Structural equation model of Farmer competence and cocoa sustainability in Aceh, Indonesia

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Abstract. Cocoa development presently has been constrained by the lack of human resources in technology application and farming management. High competence in technical, managerial and social aspects are needed to achieve high farming performance showed by farming sustainability. This paper aims to analyse the factors influencing farmer competence in implementing good agricultural practices on cocoa production and cocoa farming sustainability. Research was conducted in Pidie Jaya and Southeast Aceh, Indonesia in June – October 2019. Data and information were gathered from 352 cocoa farmers by survey methods. The results showed that farmers have high competence but cocoa farming sustainability is low. Factors that significantly affected farmer competence were farmers’ characteristics, the effectiveness of extension services and the level of farmers’ internet literacy. The factors that had direct and significant effects on cocoa farming sustainability were farmer competencies, the level of farmer adaptation to environmental changes and institutional support. The strategy of developing farmers’ competencies can be done through increasing the effectiveness of extension services and widening farmers’ access to the internet and skill in utilizing the internet to develop knowledge and skills in the application of technology.

1. Introduction
Cocoa (Theobroma cacao L.) contributes the highest value of Indonesia’s exports after palm oil and rubber. The main cocoa producing regions in Indonesia are Central Sulawesi, Southeast Sulawesi, South Sulawesi, West Sulawesi, West Sumatra, Lampung and Aceh Province dominated by smallholder plantations. Directorate General of Estate Crop Indonesia showed the total cocoa area of 1,709,284 hectares and 97.54 percent are smallholder plantations. Some limitations faced in managing small-scale cocoa farming are the limited use of technology [1] and low product competitiveness [2].

The low level of productivity is the main problem of smallholder cocoa plantations. BPS Indonesia counted the total national cocoa production reached 688,345 tons with a productivity of 407 kg/ha. This amount has not been able to meet the capacity of the national industry which reached 800,000 tons, hence cocoa imports have continued to run at 265,561 tons or the equivalent of USD 626.7 million. Aceh places the seventh largest cocoa producer in Indonesia, however the cocoa productivity still less than the national cocoa productivity.

The low cocoa productivity is generally caused by few human resources in farming management. Farmers’ inability to manage pests and diseases [1], and weak quality control and post-harvest processing, which is reflected in the high amount of unfermented beans and waste content [3], has decreases the amount of production and the quality of cocoa produced. Therefore, the behavior of farmers in managing cocoa businesses needs to be developed to achieve a better level of competence. Farmers’ competence can be measured through their ability to manage farming appropriately in accordance with recommendations or procedures [4].
Competence is an individual ability to meet referenced criteria in a particular job or situation, consists of knowledge, attitude and skills reflected on their working performance [5][6]. The knowledge aspect of competence includes academic and theoretical abilities, while skills include work ability and problem solving encountered in practice. The social cognitive learning theory states that individual learning is obtained through interaction with the environment, thus the process of developing individual competencies is not only influenced by internal factors, but environmental factors also play a role in the learning process.

Extension services support the development of farmers’ competencies, including knowledge, attitudes and skills in applying technology through the implementation of learning activities in the non-formal education system [7][8][9]. Extension services seek to raise awareness and change farmers' behaviour so they can overcome the problems faced independently and improve their quality of lives [10]. The extension system is an integrative approach to facilitating community change toward becoming better at managing resources, building cooperation, considering environmental sustainability and increasing income through various community economic activities [11]. Related to this, the implementation of agricultural extension aims to improve the welfare of farmers through appropriate business management and environmentally friendly practices to achieve farming sustainability.

The purpose of an extension system based on Indonesian Law No. 16/2006 concerning Agricultural, Forestry and Fisheries Extension System is to organize a learning process for farmers and small-scale businesses to be able to become independent in developing their businesses through wider access to information, technology, capital and other resources so that family welfare can be attained. The learning process is also influenced by the farmers’ physical and non-physical environment [12]. Schneider’s adaptation theory shows the adjustment of individuals to their environment work as a dynamic process according to the development of environmental needs. Farmers as members of the social system are also required to move dynamically to adapt to changes that occur in their social environment [13]. The recent development of information and communication technology is one of the changes that encourages the use of new media in an internet-based extension system as a source of information in developing farmers’ competencies. Information access through internet connected networks helps communities learn and increase their ability. Wider internet access for farmers creates opportunities to develop their competency through an independent learning processes.

