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Impact of Upland Agriculture and Conservation Project (UACP) on Sustainable Agriculture Development in Serang Watershed, Indonesia

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ABSTRACT

The poor economic conditions and low productivity of upland agriculture in marginal land have trapped the farmers in a poverty circle. Several attempts have been made to push the farmers out of the poverty circle. One of these attempts is the introduction of conservation farming systems suited to those conditions. In the Serang watershed, these efforts have been introduced through the Upland Agriculture and Conservation Project (UACP). This study was to evaluate the performance of the UACP in Serang Watershed (a part of Jratunseluna Watersheds). It is clear from this study that UACP has reduced soil loss drastically (60-90%) even though the erosion rate still higher than the tolerable soil loss (TSL = 10-12 ton/ha/yr) and is not compensated for by the increased farmers income (10 to 30%). The reduction of soil loss was ranged from 60 to 90% and the farmers income increment was ranged from 10 to 30 %. The still high soil loss is mainly due to the low quality of terraces (one of the soil conservation practices in UACP) because of poor maintenance. Improvements of terrace quality and crop and management practices are certainly required to further decrease soil loss to reach the local TSL.

The ability of farmers to maintain the introduced conservation technology is quite variable there are four types of farmers (A, B, C and D) in the area based on their source of income. Their income was ranged from Rp. 409.000 to Rp. 1.347.000 per year. It was observed that the type A farmers in particular did not gain enough income to continue to maintain the conservation technology. Therefore, the type A farmers still need financial assistance to maintain the introduced farming systems. All farmers however, still need guidelines and further trainings to upgrade the conservation technology and improve the soil and crop management practices to enhance the sustainability of the introduced conservation farming systems. Recommendations to increase the sustainability of the introduced farming systems are discussed.

INTRODUCTION

Java with a population density of more than 800 per square kilometer is experiencing an ever-increasing demand for food and fiber. This land use pressure results in serious environmental degradation. Consequently, the extent of degraded land is increasing year by year, and rivers of the region carry some of the highest loads of sediment in the world (Sukartiko, 1988). With the population of Java being expected to double in the next 35 years and paddy rice production reaching a plateau, the upland areas are the last frontier for food production (Barrau and Djati, 1985). One of the important group of soil in the upland areas in Java is the Ultisols, which have a thin surface horizon, high clay sub-soil, low pH, high aluminum levels, poor fertility, low CEC, low infiltration and permeability rate and high susceptibility to erosion. With poor management practices (cultivation without adequate soil and water conservation practices, SWCP), erosion rates in the upland area are high and productivity is low. Typical erosion rate in upland areas in Jratunseluna and Brantas Watersheds is 30 to 80 ton/ha/yr (Sukartiko, 1988) although erosion rates of greater than 200 ton/ha/yr have been recorded (USAID, 1984; Suwardjo and Sofijah, 1989). The deleterious effect of erosion on productivity is not well defined. Some data from a soil scalping experiment have shown yield losses of 48 % following removal of 150 mm of soil in Sumatra, Indonesia (Sudirman et al., 1986), 23 % for 229 mm, 46 % for 457 mm and 63 % for removal of 686 mm of soil in Australia (Harmswarth and Barreth, 1972). Due to the low productivity, the average income of farmers in the upland area is less than US $ 500.00 per household per year with each household having an average of 5 members (Achlil, 1978; PT EXSA, 1993). This very low level of income has discouraged farmers from spending on soil and water conservation practices even though they know that erosion is occurring and decreasing their land's productivity. They tend to use all their income to satisfy their daily consumption needs (Djajadiningrat and Amin, 1992). This situation has trapped the poor farmers and marginal land in a poverty circle; the farmers and the land become poorer and worse year-by-year. The offsite effects of soil erosion can be even greater, although difficult to quantify. Degraded lands produce higher rates of runoff resulting in increased flood damage to structures and farmlands. Sediment associated with this runoff is causing problems by reducing the life of multipurpose reservoirs, disrupting irrigation systems, polluting fisheries, and degrading the quality of drinking water. One of the conservation projects that was intended to alleviate the above problems and to establish a sustainable conservation farming systems was the UACP. The UACP was designed to increase the productivity and sustainability of upland agriculture in Jratunseluna and Brantas watersheds (1985-1990). The main components of this project were the construction or rehabilitation of bench terraces and the improvement of crop management practices. The purpose of this paper is to evaluate the performance of the UACP in Serang watershed (part of Jratunseluna watershed).

