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Original article

Study of Farmers Adopting Technological Innovation on Cocoa Farming System: The evidence in Southeast Sulawesi Province, Indonesia

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Abstract

Cocoa beans have been existed in Indonesia particularly for smallholder farmers as the cash crop of household in the rural area. Today's its productivity is going down due to the aging cocoa three, pest and diseases. Introducing technology into the farmers group as the alternative way for income diversification based on the cocoa commodity. This study was conducted in East Kolaka District of Southeast Sulawesi Province. Purposive sampling technique was used to select four sub districts of Aere, Ladongi, Lambandia and Tinondo. In each sub district, we chose two sample villages by purposive sampling based on the number of cocoa growers per village and selected 15 farmers respectively based on the random technique due to the homogeneity of the population. In total, we selected eight villages as our sample villages with a total sample size of 120 households. Five components of technology has been introduced, viz. Introducing utilization of cocoa shell for bio-char, utilization of cow dung as organic fertilizer, making cocoa powder for instant beverage, utilization of cocoa shell as the alternative feed cow, and utilization of cow dung as Bio-Gas. This study results show that most farmers have a good and positive response by following or implementing recommended technology. The results of open interviews with farmers at the study site show that the technology introduced is technically feasible based on indicators of easiness of technology application (uncomplicated), easily access to technology, available of supporting materials and inexpensive, easily labor used, and easily in supporting facilities and infrastructure. A good response of farmers indicated that introduced technology has been implemented and adopted by farmers. Moreover, these technology have been implemented which economically feasible, technically easy, culturally done by farmers and environmental friendly.

Keywords: Cocoa, Technology, Introducing, Farmers, Implementing.

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INTRODUCTION

In developing countries, the agricultural sector is economically important for its contribution to the achievement of national goals such as food security, employment, and social security. In Indonesia, for example, agriculture is mainly extensive, limited by climatic conditions such as unreliable rainfall and very high temperatures. Key to the continued contribution of agriculture to Indonesia's economy and beyond, is the adoption of new management, communication, innovation, and production practices, which are expected to maintain long-term profitable agricultural operation. This is particularly urgent in developing countries because agriculture remains a central element of the economy and innovation is the key to the agricultural growth needed to reduce poverty (Collier and Dercon, 2014). According to Dhehibi et al. (2020) the adoption of the technology depends on the knowledge, perception, and attitude of the end users as well as the characteristics of the technology. This is why farmers sometimes think that investment in such technologies will not have the expected advantages, leading to them not adopting any introduced technologies.

The adoption of new technology has paid attention due to poor livelihood in the developing countries depends on the agricultural production and offers opportunity to increase production and income substantially. These countries are characterized by large rural populations engaged in small-scale farming. Their farmers operate typically under conditions of low resources, limited technology and low productivity. In most cases, agricultural technologies in packages that include several components of a package may complement each other, some of them can be adopted independently. Thus, farmers may face several distinct technological options. They may adopt the complete package of innovation introduced in the region or sub sets of the package that can be adopted individually. Therefore, to be fully appropriate, technologies must not only improve productivity, but be acceptable and attractive to small-scale farmers and enhance the community's overall social welfare (Bozeman, 2000).

In Indonesia such developing countries agriculture is the predominant as well as Southeast Sulawesi Province particularly for estate crops. Cocoa commodity is the cash crop of smallholder farmers which have been cultivated widely across the county. Southeast Sulawesi is the one provinces in Indonesia which is the third largest area cultivated cocoa. Cocoa planting area in Southeast Sulawesi reached 246,508 ha which is employed 159,174 households. However, in recent years, the productivity of cocoa plantations in this area has begun to decline 0.8 t per hectare per year due to pest and disease is very seriously threat to the sustainability of cocoa plantations in Southeast Sulawesi. Low productivity is the one of major problems facing cocoa production in Southeast Sulawesi. According to Sahardi (2010) among the factors contributing to low productivity of cocoa in this region are: the aged trees; low yielding varieties; the incidence of pests and diseases; non-replacement of plant nutrients; and poor maintenance practices. Moreover, in Southeast Sulawesi cocoa is mainly produced by small subsistence

farmers which have contributed more than 90% production in this region. Traditional cocoa production with minimal maintenance produces between 300 and 500 kg per hectare yearly. Improved agricultural practices under optimal conditions can produce around 2,500 kg per hectare annually.

This paper describes the performance of introducing technology into the cocoa farmers community which aimed to find out the response of farmers and the percentage of adoption due to technological implemented of utilization of cocoa shell for bio-char, Utilization of cow dung as organic fertilizer, Making cocoa powder for instant beverage, Utilization of cocoa shell as the alternative feed cow, and Utilization of cow dung as Bio-Gas.). The objective of this study was to evaluate different aspects of adoption of new technology and its possible contribution in improvement of cocoa production.

