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Submission date: 19-Jul-2022 11:15AM (UTC+0700)
Submission ID: 1872471897
File name: Jurnal_Versi-online-3761-17042-4-PB__3___1.pdf (678.19K)
Word count: 6128
Character count: 36543

AGRIVITA
Journal of Agricultural Science
www.agrivita.ub.ac.id

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

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ARTICLE INFO

Keywords:
Agricultural Extension
Farmer's Income
Heterogeneity
Multiple Cropping System

Article History:
Received: April 19, 2022
Accepted: June 13, 2022

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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 patterns and types of crops is aimed at avoiding crop failure. The advantage of multiple cropping is that the use of soil nutrients is more effective because plants grow together on the same land. It also provides a higher income compared to monocropping and tends to reduce operational costs. Among the five factors evaluated, only three influenced farmers' income through extension activities. They are information on credit amount obtained, level of heterogeneity, and agricultural production. These factors are important aspects of communication activities that can increase knowledge in a heterogeneous environment of multiple cropping systems, which will, in turn, improve farmers' income.

INTRODUCTION

Multiple cropping farming systems, agricultural extension, and farmers' income are considered serious issues in agricultural development. The practice of multi-cropping, where more than one crop cultivar or species is grown simultaneously is increasingly gaining massive attention and application. The potential benefits include increased production, effective pest, disease and weed control, as well as improved soil health (Ehrmann & Ritz, 2014). The diversity of information received by farmers including multiple cropping can provide new knowledge thereby affecting productivity and income. The agricultural sector is dominated by small farming families who use basic technology in production, hence, most crop yields are below attainable levels. Given the stagnant agricultural productivity and persistent food insecurity in low-income countries, there has been a continuous interest in the adoption of new technology and its impact on productivity (Takahashi, Muraoka, & Otsuka, 2020). Several factors explain the low yields in Indonesia including the use of basic technology, dependence on rainfall for production, and low adoption of modern technologies such as superior seeds, irrigation, chemical fertilizers, and mechanization. In several agriculture-based developing countries, multiple cropping systems have become a new discussion

ISSN: 0126-0537 Accredited First Grade by Ministry of Research, Technology and Higher Education of The Republic of Indonesia, Decree No: 30/E/KPT/2018

Cite this as: Akhsan., Arsyad, M., Amiruddin, A., Salam, M., Nurlaela., & Ridwan, M. (2022). An in-depth study of multiple cropping farming systems: the impact on cocoa farmers' income. *AGRIVITA Journal of Agricultural Science*, *44*(2), 355–365. http://doi.org/10.17503/agrivita.v44i2.3761

for smallholder farmers. For example, it was reported that a polyculture system positively affects land productivity and efficiency (Arsyad, Sabang, Agus, Bulkis, & Kawamura, 2020). Other studies have also confirmed the long-term agricultural availability of homogeneous farming systems, including land-used scenarios (Morgan-Davies, Wilson, & Waterhouse, 2017), 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 study on the interrelationship between intercropping, agricultural extension, and heterogeneity with farmers' income.

Cocoa is one of the leading commodities in the plantation sub-sector, it has consistently played a role as a source of foreign exchange with a significant contribution to the structure of Indonesia's economy (Arsyad, Sinaga, & Yusuf, 2011). Over the past five years between 2013-2017, Indonesia has produced approximately 1,951,270 hectares of cocoa plants (Fahmid, Harun, Fahmid, Saadah, & Busthanul, 2018). Based on Sumardjo (1999), the openness of the economy due to the world economy globalization creates conditions or challenges that greatly demand modern behavior of the actors, efficiency as well as business competitiveness of every commodity produced, including agricultural commodities. Therefore, it is necessary to increase human resources, farmers, technology, as well as access to capital resources, and the market. Consumer demand for agricultural products has prompted agricultural practices and necessary efforts to maximize plant harvest (Arsyad, Sabang, Agus, Bulkis, & Kawamura, 2020). Cocao farmers in Indonesia have sought various policies to increase their income, one of which is the multiple cropping technique.

