

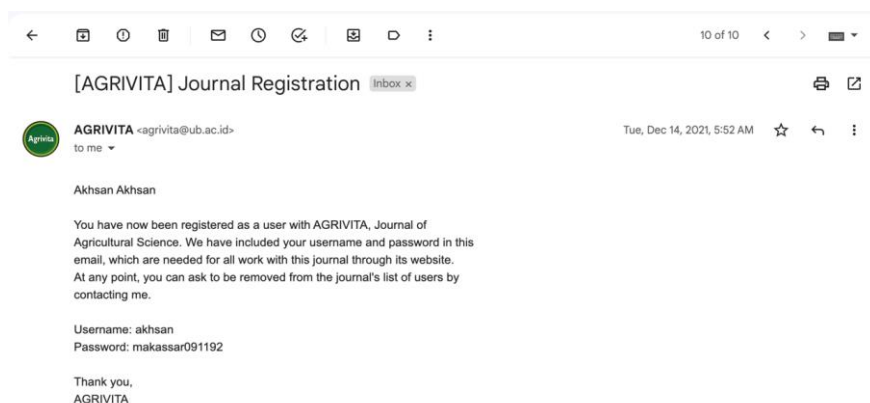
# IN-DEPTH STUDY OF MULTIPLE CROPPING FARMING SYSTEMS: THE IMPACT ON COCOA FARMERS' INCOME

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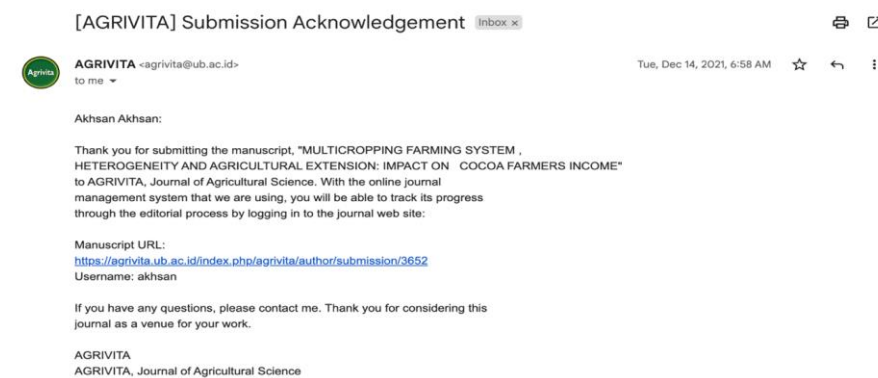
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## 1. Regisrration (bukti mail register)



## 2. Submission (bukti email Acknowledgment submiison).



### 3. Reviewer/Editor Comments and Respons

#### Feedback table for reviewers Round 1 (3.1)

#### IN-DEPTH STUDY OF MULTIPLE CROPPING FARMING SYSTEMS: THE IMPACT ON COCOA FARMERS' INCOME

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Comment	Revision
Indonesia has provided about 1,951,270 hectares' area of cocoa plants (Fahmid et al., 2018). (What year ?)	In the period 2013-2017.
Cocoa is a perennial crop, why do the author did not include age of the tree? Why not include the variable of multiple cropping ?	The age of the cocoa trees of the respondents in this study were almost the same, because the farmers planted the trees at the same time. Therefore, the focus is on the role of agricultural extension in facilitating the needs of farmers..
Tribe or ethnic group? Better to use no of tribe or ethnic group	The correct use of the word is syllable. We have fixed it in the paper. The difference in ethnicity that is the research objective, whether information from other tribes affects farming behavior that has an impact on income.
If monoculture, what is the reason to include clove since your focus is on the cocoa?	Clove is a companion plant for cocoa. we made a comparison between farmers who only planted monocultures, namely cocoa and cloves. After that, we will see again how the farmers cultivate these two commodities simultaneously.
It does not make sense that multiple cropping produced higher production compared to monoculture. Please describe the monoculture and multiple cropping system in the field	Clove plants have many advantages for cocoa plants, some of the advantages as a shade plant and also the knowledge of farmers who cultivate polyculturally is better, in plant maintenance until harvest, so that the costs incurred are more efficient.

## IN-DEPTH STUDY OF MULTIPLE CROPPING FARMING SYSTEM AND ITS ~~HETEROGENEITY AND~~ ~~AGRICULTURAL EXTENSION:~~ THE IMPACT ON COCOA FARMERS INCOME

**Abstract.** Multiple cropping farming systems, agricultural extension and its the impact on farmers income still become serious issue in agricultural development. The diversity of information received by the farmers including multiple cropping can provide new knowledge and will have an impact on farmers productivity and income. ~~The benchmarks taken into consideration are profit, compatibility with farmer values, the level of complexity an innovation.~~ **The objective of this research was to evaluate advantage of multiple cropping and its economic impact on cocoa farmers income.** ~~This paper examines the linkage between multiple cropping system, extension, heterogeneity level and farmers income.~~ The research employed Ordinary Least Square Method to estimate parameters and RC Ratio for income comparison from the farming systems. The results showed **that choice of farmers in cropping patterns and types of crops is done to avoid failure that will lead to crop failure. The advantage of multiple cropping is that the utilization of soil nutrients is more effective because plants grow together on the same land.** Multiple farming system provided a higher income compare to monocropping and success to reduce operational costs. ~~Of~~ the five factors studied, there were three factors influenced farmers' income through extension activities. They are information of credit amount obtained, level of heterogeneity, and agricultural production. These factors are of concern in communication activities that can increase knowledge in a heterogeneous environment, will in turn increase farmers income.

**Keywords:** Multicropping System, Heterogeneity, Extension, Farmers Income

### Introduction

Multicropping farming systems, agricultural extension and farmers income still become serious issue in agricultural development. The diversity of information received by the farmers including multicropping can provide new knowledge and will have an impact on farmers productivity and income. The agricultural sector is dominated by small farming families who use basic technology in production. As a result, most crop yields are below attainable levels. ~~For example, main crops such as maize and rice are below half of the economically achievable levels.~~ Given the stagnant agricultural productivity and persistent food insecurity in low-income countries, there has been continued interest in the adoption of new technology and its impact on productivity (Takahashi, Muraoka, and Otsuka 2020) and agricultural practices affect biodiversity, agroecosystems (Altieri and Nicholls 2004). Several factors that explain the low yields in Indonesia include the use of basic technology in production, dependence on rainfall for production, low adoption of modern production technologies such as superior seeds, irrigation, chemical fertilizers, and mechanization. Other factors include the low level of education of farmers (Anang, Bäckman, and Sipiläinen 2020) and their farming systems. Regarding many agriculture-based developing countries, multicropping system is becoming new discussion for smallholders. For example, polyculture system positively affect land productivity and land-used efficiency (Arsyad et al. 2020), Other studies also confirmed that homogeneous farming systems contributed to the decrease of plant resistance to insect pests, especially related to the use of pesticides (Altieri and Nicholls 2004), long term of agricultural availability, including land-used scenarios (Morgan-

Davies, Wilson, and Waterhouse 2017), land capacity, soil organisms (Doran and Zeiss 2000), feeding activity (Reimer et al. 2018), on-farm diversification, food security, and income sufficiency (Anderzén et al. 2020). These findings crystallize the idea of this research on the interrelationship of intercropping, agricultural extension and heterogeneity with farmer's income.

One of the agricultural sectors that contributes to the country's foreign exchange is the plantation sector. Plantation is one of the important sectors in national economic development. The development of the plantation sector is inseparable from various national and global environmental dynamics. The plantation sector is also influenced by the dynamics of the central to regional governments because it is considered one of the government's options for poverty reduction (Sinartani 2014).

Cocoa is one of the leading commodities in the plantation sub-sector. The cocoa commodity has consistently played a role as a source of foreign exchange for the country which makes a very important contribution to the structure of Indonesia's economy (Muhammad, Sinaga, and Yusuf 2011). The cocoa commodity also provides job opportunities because it is able to absorb a sizable workforce. In addition, Cocoa also plays a role in encouraging regional development and agro-industrial development. Currently cocoa is the third largest plantation commodity after oil palm and rubber. Cocoa plays an important role in improving the economy as a contributor to foreign exchange as well as improving the farmer's economy. The increase in cocoa productivity has not been supported by efforts to increase human resource competence and marketing. Increased productivity requires support for increasing farmer competence which aims to increase farmers' income and welfare. It is hoped that the increase in income for the welfare of farmers can be increased through increasing competence in the fields of cultivation, harvest, post-harvest, technical processing and marketing. The increase in income and welfare of farmers is considered low because it is not supported by efforts to increase the competence of cocoa farmers. Based on (Sumardjo 1999) the openness of the economy due to the globalization of the world economy creates conditions (challenges) that more demanding modern behavior of the actors, efficiency and business competitiveness of every commodity produced, including agricultural commodities. Therefore, it is necessary to increase human resources, farmers, technology, access to capital resources and market access. Consumer demands for agricultural products have directed the agricultural practices to take any necessary efforts to maximize plant harvest (Arsyad et al. 2020).

