Original Article

Farmers' behavior and the potential results of cattle-oil palm integration in South Sumatra's oil palm replanting area

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Abstract

Objective: Replanting of oil palm plantations needs to be done to ensure long-term supply. However, problems arise due to the reduced income of farmers during the non-productive period of oil palm plantations, so there are various farmers' behaviors in responding to this situation. One effort to increase farmers' income is through cattle-oil palm integration. This paper aims to analyze farmers' behavior, the factors that influence it, and the potential yield obtained from the integration of cattle into oil palm in replanting fields.
Methods: The research was conducted using case studies in Cinta Damai Village, Sungai Lilin District, Musi Banyuasin Regency, South Sumatra, from November 2019 to November 2020. The survey was conducted on 35 farmers to assess behavior and factors that could influence it. Meanwhile, the potential yield of cattle-oil palm integration was measured through a demonstration plot of 1 ha of odot grass planting and processing of cow manure waste. Behavioral data were analyzed using path analysis, while the potential yield was analyzed descriptively.
Results: The results showed that farmers have behaviors that support the cattle-oil palm integration business. Factors that directly influence this behavior are land area and socio-economic motivation. Meanwhile, socio-economic motivation through success belief has a significant effect on farmers' behavior.
Conclusions: The farmers' behaviour regarding the implementation of cattle-oil palm integration in oil palm replanting areas had criteria of poor, medium and good, with percentages of 5.71%, 25.71% and 68.51% respectively. The factors that directly influence this behaviour are the area of oil palm replanting area and the socio-economic motivation of the farmers. The potential results obtained from implementing cattle-oil palm integration are 1) forage for livestock (FFL) from odot grass, and 2) manure and liquid organic fertilizer (LOF) from cow dunk.

Keywords: Cattle; Farmers' behavior; Integration; Oil palm

INTRODUCTION

Indonesia ranks first in the world as an oil palm-producing country with production reaching 42.50 million tonnes, equivalent to 58% of the total world supply of oil palm according to data from the United State Department of Agriculture, 2019 [1]. The area of oil palm plantations in Indonesia reaches 14.86 million hectares. Smallholder oil palm accounts for 42% of Indonesia's total oil palm plantations. However, the condition of the people's oil palm plantations in several areas has reached an unproductive age, so replanting is necessary [2]. Plant replanting must be carried out to maintain long-term supply. Plant replanting also provides an opportunity for Indonesia to become the world's largest producer and exporter of vegetable oil [3].

South Sumatra Province has the sixth largest area of oil palm plantations in Indonesia. The potential for replanting of smallholder oil palm reaches 2.78 million hectares out of 6.72 million hectares of Indonesian smallholder oil palm area, in South Sumatra reaching 373,028 ha [4]. Replanting is one of the efforts to increase oil palm production. However, a problem arose, namely the farmers' income decreased even to zero, due to the non-productive period of oil palm plantations. Therefore, one way to overcome this problem is by utilizing replanting land through planting intercrops between oil palm stands and other integration efforts.

One of the integration programs for oil palm and other commodities is through the integration of oil palm plantations with cattle rearing [5] known as the Oil Palm Cattle Integration System Program (SISKA). This program is in line with Indonesia's national policy in efforts to fulfill food, namely achieving self-sufficiency in beef through the availability of technology, infrastructure improvements, capacity building and progress of breeders, and market opportunities [6]. This cattle-oil palm integration could be carried out in the oil palm plantations of the people of South Sumatra.

Cattle-oil palm integration is carried out using oil palm plants for cattle cultivation and vice versa. Fulfillment of animal feed needs is obtained from the utilization of palm leaves and fronds, empty fruit bunches, processed palm juice fiber, palm sludge, palm kernel cake, and by-products oil, as well as the potential of available biomass among oil palm plants [7-9]. The integration pattern could provide forage for livestock, especially one year after replanting with a dry matter amount of 2–3 t ha^{-1}, but it is decreasing due to reduced sunlight penetration due to the oil palm canopy [10].

