





ECONOMIC BENEFITS OF WASTE MANAGEMENT BASED ON COCOA FARMING SYSTEM IN RURAL AREA: EVIDENCE FROM EAST KOLAKA DISTRICT OF SOUTHEAST SULAWESI PROVINCE

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ABSTRACT

Article History

Received: 12 May 2020

Revised: 22 June 2020

Accepted: 24 July 2020

Published: 10 August 2020

Keywords

Cocoa
Smallholder
Farmers
Zero Waste
Waste Management
Diversification.

JEL Classification

O013; Q16; Z18.

Indonesia is the three largest countries producing cocoa in the world. However, the productivity tends to be slow down, which cause concern income generation for smallholder farmers across the county. This study deals with the performance of diversification based on creating cocoa by product and waste management of livestock integrated farming in order to increasing household income due to low productivity. This research covers more than 120 household farmers as the respondent through the survey by using questionnaire in three districts population sample. The results of this study indicate that the response of farmers in this study location those are introduced technology components shows effective value. This shows a positive support for the results of this study. The results of the cost and feasibility analysis of the business of making solid organic fertilizers, processing cocoa beans and making bio-char or biological charcoal of cocoa pod show those businesses can be a pattern of diversification of farm household income in the small scale concept. The household scale model of this study development through the zero waste concepts applied at the study site is expected to be a recommendation for the local government in an effort to improve the welfare of cocoa farmer households in this region.

Contribution/Originality: The paper's primary contribution is finding that the zero waste models based on the cocoa commodity becoming the diversification of income generation for smallholder farmers due to the low productivity of cocoa beans in enhancing household income.

1. INTRODUCTION

Cocoa production in Indonesia since the last 10 years has fluctuated but indicated a symptom of a decline of 702,2017 tons in 2006 fell to 622,516 tons in 2016. While the value of Indonesian cocoa exports also fluctuated since the last 10 years with an export volume of 609,035 tons in 2006 to 240,569 tons in 2016. Southeast Sulawesi as one of the cocoa development centers in Indonesia is able to contribute 16.45% as the third central province in cocoa production. The largest cocoa production in this province comes from North Kolaka Regency with a production of 58.63 thousand tons or 46.87% of the total cocoa production in Southeast Sulawesi Province. Other

biggest cocoa producing districts in Southeast Sulawesi is East Kolaka District with production of 25.77 thousand tons (20.60%), followed by Kolaka and Konawe with production of 9.93 thousand tons (7.93%) and 7.87 thousand tons (6.3, %).

The area of smallholder plantations in Southeast Sulawesi in 2016 covered 257,277 ha, a total production of 141,523 tons with a productivity of 779 kg / ha, up \pm 20% from 2009 productivity (620 kg / ha), with a total of 155,313 family heads. The number of farmers involved makes the average control of land for each farmer relatively small, IE only 1.66 ha / head of household. In the same year, the productivity of Indonesian people's plantations was only 767 kg / ha, still below the average production of Southeast Sulawesi in 2002 which was 986.99 kg / ha. The low productivity is thought to be caused by farm management not yet optimal, as indicated by the use of various production inputs, especially in the case of fertilization, even there are some farmers who do not fertilize their farms. The low productivity of community cocoa plantations is inseparable from the not yet being applied to recommended cultivation technologies, especially by smallholder plantations and the use of superior varieties, in addition to the high number of pests and diseases. Cocoa Pod Borer (CPB) and fruit rot disease are the main cocoa pests and diseases that hinder the achievement of production targets and the quality of cocoa yields. Those are making production decreased by 80%. Pest attacks can also reduce yield, quality and increase crop costs and effected downing cocoa prices, while the fruit rot disease can reduce production by 52.99% (Indonesian & Cocoa, 2006). Leading agricultural sub-sectors such as cocoa as a regional superior commodity in Southeast Sulawesi are seen from the root of the problem domestically, not having down-stream industry, which means that it has channeled "leakage" added value to the economic value side of the region. Actually the downstream side of these superior agricultural products has the potential to grow and be developed in rural areas. Industrialization of agriculture in rural areas will open up vast employment opportunities, so agro-industrial development is a realistic choice given the abundance of agricultural resources. It is hoped that farming systems and farmers in Southeast Sulawesi can be further transformed from farming systems dominated by on-farm activities to more complex farming systems, moving towards agroindustry systems.