MATERIAL AND METHODS

Study area

The study was conducted in East Kolaka District in the Eastern Province of Southeast Sulawesi. The majority of the people survive as small-scale traders, subsistence pastoralists, and/or crop farmers. East Kolaka is the second largest area producing cocoa in Southeast Sulawesi Province. In East Kolaka cocoa cultivated in nine sub districts, namely Ladongi, Lambandia, Poli Polia, Tirawuta, Lalolae, Loea, Mowewe, Uluiwoi, and Tinondo. In order to obtain a general picture of cocoa cultivation in the whole region, we selected East Kolaka district to represent the whole region.

Study design, data collection and data analysis.

Purposive sampling technique was used to select four sub districts of Aere, Ladongi, Lambandia and Tinondo. In each sub district, we chose two sample villages by purposive sampling based on the number of cocoa growers per village and selected 15 farmers respectively based on the random technique due to the homogeneity of the population (Lalowosula and Putemata in Aera sub district, Lembah Subur and Gunung Jaya in Ladongi sub districts, Penanggosi and Lambandia in Lambandia sub district, Ameroro and Solewatu in Tinondo sub district). In total, we selected eight villages as our sample villages with a total sample size of 120 households. The survey was conducted from January 2018 to December 2019 and the data were collected at household level. The data were collected through face to face individual interview. A semi structured questionnaire based on the survey was used to collecting data. Random sampling was done targeting smallholder farmers within the farmers group.

Primary data were collected from structured interviews and focused group discussions with key informants (trained and selected cooperative members to give and to collect information by distributing questionnaires) from farmers group. The primary data collected from the respondents was entered into Microsoft Excel 2013 spreadsheets, data frequencies and tables were done using Microsoft Excel 2013. Descriptive analysis was used to explain the study findings using the score of farmer responses, the percentage of adopted farmers, and farmers perception based on the technological innovation.

RESULTS AND DISCUSSION

Profile of Adopted Farmers

Age of farmer respondents between 40-48 years old who are still classified as productive age and all are married. This age group is classified as not the young generation of agriculture which nationally still dominates the workforce in the agricultural sector, including in the crop estate subsector which reaches 76.56% (Ministry of Agriculture, 2012). The age level of farmers is very important in related to technology adoption. The results of Habib et al. (2007) stated that the age of farmers has an important role in the process of dissemination, adoption and diffusion of technological innovations. However, according to Azumah et al. (2018) the age of farmers does not have a significant relationship with access to agricultural technology information.

The education of the respondent farmers was mainly elementary school (95%) and only 2 people had a high school education, both of whom played the role of chairperson of Gapoktan (Merger of Farmers Group). Some research results show that education has a very important role in the success of farming. Alene and Manyong (2007) mentioned that farmer education provides an important contribution to the adoption of technology that has an impact on increasing productivity. Uematsu and Mishra (2010) mentioned the low level of education of farmers is an obstacle to technology adoption. Even according to Rimawi, et al. (2016) the level of education of farmers can have a broader impact.

The area of ownership of farmers' cocoa farms in the study area is 0.5 - 1 ha with an average of 0.75 ha / household farmers. Farmers' capital comes from their own capital and is limited by old cocoa plants (> 20 years). The extent of land ownership and age of farming is also important in relation to technology adoption. According to Aneani et al. (2012) the more land owned, the farmers tend to use recommended cultivation technology to increase productivity and income. Conversely, the older the cocoa plant owned, the lower the technology adopted by farmers.

In general, respondents only use family labor. External labor was used only for land clearing, planting, and harvesting. In the analysis of labor costs, family labor is calculated to be the same as the outsider labor.

Farmer’s Existing Technology Of Cocoa Farming System

Cocoa cultivated

Cocoa farming is the main source of income for all respondents. In addition to cocoa farming, the sources of additional income are rice farming, trading, civil servants and farm laborers, but in the last 5 years many people have preferred a local business as another source of income because their cocoa production has declined significantly. The average land ownership is only 0.75 ha /household farmers with the plant age of around 15-25 years. The application of cocoa cultivation technology is still very

simple, some even do not maintenance well at all. Most respondents did not carry out fertilization and pest and disease control activities. Farmers have not used certified superior seeds, but use seeds from their own or neighboring farms whose varieties are unclear. The average productivity achieved is only 250 kg / ha, still far below its potential. One reason is also in line according to Khairuddin, et al. (2015) that the slow adoption of cocoa pod borer (PBK) technology which causes a decline in productivity by an average of 50% with a range of 10% -90%.

