and marketing. This strategy can be performed by designing the partnership among various parties involving in cocoa farming from upstream to downstream. Several conditions that can be performed are:

(a) Government and private companies should support the cocoa certification effort through cocoa seed certificate guarantee and available qualified production facility. Subsidy should be performed focusing on the qualified seeds requirement, as the cocoa tree age is majority old and needs a rehabilitation. Moreover, subsidy for production facility can be focused on organic substances, such as organic fertilizers, pesticides, and insecticides, following the sustainability issue socialized by the extension activity.

(b) The extension organization should perform a guidance and monitoring for sustainable cocoa farming starting from land preparation to post-harvesting treatment following the practical standard of good cocoa practices.

(c) The extension organization should coordinate with the regional government that can facilitate a continued certification through internal control by the negotiable organization. This condition will induce the farmer preparation to perform a certification resubmission.

4. Conclusions

The cocoa farming sustainability still encounters ecological, social, and economical environmental problems. The ecological sustainability problems were found from high pest and disease attacks. The social sustainability problems were found on low cocoa plantation certificate retrieval, which required all stakeholder roles to support the sustainable production system implementation in cocoa farmers. The economical sustainability was still low, but there was an increased sustainability level after implementing the Good Agricultural Practices in cocoa culture. If being compared, the community cocoa farming in Aceh Tenggara District showed a better performance based on the economical, ecological, and social sustainability aspects than in Pidie Jaya District. A synergism among stakeholders of cocoa farming is necessary to support the cocoa sustainable farming implementation from upstream to downstream; thus, the cocoa farming can support the livelihood and increase the cocoa farmers’ prosperity.

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