Ministry of Agriculture has set four successful targets for agricultural development, namely (i) sustainable self-sufficiency; (ii) Food diversification; (iii) Increase in added value, competitiveness and exports; and (iv) Improve farmer welfare. One of the government's efforts to achieve the target of sustainable self-sufficiency and self-sufficiency is by implementing an Integrated Rice Management program so that the goal of increasing rice production and self-sufficiency can be achieved. The program is a rice cultivation approach that prioritizes the management of crops, land, water and plant pests in an integrated and specific location, each institution has its own pattern in spinning the management of land and has tangible (Mappa et al. 2018). This application is (i) participatory, (ii) dynamic, (iii) location specific, (iv) integrated, and (v) synergistic among the technology components applied.

One of the government's efforts to make an integrated crop management program a success is to involve parties or extension workers at the central and regional levels, public sector programs have attempted to overcome information-related barriers to technological adoption by providing agricultural extension services (Aker 2011). Extension in agricultural development in this case is involvement as a link between the world of science and the government as policy makers, and a link between the world of research and agricultural business practices carried out by farmers and their families who are ultimately able to mobilize. community self-help.-Efforts made so that the program can run and be successful, it is necessary to develop agricultural human resources (HR) through education, training, counseling, apprenticeships, collaborative training and other non-formal education (Wahjuti 2007). The farmer model is a common feature of many developing world agricultural extension networks where they demonstrate new cultivation techniques and technologies to local communities. The various political-economic and socio-cultural roles taken by such peasants, however, have rarely received critical scrutiny. This transfer occurs both horizontally to community members and vertically through relationships with extension agents, research institutions and private sector interests. We define how these transfers have an important impact on efficiency and equity.

Agricultural extension is expected to be surrounded by opportunities and challenges that can be seen from its contribution to the process of agricultural development in a sustainable direction (David and Samuel 2014). Many parties consider that agricultural development, human resources including the development of extension institutions and increasing agricultural extension activities are factors that have contributed greatly to the success of agricultural development in Indonesia. (Mardikanto and Soebiato 2013) states that extension agents are a bridge between the government or extension workers who are represented in delivering innovations and policies as well as providing feedback from the community which aims to help people improve their quality of life and welfare. Several studies have also shown that agricultural extension investment provides high internal returns. Therefore, agricultural extension activities are an important component in all aspects of agricultural development. However, during the process of economic transformation towards industrialization, the government budget to support agricultural sector development, including agricultural extension, experienced a significant decline (Supiyani 2009). The National Cocoa Movement Program (GERNAS) is a cocoa commodity extension program. This movement aims to accelerate the increase in productivity and quality of national cocoa products through optimal empowerment of all stakeholders and available resources (Ministry of Agriculture 2012).

Two general approaches have been used to account for heterogeneity in the analysis of farmers' preferences. Often preferences are analyzed within prior groups of farmers that are then compared (Martin-Collado et al. 2015). Researchers have to make assumptions about the factors affecting preference heterogeneity or about the group of farmers that might have different trait preferences. Increasing smallholder compliance with sustainability standards and good agricultural practices is a key feature of the global sustainability agenda. Operating in a sector subject to strong public scrutiny, Indonesian Smallholders are faced with pressure to improve their environmental performance. As smallholders experience different compliance barriers, it is widely recognized that to more effectively prioritize and target the required intervention support, farmer heterogeneity needs to be better understood (Schoneveld et al. 2019).

Agricultural extension is a system that focuses on empowering and equipping farmers with the skills to help them make the right decisions, solve their own problems, and manage their farming businesses (Jennings, Packham, and Woodside 2011). Several problems arose with this agricultural development. For example, several negative consequences have emerged regarding the environment and natural resources resulting from the intensification of agricultural production. There has been a decrease in soil fertility and increased erosion, as a result of the overuse of chemical fertilizers and pesticides. These problems arise from the need to tackle previously non-existent diseases and pests that thrive due to an imbalance of natural ecosystems (Alkhathami 2013).

One of the cocoa production centers in Indonesia is West Sulawesi. In the province resulting from the division of South Sulawesi Province, cocoa is a leading commodity because in addition to providing a large contribution to the Gross Regional Domestic Product it also acts as a provider of employment for most of the population. Cocoa development in West Sulawesi has been going on for a long time, since the 1980s. Guidance is carried out by the local community so that all of the cocoa gardens are community cocoa gardens. This development is part of the cooperation between the central and local governments, but cannot be separated from the importance of extension workers who are in direct contact with farmers. Based on this, it can be carried out by extension workers who have carried out their duties and functions. Production of cocoa in Indonesia has the potential to increase if the limiting factor can be minimized (Santoso and Zakariyya 2019).

The role of the agricultural sector in the national economy is so important and strategic, especially because the agricultural sector still provides employment for most of the population in rural areas and provides food for the population. Another role of the agricultural sector is to provide raw materials for industry and generate foreign exchange through non-oil and gas exports, even the agricultural sector has been able to become a safety valve for the national economy in the face of the economic crisis that has hit Indonesia in the last decade. The central government continues to strive to improve and develop national agriculture in various ways, including by issuing various policies. The objective of this policy is to develop sustainable agriculture, fisheries and forestry through extension systems in agriculture, fisheries and forestry. On this side, the extension system is related to the whole series of developing the abilities, knowledge, skills and attitudes of the main actors and business actors through the implementation of extension. On the other hand, it needs to elaborate how heterogeneity related to agricultural extension and farmers income. This paper examines the linkage between multicropping farming systems, extension, heterogeneity level and farmers income. The objective of this research is .....

## Research Method

### 1. Research Site and Sampling

The research was conducted from January until May 2020 in West Sulawesi Province (as one of the largest cocoa production provinces in Indonesia). For multicropping system, we consider to analyse the **advantage of multiple cropping and** estate crops (cocoa and clove). Level of farmers heterogeneity, starting from ethnicity, culture and society, made the variety of information received by local farmers. **Evaluation of multiple cropping .....** Extension activities

of the government policy program also support cocoa production activities. In addition, the geographical conditions of West Sulawesi Province are very suitable for growing cocoa crops. **Evaluation of multiple cropping held on .....** We interviewed 60 farmers (random sampling) and we also conducted a focus group discussion with the local government regarding the implementation of extension with high heterogeneity conditions.

## 2. Analysis: Ordinary Least Square

According to Bahua (2016), performance of agricultural instructors needs to be considered through increasing the competence and motivation of extension workers. Expansion of the agricultural development strategy that pays more attention to the role of agricultural extension agents by increasing the extension budget and improving extension facilities and infrastructure, which will increase the performance of extension workers in helping farmers work towards a better and more productive direction. In this study, the OLS (Ordinary Least Square) method was used to see the effect of extension on farmers' income (Figure 1).

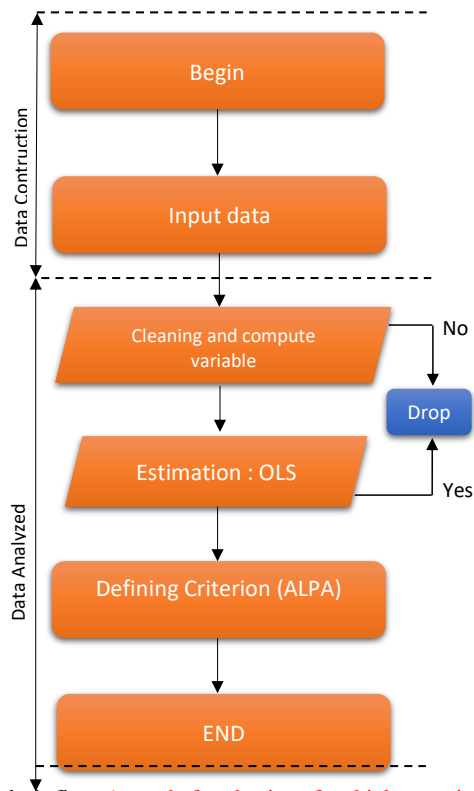


Figure 1. Research analysis flow (started of evaluation of multiple cropping. in back colour, please)

Ordinary Least Square (OLS) is one of the regression function estimation methods used in this study. The OLS criterion is the line that best fits or in other words the number of squares of the deviation between the observation point and the regression line is minimum. The test includes multicollinearity test, heteroscedasticity test, autocorrelation test, and normality test. OLS on the linear probability model and provides sufficient conditions for unbiasedness and consistency to hold. The conditions suggest that a “trimming estimator” may reduce OLS bias (Horrace and Oaxaca 2006). In OLS regression some assumptions should be met including : (1) the linearity of regression coefficients, (2) all predictors must be uncorrelated with the residuals, (3) residuals not to be correlated with each other (serial correlation) , (4) residuals have a constant variance, (5) Not predictor variables is perfectly correlated with another predictor variable (avoidance of multicollinearity), (6) residual are normally distributed (Farahani, Rahiminezhad, and Same 2010). In this study the variables to be studied are production, income, frequency of interactions with other tribes, information on the amount of credit, information on agricultural extension, price information and changes in information service improvements with significant correlation at 5% level.