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Table 1. Number and distribution of farms/farmers observed in Serang Watershed.

Village	Year of terrace Construction	Demplot Farms*	Impact Farms**	Outside Project
Gondang Legi	1986/1987	10	10	9
Gunung Sari	1988/1989	10	10	9
Bengle	1989/1990	10	10	9

*Demplot Farms are farms that received guidance and training for building terraces or improving existing terraces and improving cropping pattern. The farmers in this group also received financial assistance for purchasing seed and fertilizers.

**Impact farms are farms that received financial assistance for purchasing seed and fertilizers only.

Table 2. Average farmers income and source in the Upper Serang Watershed.

Farmers Category*	Income Sources								
	Paddy field		Upland Agric		Livestock		Off-farm		Total
	Rp 1000**)	% of total	Rp 1000	% of total	Rp. 1000	% of total	Rp. 1000	% of total	Rp 1000
Type A	0	0	265	65	144	35	0	0	409
Type B	259	24	422	40	381	36	0	0	1062
Type C	0	0	505	48	153	15	582	37	1040
Type D	310	23	425	32	207	15	404	30	1347

*Type A = Farmers who have income from upland agriculture and livestock only; Type B = Farmers who have income from upland agriculture, livestock, and paddy field; Type C= Farmers who have income from upland agriculture, livestock, and off-farm income; Type D = Farmers who have income from upland agriculture, livestock, paddy field, and off-farm income.

**1 US $ = Rp. 2000.

Table 3. Average predicted erosion rate (ton/ha/yr) as affected by conservation farming project

Farmers Scheme	Erosion before project		Erosion after project		Effectiveness of the project in decreasing erosion (%)	
	*a**	*b*	*a*	*b*	*a*	*b*
Demplot	300	466	96	51	89	77
Impact	483	671	193	180	66	86

*a: No terrace in original condition, project constructed new terrace; b: Terrace have been constructed in original condition, project improved the terraces.

MATERIALS AND METHOD

This research was carried out in the upper Serang watershed from March to December 1992. Data employed in this research were obtained from primary and secondary sources. The performance criteria of the UACP to be evaluated were the physical quality of terraces, the effectiveness of terraces and crop management improvements in controlling erosion and increasing crop yields, and the sustainability of the introduced conservation technologies. The physical quality of the terraces was measured in the sampled farms of the different schemes in term of year of construction by field observations using standard guidelines. The effectiveness of soil conservation technologies (terraces) in controlling erosion was evaluated using the USLE. The impact of the terraces and crop management technologies on crop yield and farm incomes was evaluated by interviewing selected farmers. The farms and farmers that were observed and interviewed were sampled using a stratified sampling technique; based on year of terrace construction and farmers group (demonstration plot, impact, and outside project farms and farmers). The farms/farmers observed/interviewed were 10 farms for demonstration plots and impact, and 9 farms outside the project of each fiscal year (year of terrace construction) (Table 1).

RESULTS AND DISCUSSION

Farmers Characteristics

Farmers in the Upper Serang Watershed generally owned a relatively small agriculture land, range from 0.20 to 0.22 ha of paddy field (sawah) and from 0.46 to 0.66 ha of upland area per household. Based on the sources of income, all farmers were categorized into four types (Table 2). Type A farmers are those who have income from upland agriculture and livestock; type B are farmers who have income from upland agriculture, livestock, and paddy field; type C are farmers who have income from upland agriculture, livestock, and off farm income; and Type D are farmers who have income from upland agriculture, livestock, paddy field, and off farm income. Upland agriculture is generally the main source of income in the area; it ranges from 40 to 60% of total income for type A, B and C farmers respectively (Table 2).