The cattle-oil palm integration system has also shown benefits in terms of saving on labor costs for weeding and the use of agrochemicals such as herbicides and inorganic fertilizers. The use of cattle as a biological controller for grass growth and the reduction of herbicides is an effort to improve environmental health [11-14]. The cattle-oil palm integration system is a form of bio-industrial agriculture [9], where the two commodities are synergized to achieve optimal utilization of the same land [15].

The cattle-oil palm integration system in South Sumatra is only managed by a small number of plantation owners. Cattle maintenance is carried out in intensive and semi-intensive system maintenance. The Populace's Oil Palm Replanting Program (PSR) in South Sumatra was first implemented in Sungai Lilin District, Musi Banyuasin Regency in 2017 and is scheduled to be completed in 2024. The total area of replanted oil palm plantations in Sungai Lilin District is 5,304 ha. Most of the area of the Maju Bersama People's Animal Husbandry School (SPR) in Sungai Lilin District is oil palm land covering an area of 2,957 ha with a total of 333 members and a population of 1,443 cattle.

Integration of cattle and oil palm at the location of oil palm replanting is interesting to study as an effort to reveal the various influences of internal and external factors on farmers' behavior and what potential results from the integration. This paper aims to analyze farmers' behavior, the factors that influence this behavior, and the potential results obtained from cattle-oil palm integration. The results of the paper are expected to be a reference for raising cattle with a cattle-oil palm integration system, especially at the location of replanting oil palm plantations.

MATERIALS AND METHODS

The research was conducted in Cinta Damai Village, Sungai Lilin District, Musi Banyuasin Regency. The location selection was carried out by purposive sampling because Cinta Damai Village is the first village to carry out community oil palm replanting as well as implementing cattle-oil palm integration.

Data and information collection regarding farmers' behavior was carried out in November 2020, using the survey method. The survey was conducted on 35 plasma farmers from 35 population heads of households who were carrying out the integration of cows and oil palms in the oil palm replanting area. Respondents are plasma farmers of the oil palm plantation company PT. Hindoli. The potential results of cattle-oil palm integration through planting odot grass for 1 year (November 2019–November 2020) by making a demonstration plot of 1 ha.

The individual farmers' behavior arises because of socio-economic motivation and success belief of integration. Socio-economic motivation is a strong impetus to carry out the integration of cattle and oil palm to fulfilling life's needs, increasing income, buying luxury goods, increasing savings, make life prosperous, expanding association, increasing cooperation, a sense of brotherhood, adding insight, and getting assistance. Behavioral assessment consists of aspects of knowledge, attitudes, and actions that are calculated with a score interval of 12–60.

Farmers' behavior analyzed by grouping farmers into three behavior classes [17]. The length of the class interval is then used to divide the farmers' scores into three classes with the "Good", "Medium", and "Poor" behavior criteria groups.

$$\text{The length of the class interval} = \frac{\text{highest data-lowest data}}{\text{number of classes}} \quad \text{...(1)}$$

Factors influencing farmers' behavior were analyzed using multiple linear regression followed by path analysis with the help of the SPSS version 21 program. In addition to examining the direct effect of the independent variable on the dependent variable, path analysis also explains whether there is an indirect effect given by the independent variable through the intervening variable (between) on the dependent variable. The path diagram structural equation model is as follows:

$$Y = a + P_1.X_1 + P_2.X_2 + P_3.X_3 + P_4.X_4 + e_1 \quad \text{...(2)}$$

Description:
Y = success belief
a = confidence constant success
P_1 = path coefficient of the direct influence of formal education (X_1) on the success belief
P_2 = path coefficient of the direct effect of oil palm replanting area (X_2) on confidence in success
P_3 = path coefficient of the direct effect of the number of cows reared (X_3) on the success belief
P_4 = path coefficient of the direct influence of socio-economic motivation (X_4) on success belief
e_1 = error of success belief ($\sqrt{1-R^2}$)

$$Z = a + P_5.X_1 + P_6.X_2 + P_7.X_3 + P_8.X_4 + P_9.Y + e_2 \quad \text{...(3)}$$

Description:
Z = farmers' behavior
A = farmers' behavior constant
P_5 = path coefficient of the direct influence of formal education (X_1) on farmers' behavior
P_6 = path coefficient of a direct effect of oil palm replanting area (X_2) on farmers' behavior
P_7 = path coefficient of the direct effect of the number of cows reared (X_3) on farmers' behavior
P_8 = path coefficient of the direct influence of socio-economic motivation (X_4) on farmers' behavior
P_9 = path coefficient of the direct influence of success belief (Y) on farmers' behavior
e_2 = error of farmers' behavior ($\sqrt{1-R^2}$)

The indirect effect that occurs in variable $X_1....X_4$ on farmers' behavior (Z) through the success belief variable (Y) is explained by the following model (Figure 1).