Government efforts to make a successful integrated crop management program include the involvement of parties 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 in the form of a link between the world of science and the government as policymakers, as well as between investigations and agricultural business practices carried out by farmers and their families. Another function is to change the behavior of farmers with non-formal education so that farmers have a better and more sustainable life (Sundari, Yusra, & Nurliza, 2015).

Agricultural extension is expected to be surrounded by opportunities and challenges based on its contribution to the process of agricultural development in a sustainable direction (David & Samuel, 2014). This movement aims to accelerate the productivity and quality of national cocoa products through optimal empowerment of all stakeholders and available resources to increase 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 heterogeneity in the analysis of farmers' preferences. In most cases, preferences are analyzed within prior groups of farmers which are then compared (Martin-Collado et al., 2015). Several assumptions have been made about the factors affecting preference heterogeneity or the group of farmers that might have different trait preferences. Given that smallholder farmers experience different compliance barriers, there is a need to effectively prioritize and target the required intervention support (Schoneveld et al., 2019). Other factors that affect cocoa income are production, land area, the number of crops produced, labor, age, and farming experience (Nurhapsa et al., 2020).

One of the numerous production centers in Indonesia is West Sulawesi, where cocoa is a leading commodity because it provides a large contribution to the Gross Regional Domestic Product and also acts as a provider of employment for most of the population. Cocoa development in this province has been progressing for a long time, since the 1980s. The production of cocoa in Indonesia has the potential to increase when the limiting factors are minimized (Santoso & Zakariyya, 2019). Therefore, this study aims to examine the relationship between multiple cropping farming systems, extension, the level of heterogeneity, and farmers' income. It was conducted to also determine the difference in income between farmers in multiple cropping and monoculture systems related to extension and the level of heterogeneity.

MATERIALS AND METHODS

Research Site and Sampling

This study was conducted from January to May 2020 in West Sulawesi, the largest cocoa production provinces in Indonesia. The advantages of multiple cropping for estate crops including cocoa and clove were analyzed. The level of farmer heterogeneity, starting from ethnicity, culture, and society, constituted the variety of information received by local farmers. Evaluation of multiple cocoa cropping and cloves with extension activities of government policy programs also supports production activities. Additionally, the geographical conditions of West Sulawesi Province are very suitable for growing cocoa crops. To evaluate multiple cropping in this province, 60 farmers were surveyed and interviewed randomly. Moreover, to support the validity of the surveyed data, group discussions with the local government was conducted regarding the implementation of extension with high heterogeneity conditions.

Analysis: Ordinary Least Square

Expansion of the development strategy focused mainly on the role of agricultural extension agents by increasing the extension budget and improving facilities as well as 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 examine the effect of extension on farmers' income (Fig. 1).

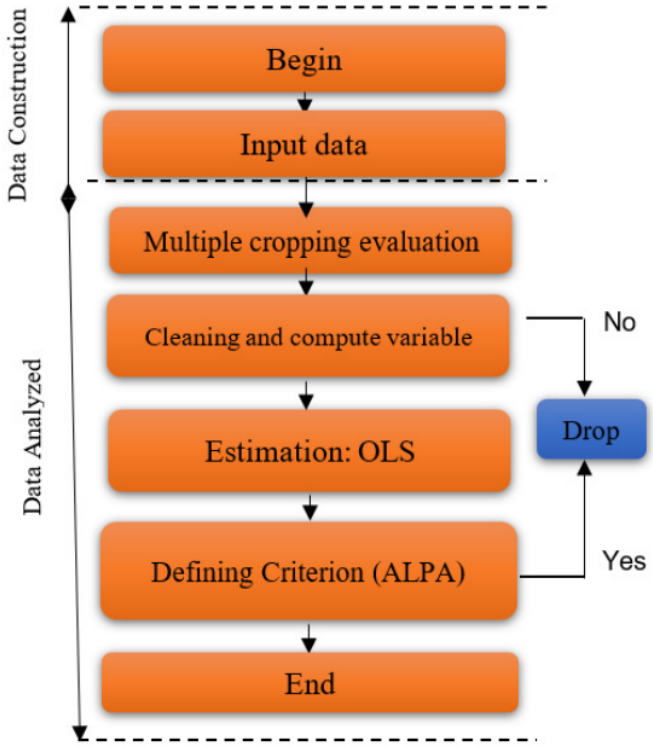

Fig. 1. Study analysis flow of the multiple cropping farming systems, 2020

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.