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \beta_7 X_7 + \beta_8 X_8 + \epsilon$$

Y	= Total Income
X1	= Tribes in the agricultural area
X2	= Interactions with different tribes during one month
X3	= Farmer groups, in which there are different tribes
X4	= Benefits of information obtained from other tribes
X5	= Agricultural extension information
X6	= Agricultural information service improvements
X7	= Benefits of information on extension activities are useful for farming activities
X8	= Agricultural credit information
$\beta_0$	= Constants / Intercept
$\beta_1, \beta_2, \beta_3, \beta_4$	= Parameters are estimated
$\beta_5, \beta_6$	
$\epsilon$	= Error term

### 3. Farmers Income Analysis

Analysis of farm income using R/C analysis. R/C is the balance between the cost of farming cabbage and the revenue generated, where R/C shows the amount of revenue earned from each rupiah spent (Nurmala, Soetoro, and Noormansyah 2017). The formula is as follows:

$$R/C = \frac{TR}{TC}$$

Information :

TR = Total Revenue

TC = Total Cost

Decision making :

a. If  $R/C > 1$ , then the farming business is profitable, because the revenue is greater than the total cost.

b. If  $R/C < 1$  then the farming business is not profitable, because the revenue is smaller than the total cost

c. If  $R/C = 1$ , then the farming business carried out is not profitable and does not lose (break even) the total revenue is equal to the total cost.

## Results and Discussion

### 1. Evaluation of Multiple cropping

There are 2 types of choices for cocoa cropping patterns from farmers, namely monoculture and multi-cropping. Farmers who choose monoculture are those who have large areas of land, while those with narrow land areas choose a multi-cropping pattern. Sayogyo (1997) grouped farmers into three categories: small-scale farmers with a farming area of  $<0.5$  Ha, medium-scale farmers with an area of  $0.5 - 1.0$  Ha, and large-scale farmers with a farm area of  $>1.0$  hectares. Wider the agricultural land, the more efficient the land if the facilities and infrastructure and management are adequate, the best management practice will provide multiple benefits to agrosystem (Syarief et al. 2018).

The choice of farmers in the selection of cropping patterns and types of crops is done to avoid failure that will lead to crop failure. This choice is also taken based on the experience of farming that has been done for generations.

Add a paragraph of evaluation of multiple cropping, here ..

Scott and Rasuanto (1983), on the simple but also very strong moral of the farmer's economy. There are 3 principles of attitude from farmers related to farming developed by Scott, namely as follows: (1) Safety first: subsistence economy. The principle of safety first, that is, farmers are reluctant to take risks and focus more on avoiding falling production, not just maximizing profits; (2) Subsistence ethics, namely ethics which are a consequence of a life that is close to the boundary line, and (3) risk distribution, this risk aversion attitude is also stated why farmers prefer to plant subsistence crops rather than non-food crops whose results are for sale. The results of farming analysis shown in Table 1.

Table 1. Farming income analysis of the **monoculture and multi cropping???** System

<b>Monoculture System</b>			
<b>Cocoa</b>		<b>Clove</b>	
<b>Item</b>	<b>Venue (IDR)</b>	<b>Item</b>	<b>Venue (IDR)</b>
<b>1. Revenue</b>		<b>1. Revenue</b>	
a. Production (kg)	1.900	a. Production (kg)	1.000
b. Price	35.000	b. Price	80.000
Total revenue (axb)	66.500.000	Total revenue (axb)	80.000.000
<b>2. Production cost</b>		<b>2. Production cost</b>	
a. Fixed cost		a. Fixed cost	
- Land tax	757.000	- Land tax	600.000
- Depreciation	535.000	- Depreciation	550.000
	1.292.000		1.150.000
b. Variable cost		b. Variable cost	
- Fertilizer	7.400.000	- Fertilizer	8.250.000
- Pesticide	8.250.000	- Pesticide	9.500.000
- Labour (5 man-day)	442.000	- Labour (6 man-day)	650.000
	16.092.000		18.400.000
Total cost (a + b)	17.384.000	Total cost (a + b)	19.550.000
<b>3. Income (1-2)</b>	<b>49.116.000</b>	<b>3. Income (1-2)</b>	<b>60.450.000</b>
<b>4. RC Ratio = 3,8</b>		<b>4. RC Ratio = 4,0</b>	

Table 2. Farming income analysis of multicropping system (keep Agrivita Table style)

<b>Multicropping System</b>	
<b>Cocoa Clove</b>	
<b>Item</b>	<b>Venue (IDR)</b>
<b>1. Revenue</b>	
a. Production (kg)	
- Cacao	2.200
- Clove	1.300
b. Price	
- Cacao	

- Clove	35.000
	80.000
Total (axb)	
- Cacao (2.200 X 35.000)	77.000.000
- Clove (1.300 X 80.000)	<u>104.000.000 +</u>
	181.000.000
<b>2. Production cost</b>	
a. Fixed cost	
- Land tax	1.100.000
- Depreciation	<u>950.000</u>
	2.050.000
b. Variable cost	
- Fertilizer	15.550.000
- Pesticide	9.500.000
- Labour (15 man-day)	1.100.000
	<u>16.092.000 +</u>
Total cost (a + b)	42.242.000
<b>3. Income (1-2)</b>	138.758.000
<b>4. RC Ratio = 4.2</b>	

Table 2 clearly show that intercropping (polyculture) of cocoa and cloves is more efficient to develop (RC Ratio=4.2) with lower production costs (or reduce variables cost) compare to monocropping (RC Ratio=3.8 for cocoa and 4.0 for clove, on average of 3.9). Farmers' knowledge of biodiversity has an impact on their production processes and income. Experience has provided farmers in managing commodity management, thereby increasing their knowledge of choosing a more efficient and profitable polyculture system, reducing operational costs such as labor and plant maintenance compared to monoculture cultivation. Polyculture in general have received increasing attention by the apparent advantages in the utilization of space and environmental services offered (Cruz González, Jarquín Gálvez, and Ramírez Tobias 2013). Polycultural cropping pattern of cocoa cultivation with many tree species almost no leaves that age at the beginning of the dry season. It shows better adaptation to drought when planted with other trees (Prihastanti and Nurchayati 2018). Importance of the role of agricultural extension workers in educating farmers about the polyculture system in risk management in farming is very important, this can maximize the availability of existing land and can maximize the profits of farmers. Plant biodiversity plays a fundamental role in minimizing farmer risk when available modern varieties are not adaptive to the existing environment and are not supported by the applied cultivation methods (Coromaldi, Pallante, and Savastano 2015)

## 2. Test for Goodness of Fit and Farmers Income

Value of R Square model that affects the income factors of farmers is 0.684. Results of R Square show that the model built is fit to describe the phenomenon described as 68.4 percent by the frequency of interaction with other terms, the amount of credit information, the amount of agricultural extension information, the level of heterogeneity improvements and production.

Agricultural extension activities are needed as an item in agricultural activities, where farmers can obtain information from various sources so that the application of new technology is applied with the aim of increasing the welfare and independence of the farmers. Ballantyne and Bokre (2003) indicate that agricultural extension, which depends to a large extent on information exchange between and among farmers, has been identified as one area. This sub-chapter presents the results of the estimation of the factors that influence farmers' income on extension activities.

Table 3. Determinants of farmers income

Variable	Coefficient	Standard Error	T-Count	P-Value
Constant	-41277650.209	7944931.307	-5.195	.000
Tribes in the agricultural area	285223.888	1839043.178	.155	.878
Interactions with different tribes	5160383.934	1890455.270	2.730	.011
Number of farmer groups, in which there are different tribes	3256116.981	1906122.719	1.708	.098*
Benefits of information obtained from other tribes	1455661.012	1736470.017	.838	.408
Agricultural extension information	1455540.859	1903724.228	.765	.450
Agricultural information service improvements	4580582.126	1910486.041	2.398	.023*
Benefits of information on extension	3925735.607	1914472.532	2.051	.049*

activities are useful for farming activities				
Agricultural credit information	2671985.299	1844859.337	1.448	.158

Note: \* significant at 5% level

### 2.1. Tribes in the agricultural area

Diversity of ethnic groups or level of heterogeneity in the agricultural location has made a lot of information exchange among farmers. For example, farmers who migrate from the island of Java have their own habits that make different levels of production. This success in increasing production was then followed by local farmers who were then modified according to local culture which could become a new behavior in farming activities. Level of heterogeneity variable has results that have a significant effect on the income level of farmers. The higher level of heterogeneity, the higher production will be and in turn will increase income. It means that the more cultural differences can increase knowledge of information and also increase income. Success indicator for any development and implementation level of heterogeneity is the level of farmer satisfaction that comes from the farmer's perspective or perception. Satisfaction is defined as a form of consumer feelings after comparing with expectations, if the government's performance is below the expectations of farmers. Farmers will be disappointed and vice versa, so it can be concluded that satisfaction is a response to meeting farmers' needs. This is also in line with Gollin and Udry's (2021) research which finds that measurement error and heterogeneity together cause most of the dispersion in the measured productivity. Different styles result in different levels of intensity and sustainability, it means that encouraging and stimulating specific farming styles might result in considerable agricultural development and growth of total food production (van der Ploeg and Ventura 2014).

### 2.2. Interactions with different tribes

A growing versatility of knowledge discovery systems, there is an important component of human interaction that is inherent to any process of knowledge representation, manipulation, and processing (Mankar and Burange 2014). The variable frequency of farmers interacting with other tribes has no significant effect on farmers' income. Furthermore, the coefficient value of the frequency variable of farmers interacting with other tribes is 17588.298. The positive sign of the coefficient shows that if the farmer's interaction with other ethnic groups increases, it will also increase the income of the farmers. The more diverse the information received by the farmers will increase their knowledge and experience from a social and cultural perspective. This is also in line with Jessica and Ashish (2011) statement that traditional agricultural landscapes, created by indigenous peoples and local communities, have been shaped by the dynamic interaction of people and nature over time. Transfer of sustainable technology from older farmers who participate in extension programs to the younger generation of farmers. To improve the implementation of extension programs by young farmers, they need to be given intensive extension support for innovation (Bulkis, Rahmadanih, and Nasruddin 2020).