Based on the rules of Indonesian Agricultural Ministry No. 03/2018, the implementation of agricultural extension is prioritized through strengthening the function of extension institutions by increasing synergy between stakeholders in the implementation of agricultural extension. The excellence of an extension system in achieving farmers’ welfare is influenced by its performance in integrating various elements in the agribusiness system to establish effective and efficient farm management and partnerships. This can be done through reinforcing the role of local governments and the private sector in the provision of agricultural extension facilities and infrastructure, and developing agricultural extension through synergistic partnerships between the government and the private sector supporting cocoa smallholders’ development.

The cocoa extension in Aceh is a public and private partnership through various empowerment and training programs. The empowerment programs implemented were the National Movement Program (Gernas Cocoa) and the Aceh Cocoa Economy Improvement Program (PEKA) which focused on increasing farmers' productivity and income. Next, the programs’ orientation focused on farmer empowerment to increase product quality through the Sustainable Cocoa Production Program. This program focuses on efforts to disseminate and implement good agricultural practices based on the rules of Indonesian Agricultural Ministry No. 48/2014 concerning the technical guidelines for Good Agricultural Practices (GAP) for cocoa. The regulation explains the technical aspects of cocoa cultivation and quality guidelines to meet expected standards. The final goal of implementing good cocoa farming practices is to improve farming performance by achieving the sustainability of the cocoa business from economic, ecological and social aspects. Our research examined three aspects of
competence: technical, managerial and social, in an effort to achieve high performance of the cocoa farming through the implementation of good agricultural practices on cocoa production. Hence, this research aims to: 1) analyse the level of farmers’ competence and cocoa farming sustainability, 2) analyse the factors that affect farmers’ competence and cocoa farming sustainability.

2. Research Methods

Research was conducted in Pidie Jaya and Southeast Aceh as the main cocoa producing areas in Aceh Province. The survey was conducted from June to October 2019 within a population of 2,958 smallholder cocoa farmers. The sample size, which was determined using the Slovin Formula is 352 farmers, consisting of 171 farmers in Pidie Jaya and 181 farmers in Southeast Aceh. The sample was taken using multi-stage random sampling, which consists of: 1) determination of selected sub-district and farmer groups using a purposive sampling method by considering the number of active farmer groups, 2) determination of sample groups using a stratified random sampling method based on the position of respondents in the farmer groups as group leader and group members, 3) determining the sample in each group by proportional random sampling based on group size. Data collection was done using a questionnaire tested for validity and reliability. The results of the validity test showed that 94 percent of questions were valid with a Pearson coefficient of 0.393 - 0.875. The reliability value shown by Alpha Cronbach was 0.935 so it can be concluded that the questionnaire had a very high level of reliability when used as a research instrument.

The research variables consist of exogenous and endogenous latent variables. The exogenous latent variables include farmers’ characteristics (X1), by indicator farmers’ age (X11), education level (X12), duration working as cocoa farmers (X13), household size (X14), amount of land (X15); the level of farmers adaptation to environmental change (X2), by indicator personal adaptation capacity (X21) and the influence rate of local leader (X22); the effectiveness of extension services (X3), by indicator the functioning of extension services (X31), the level of program appropriateness (X32), and the synergy between parties in extension (X33); institutional support (X4), by indicator the support of financial institutions (X41), marketing institutions (X42), local cocoa forum (X43), farmer groups (X44); and the level of internet media literacy (X5), by indicator access to internet media (X51) and access to internet information (X52). Endogenous latent variables include the level of farmer competency (Y1), by indicator farmers’ technical competency (Y11), managerial competency (Y12) and social competency (Y13); and cocoa farming sustainability (Y2) by indicator economic sustainability (Y21), ecological sustainability (Y22) and social sustainability (Y23). The research data 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).

A Structural Equation Model (SEM) measured the effect of exogenous latent variables on endogenous latent variables. Data analysis was performed by LISREL 8.80 program. The model has been established by removing non-significant variables that refer to the t value and models’ goodness of fit value.