$$Y = ß0 + ß1X1 + ß2X2 + ß3X3 + ß4X4 + ß5X5 + ß6X6 + ß7X7 + ß8X8 + \varepsilon \quad \text{.....1)}$$

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)
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)
$ß_0$ = Constants / Intercept
$ß_1$, $ß_2$, $ß_3$, $ß_4$, $ß_5$, $ß_6$ = Parameters are estimated
ε = *Error term*

Farmers Income Analysis

The farmers' income was analyzed using R/C analysis which showed the balance between the cost of farming and the revenue generated in rupiah (IDR) (Tawakal, Siman, Djanggo, & Unde, 2019). (Formula 2)

$$R/C = \frac{TR}{TC} \quad \text{..... 2)}$$

Where: TR = Total Revenue (IDR/hectare); TC = Total Cost (IDR/hectare)

With decision making: (a) When R/C > 1, then the farming business is profitable because the revenue is greater than the total cost. (b) When R/C < 1 then the farming business is not profitable, because the revenue is smaller than the total cost. (c) When R/C = 1, then the farming business is neither profitable nor unprofitable because the total revenue is equal to the total cost.

RESULTS AND DISCUSSION

Evaluation of Multiple Cropping

There are 2 types of choices for cocoa cropping patterns, namely monoculture and multi-cropping. Farmers who practice monoculture have large areas of land, while those with narrow land areas follow a multi-cropping pattern. Sajogyo (1997) grouped farmers into three categories: small-scale with a farming area of <0.5 ha, medium-scale 0.5 – 1.0 ha, and large-scale >1.0 ha. The wider the agricultural land, the more efficient the land when the facilities, infrastructure, and management are adequate. The best management practice will provide multiple benefits to the agrosystem (Syarief, Mudjiono, Abadi, & Himawan, 2018).

The choice of farmers in the selection of cropping patterns and types of crops is important to avoid crop failure, it is also based on the experience of farming for generations. One of the advantages of multiple cropping is that it minimizes the risk of crop failure by reducing pest attacks and high profits due to the two commodities produced. Therefore, the economic level of farmers can increase by applying a double-cropping pattern.

Scott (1981) examined the simple but also very strong moral of the farmer's economy. There are three principles of attitude related to farming: (1) Safety first: subsistence economy. The principle of safety first states that farmers are reluctant to take risks and focus more on avoiding crop failure, not just maximizing profits; (2) Subsistence ethics which are a consequence of a life that is close to the boundary line, and (3) risk distribution, this risk aversion attitude principle states that farmers prefer to plant subsistence rather than non-food crops. The results of the farming analysis are presented in Table 1.

Table 2 clearly shows that the multi-cropping system of cocoa and cloves is more efficient to develop (RC Ratio=4.2) due to its lower production or variable cost compared to monocropping with RC Ratio=3.8 for cocoa and 4.0 for clove, with an average of 3.9. Farmers' knowledge of biodiversity affects their production processes and income. The experience helps farmers in managing their commodity, thereby increasing the knowledge of choosing a more efficient and profitable polyculture system, which reduces operational costs such as labor and plant maintenance compared to monoculture cultivation. Polyculture

in general has received increasing attention due to its apparent advantages in the utilization of space and environmental services offered (Cruz González, Jarquín Gálvez, & Ramírez Tobias, 2013). Furthermore, the polycultural cropping pattern of cocoa cultivation enhances various tree species having almost no leaves at the beginning of the dry season. This shows better adaptation to drought when planted with other trees (Prihastanti & Nurchayati, 2018). Agricultural extension workers play an important role in educating farmers about the polyculture system in risk management. This can maximize the availability of existing land as well as 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, & Savastano, 2015).

As clearly depicted 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, Saidah, Hapsari, & Wulandari (2021), 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.

Table 1. Farming income analysis for the monoculture system of cocoa and clove crops per hectare, in West Sulawesi Province, 2020.