### **2.3. Number of farmer groups, in which there are different tribes**

Farmer groups are farmer institutions that directly organize farmers in developing their farms. Farmer groups are organizations that can be said to function and exist for real, in addition to functioning as a vehicle for counseling and driving the activities of their members. Some farmer groups also have other activities, such as mutual cooperation, savings and loans business and work gathering for farming activities. The number of farmer groups that have different ethnic groups has no significant effect, this is because there are not too many populations from other tribes living in the research location, even though farming information from other tribes can increase the knowledge of local farmers and enrich farming methods that can increase productivity. The diversity of other tribes found in farmer groups is caused by the migration of farmers from their place of origin, there are several factors such as limited agricultural land at the place of origin or the increasing number of residents.

### **2.4. Heterogeneity for Benefits of Information**

Knowledge or information obtained from other tribes is expected to be applied in local community farming activities. Other ethnic groups have different perspectives and backgrounds, however, the regression results obtained have no significant effect on income compared to the other variables. This finding shouldn't be interpreted to mean that no effect at all. There is an effect, but insignificant. The diversity obtained from other tribal farmers against local farmers can increase the interaction of social capital between them which leads to the welfare of farmers. Programs that are usually run include farming training, and meetings to solve a problem. The existence of other tribal farmers in rural areas will have an influence on agricultural development in rural areas in terms of changing perspectives and adding information to farmers. This conveys an important message that heterogeneity will have an impact on increasing farmers income. In other words, heterogeneity in the rural agriculture area can be one of the routes for increasing welfare of smallholders.

### **2.5. Agricultural Extension**

Positive sign of the coefficient indicates that if the amount of extension information increases, it will increase farmers' income even though significant. This does not mean no impact at all, there is an impact but not significant. Therefore, there is still way to say that agricultural extension services positively affect agricultural income. The role of agricultural extension is to help farmers form a healthy opinion and make a good decision by communicating and providing information needed by farmers (Pradiana 2017). In this study, the role of agricultural instructors as motivators was seen from the frequency of instructors in motivating farmers to use compound fertilizers in their farming. Apart from being a motivator, the agricultural extension worker also acts as a mediator. As a mediator, extension agents connect farmers with sources of information needed by farmers, such as business meetings. Provision of additional sources of market price information, and ensuring that the personal features of farmers are taken into consideration when designing information service interventions is crucial (Nwafor, Ogundeji, and van der Westhuizen 2020). Arsyad, Nuddin, and Yusuf (2013) research which states that the Central Point of the Interpretative Structure Modeling (ISM) results shows that, (i) the Regional Forestry and Plantation Service (Hutbun), (ii) Plantation Field Extension Officer (PPL), and (iii) Marketing

Institutions are key institutional actors in strengthening cocoa farmer institutions. Important factor that contributes to agricultural development is information. As agricultural extension agents who connect agricultural institutions to farmers, they must have adequate information (Wulandari 2015).

Business meetings conducted in this activity are between farmers and the formulator and extension workers as mediators who are very involved in the business meeting. The formulators that usually exist in agricultural activities are providers of pesticides and fertilizers. The involvement of agricultural extension agents is as a guide and guide both during socialization and in field visits and in demonstration plots. In overcoming the problems faced by farmers, extension workers try their best, for example when fertilizer is scarce in the market, agricultural extension workers try their best to find a way out by looking for a copy to the fertilizer company. Meanwhile, to overcome other problems such as the eradication of the sundep pest, agricultural extension workers only try to provide input and then submit it to the farmers in its implementation. Thus, extension workers not only convey information or policies from the government or extension agencies to farmers, but also help solve problems faced by farmers. One example of research from Syam et al. (2019) which states that providing clear information can change the mindset of farmers towards previous information.

## **2.6. Agricultural Information Service Improvements**

The regression results of improving agricultural extension information have a significant effect on farmers' income. The evaluation and commitment by the extension workers in listening to the aspirations of the farmers will make the farmers more productive and various obstacles and problems in farming will be resolved together with the extension workers. Agriculture is one of the responsibilities given by the government to extension workers to change the behavior of farmers with the aim of improving the welfare of farmers and their families, so in essence extension workers are at the forefront of agricultural sector development in Indonesia. In addition, agricultural extension workers are an important key as an effort to improve the welfare of people who work in the agricultural sector in rural areas. Because agricultural extension agents are agents of change who are directly related to farmers. The lack of human resources in the agricultural sector encourages the creativity of extension workers in building awareness of farming that is better and more profitable. To overcome this, it is necessary to change the behavior of farmers so that they are able to overcome the problems.

## **2.7. Benefits of Information, Extension and Farming Activities**

Agricultural instructors must have broad and competent insight, besides guiding farmers (educators) they also act as providers of production facilities (facilitators), as motivators and as communicators for farmers. One indicator that shows the role of agricultural extension workers is the development of farmer skills which is shown through the increasing farming skills of farmers. Through extension activities, it is hoped that farmers' skills in farming will increase so that they can manage their farming business from the planting season to harvest properly so that production results can increase and the welfare of farmers and their families increases. Extension activities themselves have been regulated in the Government Regulation of the Republic of

Indonesia concerning Financing, Guidance, and Supervision of Agricultural, Fisheries, and Forestry Extension.

The regression results of agricultural extension profits have a significant effect on income, this shows that the extension activities carried out by the agricultural extension center are very good for the welfare of farmers. A lot of information has been provided by the extension workers such as farming practices, market and price information, and the provision of capital assistance needed in farming. Intense extension information is carried out every month and the relationship between farmers and extension workers has been connected harmoniously for a long time.

### **2.8. Amount of Credit Information**

Agricultural credit is one that is given by the government to assist farmers in funding agriculture. Variable amount of farmer credit information has a significant effect on farmer income. The higher the credit information, the higher the farmers income will be. In discussing capital in agriculture, farmers always come to the matter of credit which is capital from outside parties or financial institutions. Thus, capital can be divided into two, namely own capital (equity capital) and loan capital (credit). Indonesian government has implemented several strategies to increase domestic agricultural production such as seeds subsidy, fertilizer subsidy, and credit program (Wicaksono 2014).

In the production process there is no difference between own capital and capital from loans, each of which contributes directly to production. The difference is in the interest that must be paid to creditors. In this case there is a significant relationship between the amount of credit information and income, that agricultural credit is needed by farmers as business capital. Considering that agricultural business is a very risky business to fail because its success is determined by uncertain natural conditions. Farmers really need banks or service providers in the agricultural sector in order to protect their business continuity. The availability of community foodstuffs is very much determined by farmers who are usually neglected. Considering that agricultural business is a very risky business to fail because its success is determined by uncertain natural conditions. Farmers really need banks or service providers in the agricultural sector in order to protect their business continuity. The availability of community foodstuffs is very much determined by farmers who are usually neglected. Given that agricultural business is a very risky business to fail because its success is determined by uncertain natural conditions. Farmers really need banks or service providers in the agricultural sector in order to protect their business continuity.

### **Conclusion → add the advanted of MC**

It can be concluded that multicropping farming system provided a higher income compare to monocropping and it success to reduce operational costs. Of the series factors studied, there are three factors that influence farmers' income through agricultural extension activities, namely amount of credit information, level of heterogeneity and production. The diversity of ethnicities and cultures of the farming community can influence the process of exchanging information between farmers, which in turn will allow farmers to gain new knowledge to encourage production and improve household welfare.

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Feedback table for reviewers Round 2 (3.2)

IN-DEPTH STUDY OF MULTIPLE CROPPING FARMING SYSTEMS: THE IMPACT ON COCOA FARMERS' INCOME

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COVER PAGE

Comment	Revision
In this research the variables examined were	In this research the variables examined were production, income, frequency of interactions with other tribes, information on the amount of credit and agricultural extension, price information, as well as changes in information service improvements with a significant correlation at 5% level. The total farmer's income can be analyzed based on formula 1.
Ballantyne and Bokre (2003) stated found that agricultural extension, which depends to a large extent on information exchange between farmers, has been identified as one area.  Stated already used many times in this article.	Change mentioned
This table did not mentioned in the text	In table 3, of the 9 influential variables, there are 3 variables that have a significant effect, including Number of farmer groups, in which there are different tribes, Agricultural information service improvements, and Benefits of information on extension activities are useful for farming activities. In line with Khairunnisa's et al., (2021) research, agricultural instructors play a role in guiding farmers in managing their farms effectively and efficiently so as to improve farmers' welfare. The role of the extension agent is as a catalyst, communicator, consultant and organizer.
Nurmala, L., Soetoro, S., & Noormansyah, Z. (2017). Analisis Biaya, pendapatan dan R/C Usahatani Kubis (Brassica Oleraceal)(Suatu Kasus di Desa Cibeureum Kecamatan Sukamantri Kabupaten Ciamis). <i>Jurnal Ilmiah Mahasiswa Agroinfo Galuh</i> , 2(2), 97–102. (we request authors to change this references with scopus indexed journal articles)	Tawakal, M. A., Siman, S., Djanggo, R., & Unde, A. A. (2019). Analysis of the benefits of seaweed farming and its effects on the environment and community activities (study in the city of Tual, Southeast Maluku). <i>IOP Conference Series: Earth and Environmental Science</i> , 343(1), 12187.
Wahjuti. (2007). <i>Metodologi Penyuluhan Pertanian Partisipatif</i> . Sekolah Tinggi Penyuluhan Pertanian (STPP). (please change with journal articles)	Nurhapsa, N., Nuddin, A., Suherman, S., Sirajuddin, S. N., Al-Tawaha, A. M., & Al-Tawaha, A. R. M. (2020). Factors affecting coffee use income: A case study in the province of South Sulawesi, Indonesia <i>Ecol. Environ. Conserv</i> , 26.