3. Results and Discussion

3.1. Farmers Characteristics, Adaptation to Environmental Changes, The Effectiveness of Extension Services, Institutional Support and The Level of Internet Media Literacy

The distribution of cocoa farmers based on the farmers’ characteristics is presented in Table 1. The average of farmer is 45 years old and the number of dependents consists of 3 people per family. Farmers participated in formal education for 10 years on average, which is equivalent to senior high school. On average, farmers have taken care of their cocoa farms for 12 years, indicating that they are sufficiently capable of cultivating cocoa. The average amount of cocoa land is 0.96 ha (smaller than one hectare), which indicates relatively narrow land ownership. The number of dependents, working
duration as cocoa farmers and amount of land in Pidie Jaya are all significantly higher than those in Southeast Aceh. The cocoa farming in Pidie Jaya began to develop in the 1980s so that on average they have a longer working period as cocoa farmers with relatively broader land ownership.

Table 1. Farmers characteristics, adaptation to changes, the effectiveness of extension services, institutional support and the level of internet media literacy

| Description                                | Unit | District (n = 352) | Mann Whitney Test |
|--------------------------------------------|------|-------------------|-------------------|
|                                           |      | Pidie Jaya (n = 171) | southeast Aceh (n = 181) | Total (n = 352) |
| Farmers’ age                               | Year | 44.64             | 45.34             | 45.00          | 0.617           |
| Education level                            | Year | 10.25             | 10.55             | 10.45          | 0.186           |
| Number of dependents                       | Person | 4               | 3                 | 3              | 0.000**         |
| Working duration as cocoa farmers          | Year | 14.62             | 10.37             | 12.43          | 0.000**         |
| Amount of land                             | Hectare | 1.10           | 0.83              | 0.96           | 0.000**         |
| Level of farmers’ adaptation               | Score | 1.35             | 1.77              | 1.57           | 0.000**         |
| The effectiveness of extension services    | Score | 1.75             | 1.81              | 1.78           | 0.009**         |
| Level of institutional support             | Score | 1.94             | 1.79              | 1.86           | 0.001**         |
| Level of internet media literacy           | Score | 0.85             | 0.99              | 0.92           | 0.000**         |

Note:
Score 0.00-1.00 = very low, 1.01-2.00 = low, 2.01-3.00 = high, 3.01-4.00 = very high
** very significant, α = 0.01

Farmers have a low level of adaptation to environmental changes (score 1.57). The level of farmers’ participation in the cocoa farmer forum tend to be low and they were unwilling to join training with self-financing without government assistances. Changes occur when there were individuals or institutions outside the locality that come and drive the change. Farmers have not been able to make their own choices, but rely on choices and directions from both extension workers and local leaders. The level of farmers’ adaptation in Southeast Aceh is higher than farmers in Pidie Jaya. Farmers in Southeast Aceh are more open to technology and are quite active in seeking out information independently.

The extension services have not been effectively implemented (score 1.78) due to the limited number of extension agents and the weak supervision of technology application. Extension agents are able to foster good relations with farmers, but there was a lack of extension agents available to discuss the issues of cocoa cultivation. The extension activity served by extension workers consists of public extension worker, farmer leader and private extension agents from non-government organizations. Based on Indonesian Law No. 16/2006 on Agricultural, Fishery and Forestry Extension System, progressive farmers can be an alternative to help government extension workers in an effort to increase the availability of extension workers for farmers. Our survey has indicated that there were limited progressive farmers involved in extension activities, however the government and private extension workers also couldn’t cover all farming areas. Learning among farmers was carried out through farmer groups or with other farmers considered to have better abilities in managing cocoa production. Progressive farmers can be a good choice to be actively engaged in the extension process as agents of change.

The synergy between parties in extension services is still low. The implementation of extension services by the government, private extension workers and universities has not been well coordinated so the extension services have not been well distributed for all cocoa farmers. Some farmers have been well facilitated, but there were farmers who received minimal assistance. On the other hand, the extension programs have been appropriate with farmer’s needs. The programs called the Cocoa Field School (SL-Cocoa), Integrated Pest Control Field School (SL-PHT) and the Sustainable Cocoa Production Program (SCPP) were oriented to the adoption of good and sustainable agricultural practices by providing adequate practice in the learning process. There was a significant difference
between the effectiveness of extension services in Pidie Jaya and Southeast Aceh. This can be explained by lower intensity of field visits and fewer cocoa extension agents in Pidie Jaya compared to Southeast Aceh.