The direction of development policies, especially regional research and development in Southeast Sulawesi, has been determined by the Head of the Southeast Sulawesi Province Research and Development Agency through Decree number 21 of 2016. The decree explains the direction of the research that refers to the Regional Medium-Term Development Plan (RMTDP) of Southeast Sulawesi Province, which is essential to support research activities in the field of food security, utilization and development of regional leading commodities, and the development of technological innovation and science and technology utilization. Thus, in the future, especially agriculture in Southeast Sulawesi must be an industrial culture-based agricultural system, namely the use of knowledge for decision making, the use of technological advances as the main instrument in the use of resources and engineering to increase added value and minimize dependence on nature. Therefore, agriculture in Southeast Sulawesi must be responsive to science and technology innovation and must be utilized optimally to increase productivity and the quality and value added of agricultural products, especially in the plantation sector such as cocoa which has a high economic value.

Cocoa in Indonesia has been contributed over \$1.2 billion in exports annually and cultivated more than 1.5 million hectares, making cocoa production provides the main source of income for over 1,400,000 smallholder farmers and their families in Indonesia and they contribute 93% of national production. Smallholder farmers work more than 90% of Indonesia's cocoa cultivation area of around 1.6 million hectares, with the rest shared between state-owned and private plantation companies. Typically land holding less than one hectare, smallholder farmers lose out on economies of scale because it makes little sense for them to introduce innovation (Witjaksono & Asmin, 2016).

In the literature of agricultural economics, the diversification of sources of rural household income in developing countries is central to much study (see for example Lay and Schüler (2008); Winters et al. (2009);

Babatunde and Qaim (2009); Davis et al. (2010); Ayanwuyi and Akintonde (2011); Ibekwe et al. (2012); Combarry (2015)). Diversification concept describes the differentiation of production unit. In other words, it refers to the allocation of productive resources among different activities, agricultural or non-agricultural (Babatunde & Qaim, 2009). For example, in the agricultural sector, it means an extension of the range of animal and plant productions (horizontal diversification) or enlargement of the function via supply (vertical diversification). The decision to diversify is often led by the desire to raise constraints or rather to enjoy additional rents opportunities. Babatunde and Qaim (2009) summarize the main reasons of diversification: increase income in case of insufficient resources, reduce income risk in case of absence of insurance markets, use strategic complementarities and positive interactions between activities, fund agricultural investments in the presence of market failure.

Integrated Farming System, whether plantation crops or feed crops, is a potential alternative which can solve the problem of plantation business, feed crops and even livestock problems. According to Haryanto (2009) the Integrated farming system integrates all components of agriculture business horizontally and vertically, so that no waste is wasted. The system is very environmentally friendly and able to expand income sources and reduce failure risks (Meiske, Zaenal, Ifar, & Femi, 2013). Agricultural diversification, such integrated farming system has been identified as one of the mechanisms for managing household food security and poverty in developing economies, because it can spread the risk among multiple production enterprises and provide a range of food items for the households (Asante, Villano, Patrick, & Battese, 2018). Moreover, Abro (2012) stated that household food and income security were the basic objectives of agricultural diversification. Diversification at the farm level is supposed to increase the farm income; the utility of diversification as risk management practices however, remains.

Farming system approach is a powerful tool for natural and human resource management in developing countries such as Indonesia. It is a multidisciplinary whole-farm approach and can be effectively employed in solving the problems of small and marginal farmers. The approach aims at increasing employment and income from small-holdings by integrating various farm enterprises and recycling crop residues and by-products within the farm itself. No single farm enterprise is likely to be able to sustain the small and marginal farmers without resorting to integrated farming systems for the generation of adequate income and gainful employment year round. The basic aim of integrated farming system is to derive a set of resource development and utilization practices, which lead to substantial and sustained increase in agricultural production. Integrated farming systems are often less risky, if managed efficiently, they benefit from synergisms among enterprises, diversity in produce, and environmental soundness. On this basis, integrated farming system models have been suggested by several workers for the development of small and marginal farms across the country (Rana, 2015).