## **I. IN-DEPTH STUDY OF MULTIPLE CROPPING FARMING SYSTEMS: THE IMPACT ON COCOA FARMERS' INCOME**

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**IX. Reviewer Candidates**

**Requirements for the candidates:**

- 1. The candidates should have speciality in authors' research topic**
- 2. The candidates should come from different institutions with authors (*especially from different countries*)**
- 3. The candidates should not join the authors' research project**
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# IN-DEPTH STUDY OF MULTIPLE CROPPING FARMING SYSTEMS: THE IMPACT ON COCOA FARMERS' INCOME

## ABSTRACT

Multiple cropping farming systems have an impact on farmers' income and still become a serious issue in agricultural development. The diversity of information received by the farmers including multiple cropping can provide new knowledge and will have an impact on farmers' productivity and income. The objective of this research was to evaluate the advantage of multiple cropping and its economic impact on cocoa farmers' income. This paper examines the relationship between multiple cropping systems and farmers' income levels. The research employed the Ordinary Least Square Method to estimate parameters and RC Ratio for income comparison from the farming systems. The results showed that the choice of farmers' in cropping patterns and types of crops is done to avoid failure that will lead to crop failure. The advantage of multiple cropping is that the utilization of soil nutrients is more effective because plants grow together on the same land. Multiple farming systems provided a higher income compare to monocropping and success to reduce operational costs. Of the five factors studied, there were three factors that influenced farmers' income through extension activities. They are information on credit amount obtained, level of heterogeneity, and agricultural production. These factors are of concern in communication activities that can increase knowledge in a heterogeneous environment in multiple cropping systems, which will in turn increase farmers' income.

## KEYWORDS

Multiple Cropping System, Heterogeneity, Extension, Farmer's Income

## INTRODUCTION

Multiple cropping farming systems, agricultural extension, and farmer's income still become serious issues in agricultural development. Multi-cropping approaches in production systems, where more than one crop cultivar or species is grown simultaneously, are gaining increased attention and application. Benefits can include increased production, effective pest, disease and weed control, and improved soil health (Ehrmann & Ritz, 2014). The diversity of information received by the farmers including multiple cropping can provide new knowledge and will have an impact on farmers productivity and income. The agricultural sector is dominated by small farming families who use basic technology in production. As a result, most crop yields are below attainable levels. Given the stagnant agricultural productivity and persistent food insecurity in low-income countries, there has been continued interest in the adoption of new technology and its impact on productivity (Takahashi et al., 2020). Several factors that explain the low yields in Indonesia include the use of basic technology in production, dependence on rainfall for production, and low adoption of modern production technologies such as superior seeds, irrigation, chemical fertilizers, and mechanization. Regarding many agriculture-based developing countries, multiple cropping systems are becoming a new discussion for smallholders. For example, a polyculture system positively affects land productivity and land-used efficiency (Arsyad et al., 2020). Other studies also confirmed that homogeneous farming systems long term agricultural availability, including land-used scenarios (Morgan-Davies et al., 2017), land capacity, soil organisms (Doran & Zeiss, 2000), feeding activity (Reimer et al., 2018), on-farm diversification, food security, and income sufficiency (Anderzén et al., 2020). These findings crystallize the idea of this research on the interrelationship of intercropping, agricultural extension, and heterogeneity with farmers' income.

Cocoa is one of the leading commodities in the plantation sub-sector. The cocoa commodity has consistently played a role as a source of foreign exchange for the country which makes a very important contribution to the structure of Indonesia's economy (Muhammad et al., 2011), other than that as the main export commodity of Indonesia where over the past five years, Indonesia has provided about 1,951,270 hectares' area of cocoa plants (Fahmid et al., 2018). Based on (Sumardjo, 1999) the openness of the

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economy due to the globalization of the world economy creates conditions (challenges) that more demanding modern behavior of the actors, efficiency and business competitiveness of every commodity produced, including agricultural commodities. Therefore, it is necessary to increase human resources, farmers, technology, access to capital resources, and market access. Consumer demands for agricultural products have directed the agricultural practices to take any necessary efforts to maximize plant harvest (Arsyad et al., 2020). Cacao farmers in Indonesia have sought various policies to increase their income from cocoa farming, one of which is the multiple cropping technique. the companion commodity planted is clove, which has other economic value when cocoa prices are falling

The government's efforts to make an integrated crop management program a succesful is to involve parties or extension workers at the central and regional levels, public sector programs have attempted to overcome information-related barriers to technological adoption by providing agricultural extension services (Aker, 2011). Extension in agricultural development in this case is involvement as a link between the world of science and the government as policymakers, and a link between the world of research and agricultural business practices carried out by farmers and their families who are ultimately able to mobilize. community self-help.-Efforts made so that the program can run and be successful, it is necessary to develop agricultural human resources (HR) through education, training, counseling, apprenticeships, collaborative training, and other non-formal education (Wahjuti, 2007).

Agricultural extension is expected to be surrounded by opportunities and challenges that can be seen from its contribution to the process of agricultural development in a sustainable direction (David & Samuel, 2014). This movement aims to accelerate the increase in productivity and quality of national cocoa products through optimal empowerment of all stakeholders and available resources (*Increasing Production, Productivity and Quality of Spices and Refresher Plants. Technical Guidelines for the National Movement for Increasing Production*, 2012). Two general approaches have been used to account for for heterogeneity in the analysis of farmers' preferences. Often preferences are analyzed within prior groups of farmers that are then compared (Martin-Collado et al., 2015). Researchers have to make assumptions about the factors affecting preference heterogeneity or about the group of farmers that might have different trait preferences. As smallholders experience different compliance barriers, it is widely recognized that to more effectively prioritize and target the required intervention support, farmer heterogeneity needs to be better understood (Schoneveld et al., 2019). Several other factors that affect cocoa income are production, land area, the number of crops that produce, labor, age, and farming experience (Nurhapsa et al., 2020).

One of the cocoa production centers in Indonesia is West Sulawesi. In the province resulting from the division of South Sulawesi Province, cocoa is a leading commodity because in addition to providing a large contribution to the Gross Regional Domestic Product it also acts as a provider of employment for most of the population. Cocoa development in West Sulawesi has been going on for a long time, since the 1980s. Guidance is carried out by the local community so that all of the cocoa gardens are community cocoa gardens. Production of cocoa in Indonesia has the potential to increase if the limiting factor can be minimized (Santoso & Zakariyya, 2019). This paper examines the relationship between multiple cropping farming systems, extension, the level of heterogeneity, and farmers' income. The objective of this research is to determine the difference in income between farmers in multiple cropping and monoculture systems related to extension and the level of heterogeneity.

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## MATERIALS AND METHODS

### 1. Research Site and Sampling

The research was conducted from January until May 2020 in West Sulawesi Province (one of the largest cocoa production provinces in Indonesia). For multiple cropping systems, we consider to analyzing the advantage of multiple cropping of estate crops (cocoa and clove). The level of farmer heterogeneity, starting from ethnicity, culture, and society, made the variety of information received by local farmers. Evaluation of multiple cropping of cocoa and cloves with extension activities of government policy programs also supports cocoa production activities. The extension activities of the government policy program also support cocoa production activities. In addition, the geographical conditions of West Sulawesi Province are very suitable for growing cocoa crops. Evaluation of multiple cropping held on West Sulawesi, we surveyed and interviewed 60 farmers randomly. In supporting the validity of the surveyed data, we also conducted a focus group discussion with the local government regarding the implementation of extension with high heterogeneity conditions.

## 2. Analysis: Ordinary Least Square

Expansion of the agricultural development strategy that pays more attention to the role of agricultural extension agents by increasing the extension budget and improving extension facilities and infrastructure, will increase the performance of extension workers in helping farmers work towards a better and more productive direction. In this study, the OLS (Ordinary Least Square) method was used to see the effect of extension on farmers' income (Figure 1).