Monoculture System			
Cocoa		**Clove**	
Item	**Venue (IDR)**	**Item**	**Venue (IDR)**
1. Revenue		**1. Revenue**	
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
2. Production cost		**2. Production cost**	
a. Fixed cost		a. Fixed cost	
- Land tax	757,000	- Land taxt	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
3. Income (1-2)	49,116,000	**3. Income (1-2)**	60,450,000
4. RC Ratio = 3.8		**4. RC Ratio = 4.0**	

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

Multiple cropping Systems (Cocoa and Clove)	
Item	**Venue (IDR)**
1. Revenue	
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 +
2. Production cost	
a. Fixed cost	
- Land tax	1,100,000
- Depreciation	950,000
	2,050,000
b. Variable cost	
- Fertilizer	15,550,000
- Pesticide	9,500,000
- Labour (15 man-day)	1,100,000
	16,092,000 +
Total cost (a + b)	42,242,000
3. Income (1-2)	138,758,000
4. RC Ratio = 4.2	

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

Remarks: * significant at 5% level

Test for Goodness of Fit and Farmers Income

The value of R Square model that affects the income factors of farmers was 0.684 indicating that at least 68.4% of the farmer's income variance can be explained by the frequency of interaction with other terms, including the amount of credit and agricultural extension information, as well as the level of heterogeneity improvements and production. Therefore, it can be concluded that the model built is relatively good to describe the phenomenon studied. Agricultural extension activities are needed for farmers to obtain information from various sources. This will facilitate the application of new technology to increase the welfare and independence of the farmers. Richardson (2006) mentioned found that agricultural extension, which depends to a large extent on information exchange between farmers, has been identified as one area. This sub-chapter presents the estimation results of the factors that influence farmers' income in extension activities.

Tribes in the Agricultural Area

The diversity of ethnic groups or level of heterogeneity in the agricultural location has enabled information exchange among farmers. For example, farmers who migrate from the island of Java have their own habits that culminate in different levels of production. This success in increasing production is imbibed by local farmers who are modified according to the culture which might become a new behavior in farming activities. The level of heterogeneity variable had a significant effect on the income level of farmers. The higher the level, the greater the production which in turn leads to an increase in income. This implies that high cultural differences can increase knowledge as well as income. The success indicator for any development and implementation level of heterogeneity is the state of farmer satisfaction that comes from their perspective or perception. Satisfaction is defined as a form of consumer feelings after comparing with the expectations. It can also be defined as the response to meeting farmers' needs. This is also in line with Gollin & Udry (2021) which reported that measurement error and heterogeneity caused most of the dispersion in the measured productivity. Different styles culminate in varying levels of intensity and sustainability, hence, promoting and stimulating specific farming styles might yield considerable agricultural development and growth of total food production (van der Ploeg & Ventura, 2014).

Interactions with Different Tribes

Due to the 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 income. Furthermore, the coefficient value of the frequency variable for farmers interacting with other tribes was 1890455.270. The positive sign of the coefficient shows that when the farmer's interaction with other ethnic groups increases, this will also improve their income. The more diverse the information farmers receive, the higher their knowledge and experience from a social and cultural perspective. This is also in line with Brown & Kothari (2011) which stated that traditional agricultural landscapes, created by indigenous peoples and local communities, have been shaped by their dynamic interaction and nature over time. There is a transfer of sustainable technology from older farmers who participate in extension programs to the younger generation. To improve the implementation of extension programs by young farmers, intensive extension support for innovation is needed (Bulkis, Rahmadanih, & Nasruddin, 2020). This indicates that the more interactions with different tribes in agriculture activity, the higher the farmers' income.

Number of Farmer Groups, in which there are Different Tribes

Farmer groups are institutions that directly organize farmers in developing their farms, they function to counsel and drive the activities of their members. Some farmer groups also have other activities, such as mutual cooperation, savings and loans business, as well as work gathering. The number of groups with different ethnicity had no significant effect; this is because the population of farmers from other tribes living in the study location is few. Meanwhile, information from other tribes can increase the knowledge of local farmers and enrich farming methods. The diversity of other tribes found in the groups is caused by the migration of farmers from their place of origin due to several factors such as limited agricultural land and the increasing number of residents.