To sum up, an integrated farming system is an agricultural system that combines such elements as crops, livestock and fish in such a way that synergize with each other to create biological recycles, where the output of one component becomes the input for another component with a high complementary effect (Gill, Singh, & Gangwar, 2009). Integrated farming systems were reported by many researchers to be able to overcome the constraints of small-sized farm income (Dash et al., 2015; Kumar, Subash, Shivani, Singh, & Dey, 2012). In addition, integrated farming systems could deal effectively with recycling of waste material in farming system. Use of waste material of one component in the other at the least cost reduces cost of production and net profit is increased (Lal, 2006; Niggol, 2010; Soedjana, 2004). Next, integrated farming systems could not only generate more profits and increase the welfare of farmer families, but also improve ecology and biodiversity (Hilimire, 2011; Liswati, 2012). Finally, integrated farming systems could support the provision of organic fertilizers, improve efficient use of chemical fertilizers, and increase agricultural productivity.

Zero-waste integrated cocoa production (ZWICP) system is a model of sustainable cocoa production, which is integrated and synergized cocoa with animal such as cows or goats, productions. All production units (cocoa, other crops and animals) are synergized under a zero waste system, so that total farm productivity increases sustainable. Wastes from cocoa and shade tree pruning, grasses, pod husks, and other agricultural wastes are used to feed the

animals; while manures, solid and liquid, are utilized for compost, methane gas and bio-pesticide productions. Due to its advantageous, ZWICP is suggested to be an appropriate model for smallholder cocoa production, hence should be scaled up in the field.

The integrated agricultural system such as the integration between agriculture and livestock become alternative solution of farming system by not disposing waste result by using concept of zero waste models. A study resulted by [Tiyas \(2017\)](#) showed that the system integration of farming corn and cattle using a model of zero waste had leveraged products and wastes in accordance with the concept of integrated farming 4F (Food, Feed, Fertilizer, Fuel) made a positive impact on both the component sectors of farming corn and beef cattle breeding. The implementation of zero waste model from corn plants, it was used as feed for beef cattle that was useful in the process of fattening cattle weight and could be used as compost, while waste from cattle in the form of feces and urine could be used by farmers as organic manure to increase fertility corn farming land then, it could be used as alternative fuel of LPG replacement for farm household through biogas installation.

Most of the related studies in literature focus on economic assessment of bio-char systems ([Galinato, Yoder, & Granatstein, 2011](#); [McCarl, Peacocke, Chrisman, Kung, & Sands, 2009](#); [Pratt & Moran, 2010](#); [Roberts, Gloy, Joseph, Scott, & Lehmann, 2010](#); [Shackley, Hammond, Gaunt, & Ibarrola, 2011](#); [Yoder, Galinato, Granatstein, & García-Pérez, 2011](#)). These studies typically found that the potential economic profitability of bio-char production systems varies depending on the feedstock used ([Roberts et al., 2010](#)) the conversion technology employed ([Pratt & Moran, 2010](#)); ([Bruun, Müller-Stöver, Ambus, & Hauggaard-Nielsen, 2011](#)). Recent techno-economic assessments of slow-pyrolysis bio-char and heat production ([Klinar, 2016](#); [Patel, Zhang, & Kumar, 2016](#)) also showed that the bio-char system can be profitable provided it is customized into the local production system.

This study is matched with the regional policy development, particularly in agriculture. The purpose of this study is as follows:

- To identify the technological innovation of smallholders farmers in optimizing natural resources in terms of integrated farming.
- To analyze the economic feasibility of utilization of local resources based on cocoa and livestock integrated farming in rural area.
- To provide specific recommendation for local government in order to increase rural household on the basis of the results of this study.

2. METHODOLOGY

The region of Southeast Sulawesi, one of the biggest cocoa-producing regions in Indonesia, was selected as the research area. It is the largest cocoa-producing region, both in terms of area and production. This study has been carried out in East Kolaka District over a three month period for the 2018 fiscal year. Three out of the nine sub-districts were purposefully selected for this research. In each sub-district, two villages were randomly selected for the survey. In total, 120 household heads (HH) of cocoa farmers were selected randomly from all cocoa farmers who produced cocoa beans in the sample area for the purpose of answering the questionnaires. Data collection related to primary data was collected through surveys, interviews using semi-structured questionnaires and Focus Group Discussion (FGD) at the farmer group level. Primary data were obtained from the results of the observations and direct interviews in the field using the Focus Group Discussion (FGD) method. The data and information are presented in tabular form and interpreted descriptively. The data were analyzed anonymously; for this purpose, the questionnaire was created without a name line for the respondents. During the interviews, the background of the research was explained to the respondents, and they were also told that there was no pressure on them to participate. The respondents were cooperative in providing information. This research employed a cross-section of data, comprising both qualitative and quantitative data. Questionnaires were used in this research for data collection. In order to analyze the expenditure and the profit of organic fertilizer production, bio-char production

