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FEASIBILITY OF SOIL AND WATER CONSERVATION TECHNIQUES ON OIL PALM PLANTATION

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ABSTRACT

The objective of the study is to examine the effectiveness and feasibility of soil and water conservation techniques. The production of oil palm comprising the fresh fruit bunch, number of bunches, and average of bunch weight were recorded at every harvesting schedule. Tabular data were analyzed by logical comparison among the blocks as a result of application of bund terraces and silt-pit. Financial and sensitivity analysis of the effect of the techniques on FFB production were done. Bund terrace treatment was more effective (4.761 ton or 21.5%) in increasing FFB production than the silt-pit treatment (3.046 ton or 13.4%) when it is compared to that of the control block. The application of bund terraces and silt-pit also presents positive effects i.e. increases the average bunch weight and the number of bunch compared to that of the control. Furthermore, the financial analysis as well as sensitivity analysis shows that the bund terrace application is profitable and feasible (B/C = 3.06, IRR = 47%) while the silt pit treatment is profitable but not feasible.

Keywords: Bund terrace, feasibility, production of FFB, silt-pit

INTRODUCTION

Oil palm plants can have an optimal production in areas with relatively high rainfall (±2,500 mm) and distributed evenly along the year (Harahap and Latif, 1998; Henson *et al*., 2005; Kallarackal *et al*., 2004; Umana and Chinchilla, 1991; Darmosarkoro *et al*., 2001). Relatively long drought (6 consecutive months) can reduce the production of fresh fruit bunch (FFB) until 30 % in the succeeding year. Therefore, rainfall harvesting during the rainy season by the application of soil and water conservation techniques will be important to increase the soil moisture storage during the dry season and maintain the oil palm production (Harahap and Darmosarkoro, 1999), particularly in areas with soil depth of less than 1.5 meters (Murtilaksono *et al*., 2008a; 2009).

The implementation of soil and water conservation techniques in oil palm plantations such as the application of bund terraces or silt-pits combined with retarded-water holes is still limited due to the required additional cost that becomes the main consideration of the estate company. Even though since 2005, the researches of Murtilaksono *et al*. (2006; 2007; 2008a; 2008b; 2009) have shown that the implementation of soil and water conservation effectively reduces run-off and soil erosion, and increases the soil moisture storage and production of oil palm in Management Unit of Rejosari, Nusantara Plantation Company VII, Lampung. Some previous research in other plantations also show the same results (Dariah *et al*., 2004; Firman, 2006). Though the soil and water conservation techniques have a significantly positive effect, this effectiveness will become less substantial and will not be adopted by the estate management if the techniques do not provide profit to the company or economically feasible. Therefore, detailed analyses on the cost and profit (in monetary unit) of the terrace bund and silt-pit implementation will be the major consideration for the estate management. The achieved profit is indicated in the incremental production and additional value of FFB selling or the quantitative additional net profit of the company in standard economic parameters, i.e. profit cost ratio (B/C), net present value (NPV), and internal rate of return (IRR). An investment is feasible when discounted net profit (NPV) is not negative and IRR is more than the interest rate.

Based on the background described above, this research aims to study the effectiveness and feasibility of the implementation of ditched bund terraces and silt-pits combined with retarded-water holes on oil palm plantation of the Management Unit of Rejosari, Nusantara Plantation Company VII, Lampung.

MATERIALS AND METHODS

The research was conducted at Afdeling III, Management Unit of Rejosari, Nusantara Plantation Company VII, Natar Sub-district, South Lampung Regency. Three blocks namely block 375 (block 1), block 415 (block 2), and block 414 (block 3) were chosen to apply the soil and water conservation techniques.

The soil and water conservation techniques consisted of the applications of (a) ditched bund terraces combined with retarded-water holes filled with mulch in block 1, (b) silt-pits combined with retarded-water hole filled with mulch in block 3, and (c) control treatment, in which no application of water retardation technique (left as the Management Unit use to practice) in block 2. The soil and water conservation techniques were not replicated due to the variability of micro topography of the blocks in the study area.