The potential results obtained from the cattle-oil palm integration were analyzed descriptively by calculating the potential results of the integration in the form of planting 1 hectare of forage fodder (odot
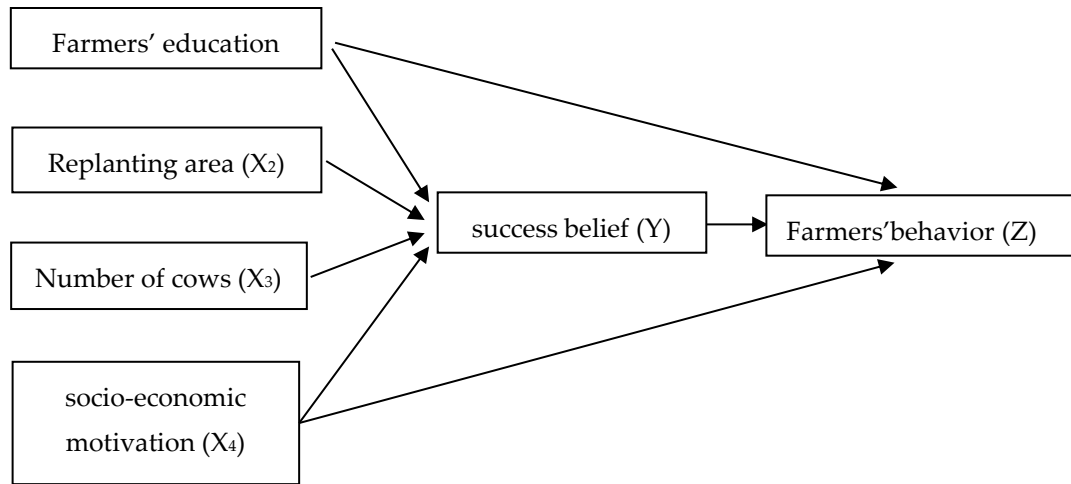
Figure 1. Path analysis model

grass) in the replanting area and processing cow manure managed by farmers.

RESULTS

Farmers' behavior on cattle-oil palm integration

The farmers' behavior analyzed includes aspects of attitude, knowledge, and actions taken in the oil palm replanting program that implements a cattle-oil palm integration system. Behavior is an individual's response/reaction to environmental stimuli. Skinner [17] states that behavior occurs from the process of a stimulus to the organism which is then responded to by the organism. Lewin [18] stated that behavior is a function of the characteristics between the individual and the environment. Individual characteristics include various factors such as motives, values, personality traits, and attitudes which interact with each other and then also interact with environmental factors that influence behavior. Skinner [17] said that behavior consists of cognitive, affective, and psychomotor aspects or in a more operational form that can be measured by knowledge (knowledge), attitude (attitude), and practice (action). Class categories and farmers' behavior can be seen in Table 1.

Farmers have supportive behavior in the application of the integrated system of cattle and oil palms. One of the requirements for knowing the factors that influence the farmers' behavior is the samples taken must be normally distributed. Based on the results of the Kolmogrov-Smirnov Normality Test it shows the significance value of Asyimp. Sig (2-tailed) is 0.311 or > 0.05 which means that the data is normally distributed so that the requirements for normality in the regression model have been fulfilled.

Model I path analysis

The summary model of regression analysis I shows the value of R Square = 0.233. This shows that farmers' success belief (Y) in the integration of cattle and oil palm is 23.3%. The Y variable is influenced by farmer education (X_1), replanting area (X_2), number of cows kept (X_3), and socio-economic motivation (X_4), while the remaining 77.75% is influenced by other variables outside the model (Table 2).

Furthermore, the value of e_1 (error of believing successful) can be found by the formula $e_1 = \sqrt{1- 0{,}233} = 0.8757$ so that a structural model path diagram is obtained as shown in Figure 2.