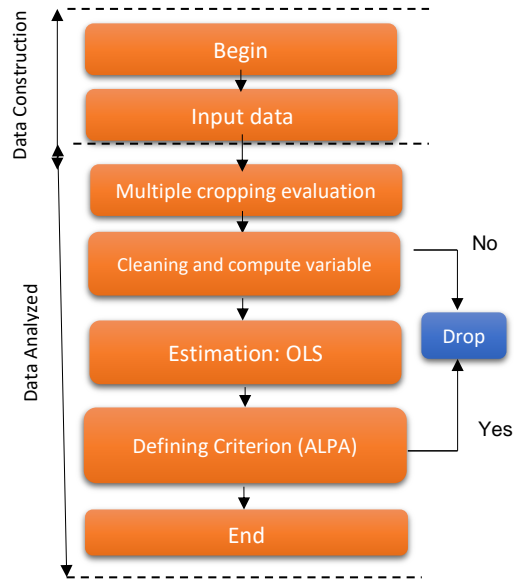


Figure 1. Research analysis flow of the in-depth study of multiple cropping farming systems, 2020

Ordinary Least Square (OLS) is one of the regression function estimation methods used in this study. The OLS criterion is the line that best fits in other words the number of squares of the deviation between the observation point and the regression line is minimum. The test includes a multicollinearity test, heteroscedasticity test, autocorrelation test, and normality test. OLS on the linear probability model provides sufficient conditions for unbiasedness and consistency to hold. The conditions suggest that a "trimming estimator" may reduce OLS bias (Horrace & Oaxaca, 2006). In OLS regression some assumptions should be met including : (1) the linearity of regression coefficients, (2) all predictors must be uncorrelated with the residuals, (3) residuals not to be correlated with each other (serial correlation), (4) residuals have a constant variance, (5) Not predictor variables is perfectly correlated with another predictor variable (avoidance of multicollinearity), (6) residual are normally distributed (Farahani et al., 2010). In this study, the variables to be studied are production, income, frequency of interactions with other tribes, information on the amount of credit, information on agricultural extension, price information, and changes in information service improvements with a significant correlation at 5% level (commonly used).

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \beta_7 X_7 + \beta_8 X_8 + \epsilon$$

where:

- Y = Total Income (IDR per hectare)
- X1 = Tribes in the agricultural area (number of tribes)
- X2 = Interactions with different tribes during one month (times per year)

**Commented [AR3]:** Cocoa is a perennial crop, why do the author did not include age of the tree? Why not include the variable of multiple cropping?

**Commented [AR4]:** Tribe or ethnic group? Better to use no of tribe or ethnic group

- X3 = Farmer groups, in which there are different tribes (number of interactions per year)
- X4 = Benefits of information obtained from other tribes (times of information exchange)
- X5 = Agricultural extension information (times per year)
- X6 = Agricultural information service improvements (times per year)
- X7 = Information on extension activities are useful for farming (times per year)
- X8 = Agricultural credit information (times per year)
- $\beta_0$  = Constants / Intercept
- $\beta_1, \beta_2, \beta_3, \beta_4$  = Parameters are estimated
- $\beta_5, \beta_6$  = Error term

### 3. Farmers Income Analysis

Analysis of farm income using R/C analysis. R/C is the balance between the cost of farming and the revenue generated, where R/C shows the amount of revenue earned from each rupiah (IDR) spent (Nurmala et al., 2017). The formula is as follows:

$$R/C = \frac{TR}{TC}$$

where:

TR = Total Revenue (IDR/Hectare)

TC = Total Cost (IDR/Hectare)

with decision making:

- (a). If  $R/C > 1$ , then the farming business is profitable because the revenue is greater than the total cost,
- (b). If  $R/C < 1$  then the farming business is not profitable, because the revenue is smaller than the total cost,
- (c). If  $R/C = 1$ , then the farming business carried out is not profitable and does not lose (break-even) the total revenue is equal to the total cost.

## RESULTS AND DISCUSSION

### 1. Evaluation of Multiple Cropping

There are 2 types of choices for cocoa cropping patterns from farmers, namely monoculture and multi-cropping. Farmers who choose monoculture are those who have large areas of land, while those with narrow land areas choose a multi-cropping pattern. Sayogyo (1997) grouped farmers into three categories: small-scale farmers with a farming area of <0.5 Ha, medium-scale farmers with an area of 0.5 – 1.0 Ha, and large-scale farmers with a farm area of >1.0 hectares. Wider the agricultural land, the more efficient the land if the facilities and infrastructure, and management are adequate, the best management practice will provide multiple benefits to the agrosystem (Syarif et al., 2018).

The choice of farmers in the selection of cropping patterns and types of crops is done to avoid failure that will lead to crop failure. This choice is also taken based on the experience of farming that has been done for generations. The advantage of farmers who plant multiple cropping is that they have a small risk of crop failure because it reduces pest attacks and high profits due to the two commodities produced. Thus, the economic level of farmers can increase by applying a double-cropping pattern.

Scott and Rasuanto (1983), on the simple but also very strong moral of the farmer's economy. There are 3 principles of attitude from farmers related to farming developed by Scott, namely as follows: (1) Safety first: subsistence economy. The principle of safety first, that is, farmers are reluctant to take risks and focus more on avoiding falling production, not just maximizing profits; (2) Subsistence ethics, namely ethics which are a consequence of a life that is close to the boundary line, and (3) risk distribution, this risk aversion attitude is also stated why farmers prefer to plant subsistence crops rather than non-food crops whose results are for sale. The results of the farming analysis are shown in Table 1.

Table 1. Farming income analysis of the Monoculture System of Cocoa and Clove Crops per Hectare, in West Sulawesi Province, 2020.

<b>Monoculture System</b>	
Cocoa	Clove

Commented [AR5]: If monoculture, what is the reason to include clove since your focus is on the cocoa?

Item	Venue (IDR)	Item	Venue (IDR)
<b>1. Revenue</b>		<b>1. Revenue</b>	
a. Production (kg)	1,900	a. Production (kg)	1,000
b. Price	35,000	b. Price	80,000
Total revenue (a x b)	66,500,000	Total revenue (a x b)	80,000,000
<b>2. Production cost</b>		<b>2. Production cost</b>	
a. Fixed cost		a. Fixed cost	
- Land tax	757,000	- Land tax	600,000
- Depreciation	535,000	- Depreciation	550,000
	1,292,000		1,150,000
b. Variable cost		b. Variable cost	
- Fertilizer	7,400,000	- Fertilizer	8,250,000
- Pesticide	8,250,000	- Pesticide	9,500,000
- Labour (5 man-day)	442,000	- Labour (6 man-day)	650,000
	16,092,000		18,400,000
Total cost (a + b)	17,384,000	Total cost (a + b)	19,550,000
<b>3. Income (1-2)</b>	49,116,000	<b>3. Income (1-2)</b>	60,450,000
<b>4. RC Ratio = 3.8</b>		<b>4. RC Ratio = 4.0</b>	

Table 2. Farming income analysis of multiple cropping system of cocoa and clove crops per hectare, in West Sulawesi Province, 2020.

<b>Multiple cropping System (Cocoa and Clove)</b>	
Item	Venue (IDR)
<b>1. Revenue</b>	
a. Production (kg)	
- Cacao	2,200
- Clove	1,300
b. Price	
- Cacao	35,000
- Clove	80,000
Total (a x b)	
- Cacao (2,200 x 35,000)	77,000,000
- Clove (1,300 x 80,000)	104,000,000 +
	181,000,000
<b>2. Production cost</b>	
a. Fixed cost	
- Land tax	1,100,000
- Depreciation	950,000
	2,050,000
b. Variable cost	
- Fertilizer	15,550,000

**Commented [AR6]:** It does not make sense that multiple cropping produced higher production compare to monoculture. Please describe the monoculture and multiple cropping system in the field

- Pesticide	9,500,000
- Labour (15 man-day)	1,100,000
Total cost (a + b)	<u>16,092,000 +</u> 42,242,000
<b>3. Income (1-2)</b>	138,758,000

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#### 4. RC Ratio = 4.2

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Table 2 clearly shows that multi-cropping system (polyculture) of cocoa and cloves is more efficient to develop (RC Ratio=4.2) with lower production costs (or reduce variables cost) compared to monocropping (RC Ratio=3.8 for cocoa and 4.0 for clove, on average of 3.9). Farmers' knowledge of biodiversity has an impact on their production processes and income. Experience has provided farmers in managing commodity management, thereby increasing their knowledge of choosing a more efficient and profitable polyculture system, reducing operational costs such as labor and plant maintenance compared to monoculture cultivation. Polyculture in general has received increasing attention by the apparent advantages in the utilization of space and environmental services offered (Cruz González et al., 2013). Polycultural cropping pattern of cocoa cultivation with many tree species almost no leaves that age at the beginning of the dry season. It shows better adaptation to drought when planted with other trees (Prihastanti & Nurchayati, 2018). The importance of the role of agricultural extension workers in educating farmers about the polyculture system in risk management in farming is very important, this can maximize the availability of existing land and can maximize the profits of farmers. Plant biodiversity plays a fundamental role in minimizing farmer risk when available modern varieties are not adaptive to the existing environment and are not supported by the applied cultivation methods (Coromaldi et al., 2015)

#### 2. Test for Goodness of Fit and Farmers Income

The value of R Square model that affects the income factors of farmers is 0.684. It means that at least 68.4 percent the farmer's income variance can be explained by the frequency of interaction with other terms, the amount of credit information, the amount of agricultural extension information, and the level of heterogeneity improvements and production. Therefore, we may say that the model built is good enough to describe the phenomenon studied. Agricultural extension activities are needed as an item in agricultural activities, where farmers can obtain information from various sources so that the application of new technology is applied with the aim of increasing the welfare and independence of the farmers. Ballantyne and Bokre (2003) indicate that agricultural extension, which depends to a large extent on information exchange between and among farmers, has been identified as one area. This sub-chapter presents the results of the estimation of the factors that influence farmers' income on extension activities.