The bund terrace was constructed in line with the contour between plants with a vertical interval of 80 cm. The height, width, and depth of the ditched bund are 30 cm each. The water-retarded holes were constructed with Belgi auger in the middle of the ditch with 2 m distance each other hole. Plant residue of oil palm leaf and shrub were inserted into the water-retarded holes and the other parts were placed on the ditch of the bund.

The silt-pit (300 cm length, 50 cm width, and 50 cm depth) was constructed between plants in line with the contour with zigzag model inter the contour lines. The distance between the slit-pits within a contour line was 2 m. In each silt-pit 2 (two) water-retarded holes with 2 m distance were constructed, and the diameter and depth are the same as those of the ditch of bund. Plant residues and shrub were put into the silt-pit and its holes as the mulch.

Bund terraces and slit-pits combined with water-retarded holes were constructed in the dry season (June – September) 2005, while monthly production parameters FFB, ABW and number of bunch per stand (NB) were counted and recorded for three years (January 2007 until December 2009). Weighing, recording, and counting of the production parameters were carried out every harvesting time and compiled monthly. The data of production in the form of tables and graphs were analyzed descriptively and logically by comparing the numbers of the blocks affected by the application of water-retarded holes bund terraces and silt-pits.

Financial analysis was done with a time horizon of 15 years (the planting year of the oil palm was 1997 and 10 years old) in line with the remaining time for one cycle of oil palm plant production (25 years). The cost components were the expenses for the construction and maintenance of bund terraces and silt-pits, namely the materials and equipments, wage of workers and designing service. The profit component was the difference between the selling prices of FFB produced in the bund terrace as well as silt-pit blocks and the control blocks. The indicators of financial feasibility applied consist of B/C, NPV, and IRR. The discount interest rate applied was the interest rate for the agricultural commodity loan which was 18%. The equation for financial analysis applied is as follows:

$$B\ /\ C = \sum_{t=1}^{n}\{B_t / (1+r)^t\}\ /\ \sum_{t=1}^{n}\{C_t / (1+r)^t\}$$

$$NPV = \sum_{t=1}^{n}\{B_t / (1+r)^t\} - \sum_{t=1}^{n}\{C_t / (1+r)^t\}$$

where: B = profit, C = cost, t = time horizon (1 – 15 years), r = interest rate (18%)

Meanwhile, IRR is the interest rate where NPV = 0 or discounted profit is equal to discounted cost.

The sensitivity analysis was done by a simulation of decreasing FFB production to 15%

(assuming the dryness effect or dry spell), declining FFB price to 32% (the lowest price that has ever happened), increasing the wage rate by 11% (the highest component of the cost structure), or the combination. The project is stated feasible when B/C > 1.0, NPV > 0, and IRR > bank interest rate (18%).

RESULTS AND DISSCUSION

Production

Recapitulation of the monthly FFB total production as the effect of the implemented treatment in 2007-2009 is depicted in Table 1. Consistently, the application of bund terrace has a positive effect in increasing the production incremental than the application of silt-pit and control (without the application of soil and water conservation techniques). The highest FFB production was obtained from the block with bund terrace treatment i.e. 25.2, 24.9, and 26.2 ton/ha in 2007, 2008, and 2009 respectively, compared to the block treated with silt-pit i.e. 23.6, 22.8, and 24.8 ton/ha in 2007, 2008, and 2009 respectively. The FFB productions in the control block in 2007, 2008, and 2009 that were 20.8, 22.1, and 19.9 ton/ha respectively were lower than those from the blocks treated with bund terraces and silt-pits.

The application of bund terraces for an average of three years effectively increased the average FFB production by 21.5 % compared to the average production from the silt-pit treatment increasing only 13.4 % from the production in the control block. In 2007 the bund terrace treatment was able to increase FFB production up to 21.09 % while the silt-pit treatment only increased by 13.48 %.

In other word, the bund terrace treatment is more effective to increase FFB production than the silt-pit treatment. Those incremental productions indicated that rainfall harvesting to be utilized in the dry season by oil palm plants for the photosynthesis process could increase the production of FFB. The correlation between FFB production in 2007 and the monthly soil moisture storage in 2006 was closely related (correlation coefficient (r) was 0.70). The same effect on FFB production occurred in 2009, wherein FFB productions on bund terrace and silt-pit blocks were higher by 31.5 and 24.5% respectively than that on the control block although there was no dry spell in 2008.