Farmers experienced low institutional support in managing their cocoa farming (score 1.86). The limited access to financial institutions is caused by the lack of farmers’ ability to meet loan requirements and the interest rate. Marketing institutions are quite good at providing purchasing services, but they conceal information about prices and potential consumers that can be accessed by farmers. The local cocoa forum is active in organizing annual meetings involving farmers and cocoa stakeholders, but does not provide intensive field assistances and services. The support of farmer groups tends to be high, shown by the ability of farmer groups to share information and marketing products. The level of institutional support is higher in Pidie Jaya due to closer access to information and marketing centers so it is easier for farmers to reach related institutions needed.

Farmers have started using the internet to search for information on cocoa production and technology application, but farmers’ internet media literacy is still very low (score 0.92). The internet tools most often accessed by farmers are Google and WhatsApp, while the use of Cyber Extensions is still very low. The use of the internet is primarily for finding technical information on controlling pests and diseases, as well as sharing information on technology. Internet network availability is better in Pidie Jaya because of the adequate support of infrastructure. In some areas in Southeast Aceh, the internet network is inadequate, but farmers in Southeast Aceh have an easier time finding information and learning to use the internet which makes it easier to access information about updates.

3.2. The Level of Farmers’ Competence and Cocoa Farming Sustainability
Cocoa farmers have high competence in implementing good cocoa farming practices (Table 2). Farmers have the highest competence in the social aspects (score 2.38). Cocoa farmers are open to accepting criticism and tend to easily accept changes introduced by an agent of change. Farmers also have a good harmonious relationship with their social environment, but the ability to communicate and develop farmers' partnership with other parties is still low.

In managerial aspects, farmers are good at planning. Farmers are able to calculate seed and fertilizer needs even with a simple calculation. Farmers also market their products through farmer groups. Farmers’ financial management and quality control of cocoa production abilities are still limited. They don’t have any planning documents or reports on farming production and income. The majority of farmers sell cocoa without a sorting or fermentation process, and those who do so will do it manually. Therefore, the management used by farmers is still conventional.

Table 2 also shows that technical competence tends to be the lowest competence advancing by farmers (2.00). In terms of technical aspects, the application of technology has not been precisely implemented as recommended; especially in land preparation and postharvest activities. Farmers do not examine the suitability of their land to cocoa production which must be done by testing soil pH and measuring effective soil depth before planting. Almost all farmers don’t conduct a cocoa fermentation process due to limited buyers and urgent needs. Farmers generally sell their fresh product or conduct a simple drying process which tends to have a lower price rate.

There was no significant difference between farmers’ competence in Pidie Jaya and Southeast Aceh, but the average competence rate shows that cocoa farmers in Southeast Aceh were more qualified in technical and managerial skills, whereas social competence was better achieved by farmers in Pidie Jaya. Here we can consider that the higher institutional support for farmers in Pidie Jaya didn’t contribute to farmers' technical abilities. We observed that external institutions that exist in farmers’ localities (such as banks, marketing institutions and local cocoa forums) didn’t have a direct role in farmers' learning process. External institutions contribute more in providing capital, purchasing products and building farmer relations with other parties in business development. Farmers in Southeast Aceh are competent in technical and managerial skills which are supported by more effective extension services. In addition, they have better adaptability skills and are more active in
utilizing the internet as a source of information which can increase their competence in applying technology appropriately.

| Description                        | District          | Total  | Mann Whitney Test |
|------------------------------------|-------------------|--------|--------------------|
|                                    | Pidie Jaya (n = 171) | Southeast Aceh (n = 181) | (n =352) | Test         |
| Farmers’ competence                | 2.20              | 2.23          | 2.21            | 0.859        |
| Technical competence               | 1.91              | 2.10          | 2.00            | 0.177        |
| Managerial competence              | 2.21              | 2.33          | 2.27            | 0.186        |
| Social competence                  | 2.49              | 2.27          | 2.38            | 0.076        |
| Farming sustainability             | 1.59              | 1.83          | 1.72            | 0.202        |
| Economic sustainability            | 1.80              | 2.04          | 1.93            | 0.037**      |
| Ecological sustainability          | 1.55              | 1.76          | 1.66            | 0.008**      |
| Social sustainability              | 1.43              | 1.69          | 1.56            | 0.058        |

Note: Score 0.00-1.00 = very low, 1.01-2.00 = low, 2.01-3.00 = high, 3.01-4.00 = very high
**) very significant, α = 0.01

The level of cocoa sustainability in Aceh Province is still low (Table 2). The use of superior seeds and organic fertilizer is economically able to increase production up to 23 percent, but it does not fully cover costs needed for technology application. The economic sustainability in Southeast Aceh is significantly higher compared to Pidie Jaya. The better implementation of good agricultural practices in this region resulted in increasing production and farming income, thereby increasing farmers’ access to farming resources.