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 showed no significant effect on income compared to the other variables. The diversity obtained from other tribes against local farmers can increase the interaction of social capital between them which will lead to an increase in their welfare. Programs usually implemented include farming training, and meetings to solve a problem. The existence of other tribal farmers in rural areas will influence agricultural development in terms of changing perspectives and adding information. This implies that heterogeneity can increase farmers' income, in other words, heterogeneity in the rural agriculture area is one of the routes for increasing the welfare of smallholder farmers.

Agricultural Extension and Farming Activities

A positive sign of the coefficient indicates that when the amount of extension information increases, there will also be an improvement in the farmers' income. In other words, agricultural extension services positively affect farmers' income. The role of agricultural extension is to help farmers form a healthy opinion and make good decisions by communicating and providing the right information (Wida, 2017). In this study, the role of agricultural instructors as motivators was observed from the frequency of motivating farmers to use compound fertilizers. Apart from being a motivator, the agricultural extension worker also acts as a mediator by connecting farmers with sources of information needed, such as business meetings. The provision of additional market price information sources, and ensuring that the personal features of farmers are considered when designing information service interventions is crucial (Nwafor, Ogundeji, & van der Westhuizen, 2020). Arsyad, Nuddin, & Yusuf (2013) on the Central Point of the Interpretative Structure Modeling (ISM) showed 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 farmers. The important factor that contributes to agricultural development is information. Given that extension agents connect agricultural institutions to farmers, they must have adequate information (Wulandari, 2015). Business meetings conducted in this activity are between farmers, formulators, and extension workers as mediators. The formulators that usually exist in agricultural activities are providers of pesticides and fertilizers. Furthermore, the involvement of agricultural extension agents is as a guide both during socialization in field visits and in demonstration plots. Extension workers make different efforts to overcome the problems faced by farmers, for example, when fertilizer is scarce in the market, they search for a copy of the fertilizer company. To overcome other problems such as the eradication of the sundep pest, agricultural extension workers provide input and then submit it to the farmers for its implementation. Therefore, extension workers not only convey information or policies from the government or agencies to farmers but also help solve problems. Syam, Salman, Hasan, Ismartoyo, & Sirajuddin (2019) found that providing clear information can change the mindset of farmers toward previous knowledge.

Agricultural instructors must have broad and competent insight, because aside from guiding farmers, they also act as providers of production facilities, motivators and communicators. One indicator that shows the role of agricultural extension workers is the state of the farmers' skills. Through extension activities, they sharpen farmers' skills in managing their farming business from the planting season to harvest. This will increase production and the welfare of farmers as well as that of their families. Besides, extension activities 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 had a significant effect on income, this implies that the extension activities are very good for the welfare of farmers. Information has been provided by the extension workers such as farming practices, market and price, as well as capital assistance needed in farming. Intense extension information is communicated every month and the relationship between farmers and extension workers has been well-connected harmoniously for a long time. This indicates that agricultural extension can improve the farming system including multiple cropping and in turn, encourage farmers' income.

Agricultural Information Service Improvements

The regression results of improving agricultural extension information had a significant effect on farmers' income. The evaluation and

commitment of the extension workers in listening to the aspirations of the farmers will increase productivity and help remove obstacles. Agriculture is one of the responsibilities given by the government extension workers to change the behavior of farmers with the aim of improving their welfare. Therefore, extension workers are at the forefront of agricultural sector development in Indonesia. They are also an important key to improving the welfare of this sector workers in rural areas. 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.

Amount of Credit Information

Agricultural credit is given by the government to assist farmers in funding their farming activities. Based on the results, the amount of farmer credit information had a significant effect on farmer income, hence, the higher the credit information, the greater the farmers' income. Farmers always prefer to use credit which is capital from outside parties or financial institutions. Capital can be divided into personal (equity capital) and loan (credit). To increase domestic agrculttural production, The Indonesian government has implemented several strategies-such as seeds and fertilizer subsidies, as well as credit programs (Wicaksono, 2014).