Harvesting

Cocoa harvesting activities are carried out in a simple way. Generally the harvest is done when the fruit is ripe 153-160 days old. Fruit that is harvested too ripe will cause the percentage of defective seeds to increase and the seeds tend to start to germinate. Meanwhile, the fruit harvested is too young, the seeds have a low fat yield, many produce flat seeds, and the distinctive chocolate flavor is not optimal. Harvesting is done by picking or cutting fruit stalks, leaving 1/3 of the fruit stalks. Picking until the base of the fruit will damage the flower cushions so that flower formation is disrupted. If this is done continuously then fruit production will decrease. The picked fruit is put in a sack and collected near the tree. Picking is done in the morning and fruit breaking is done during the day. Fruit splitting is still done manually, namely by hitting the stone or hitting the fruit with wooden blocks. Next, the seeds are put into a sack, while the shell is left just around the tree.

Post harvest

Processing of cocoa beans is still done in a simple and diverse way. The process is carried out by inserting freshly shelled cocoa beans into a sack and left for one night, then dried in the next day for 1 to 5 days. If the storage process is carried out in the sack for two nights and then dried in the sun for 4-5 days can be categorized as semi-fermented dry beans. The length of the drying process carried out by farmers is very dependent on weather conditions and also the urgency of needs. If there is an urgent need, farmers can sell semi-wet seeds for drying for only 1-2 days. Under these conditions, the selling price received by farmers is very low (Karmawati et al., 2010).

At the time of mentoring activities, the sale of cocoa beans under these conditions only reached Rp 14,000.00 to Rp 16,000.00 per kg, so far lower than dry cocoa beans which reached Rp 23,000.00 per kg. In the study site, there were no farmers who had fermented on the grounds that it was too long, impractical, and urgent needs. In addition, the cost of the fermentation process is considered quite high, which is Rp. 1,550.00 / kg of cocoa, while the prices received by farmers is significantly different. Based on the results of interviews with cocoa traders, although there are those who do fermentation, but the amount is only a little so it is difficult to separate fermented beans from non-fermented beans in the shipping process. Fermented and non-fermented cocoa beans are finally mixed. This causes traders not to be able to pay more for fermented cocoa beans, except in large quantities, and even the price is

difference of Rp1,500.00 / kg. Traders generally buy cocoa beans with varying levels of drought, so they must be re-dried until they reach an optimal and uniform level of drought.

Cocoa farmer's responses

Response is the result of stimulus behavior, the activity of the person concerned, regardless of whether the stimulus can be identified or cannot be observed. The response will be related to the stimulus, so that if the stimulus occurs then a response will follow (Heliati and Nurlina, 2009). The table below shows the response of farmers from the results of the study activities of the types of technology introduced which are divided into 5 response categories by scoring the response rank. The results of open interviews with farmer group members at the study site show that on average farmers are willing to accept technological innovations that are produced, this is indicated by the change in behavior that they want to implement technological recommendations, although not all of them implement, but it can be concluded that they have a good response and positive during the assessment activities.

Table 1. Farmer's Reponses during the technological implementation

#	Justified	STM	TM	R	M	SM
1.	Introducing utilization of cocoa shell for bio-char				V	
2.	Utilization of cow dung as organic fertilizer					V
3.	Making cocoa powder for instant beverage					V
4.	Utilization of cocoa shell as the alternative feed cow				V	
5.	Utilization of cow dung as Bio-Gas				V	

Description : STM = Fully Denied (skor 1), TM = not accepted (skor 2), R = doubtly (skor 3), M = Accepted (skor 4), SM = Fully accepted (skor 5).

Source : Primary Data

Percentage of Technological Application

The percentage of the application of introduced technology is a picture that cocoa farmers or farmer group members participating in the study activities have a good and positive response. Table 2 below is the percentage level of technology application during mentoring activities.

The results of an open interview with the participants or farmer group members who took part in the study activities in Atula Village, Ladongi Sub District shows that the percentage of the application of the technology produced is more than 50%. This shows that most farmers have a good and positive response by following or implementing recommended technology even though not all have a good response. However, the percentage level shows that technology assistance activities at the assistance location are quite effective. The percentage level of the application of the technology cannot be separated from the element of farmer motivation. Motivation is an impulse that comes from within an individual to do something. Motivation will encourage someone to achieve the desired goal. According to

Odoemenem and Obinne (2010) motivation is the factors that exist in a person who moves and directs someone to meet certain goals.