and cocoa powder the feasibility analysis has been done. Benefit-cost analysis (BCA) is a technique for evaluating a project or investment by comparing the economic benefits of an activity with the economic costs of the activity. Typically, we use the symbol B to represent our measure of benefits and the symbol C to represent our measure of costs. Benefit-cost analysis has several objectives. First, BCA can be used to evaluate the economic merit of a project. Second the results from a series of benefit-cost analyses can be used to compare competing projects. BCA can be used to assess business decisions, to examine the worth of public investments, or to assess the wisdom of using natural resources or altering environmental conditions. Ultimately, BCA aims to examine potential actions with the objective of increasing social welfare (Shively, 2012). The benefit-cost ratio (BCR) is calculated as the present value (PV) of benefits divided by the present value (PV) of costs:

$$BCR = \frac{\sum_{t=0}^T \frac{B_t}{(1+r)^t}}{\sum_{t=0}^T \frac{C_t}{(1+r)^t}}$$

We use the same definitions as above: B_t is the benefit at time t and C_t is the measure of costs at time t. Again, it is a convention to begin counting with the current time period as t=0. If the BCR exceeds one, then the business might be a good candidate for acceptance. BCA is a valuable tool for decision making. It is most useful because it provides a starting point from which to begin evaluation of a project. BCA forces project advocates and opponents to provide quantitative data to back up qualitative arguments. With BCA actual data must be used to support the analysis. Typically, some subjective reasoning or value judgments come into play when deciding on projects or investments. While BCA may not be able to include all the criteria which is deemed important in evaluation, it does allow interested parties to clearly define the issues involved (Mehmood, Anjum, & Sabir, 2011).

3. RESULTS AND DISCUSSION

Table 1 shows the results of a feasibility analysis of the business of making solid organic fertilizer at the study site conducted by the household farmer group. The results of the analysis per 10 tons of organic fertilizer show that the cost of the main raw material is IDR 4,335,000, - consisting of cow dung, straw, husks, decomposes and zeolite. While the need for supporting raw materials consisting of the purchase of sacks, yarn and supporting labor is IDR 1,200,000, - thus the profit derived from the sale value of 200 sacks of organic fertilizer or equivalent to 10 tons with a sales value of IDR 10,000,000. Therefore, the net profit of making this business is IDR 5,665,000 per 10 tons of organic fertilizer.

Table-1. Feasibility analysis for organic fertilizer production (n=120).

No.	Raw materials	Amount	Total (Kg)	Unit Price (IDR)	Total (IDR)
Main Materials (A)					
1.	Cow dung	500 sacks @50 kg	25.000	100	2.500.000
2.	Husk	200 sacks @ 50 kg	10.000	50	500.000
3.	Straw	10 Pick Up cars	10.000	200.000/2 cars	1.000.000
4.	Zeolites	1 quintal	100	85.000/quintal	85.000
5.	Em4	10 bottles	-	25.000/bottle	250.000
Total Value (A)					4.335.000
Supporting Materials (B)					
1.	Sacks	200	-	2000/sacks	400.000
2.	Yarn	5 Rolls	-	20.000/roll	100.000
3.	Labor	10 days person labor	-	70.000	700.000
Total Value (B)					1.200.000
Amount (A+B)					5.535.000
1.	Selling (C)	200 sacks @ 50 kg	10.000	50.000	10.000.000
2.	Profit	C - (A+B)			5.665.000

The bio-char manufacturing business in this study was carried out using simple technology, is the use of drums for the combustion process. In this activity the process of making bio-char using simple technology does not require a large cost, with material from cocoa pod waste can be obtained at very low cost, while other variable costs are 3 kg liquid gas or wood burn as a source of energy in the combustion process. In principle bio-char can be made from any type of biomass. It is important to understand how different production conditions can result in different types of bio-chars and how these chars interact with different types of soils. Two elements critical to every bio-char system are (a) the source of biomass, and (b) the means of bio-char production. The source, or feedstock, can be almost any type of biomass including agricultural wastes such cocoa pod, and production systems range in scale from small household cook stoves to large industrial pyrolysis plants. Systems are generally classified pyrolysis depending on the technology applied (Sebastian et al., 2014). The following table below is an analysis of the cost of making bio-char.