Table 1. The production of fresh fruit bunch (FFB) of oil palm as the effect of the applications of bund terrace and silt pit combined with mulched retarded-water holes in 2007, 2008, and 2009

Months	Bund Terrace			Control			Silt Pit		
	2007	2008	2009	2007	2008	2009	2007	2008	2009
January	24,370	38,931	16,138	25,470	7,180	11,265	24,380	13,250	15,598
February	29,290	29,645	5,750	29,440	25,650	4,770	29,760	24,026	4,270
March	28,870	24,290	14,130	25,110	23,820	14,590	28,830	22,221	23,809
April	26,860	26,790	21,850	22,030	29,230	9,145	26,040	21,350	16,500
May	33,720	27,530	29,346	31,260	29,200	30,962	44,340	21,810	26,109
June	32,812	42,598	43,700	32,649	41,190	29,985	35,376	40,736	35,600
July	35,465	23,860	38,710	33,576	39,250	31,155	30,594	38,206	34,410
August	15,840	31,275	58,082	17,048	15,831	55,500	16,802	18,851	46,650
September	17,880	24,340	47,954	16,033	25,823	50,260	20,339	24,416	40,960
October	75,160	49,455	41,260	43,786	47,420	21,296	46,849	50,010	39,785
November	32,200	41,420	30,250	25,270	31,840	19,800	24,374	32,710	21,860
December	34,350	24,386	24,160	30,790	36,530	28,160	29,300	37,640	26,420
Average*	**25,162**	**24,901**	**26,180**	**20,779**	**22,060**	**19,910**	**23,579**	**22,805**	**24,790**

Remarks: monthly FFB weight in kg; * = unit in kg/ha

The ABW and the NB harvested per plant on the treated blocks with bund terrace and silt-pit were higher than that on the block without treatment though it was not significantly different (Figure 1 and 2). The increment of ABW due to the effect of bunch terrace and silt-pit treatments varied from 4 to 16 %, while the increment of the number of bunch was less than 10 %.

The oil palm root that is not deep (1-2 m) on block 1 (bund terrace) could immediately and maximally utilize the soil moisture storage on soil solum that is not deep for the processes of evapotranspiration and photosynthesis. Moreover, the temporary ground water in block 1 was shallower (measured by monitoring the well) therefore it was easily available for the water requirement of oil palm. On the contrary, the soil solum on block 3 (silt-pit) that was deeper (> 3 meter) caused the infiltrated and percolated rainfall to go down much deeper than the root depth (measured by monitoring the well) thus it was not readily available and more difficult to be utilized by oil palm root that was only 1 – 2 meter depth. In line with this result, the silt-pit treatment on a cashew plantation in Sano Ngguang, Manggarai Barat NTT could increase the soil moisture storage in the dry season and the production (Firman, 2006). The application of silt-pit on coffee plantation could also increase the soil moisture storage due to surface runoff could significantly be decreased (Dariah *et al*., 2004). Subagyono (2007) stated that the soil and water conservation technology was designed to increase the water absorption through infiltration and water detention in the depression storage and reduce water loss due to evaporation. Water harvesting aims to reduce the surface runoff volume, but it could also increase the soil moisture storage and water availability for plants (Irianto and Rejekiningrum, 2008; Murtilaksono *et al*., 2008b). Based on the description of the treatment effects on the ABW, NB, and FFB, the application of ditched bund terraces and silt-pits effectively increased the productions (ABW, NB, FFB) of oil palm in Afdeling III, Management Unit of Rejosari, Nusantara Plantation Company VII, Lampung in 2007 – 2009.