Table 2. Adoption rate using the technology

#	Justified	Number of farmers	Number of farmers adopted	Persentage (%)
1	Introducing utilization of cocoa shell for bio-char	10	3	30
2	Utilization of cow dung as organic fertilizer	15	15	100
3	Making cocoa powder for instant beverage	15	10	66,7
4	Utilization of cocoa shell as the alternative feed cow	15	7	46,7
5	Utilization of cow dung as Bio-Gas	15	1	6,7

Source: Primary data

Participation rate of farmers group

The level of participation of farmer group members in attending group meetings during the mentoring activities also shows the effectiveness of the mentoring activities carried out at the mentoring location.

Table 3. Participation Rate of Farmers Group

No.	Justification	Percentage
1.	Involving in farmers group activities	
	Frequently	85
	Occasionally	15
	Never	-
2.	Outcome	
	Helpful	100
	Less Helpful	-
	Not helpful	-

Sources : Primary Data

Table 3 shows the level of farmer participation based on the participation component, namely participation in group activities and the benefits felt by farmers. In the component of farmer involvement in each meeting of the 5 times the frequency of meetings held shows the majority of farmers with a frequency of attendance at each meeting is 85%, the remaining 15% frequency of attendance is less (sometimes) and 0% have never attended any meetings held. While the benefits component shows that farmers have a sense of benefits that can be obtained from every meeting that is held.

Farmer's perception

According to Salasya et al. (2007) explains that in general perception can be seen as a process of gathering, selecting, organizing, and interpreting information. The process starts from receiving information from various senses and then analyzed to give meaning. Thus perception is a cognitive process experienced by every human being in understanding information about their environment, producing a picture of the reality at hand. Perception is an important element in adjusting behavior and environment.

Table 4. Farmers Perception of Introducing Technology

No.	Justified	Percentage	Level
1	Technical Aspects		
	Easily to introduce technology	85	High
	Access to technology	100	High
	Availability of supporting materials	100	High
	Availability of labor resources	75	High
	Supporting infrastructure	90	High
2.	Economic Aspects		
	Increasing Farmers Incone	90	High
	Farmers welfare	75	High
	Capital owner	50	Middle
	Access to capital resources	50	Middle
3.	Social Aspects		
	Environmentally Friendly	85	High
	Group Meeting	100	High
	Rule of the game	75	High
	Stakeholder supported	90	High
	Knowledge	100	High

Description : Level (≥ 60% =high; ≤ 59% - 40% =middle; dan ≤ 39% =low)

Source : Primary data

The easiness of application the technology shows that the technology disseminated is easy to apply from technical aspects, economically feasible to apply and easily accepted from the socio-cultural aspects of society. The results of open interviews with farmers at the study site show that the technology introduced is technically feasible based on indicators of easiness of technology application (uncomplicated), access to technology, supporting materials are easily available and inexpensive, easily access to labor force, and easily in supporting facilities and infrastructure. Whereas from the economic aspect it is beneficial based on indicators of increasing income (reducing production costs), increasing welfare, ownership of farmers' capital (not requiring large capital), and easily access to capital institutions. Socio-cultural aspects also show that technology that is disseminated is easily accepted by the community (not contrary to the values and norms of the local community. This can be seen in Table 4 that technology that is disseminated to be environmentally friendly (does not cause pollution or environmental damage), increases a sense of togetherness (through the intensity of group meetings),

does not conflict with group rules, receives support from the local government and increases community knowledge.

CONCLUSION

The development of cocoa bio-industry is needed to answer the challenges of downstream processing of cocoa products so that it can become a cornerstone of cocoa farmer's household income. The response of farmers in this study shows that the technology components produced added value effectively. This shows that there is positive support for the results of the study. The household scale cocoa bio-industry development model through the zero waste concept applied in the study location is expected to be a recommendation for the Regional Government in efforts to improve the welfare of cocoa farmer households, especially in East Kolaka Regency and in Southeast Sulawesi in general.

Ethics approval and consent to participate

This study was designed based on the respondent participation during the collecting data by Interviewed throughout the questionnaire. The nature of this study was fully explained to respondents to obtain consent. No false promise such as remuneration and or per diem, food and financial aids was given. Information was collected after securing consent from study participant. Data obtained from each study participant were kept confidential, and all peoples who participated in the study were acknowledged. The consent form has been read to me and voluntarily I agree to participate in this study.

Authors' Contributions

Julian Witjaksono was did analysis, methodology, reviewing and editing of manuscript. He also initiated the research, wrote the research proposal, conducted the research, did data entry and analysis and wrote the manuscript. *Muhammad Alwi, Sarjoni and Imran* did reviewing, discussion writing and manuscript preparation. They were contributed of this manuscript to assist for finishing this manuscript. All authors contributed equally, read and approved the final manuscript.

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