Table 3. Determinants of farmers' income of the in-depth study of multiple cropping farming systems, 2020

Variable	Coefficient	Standard Error	T-Count	P-Value
Constant	-41277650.209	7944931.307	-5.195	.000
Tribes in the agricultural area	285223.888	1839043.178	.155	.878
Interactions with different tribes	5160383.934	1890455.270	2.730	.011
Number of farmer groups, in which there are different tribes	3256116.981	1906122.719	1.708	.098*
Benefits of information obtained from other tribes	1455661.012	1736470.017	.838	.408

Agricultural extension information	1455540.859	1903724.228	.765	.450
Agricultural information service improvements	4580582.126	1910486.041	2.398	.023*
Benefits of information on extension activities are useful for farming activities	3925735.607	1914472.532	2.051	.049*
Agricultural credit information	2671985.299	1844859.337	1.448	.158

Note: \* significant at 5% level

### 2.1. Tribes in the agricultural area

Diversity of ethnic groups or level of heterogeneity in the agricultural location has made a lot of information exchange among farmers. For example, farmers who migrate from the island of Java have their own habits that make different levels of production. This success in increasing production was then followed by local farmers who were then modified according to the local culture which could become a new behavior in farming activities. The level of heterogeneity variable has results that have a significant effect on the income level of farmers. The higher level of heterogeneity, the higher production will be and in turn will increase income. It means that more cultural differences can increase knowledge of information and also increase income. The success indicator for any development and implementation level of heterogeneity is the level of farmer satisfaction that comes from the farmer's perspective or perception. Satisfaction is defined as a form of consumer feelings after comparing with expectations if the government's performance is below the expectations of farmers. Farmers will be disappointed and vice versa, so it can be concluded that satisfaction is a response to meeting farmers' needs. This is also in line with Gollin and Udry's (2021) research which finds that measurement error and heterogeneity together cause most of the dispersion in the measured productivity. Different styles result in different levels of intensity and sustainability, which means that encouraging and stimulating specific farming styles might result in considerable agricultural development and growth of total food production (van der Ploeg & Ventura, 2014).

### 2.2. Interactions with different tribes

A growing versatility of knowledge discovery systems, there is an important component of human interaction that is inherent to any process of knowledge representation, manipulation, and processing (Mankar & Burange, 2014). The variable frequency of farmers interacting with other tribes has no significant effect on farmers' income. Furthermore, the coefficient value of the frequency variable of farmers interacting with other tribes is 17588.298. The positive sign of the coefficient shows that if the farmer's interaction with other ethnic groups increases, it will also increase the income of the farmers. The more diverse the information received by the farmers will increase their knowledge and experience from a social and cultural perspective. This is also in line with Jessica and Ashish (2011) statement that traditional agricultural landscapes, created by indigenous peoples and local communities, have been shaped by the dynamic interaction of people and nature over time. Transfer of sustainable technology from older farmers who participate in extension programs to the younger generation of farmers. To improve the implementation of extension programs by young farmers, they need to be given intensive extension support for innovation (Bulkis et al., 2020). These facts above indicate that the more interactions with different tribes in agriculture activity, the more farmer's income will be.

### 2.3. Number of farmer groups, in which there are different tribes

Farmer groups are farmer institutions that directly organize farmers in developing their farms. Farmer groups are organizations that can be said to function and exist for real, in addition to functioning as

a vehicle for counseling and driving the activities of their members. Some farmer groups also have other activities, such as mutual cooperation, savings and loans business, and work gathering for farming activities. The number of farmer groups that have different ethnic groups has no significant effect, this is because there are not too many populations from other tribes living in the research location, even though farming information from other tribes can increase the knowledge of local farmers and enrich farming methods that can increase productivity. The diversity of other tribes found in farmer groups is caused by the migration of farmers from their place of origin, there are several factors such as limited agricultural land at the place of origin or the increasing number of residents.

#### 2.4. Heterogeneity for Benefits of Information

Knowledge or information obtained from other tribes is expected to be applied in local community farming activities. Other ethnic groups have different perspectives and backgrounds, however, the regression results obtained have no significant effect on income compared to the other variables. This finding shouldn't be interpreted to mean that no effects at all. There is an effect, but insignificant. The diversity obtained from other tribal farmers against local farmers can increase the interaction of social capital between them which leads to the welfare of farmers. Programs that are usually run include farming training, and meetings to solve a problem. The existence of other tribal farmers in rural areas will have an influence on agricultural development in rural areas in terms of changing perspectives and adding information to farmers. This conveys an important message that heterogeneity will have an impact on increasing farmer's income. In other words, heterogeneity in the rural agriculture area can be one of the routes for increasing the welfare of smallholders.

#### 2.5. Agricultural Extension and Farming Activities

A positive sign of the coefficient indicates that if the amount of extension information increases, it will increase farmers' income even though significant. This does not mean no impact at all, there is an impact but insignificant. Therefore, there is still a way to say that agricultural extension services positively affect agricultural income. The role of agricultural extension is to help farmers form a healthy opinion and make a good decisions by communicating and providing the information needed by farmers (Pradiana, 2017). In this study, the role of agricultural instructors as motivators was seen from the frequency of instructors in motivating farmers to use compound fertilizers in their farming. Apart from being a motivator, the agricultural extension worker also acts as a mediator. As a mediator, extension agents connect farmers with sources of information needed by farmers, such as business meetings. Provision of additional sources of market price information, and ensuring that the personal features of farmers are taken into consideration when designing information service interventions is crucial (Nwafor et al., 2020). Arsyad, Nuddin, and Yusuf (2013) research states that the Central Point of the Interpretative Structure Modeling (ISM) results show that, (i) the Regional Forestry and Plantation Service (Hutbun), (ii) Plantation Field Extension Officer (PPL), and (iii) Marketing Institutions are key institutional actors in strengthening cocoa farmer institutions. The important factor that contributes to agricultural development is information. As agricultural extension agents who connect agricultural institutions to farmers, they must have adequate information (Wulandari, 2015). Business meetings conducted in this activity are between farmers and the formulator and extension workers as mediators who are very involved in the business meeting. The formulators that usually exist in agricultural activities are providers of pesticides and fertilizers. The involvement of agricultural extension agents is as a guide and guide both during socialization in field visits and in demonstration plots. In overcoming the problems faced by farmers, extension workers try their best, for example when fertilizer is scarce in the market, agricultural extension workers try their best to find a way out by looking for a copy from the fertilizer company. Meanwhile, to overcome other problems such as the eradication of the sundep pest, agricultural extension workers only try to provide input and then submit it to the farmers in its implementation. Thus, extension workers not only convey information or policies from the government or extension agencies to farmers but also help solve problems faced by farmers. One example of research from Syam et al. (2019) states that providing clear information can change the mindset of farmers toward previous information.

Agricultural instructors must have broad and competent insight, besides guiding farmers (educators) they also act as providers of production facilities (facilitators), as motivators and communicators for farmers. One indicator that shows the role of agricultural extension workers in the development of farmer skills is shown through the increasing farming skills of farmers. Through extension activities, it is hoped that farmers' skills in farming will increase so that they can manage their farming business from the planting

season to harvest properly so that production results can increase and the welfare of farmers and their families increases. Extension activities themselves have been regulated in the Government Regulation of the Republic of Indonesia concerning Financing, Guidance, and Supervision of Agricultural, Fisheries, and Forestry Extension.

The regression results of agricultural extension profits have a significant effect on income, this shows that the extension activities carried out by the agricultural extension center are very good for the welfare of farmers. A lot of information has been provided by the extension workers such as farming practices, market and price information, and the provision of capital assistance needed in farming. Intense extension information is carried out every month and the relationship between farmers and extension workers has been well-connected harmoniously for a long time. All this conveys an important message that agricultural extension can be expected to prove the farming system (including multiple cropping) and in turn encourage farmers' income.

#### 2.6. Agricultural Information Service Improvements

The regression results of improving agricultural extension information have a significant effect on farmers' income. The evaluation and commitment by the extension workers in listening to the aspirations of the farmers will make the farmers more productive and various obstacles and problems in farming will be resolved together with the extension workers. Agriculture is one of the responsibilities given by the government to extension workers to change the behavior of farmers with the aim of improving the welfare of farmers and their families, therefore in essence, extension workers are at the forefront of agricultural sector development in Indonesia. In addition, agricultural extension workers are an important key as an effort to improve the welfare of people who work in the agricultural sector in rural areas. Because agricultural extension agents are agents of change who are directly related to farmers. The lack of human resources in the agricultural sector encourages the creativity of extension workers in building awareness of farming that is better and more profitable. To overcome this, it is necessary to change the behavior of farmers so that they are able to overcome the problems.

#### 2.7. Amount of Credit Information

Agricultural credit is one that is given by the government to assist farmers in funding agriculture. A variable amount of farmer credit information has a significant effect on farmer income. The higher the credit information, the higher the farmers' income will be. In discussing capital in agriculture, farmers always come to the matter of credit which is capital from outside parties or financial institutions. Thus, capital can be divided into two, namely own capital (equity capital) and loan capital (credit). The Indonesian government has implemented several strategies to increase domestic agricultural production such as seeds subsidy, fertilizer subsidies, and credit programs (Wicaksono, 2014).