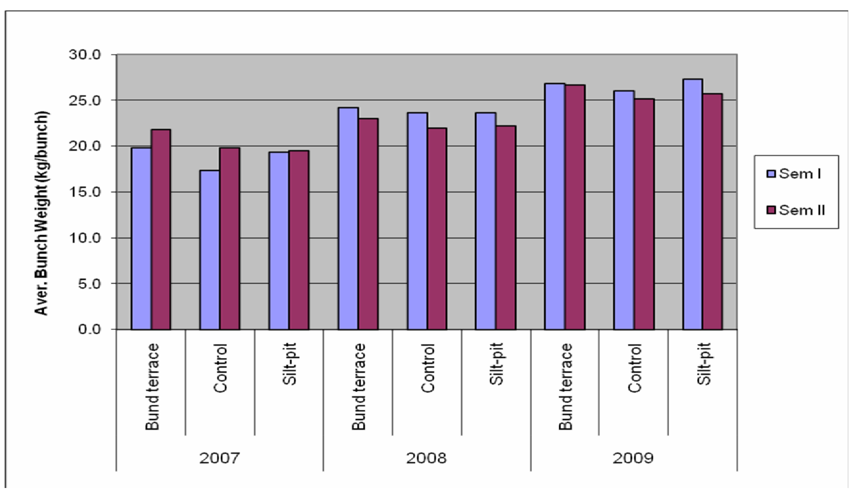

Figure 1. Average of bunch weight (ABW) per semester of each treatment in 2007 - 2009

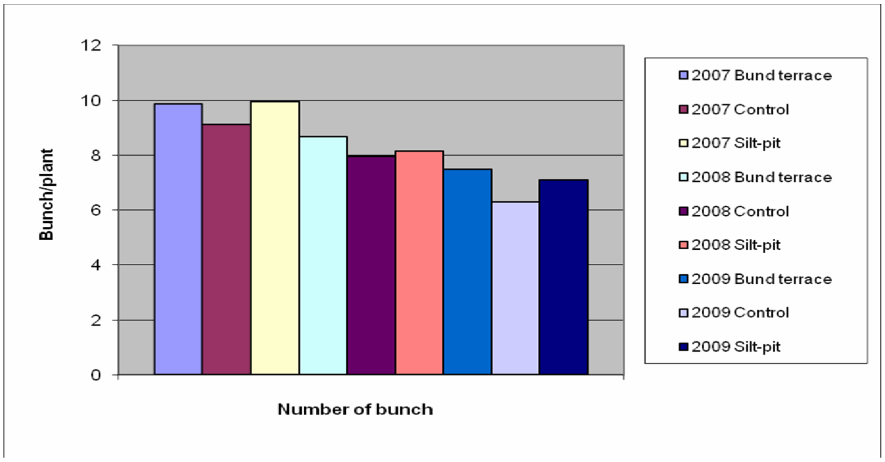

Figure 2. Average of number of bunch (ANB) per plant of each treatment in 2007-2009

Financial Analysis of the Application of Soil and Water Conservation

Evaluation on the success of a project implementation can be done by studying the financial feasibility. In financial analysis, the project profit for stakeholders particularly the estate management can be assessed. In order to assess the financial feasibility all data related to the cost aspect and obtained profit are needed. The data used for the analysis consisted of manpower, production infrastructures, production, price, manpower wage, and interest rate (Gittinger, 1986). To find out the financial feasibility, this research applied the analyses of BCR, NPV, and IRR, as well as sensitivity. There were four assumptions applied in the sensitivity analysis, namely a) the decline of FFB price, b) the drop in production, c) the fall of FFB price & production, and d) the decrease of FFB price & production occurring simultaneously with the rise in manpower wage. The rate of wage increment for the sensitivity test was 11%.

This figure was obtained from the average wage rate increment in Lampung from the beginning of the research (2005) until the end of the research (2009). The decrease of FFB price was assumed to be similar with the lowest FFB price happened in 2006 and fixed at Rp 750 per kg FFB or 32% from the normal price (Rp. 1,000 per kg FFB). The decline in production was assumed 15 % referring to the literature when there was dry spell in the previous year. In the development of an agriculture project, the fund generally comes from a bank loan. The interest rate of a loan for the investment in oil palm plantation is 18% since it was assumed that the estate management financed the investment with a bank loan. The values of BCR, NPV, and IRR in the financial analysis on the effect of bund terrace and silt-pit treatments on FFB production is enumerated completely in Table 2.