Table-2. Economic analysis of making bio-char in production per 100 Kg (n=120).

No.	materials	Amount	Total (Kg)	Unit Price (IDR)	Total (IDR)
Main Materials (A)					
1.	Cocoa Shells (dry)	8 sacks @50 kg	200	5.000 per sack	40.000
Total (A)					40.000
Supporting Materials (B)					
1.	Sacks @ 25 kg	4 sacks (Labeling)	-	5.000/sacks	20.000
2.	Yarn	2 rolls	-	20.000/roll	40.000
3.	Liquid gas 3 kg	1 tube	-	20.000	20.000
Total (B)					80.000
Total (A+B)					120.000
1.	Selling (C)	4 sacks @ 25 kg	100	2.500	250.000
2.	Profit	C – (A+B)			130.000
3.	B/C ratio				1.08

The results of the analysis in Table 2 show the cost needed to produce 100 kg of bio-char is IDR 120,000, which consists of purchasing raw materials for dried cocoa shells at a price of IDR 5,000 per sack @ 50 kg, purchase of labeled sacks, yarn and Liquid gas for fuel, making the process of making 100 kg of bio-char. The value of the sale of bio-char is IDR 2,500 per kg with a yield of 100 kg, a value of IDR 250,000, thus a profit of IDR 130,000 per 100 kg of bio-char with the B / C ratio of 1.08.

Indonesia is the three largest cocoa producing countries in the world, so far has not focused on the downstream industry of cocoa beans, especially chocolate. The downstream cocoa industry is actually developed in countries that have relatively no source of raw material for cocoa beans, such as European countries, the United States, China, Malaysia and Singapore. Based on data from Indonesian and Cocoa (2006) it shows that the chocolate processing industry is currently controlled by countries in Europe. European countries such as Germany buy basic chocolate (cocoa powder, cocoa liquor, cocoa butter) from other countries and also Indonesia and then convert it into various kinds of processed chocolate, which is then marketed in other countries, especially Indonesia. Therefore, in the study of cocoa bio-industry, efforts have been made to assist farmer groups to gain knowledge and skills in processing ready-to-use cocoa powder. The following table is an analysis of the cost of a ready-made cocoa powder business that has been fostered in this study.

Table-3. Cost analysis of making cocoa instant powder (n=120).

No.	Materials	Amount	Total (Kg)	Unit price (IDR)	Total(IDR)
Main materials (A)					
1.	Dry cocoa beans, fermented	-	2 kg	25.000	75.000
Total					50.000
Supporting materials (B)					
1.	Plastic packaging	5 plastics	-	1.000	5.000
2.	Labeling	5 units	-	500	2.500
3.	Liquid gas	1 tube	-	20.000	20.000
Total					27.500
Amount (A+B)					77.500
1.	Selling (C)	5 plastics @ 200 grams	1	33.500	167.500
2.	Profit	C - (A+B)			90.000
3.	B/C ratio				1.16

The results of the analysis in the Table 3 show that the business of making cocoa powder with simple technology for household scale with B / C ratio of 1.16, thus the business is economically or financially feasible for a larger scale. The cost required to produce 1 kg of ready-made cocoa powder that has been packaged in plastic labeled is IDR 77,500, with the selling price in 200 gr packaging palette, IDR 33,500 per 200 gr, the profit gained is IDR 90,000 per 1 kg of cocoa powder.

4. CONCLUSION

The results of cost analysis and business feasibility of making solid organic fertilizer, processing cocoa beans into ready-to-use cocoa powder and making bio-char or bio-charcoal show that these business is able to become a pattern of diversification of farmer's household income in the household-scale agro-industry concept. The household scale cocoa household agro-industry development model through the concept of zero waste applied at the study site is expected to be a recommendation for the Regional Government in an effort to improve the welfare of cocoa farmers' households, especially in East Kolaka Regency and Southeast Sulawesi in general. Scaling up of the those businesses requires the support of policies and programs from the Regional Government, especially the Plantation Service or other related agencies in an effort to increase the business scale, especially the assistance of tools needed by farmers.

Funding: This study received no specific financial support.

Competing Interests: The authors declare that they have no competing interests.

Acknowledgement: All authors contributed equally to the conception and design of the study.

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