Table 1. Class interval values, and the percentage of farmers based on farmers' behavior

No	Farmers' behavior	Class interval values	Number of farmers (people)	Percentage (%)
1.	Poor	12–28	2	5.7
2.	Medium	> 28–44	24	68.6
3.	Good	> 44–60	9	25.7
	Total		35	100

Table 2. Model summary regression analysis I

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	0.483[a]	0.233	0.131	0.82680

a, Predictors: (Constant); socio-economic motivation (X_4), number of cows (X_3), farmers' education (X_1), replanting area (X_2)
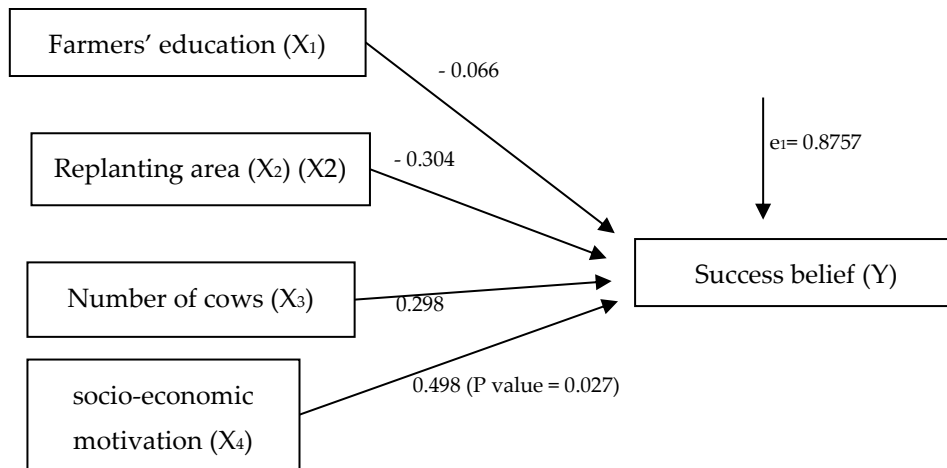

Figure 2. Structural model of the relationship of variables that influence the success belief of an integrated oil palm replanting business
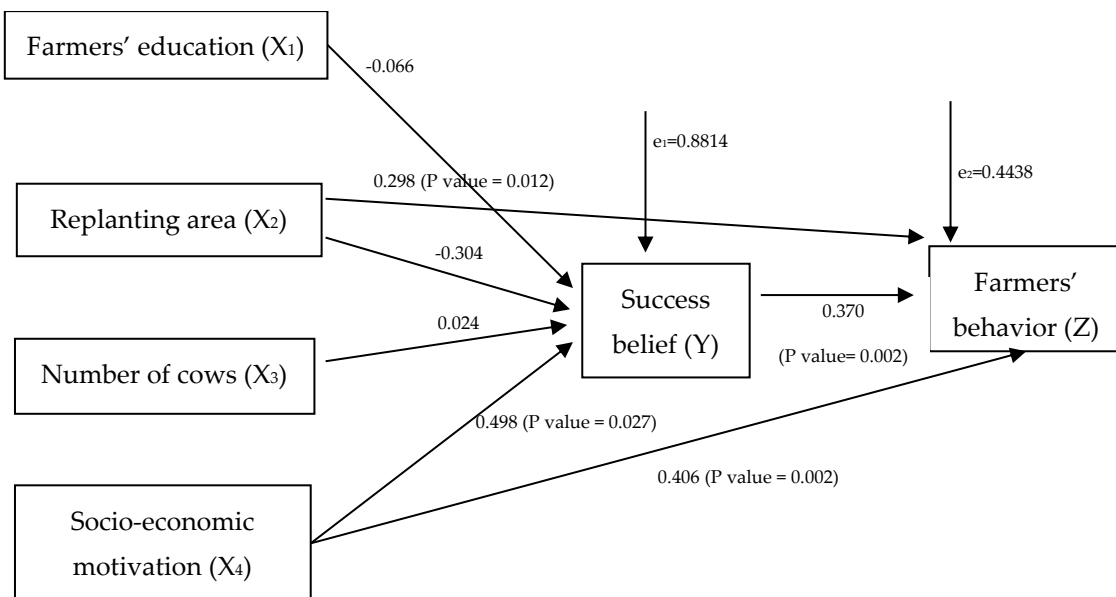