Cocoa farming in both regions also have a low level of ecological sustainability (score 1.66). There were good improvements in the application of waste management by farmers, but pests and diseases also tended to increase. The cocoa ecological sustainability in Southeast Aceh is significantly higher than Pidie Jaya. This is related to the better waste utilization and the reduction of the use of chemical compounds in Southeast Aceh. There are four main reasons for the low ecological sustainability of the cocoa business, namely: 1) old plants; 2) low productivity; 3) high rates of pest and disease attacks; and 4) low use of superior seeds [14].

The social sustainability of cocoa farming is in the low category (score 1.77). Farmers found difficulties building partnerships with other parties, and consequently cocoa farming tended to stagnate and failed to improve farmers’ welfare. The ability to obtain sustainability of product certification is still low, therefore farmers still complain about the price of cocoa that has not been able to compete in the world market. In addition, farmers also do not get a premium fee which can help improve their welfare.

### 3.3. Factors Affecting Farmers’ Competence and Cocoa Farming Sustainability

The analysis of factors affecting farmers’ competence and cocoa sustainability using Structural Equation Model (Figure 1) showed that first, the competence of cocoa farmers is significantly affected by the level of farmers’ internet literacy (0.59), farmers’ characteristics (0.27) and the effectiveness of extension services (0.26). Second, cocoa sustainability is directly affected by the level of farmers’ competence (0.32), the level of farmers’ adaptation to environmental changes (0.27) and the level of institutional support (0.18). The model’s goodness of fit indicates the minimum criteria have been met so that the model constructed is feasible to use as presented in Table 3.
Table 3. Goodness of Fit (GoF)

| No | Goodness of Fit | Cut of Value | Value | Results |
|----|-----------------|--------------|-------|---------|
| 1  | Chi Square      | Minimum value| 295.61 (Fit value 300.53) | Good Fit |
| 2  | RMSEA           | ≤ 0.08       | 0.07  | Good Fit |
| 3  | GFI             | ≥ 0.90       | 0.91  | Good Fit |
| 4  | NFI             | ≥ 0.90       | 0.94  | Good Fit |
| 5  | NNFI            | ≥ 0.90       | 0.95  | Good Fit |
| 6  | CFI             | ≥ 0.90       | 0.96  | Good Fit |
| 7  | IFI             | ≥ 0.90       | 0.96  | Good Fit |
| 8  | RFI             | ≥ 0.90       | 0.92  | Good Fit |
| 9  | PNFI            | 0.60 – 0.90  | 0.70  | Good Fit |
| 10 | PGFI            | 0.50 – 1.00  | 0.60  | Good Fit |

Figure 1. Structural Equation Model (SEM) on factors affecting farmers’ competence and cocoa sustainability

The structural equation model of the farmers’ competence and the affecting factors is $Y_1 = 0.27X_1 + 0.26X_3 + 0.59X_5 + 0.33$, $R^2 = 0.67$. This equation shows that the contribution of farmer characteristics, the effectiveness of extension services and the level of farmers’ internet literacy to farmers’ competence was 0.67 (67 percent), the remaining 33 percent was influenced by other
variables that are not examined in this study. The characteristics of farmers are reflected by age, working duration as a cocoa farmer and amount of land. The relatively young age of farmers with qualified experience is the farmers’ potential to be able to engage actively in the learning process. The amount of land affects the technology application because farmers tend to avoid the risk of crop failure by applying appropriate cocoa management practices to increase their production and income.

The level of farmers’ internet literacy has the highest effect on the farmers’ competence level. Farmers are quite active in using internet-based communication devices. The most common device used by farmers is a smartphone. The ability of farmers to use internet-based communication tools push them to learn about recent issues relating to cocoa production, technologies and experiences of other farmers around the world. The ability of farmers to utilize digital media significantly influences the development of farmers’ knowledge and skills [15] [16]. The information generally accessed by farmers is the technical application of technology, and pest and disease control management. The use of agricultural information has a significant effect on increasing farm productivity, especially information on best practices in farming technology application [3]. On the other hand, our study showed that farmers have not been able to process and interpret various information from the internet to be directly practiced in their farming. Farmers claim that internet media provides a very wide variety of information so they need assistance to choose appropriate information based on farming needs. Therefore, farmers generally confirm and discuss issues from the internet with extension workers and other farmers. This shows that the role of extension workers is still very important in guiding farmers to choose and utilize information obtained from the internet.