The analysis shows that the bund terrace treatment on oil palm plantation is significantly feasible to be implemented because it fulfills the requirement of feasibility i.e. BCR>1, NPV>0, and IRR> 18%. The bund terrace treatment still indicates feasible values by fulfilling the requirement of financial feasibility though the sensitivity analysis was applied. The application of bund terrace is still feasible though the FFB price and production dropped, even when the FFB price and production declined simultaneously with the increase in the wage rate. The application of silt-pit treatment indicates that it is sensitive to the decreases of FFB price and production, as well as the increment of the wage rate though the analysis shows that Rp. 1.00 of cost investment will provide a net profit of Rp. 0.13. The result of the sensitivity test shows that silt-pit treatment does not indicate good feasibility criteria (B/C<1, NPV<0, IRR<18%).

This is due to the discrepancy of FFB production from the silt-pit block and the control block that was not significant in 2008 and in the succeeding years by assuming that the production would be just the same as the production in 2008. This assumption considers that the rainfall would be normal and there would no dry spell.

Table 2. The values of benefit cost ratio (BCR), net present value (NPV), and internal rate of return (IRR) due to the effect of bund terrace and silt pit on fresh fruit bunch (FFB) production (in unit of hectare)

Kinds of analysis		**Bund terrace**	**Silt-pit**
Financial	BCR	3.06	1.13
	NPV (Rp)	8,041,880.00	507,998.00
	IRR (%)	47.00	5.00
Sensitivity			
a. Price of FFB dropped to Rp.750,-/kg	BCR	2.09	0.77
	NPV (Rp)	4,253,244.00	866,481.00
	IRR (%)	27.0	- 9.0
b. Production dropped by 15%	BCR	2.61	0.96
	NPV (Rp)	6,255,808.00	- 139,971.00
	IRR (%)	38.0	- 1.3
c. Price of FFB dropped to Rp.750,-/kg & production dropped by 15%	BCR	1.78	0.66
	NPV (Rp)	3,035,467.00	-1,308,278.00
	IRR (%)	20.0	- 13.1
d. Price of FFB dropped to Rp.750,-/kg, production dropped by 15%, and wage rose by 11%	BCR	1.73	0.64
	NPV (Rp)	2,924,225.00	- 1,419,520.00
	IRR (%)	19.0	- 14.1

Assumption: the price of FFB is Rp 1,100.00/kg

The financial analysis shows that bund terrace treatment for a period of 10 years (the remaining plant productive age in the study area) is still profitable and feasible to be applied on oil palm plantation even though the FFB price and production drop and the wage rate increases. The application of silt-pit treatment on the oil palm plantation in the following 10 years is still profitable, however, it is not feasible because the sensitivity test shows that the treatment does not meet the feasibility requirement, BCR<1, NPV<0, and IRR<18%. The research was carried out on 13 years old oil palm plants and the economic life of oil palm approaches 25 years, therefore the analysis used the horizon time of 10 years. The calculation shows that the implementation of silt-pit treatment will be profitable if the FFB price is Rp. 1,000/kg. If the FFB price is less than Rp.1.000/kg and the wage increases more than 10%, the implementation of silt-pit treatment will not be feasible. Moreover, the cost and possible environmental and social benefits can actually be calculated because the application of soil and water conservation highly affects the calculation of NPV, or in determining the feasibility of investment (Manurung, 2001).

CONCLUSSIONS AND SUGGESTION

The application of ditched bunch terraces and silt-pits combined with water-retarded holes effectively increases the number of bunches , average of bunch weight, and the production of FFB.

In the period of 2007 – 2009, the application of bund terraces gives the best effect on the production of FFB per block or per hectare (25.2, 24.9, and 26.2 ton/ha) compared to the production of FFB with the silt-pit treatment (23.6, 22.8, and 24.8 ton/ha), even compared to the block without the application of soil and water conservation or the control block (20.8, 22.1, and 19.9 ton/ha).

The application of bund terraces is more effective to increase the average FFB production by 21.5% while the silt-pit treatment only increases the production by 13.4% compared to the production of the block without the application of soil and water conservation techniques.

The application of bund terraces is more feasible to be implemented than the silt-pits because it is not sensitive to FFB price and production drops and the wage rate increase (B/C = 1.73, IRR = 19.0%) though the application of silt-pit is still more profitable than the production of the block without the application of soil and water conservation techniques.

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