Figure 3. Structural model of variable relationships that influence farmers' behavior

Model II path analysis

Regression analysis summary model II has an R Square value of 0.803 which means 80.3% of farmers' behavior (Z) is influenced by education (X_1), replanting area (X_2), number of cows (X_3), socio-economic motivation (X_4), and success belief (Y); while the remaining 19.7% is influenced by other variables outside the model (Table 3).

The value of e_1 is obtained using the formula $e_1 = 0.8814$ and $e_2 = 0.4438$ so that the structural model path diagram is obtained in Figure 3.

Potential results of cattle-oil palm integration in oil palm replanting area

The potential results obtained from the implementation of cattle-oil palm integration in oil palm replanting areas are the provision

Table 3. Regression Analysis Summary Model II

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	0.896[a]	0.803	0.769	3.99522

a. Predictors: (Constant); success belief (Y), replanting area (X_2), farmers' education (X_1), number of cows (X_3), socio-economic motivation (X_4)

Table 4. Results of Regression Analysis Model I

		Coefficients[1]				
	Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	4.568	1.138		4.015	0.000
	Farmers' education (X_1)	-0.011	0.035	-0.066	0.321	0.750
	Replanting area (X_2)	-0.143	0.098	-0.304	-1.465	0.153
	Number of cows (X_3)	0.047	0.029	0.298	1.603	0.119
	socio-economic motivation (X_4)	0.087	0.038	0.498	2.325	0.027

[1], Dependent Variable; success belief, Y.

of animal feed using oil palm plants and forage plants between oil palm stands, and the use of animal manure waste for organic fertilizer.

Intensive cattle rearing makes it easier for farmers to collect cow dung waste. Potential livestock waste in the form of solid cow manure production of 14 kg and 5 liters of urine per head per day. The potential for livestock waste is calculated based on the potential for solid and liquid manure resulting from the average number of intensively reared cows per family [19].

DISCUSSION

The results of the analysis show that as many as 68.51% of farmers fall into the category of moderate behavior with class interval values of >28–41. As many as 25.71% of farmers fall into the good behavior category with class interval values >44–60; while the bad behavior group was 5.71% of farmers, with class interval values of 12–28 (Table 1). This shows that the majority of farmers have knowledge, attitudes, and actions that support the application of cattle-oil palm integration so that it has the potential for future development.

The results of the regression analysis of model 1 show that only the socio-economic motivation variable (X_4) has a significant value

(Table 4). This means that only the variable socio-economic motivation (X_4) has a significant effect on the success belief variable of the integration effort (Y). Strong socio-economic motivation to increase income to meet the needs of family life. Meanwhile, from a social perspective, it can expand cooperation, association, and even opportunities to get assistance and encourage farmers to have confidence in the success of the oil palm replanting business by implementing cattle-oil palm integration.

Based on the output of the regression model II, it is known that the significant value of the area of the replanting variable (X_2) is 0.012, which is less than $\alpha = 0.05$ (Table 5), which means that the area of replanting of oil palm has a significant effect on farmers' behavior (Z). While the socio-economic motivation variable (X_4) and the success belief variable (Y) each have a significance value of 0.002 and 0.000 less than $\alpha = 0.01$, which means that these two variables have a very significant effect on the farmer's behavior variable (Z).

The results of the path analysis show that socio-economic motivation (X_4) has a significant direct effect on success belief (Y), with a significance value of 0.027. The broad variable of oil palm replanting area (X_2) directly has a significant effect on farmers' behavior (Z) with a significance value of 0.012,

Table 5. Results of Regression Analysis Model II

	Coefficients[1]				
Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
1 (Constant)	-16.507	6.816		-2.422	0.022
Farmers' education (X_1)	0.206	0.168	0.131	1.227	0.230
Replanting area (X_2)	1.318	0.490	0.298	2.692	0.012
Number of cows (X_3)	0.035	0.147	0.024	0.239	0.813
socio-economic motivation (X_4)	0.668	0.197	0.406	3.389	0.002
success belief (Y)	3.471	0.882	0.370	3.934	0.000