The effect of extension service effectiveness was reflected by the functioning of extension services and the level of program appropriateness. Farmers participation in the extension program affected the improving farmers’ skills in managing cocoa farms. Practical methods through field schools forced farmers to better understand the knowledge and how to implement it well. The effectiveness of extension performance had a positive effect on farmer competencies [6]. The weak function of extension services in providing services to farmers is due to the lack of extension workers, so they have limitations in conducting visits and monitoring the application of technology. The polyvalent policy of extension workers has not been fully supported by adequate training and technical guidance for extension workers. The weak function of extension had an impact on the low level of farmers learning [7]. This is because the function of extension services as a source of information and driver for the adoption of innovations does not work properly.

The level of farmers’ adaptation to environmental change and institutional support do not significantly affect the competence of farmers, but directly affects cocoa sustainability. The structural equation that shows the factors affecting cocoa sustainability is $Y_2 = 0.32Y_1 + 0.27X_2 + 0.18X_4 + 0.41$, $R^2 = 0.59$. An R square of 0.59 indicates that the variables together contribute 59 percent in explaining the level of cocoa farm sustainability, while the other 41 percent was explained by other variables not examined in this study. The equation shows that the sustainability of cocoa farms was positively and significantly affected by the level of farmers’ competence, the level of farmers’ adaptation to environmental changes and institutional support.

Farmer competency has the highest contribution to the level of farming sustainability. Appropriate application of good farming practices encourages the adoption of environmentally friendly cocoa farming through waste management and reduction in the use of chemicals. The purpose of implementing good agricultural practices for cocoa is to achieve business sustainability, hence the farmers’ ability to implement recommendations encourages the achievement of high farming performance. The competence of farmers positively and significantly affected the sustainability of cocoa farming, from environmental, economic and social aspects [17]. Farming sustainability is determined by the level of farmers’ empowerment in managing their farming [18]. Empowered farmers are technically, managerially and socially competent farmers and are able to implement sustainable farming independently. Farmers’ ability to adapt to environmental changes significantly affects the sustainability of farming. Farmers’ openness influences the ability of farmers to maintain good relations with the community. Cocoa sustainability will be achieved when the stewardship of
farmers’ activities and their farming environment also meet the social responsibilities [19]. This shows the importance of farmers in associating themselves with the changes to realize sustainable farming. We observed that farmers in the study area tend to easily follow changes in their environment, especially when the changes were introduced by extension workers or local leaders. Relations between farmers and extension workers or local leaders was quite good, but the local leader participated passively in extension activities. Cocoa farmers have limited skill in seeking technical information independently, but they are quite active in following innovations introduced by extension agents in cocoa farming management.

Institutional support was reflected by the support of marketing institutions and local cocoa forums. Marketing institutions accessed by farmers in Pidie Jaya are merchants, cooperatives and the cocoa industry, while in Southeast Aceh farmers usually access merchants, cooperatives and large traders. Marketing institutions contribute to the purchasing of cocoa products. The local cocoa forum facilitates farmer group meetings with cocoa stakeholders which opens up opportunities for the farmer group to meet and collaborate with other parties, especially in marketing products and solving farming problems. The technical and social sustainability of farmers will be achieved if there is a sustainable role of local, national and other supporting institutions in the cocoa farming system [20].

4. Conclusions
Cocoa farmers have been competent in implementing good agricultural practices for cocoa, but cocoa farming is still in a less sustainable condition. High competence was supported by the characteristics of farmers, the effectiveness of extension services and the level of farmers’ internet literacy. The effectiveness of extension services was determined by the function of extension systems in monitoring technology implementation and the appropriateness of extension programs for farmers. Access to internet media and the use of internet-based information influenced the development of farmers’ knowledge and skills in managing cocoa production.

The sustainability of cocoa farming was determined by farmers’ competence in applying technology, farmers’ adaptation to environmental changes and institutional support. High competence was recognized by the implementation of good agricultural practices in accordance with the recommendations. This encourages farming sustainability to rise in economic, ecological and social aspects.

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