In the production process, there is no difference between own capital and capital from loans, each of which contributes directly to production. The difference is in the interest that must be paid to creditors. In this case, there is a significant relationship between the amount of credit information and income, and agricultural credit is needed by farmers as business capital. Considering that agricultural business is a very risky business to fail because its success is determined by uncertain natural conditions. Farmers really need banks or service providers in the agricultural sector in order to protect their business continuity. The availability of community foodstuffs is very much determined by farmers who are usually neglected. Considering that agricultural business is a very risky business to fail because its success is determined by uncertain natural conditions. Farmers really need banks or service providers in the agricultural sector in order to protect their business continuity. The availability of community foodstuffs is very much determined by farmers who are usually neglected. Given that agricultural business is a very risky business to fail because its success is determined by uncertain natural conditions. Farmers really need banks or service providers in the agricultural sector in order to protect their business continuity.

### **CONCLUSIONS AND SUGGESTION**

It can be said that the advantage of multiple cropping farming systems provides a higher income than monocropping and has succeeded in reducing operational costs. The benefits of multiple cropping also reduce the risk of pest attack and the opportunity to get greater profits because of the variety of commodity yields obtained. From the series of factors studied, there are three factors that affect the amount of income

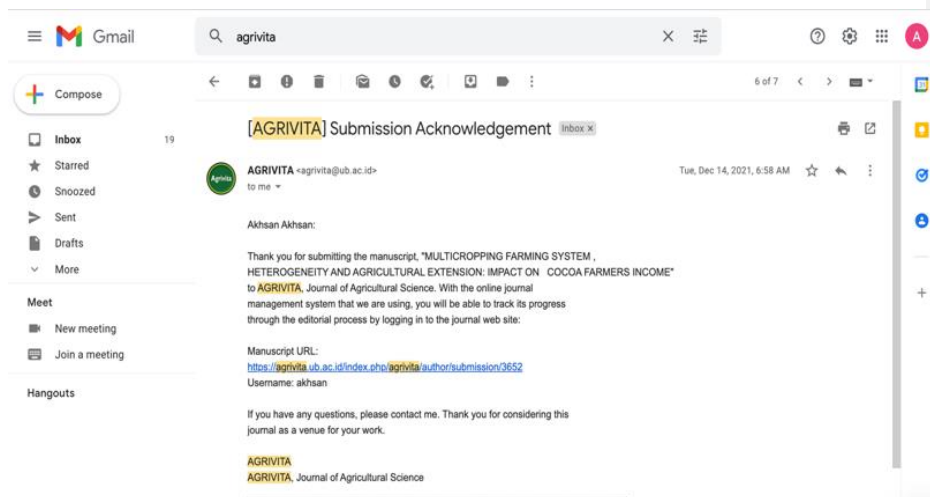
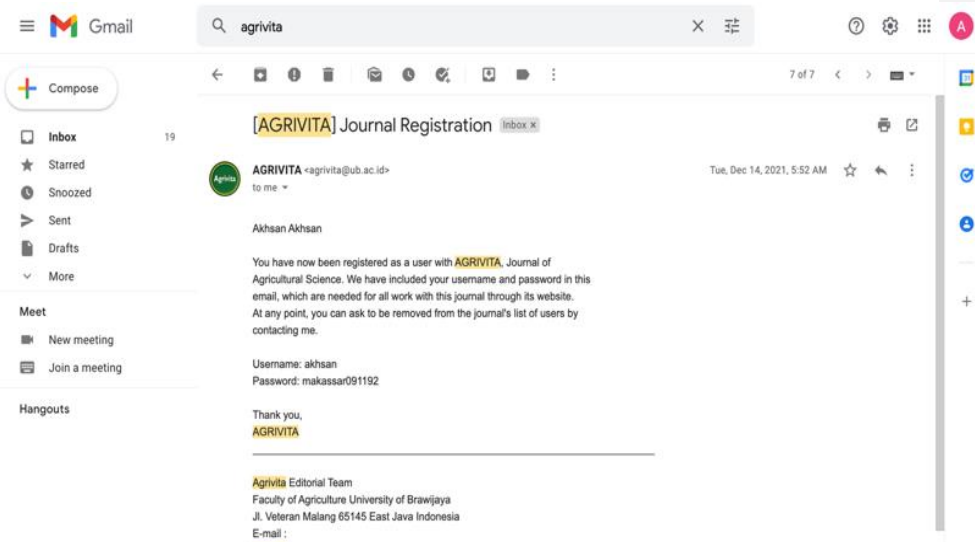
through agricultural extension activities, namely credit information, heterogeneity, and production levels. The ethnic and cultural diversity of the community can also affect the process of exchanging information between farmers, which in turn influences farmers to acquire new knowledge in encouraging production and improving household welfare.

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#### 4. Editor Decision (Histories Email)



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**[AGRIVITA] Submission Acknowledgement**

AGRIVITA <agrivita@ub.ac.id> to me • Tue, Apr 19, 10:30 AM

Akhsan Akhsan:

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Akhsan Akhsan:

We have reached a decision regarding your submission to **AGRIVITA**, Journal of Agricultural Science, "IN-DEPTH STUDY OF MULTIPLE CROPPING FARMING SYSTEMS: THE IMPACT ON COCOA FARMERS' INCOME".

Our decision is to: Revision required

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**[AGRIVITA] Editor Decision**

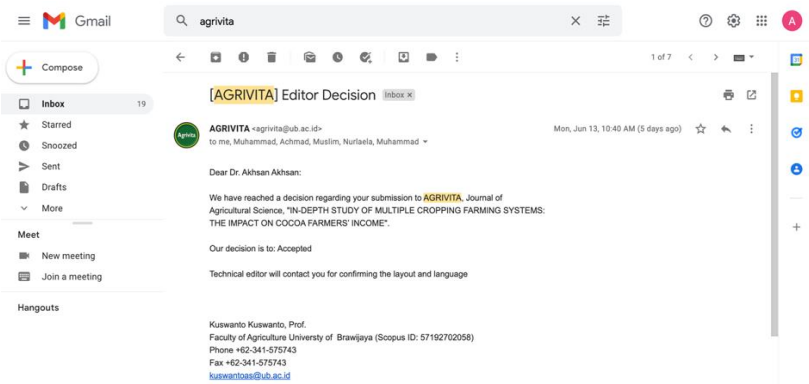
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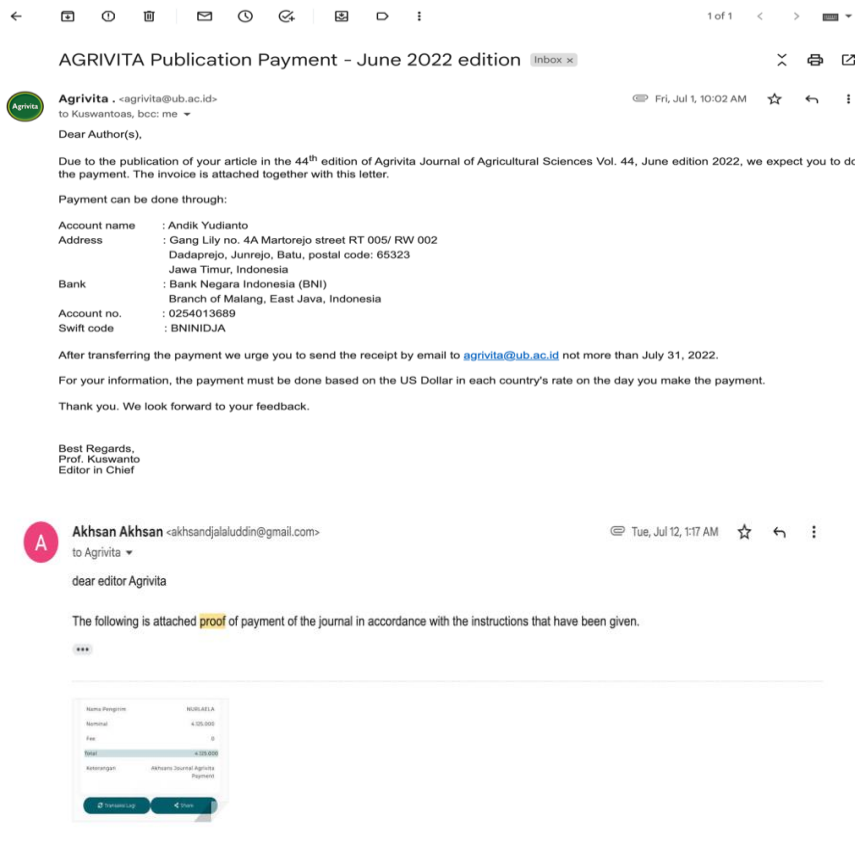
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**An In-Depth Study of Multiple Cropping Farming Systems: The Impact on Cocoa Farmers' Income**

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**ABSTRACT**

Multiple cropping farming systems affect farmers' income and have become a serious determinant in agricultural development. The diversity of information received by the farmers including multiple cropping can provide new knowledge, which will in turn influence productivity and income. Therefore, this study aims to evaluate the benefits of multiple cropping and its economic impact on cocoa farmers' income. It was conducted using the Ordinary Least Square Method to estimate parameters and RC Ratio for income comparison from the farming systems. The results showed that the choice of farmers in cropping

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