[1], Dependent variable.

while socio-economic motivation (X_4) directly has a very significant effect on farmers' behavior (Z) with a significance value of 0.002. This is also in line with several research results which suggest that farmers with wider land ownership tend to adopt innovations because they are willing and able to apply new technologies [20-22]. This means that farmers with larger areas are more likely to adopt the implementation of cattle-oil palm integration in oil palm replanting areas. This is also supported by the understanding of these farmers, who are more open-minded (moderate) farmers that implementing new innovations will increase oil palm production and oil palm farmer incomes. The success variable (Y) in the cattle-oil palm integration has a very significant direct effect on farmers' behavior (Z) with a significance value of 0.000.

Path analysis apart from testing the direct effect of the independent variables on the dependent variable, is also able to explain whether there is an indirect effect exerted by the independent variables through the intervening (between) variables on the dependent variable. It is known that there is a direct effect of socio-economic motivation (X_4) on farmers' behavior (Z) of 0.406. To find out the indirect effect of socio-economic motivation (X_4) through success belief (Y) on farmers' behavior (Z) can be obtained by multiplying the beta value of socio-economic motivation (X_4) on success belief (Y) with the beta value of success belief (Y) on farmers' behavior (Z), namely: 0.498 x 0.370 = 0.184. Furthermore, the total effect is the sum of the direct and indirect effects, namely 0.406 + 0.184

= 0.590 so that the total effect given by social motivation (X_4) on farmers' behavior (Z) is 0.590. The direct effect value (0.406) is greater than the indirect effect value (0.184). This shows that the variable socio-economic motivation (X_4) through success belief (Y) indirectly has a significant effect on farmers' behavior (Z).

Motivation is an important aspect that influences farmers' decisions and behavior to adopt innovations [23]. Some research results suggest that the combination of obtaining economic/financial and environmental (social) benefits is a motivation for farmers that influences farmers' behavior [24-26].

Planting forage in the form of fodder grass can be planted as an intercrop on immature oil palm areas because the plant canopy is not yet tall, besides it can also function as a cover crop to maintain soil moisture and fertility.

Forage planting in the form of demonstration plots for planting odot grass (*Pennisetum purerium* cv Mott) at the research location in Cinta Damai Village was carried out in the plasma farmer's garden. This is intended to provide quality feed for cows. The population of odot grass in the oil palm replanting area is 2,500 clumps ha^{-1}. Odot can be harvested for the first time at the age of 105 days after planting by cutting. Grass can be harvested again at an interval of 40 days after the previous harvest. The average wet weight of the harvest was 3.64 kg per clump or 1.34 kg per clump for the dry weight.

Planting odot grass during the first year of immature oil palm replanting (IOP 1) at the

Table 6. Yield potential of odot grass and cattle fattening opportunities per hectare in oil palm replanting area

Age of oil palm	Odot grass dry weight production (kg yr^{-1})	Number of cattle to be fattened (head per period)	Fattening period (times yr^{-1})
immature oil palm (IOP 1) (0-1 year old)	23.450	4	2
immature oil palm (IOP 2) (> 1-2 year old)	33.500	4	4

IOP, Immature Oil Palm.

study site yielded 7 harvests per year, with a total yield of 23,450 kg of dry grass per year. Whereas when IOP 2 can harvest 10 times in one year it produces 33,500 kg of dry grass (Table 6). This is because in IOP 1 the grass production is still low, and the grass is still in the growth process, so the production is not maximized. The results of planting odot grass were far greater than those [27]. Forage potential that grows naturally under 3 years old oil palm stands in Samboja District, Kutai Kartanegara Regency, East Kalimantan, produces 13.16 t ha^{-1} wet weight or 3.2 t ha^{-1} dry weight. The forage plants that dominate include *Paspalum conjugatum* (45.54%), *Mikania micrantha* (9.93%), and *Ottochloa nodosa* (7.89%). Whereas at the age of 6 years, it was dominated by *Ottochloa nodosa* (33.89%), *Melastoma malabatrichum* (28.23%), and *Paspalum urvillei* (8.37%), producing 6.38 t ha^{-1} wet weight or equivalent to 1.16 t ha^{-1} year^{-1} dry weight [29]. The population of odot grass must be reduced as soon as the replanting of the oil palm trees begins to bear fruit (end of IOP 2) because some of the lands will be used as roads for oil palm harvesting activities. Likewise, the grass that is close to the palm stems.