In the production process, there is no difference between personal and loan capital, each of which contributes directly to production. The difference lies only in the interest that must be paid to creditors. Considering that agricultural business is very risky because its success is determined by uncertain natural conditions, farmers need banks or service providers in the agricultural sector to ensure business continuity. The availability of community foodstuffs is significantly determined by farmers who are usually neglected.

CONCLUSION AND SUGGESTION

Based on the results, the multiple cropping farming systems provide a higher income than monocropping and it also reduces operational costs. Other benefits include the ability to reduce the risk of pest attacks and increase profits due to the variety of commodity yields produced. Furthermore, three factors 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 access to new knowledge in promoting production and improving household welfare.

ACKNOWLEDGEMENT

Authors wish to thank anonymous referees for their critical and valuable comments on early drafts of this paper. Special word of thanks to Rio Akbar Rahmatullah, Department of Agribusiness, Faculty of Agriculture, Universitas Hasanuddin and Nur Adyla Suriadi, Department of Urban and Regional Planning Faculty of Engineering, Universitas Sulawesi Barat for their great helps in handling field survey for the research.

REFERENCES

Aker, J. C. (2011). Dial "A" for agriculture: a review of information and communication technologies for agricultural extension in developing countries. *Agricultural Economics*, *42*(6), 631–647. https://doi.org/10.1111/j.1574-0862.2011.00545.x

Anderzén, J., Guzmán Luna, A., Luna-González, D. V., Merrill, S. C., Caswell, M., Ernesto Méndez, V., … Mier y Terán Giménez Cacho, M. (2020). Effects of on-farm diversification strategies on smallholder coffee farmer food security and income sufficiency in Chiapas, Mexico. *Journal of Rural Studies*, *77*, 33–46. https://doi.org/10.1016/j.jrurstud.2020.04.001

Arsyad, M., Nuddin, A., & Yusuf, S. (2013). Strengthening institutional towards smallholders welfare: Evidence from existing condition of cocoa smallholders in Sulawesi, Indonesia. *Ryukoku Journal of Economic Studies*, *52*(1), 71–86. Retrieved from https://cir.nii.ac.jp/crid/1050008156633691392

Arsyad, M., Sabang, Y., Agus, N., Bulkis, S., & Kawamura, Y. (2020). Intercropping farming system and farmers income. *AGRIVITA Journal of Agricultural Science*, *42*(2), 360-366. https://doi.org/10.17503/agrivita.v42i2.2724

Arsyad, M., Sinaga, B. M., & Yusuf, S. (2011). Analisis dampak kebijakan pajak ekspor dan subsidi harga pupuk terhadap produksi dan ekspor kakao Indonesia pasca putaran Uruguay. *Jurnal Sosial Ekonomi Pertanian*, *8*(1), 63-71. Retrieved from https://core.ac.uk/download/pdf/25485445.pdf

Brown, J., & Kothari, A. (2011). Traditional agricultural landscapes and community conserved areas: an

overview. *Management of Environmental Quality: An International Journal*, *22*(2), 139–153. https://doi.org/10.1108/14777831111113347

Bulkis, S., Rahmadanih, & Nasruddin, A. (2020). Rice farmers' adoption and economic benefits of integrated pest management in South Sulawesi Province, Indonesia. *Journal of Agricultural Extension*, *24*(4), 31–39. https://doi.org/10.4314/jae.v24i2.4

Coromaldi, M., Pallante, G., & Savastano, S. (2015). Adoption of modern varieties, farmers' welfare and crop biodiversity: Evidence from Uganda. *Ecological Economics*, *119*, 346–358. https://doi.org/https://doi.org/10.1016/j.ecolecon.2015.09.004

Cruz González, B., Jarquín Gálvez, R., & Ramírez Tobias, H. M. (2013). Rubber, coffee and cocoa polyculture economic and environmental viability. *Revista Mexicana de Ciencias Agrícolas*, *4*(1), 49–61. Retrieved from http://www.scielo.org.mx/pdf/remexca/v4n1/v4n1a4.pdf