Effect of Conservation Farming in Controlling Erosion

The activities in the UACP in assisting farmers to establish a better conservation farming system have been very successful in term of decreasing erosion rate. The erosion rate has been decreased significantly; its effectiveness ranged from 66% to 89% (Table 3). The projects that were most effective in decreasing erosion rates on the demonstration plot farms were those where there were no terraces in the original condition (Table 3). The lack of conservation measures on these farms before project led to a very high erosion rate. On the other hand, during the project these farms received guidance and assistance from extension workers in building better terraces that would reduce erosion rates. Even though the erosion rate has been decreased substantially, the rate is still greater than the tolerable soil loss (TSL) in the area that ranges from 10-12 ton ha^{-1} yr^{-1}. This is apparently because rainfall erosivity in this area is high (1750 – 2750), most of the farms are in steep slope (8-35%), and the effectiveness of the terraces in controlling erosion is medium (medium quality terrace). The factors that decreased the effectiveness of the terraces are the poor maintenance of the terrace channel, poor maintenance of drop structures, poor drainage ditch, poor maintenance, and uncovered terrace risers. It is apparent that the poor maintenance of the terraces is the main factor that caused the terraces to be less effective in controlling erosion. This is perhaps due to the lack of knowledge and skill of farmers in maintaining the function of the terraces. The high cost (Rp. 148,000 ha^{-1} yr^{-1}) for terrace maintenance may also substantially contribute to the poor maintenance inputs. To make the terraces more effective in controlling erosion and the conservation farming systems more sustainable, the terrace quality, cropping system, and crop management practices should be improved. The terrace risers and ridges should be covered by protective grasses; terrace channels, drop structures, and drainage ditches should also be improved. Cropping systems (pattern) should also be improved to ensure the field has adequate plant cover at the beginning and during the rainy season. Crop residues should also be applied as mulches to protect the soil surface from rain drop impact energy.

Farmer Incomes

The conservation farming project has increased farmer incomes in the upper Serang watershed (Table 4). This is because the conservation farming project has increased the farms productivity.

Table 4. Farmers total income (Rp/household/yr) and the income share of upland agriculture before and after the conservation farming project.

Farmers Type	Extent of Upland Agric (ha)	Before Project		After Project		Income Increment due to the Project		
		UA Rp.1000*	Total (Rp 1000)	UA (Rp 1000)	Total (Rp 1000)	UA (Rp 1000)	% of Upland	% of Total Income
Type A	0.358	226	370	265	409	39	11	10
Type B	0.441	130	770	422	1062	292	225	27
Type C	0.520	188	723	505	1040	317	169	30
Type D	0.396	230	1153	425	1347	194	84	14

*1 US$ = Rp. 2000.,

Table 5. Alternative of soil and crop management practices and erosion control improvement in the Upper Serang Watershed.

No	Alternative Management Practices	Values of			Predicted Erosion (ton/ha/yr)	TSL	Remarks
		C	P	CP			
1	Good quality terrace*. Intercroping corn + Upland rice rotate with groundnuts or soybean, crop residue used as mulch with minimum tillage**	0.090	0.04	0.0036	11.7	12.8	
2.	Good quality terrace* Intercroping Corn + cassava + soybean rotate with groundnuts + corn, crop residue used as mulch with minimum tillage **	0.075	0.04	0.0030	10.7	11.4	
3.	Good quality terrace*. Intercroping Corn + groundnuts, rotate with soybean, crop residue used as mulch with minimum tillage **	0.083	0.04	0.0030	10.0	11.4	
4.	Good quality terrace*. Upland rice-corn in rotation, crop residue used as mulch	0.083	0.04	0.0030	11.7	11.8	

*Good quality terrace refers to terrace on the contour with the following characteristics; a good and or/ maintained terrace channel and drop structure, terrace is level, dikes and risers are covered by grasses and there are no land slides.

**Minimum tillage is a tillage system, which cultivates the soil only as needed for planting. Not all areas cultivated.

It is obvious from Table 4 that the farmers total incomes were quite different for each farmer category before and after the project. The magnitude of the income increment after the project was also substantially different for each category. This indicates that the influence of the project was not the same to each farmer category even though the extent of their upland agriculture was more or less the same. This suggests that the subsidy through the project differentially affected farmer incomes for each category. The effectiveness of the project was the least for Type A farmers, followed by Type D, B, and C respectively. Type A farmers earned only an additional Rp. 39,000 through the conservation farming. This amount was not enough for terrace maintenance, which cost the farmers at least Rp. 148,000 ha^{-1} yr^{-1}. Even with their total income of Rp. 409,000 per year, these farmers could not escape from the poverty line of Rp. 600,000 per year. Therefore, it is impossible for these farmers to sustain their farms in good condition through improved conservation practices. Perhaps, some of the subsidies were used for home consumption making the subsidies ineffective. For the type D, B, and C farmers the subsidies through the conservation farming project increased incomes substantially. The magnitude of income increment was greater than the cost for terrace (*conservation technologies*) maintenance, which enabled the farmers to sustain their conservation farming systems as well. All of these farmers (types D, B, C) earned more income from other sources that enable them to sustain the conservation farming systems.