The target of fattening 4 cows with a body weight gain of 0.5 kg per day can be done in 2 fattening periods per year for the first IOP period. Meanwhile, in the second IOP period, 4 fattening periods can be done per year (Table 6). This is based on the results of interviews with cooperator farmers who are implementing cattle-oil palm integration on oil palm replanting areas by planting odot grass and fattening cattle. A fattening period for cattle lasts 3 months, so there are 4 fattening periods per year. This can be done in the second IOP period. However, fattening cattle in the first IOP period can be done in two periods per year. This is related to the first harvest of odot grass 105 days after planting, where the odot grass demonstration plot was planted in February, so that the first harvest of odot grass as forage for livestock (FFL) was carried out in mid-May. Therefore, the first cattle fattening period in the first IOP period begins in mid-May and the second cattle fattening period begins in mid-August for harvesting in mid-November.

The fronds of oil palm trees can also be used as a source of cattle feed. The average population of oil palm trees is 130–140 ha^{-1}. The average yield of pruning fronds reaches 22 fronds per tree per year, with a weight of 7 kg per frond or 0.5 kg of leaves without sticks. So that in one year it reaches 20,020 kg of fresh fronds or 5,214 kg of dry matter and 1,430 kg of leaves without sticks or 658 kg of dry material without sticks [7]. Oil palm also produces other dry matter by-products that can be used for animal feed such as empty fruit bunches (3,386 kg), pressed fiber (2,681 kg), oil palm solid mud (1,132 kg), and oil palm cake (514 kg). The lignin content in the crude fiber of the palm fronds reaches 17.4%; 27.6% in leaves. These products can be used as alternative feed during the dry season due to the limited availability of grass [9].

During the manufacture of manure will be a decrease in the initial weight of cow waste, so that the manure produced ranges from 20.5–28.8% and the C/N ratio has reached 15.5–17.5 [28]. The results showed that the potential for livestock waste to be produced was 115.8 kg of cow manure and 77.2 liters of urine per head per day so after depreciation a total of 81.06 kg of cow manure and 77.2 liters of liquid organic fertilizer per head of household per day (Table 7). The cow manure and urine produced can be used as a source of macro and micro nutrients for plants.

Table 7. Potential for cow manure per household per day in Cinta Damai Village in 2020

Type of Cattle	Average Number of cows per head (head)	The potential of cow dung per day (kg)	The potential of cow urine per day (l)
Male calf	1.02	15.30	10.20
Female calf	1.62	24.30	16.20
Broodstock	3.31	49.65	33.10
Male	1.77	26.55	17.70
Total		115.80	77.20

Based on the results of the calculation of the potential contribution of manure and liquid fertilizer at the study site, it produced 15,696 kg N; 11,772 kg P; 15,696 kg K for solid manure, and 26,160 kg N; 13,080 kg P; and 39,240 kg K for urine. This indicates that cow manure can be an effective source of nutrition, and is comparable to commercial fertilizers [29-30].

CONCLUSIONS

The majority of farmers, as much as 68.51%, are in the category of moderate behavior and 25.71% are in a good category and show behavior supporting the integration of cattle-oil palm in replanting areas. The farmer's behavior is directly influenced by the area of oil palm replanting and socio-economic motivation so farmers with larger land areas and high socio-economic motivation have better attitudes, knowledge, and actions towards cattle-oil palm integration. In addition, the socio-economic motivation variable indirectly through the success belief variable also has a significant influence on farmers' behavior towards cattle-oil palm integration.

The potential results obtained from the application of cattle-oil palm integration are fodder from odot grass sheaths as intercrops in oil palm replanting areas which can be used for fattening cattle. In addition, by raising cow's farmers will produce cow manure which can be used as manure and liquid organic fertilizer.

CONFLICT OF INTEREST

The author declares that there is no conflict of interest with other parties regarding funding and research objects.

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