David, M. M., & Samuel, H. S. (2014). The role of agriculture extension in the 21 century: Reflections from Africa. *International Journal of Agricultural Extension*, *2*(1), 89–93. Retrieved from https://esciencepress.net/journals/index.php/IJAE/article/view/658

Doran, J. W., & Zeiss, M. R. (2000). Soil health and sustainability: managing the biotic component of soil quality. *Applied Soil Ecology*, *15*(1), 3–11. https://doi.org/10.1016/S0929-1393(00)00067-6

Ehrmann, J., & Ritz, K. (2014). Plant: soil interactions in temperate multi-cropping production systems. *Plant and Soil*, *376*(1), 1–29. https://doi.org/10.1007/s11104-013-1921-8

Fahmid, I. M., Harun, H., Fahmid, M. M., Saadah, & Busthanul, N. (2018). Competitiveness, production, and productivity of cocoa in Indonesia. *IOP Conference Series: Earth and Environmental Science*, *157*(1), 012067. https://doi.org/10.1088/1755-1315/157/1/012067

Gollin, D., & Udry, C. (2021). Heterogeneity, measurement error, and misallocation: Evidence from African agriculture. *Journal of Political Economy, 129*(1), 711369. https://doi.org/10.1086/711369

Khairunnisa, N. F., Saidah, Z., Hapsari, H., & Wulandari, E. (2021). Pengaruh peran penyuluh pertanian terhadap tingkat produksi usahatani jagung. *Jurnal Penyuluhan*, *17*(2), 113–125. https://doi.org/10.25015/17202133656

Mankar, A. B., & Burange, M. S. (2014). Data Mining-an evolutionary view of agriculture. *International Journal of Application or Innovation in Engineering and Management*, *3*(3), 102–105. Retrieved from https://www.ijaiem.org/volume3issue3/IJAIEM-2014-03-11-022.pdf

Martin-Collado, D., Byrne, T. J., Amer, P. R., Santos, B. F. S., Axford, M., & Pryce, J. E. (2015). Analyzing the heterogeneity of farmers' preferences for improvements in dairy cow traits using farmer typologies. *Journal of Dairy Science*, *98*(6), 4148–4161. https://doi.org/10.3168/jds.2014-9194

Morgan-Davies, C., Wilson, R., & Waterhouse, T. (2017). Impacts of farmers' management styles on income and labour under alternative extensive land use scenarios. *Agricultural Systems*, *155*, 168–178. https://doi.org/https://doi.org/10.1016/j.agsy.2017.04.011

Nurhapsa, Nuddin, A., Suherman, 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. *Ecology, Environment and Conservation, 26*(Feb Suppl. Issue), 265-272. Retrieved from http://www.envirobiotechjournals.com/article_abstract.php?aid=10255&iid=296&jid=3

Nwafor, C. U., Ogundeji, A. A., & van der Westhuizen, C. (2020). Marketing information needs and seeking behaviour of smallholder livestock farmers in the Eastern Cape Province, South Africa. *Journal of Agricultural Extension*, *24*(3), 98–114. https://doi.org/10.4314/jae.v24i3.9

Prihastanti, E., & Nurchayati, Y. (2018). The comparison of cocoa growth in different vegetation compositions. *IOP Conference Series: Materials Science and Engineering*, *434*(1), 012116. https://doi.org/10.1088/1757-899X/434/1/012116

Reimer, A., Wiebe, K., Rao, J., Yao, B., Gui, Y., Jian, F., … Hu, C.-M. (2018). A compact microwave device for monitoring insect activity in grain samples. *Biosystems Engineering*, *175*, 27–35. https://doi.org/10.1016/j.biosystemseng.2018.08.010

Richardson, D. (2006). ICTs – Transforming agricultural extension? Report of the 6th Consultative Expert Meeting of CTA's Observatory on ICTs. *CTA Working Document Number 8034*. Wageningen, the Netherlands: CTA. Retrieved from https://cgspace.cgiar.org/bitstream/handle/10568/63626/WD8034.pdf

Sajogyo. (1997). *Garis kemiskinan dan kebutuhan minimum pangan*. Pusat Studi Pembangunan