Farmers Perception of the Conservation Farming Technologies

Farmers perception of the conservation farming technologies are one of the determinant factors of the technology sustainability. Almost all farmers felt that the upland farming development was of the utmost important for their continued source of food and livelihood. This applies to situations where upland agriculture provides more than 40 % of their total income. After the conservation farming project, all farmers who participated the project understand the importance of soil conservation technologies in controlling erosion, the impact of erosion on declining soil fertility and farm productivity, and the importance of their active and continuous participation in establishing productive and sustainable conservation farming systems. Their failure to maintain the conservation farming systems adequately was not because of their lack of understanding or poor perception of the value of conservation farming, but rather that the farmers faced one or more of the following constraints:

1) The farmers lacked of detailed knowledge of the functions of the terrace components (terrace channel/drainage ditch, terrace risers and ridges, waterways and drop structures);
2) The farmers lacked of skills for constructing and maintaining a certain terrace component which requires precise accuracy;
3) The farmers lacked of family labor to maintain the terraces;
4) The farmers lacked of capital to hire adequate labor for constructing and maintaining good terraces;
5) The farmers lacked of knowledge about improving soil and crop management practices such as planting protective grasses on terrace risers, using crop residues as mulches, not planting cassava on terrace ridges, and applying appropriate crop rotation.

Sustainability of the Conservation Farming Technologies

Sustainability of a conservation farming systems (CFS) is very much dependent on three main characteristics. They are: (1) the ability of the CFS to maintain soil loss below TSL, (2) the effectiveness of the CFS to increase farmers income to enable the farmers to use their savings to maintain the conservation technologies, and (3) the acceptance and replicability of the applied technologies. The technology should be acceptable socially and replicable by local resources including knowledge, skill, and perception. A sustainable CFS should have these three characteristics. In the upper Serang watershed, the introduced CFS certainly has improved the agriculture systems significantly as mentioned earlier but not to the stage where they are sustainable. The rate of erosion is still too high, farm productivity and farmer incomes are still too low particularly for type A farmers, and the knowledge and skill of the farmers for terrace maintenance still needs improvement. To make the Introduced agriculture systems and conservation technologies sustainable the following recommendations should be implemented:

- The soil loss should be decreased further until it is lower than the TSL in the area.
- The soil loss should be further decreased by improving terrace quality and improving soil and crop management practices.
- Farmers income should also be further increased by increasing farms productivity and improving produce marketing systems.

Alternative mitigations that are based on local conditions (biophysics and farmers socioeconomic circumstances) are listed in Table 5.

Farm productivity can be further increased by improvements in soil and crop management systems including the selection of appropriate crops and the application of proper cropping systems and/or rotation (Table 5). Financial assistance for purchasing seed and fertilizers are still needed in the area particularly for type A farmers. The scheme of financial assistance need not be the same for all farmers. Type A farmers need the assistance the most compared to other farmer categories. This financial assistance may not be in the form of a subsidy but as a soft loan. By a continuous and deliberate assistance program, all farmers should be capable of increasing their farm productivity and income gradually. Continuous extension services on terrace maintenance, better soil and crop management practices, and improved produce marketing systems are extremely important for the area. Therefore, the number and quality of extension workers should be increased through a good training program. Guidelines (manual) for terrace maintenance should be provided to the extension workers.

CONCLUSIONS

Farmers in the Upper Serang Watershed comprise at least four types of farmers with different capability and potential to maintain the introduced conservation farming systems. The conservation farming systems have decreased erosion significantly but the magnitude of the existing erosion should be further decreased to reach the local tolerable soil loss. Income increments as affected by the introduced conservation farming systems are significantly different for each different type of farmer. Type A farmers do not have the capacity to gain sufficient extra income to continue to maintain the conservation technology. However, the type B, C, and D farmers have achieved considerably higher income increment due to the conservation farming and they may be able to continue to maintain the conservation technology. Type A farmers still need financial support to maintain their conservation farming. All farmers need further training to fine tune and upgrade the conservation technology and to improve the soil and crop management practices to enhance the sustainability of the conservation farming systems.

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