Pertanian dan Pedesaan. Bogor: LPPM IPB. Retrieved from https://repository.ipb.ac.id/jspui/bitstream/123456789/24089/1/Garis%20Kemiskinan%20dan...%2810%20hal%29.pdf

Santoso, T. I., & Zakariyya, F. (2019). Several physiological changes of cocoa (*Theobroma cacao* L.) in response to vascular streak dieback diseases. *AGRIVITA Journal of Agricultural Science*, *41*(1), 129–138. http://doi.org/10.17503/agrivita.v41i1.1668

Schoneveld, G. C., van der Haar, S., Ekowati, D., Andrianto, A., Komarudin, H., Okarda, B., … Pacheco, P. (2019). Certification, good agricultural practice and smallholder heterogeneity: Differentiated pathways for resolving compliance gaps in the Indonesian oil palm sector. *Global Environmental Change*, *57*, 101933. https://doi.org/10.1016/j.gloenvcha.2019.101933

Scott, J. C. (1981). *Moral ekonomi petani: Pergolakan dan subsistensi di Asia Tenggara*. In H. Basri & B. Rasuanto (Eds.). Jakarta: Lembaga Penelitian, Pendidikan dan Penerangan Ekonomi dan Sosial. Retrieved from http://digilib.ui.ac.id/detail?id=20162838

Sumardjo. (1999). *Transformasi model penyuluhan pertanian menuju pengembangan kemandirian petani (Kasus di Propinsi Jawa Barat)*. Disertation. IPB University. Retrieved from https://repository.ipb.ac.id/handle/123456789/42580

Sundari, Yusra, A. H. A., & Nurliza. (2015). Peran penyuluh pertanian terhadap peningkatan produksi usahatani di Kabupaten Pontianak. *Social Economic of Agriculture*, *4*(1), 26–31. Retrieved from https://jurnal.untan.ac.id/index.php/jsea/article/view/10129

Syam, J., Salman, D., Hasan, S., Ismartoyo, & Sirajuddin, S. N. (2019). Adaptive strategies of livestock waste processing technology to vulnerability availability of animal feed. *IOP Conference Series: Earth and Environmental Science*, *235*(1), 012094. https://doi.org/10.1088/1755-1315/235/1/012094

Syarief, M., Mudjiono, G., Abadi, A. L., & Himawan, T. (2018). Arthropods diversity and population dynamic of *Helopeltis antonii* Sign. (Hemiptera: Miridae) on various cocoa agroecosystems management. *AGRIVITA Journal of Agricultural Science*, *40*(2), 350–359. http://doi.org/10.17503/agrivita.v39i2.1038

Takahashi, K., Muraoka, R., & Otsuka, K. (2020). Technology adoption, impact, and extension in developing countries' agriculture: A review of the recent literature. *Agricultural Economics*, *51*(1), 31–45. https://doi.org/10.1111/agec.12539

Tawakal, M. A., Siman, S., Djanggo, R. T. P. M., & 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). *IOP Conference Series: Earth and Environmental Science*, *343*(1), 012187. https://doi.org/10.1088/1755-1315/343/1/012187

van der Ploeg, J. D., & Ventura, F. (2014). Heterogeneity reconsidered. *Current Opinion in Environmental Sustainability*, *8*, 23–28. https://doi.org/10.1016/j.cosust.2014.07.001

Wicaksono, E. (2014). The impact of agricultural credit on rice productivity. *International Journal on Advanced Science, Engineering and Information Technology*, *4*(5), 322-325. https://doi.org/10.18517/ijaseit.4.5.427

Wida, P. (2017). The role of agricultural extension and institutional capacity in supporting increased program of rice corn and soybean production in Sukabumi-Indonesia. *International Journal of Research in Social Sciences*, *7*(5), 516–528. Retrieved from https://indianjournals.com/ijor.aspx?target=ijor:ijrss&volume=7&issue=5&article=038

Wulandari, R. (2015). Information needs and source information of agricultural extension workers in DIY. *AGRARIS Journal of Agribusiness and Rural Development Research*, *1*(2), 85–97. https://doi.org/10.18196/agr.1212

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