SOCIAL-ECONOMIC REASONS TO SOIL CONSERVATION: AN ECONOMETRIC ANALYSIS ON CROSS-SECTIONAL LORE LINDU DATA[a]

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ABSTRAK

Konservasi tanah memiliki peranan penting dalam menentukan keberlanjutan sektor pertanian. Tujuan penelitian ini adalah menganalisis faktor-faktor yang mempengaruhi keputusan petani untuk mengkonservasi atau tidak mengkonservasi lahan pertaniannya. Penelitian ini menggunakan data primer sampel petani sawah di sekitar kawasan Taman Nasional Lore Lindu (TNLL). Dari sampel tersebut, hanya 13,5 persen saja yang melakukan konservasi lahan. Di antara hasil penelitian ini, ditemukan bahwa ternyata konservasi lahan merupakan variabel endogenus, yang berarti keputusan petani untuk mengkonservasi (atau tidak mengkonservasi) lahan tergantung pada beberapa faktor. Faktor yang berpengaruh nyata di antaranya ialah jumlah output yang dihasilkan, persepsi kualitas lahan, jumlah anggota rumah tangga petani, dan usia petani. Dengan menggunakan pendekatan *instrumental variable*, ditemukan bahwa keputusan untuk mengkonservasi (atau tidak mengkonservasi) lahan berpengaruh nyata terhadap jumlah output yang dihasilkan. Output tersebut juga dipengaruhi oleh luas areal dan—dengan taraf signifikansi yang lebih lemah—oleh jumlah kredit. Agar usahatani berkelanjutan, pemerintah disarankan untuk menentukan batas-batas TNLL secara jelas, mengeluarkan sertifikat tanah, dan memperbaiki akses petani kepada kredit mikro.

Kata kunci : *endogenitas dari konservasi lahan, faktor-faktor sosial-ekonomi, model logit, Taman Nasional Lore Lindu,*

ABSTRACT

Soil conservation plays critical role on agricultural sustainability. The aims of this study are to analyze factors affecting farmers' decision to conserve or not to conserve their farming land and to evaluate simultaneously effects of such decision on their output. The study uses data gathered from samples of wetland rice farmers in the surrounding area of the Lore Lindu National Park (LLNP). There are only 13.5 percent of the farmers undertaking soil conservation. Soil conservation is found to be an endogenous variable, implying that farmers' decision to conserve (or not to conserve) depends on a number of factors. Among these factors, the significant ones are quantity of output produced, the perceived quality of farm land, farmer's family size, and age of the farmer. Using the

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instrumental variable approach, it is found that the decision of whether or not to carry out soil conservation affects the output significantly. This output is also affected by acreage and, to a lesser significance level, by the amount of credit. The government is recommended to establish clear boundaries of the LLNP, issue proper land rights, and improve accesses to micro-credit in order to promote sustainable agricultural practices.

Key words : *endogeneity of soil conservation, social-economic factors, logit model, Lore Lindu National Park*

INTRODUCTION

Background

Conservation of agricultural or farm land plays a critical role in determining long run quality, and hence productivity, of the land. Thus negligence in farm land conservation would affect farm productivity, agricultural output, and sustainability of agricultural sector. In Indonesia's agricultural economic literature, farmland conservation related studies generally attempt to measure economic effects of conservation. In order to carry out the measurement, most of these studies assume that conservation is given (i.e. exogenous), implying that farmers' decision to conserve or not to conserve is irrelevant. Such an approach seems to be counter factual because at least some farmers have considerations on whether to conserve their land or not. The fact that farmers tend to be short sighted (i.e. maximize short run gains by not conserving their land) indeed reflects that conservation is not exogenous. Even when conservation is made available (given) to farmers farming in the buffer zone of the Lore Lindu National Park (LLNP) as a program, still they cannot be forced to adopt such a program on their own land. In order to promote conservation, therefore, it is important to acquire factors affecting farmers' decision to conserve or not to conserve their land. By understanding these factors, it is hoped that conservation program can be designed appropriately, increasing the probability of farmers to adopt the program and the sustainability of the farms as well as the national park.

A study which does not treat conservation as an exogenous factor is Pakpahan and Syafa'at (1991).[1] A crucial problem with this study, however, is that 'conservation' is represented indirectly by locations experiencing heavy versus low land erosion. Such a representation might only be valid under the condition that variations in the degrees of erosion are due to variations in applications of conservation method(s). This condition apparently does not hold because none of the explanatory variables (i.e. factors affecting conservation) in Pakpahan and Syafa'at's model is statistically significant. Instead of indirectly

[1] Sudaryanto and Kasryno (1999) constructed a quite similar approach for adoption of modern rice variety.

representing conservation with this kind of proxy, it is therefore instructive to use a more direct measure of conservation application in similar modeling.[2] In addition to this, it is also important to evaluate how the decision to conserve or not to conserve affects production. These two points motivate us to carry out this study.

Aims and Objectives

The main aims of this paper are to analyze factors affecting farmers' decision to conserve or not to conserve their land plots, and to evaluate simultaneously effects of such a decision on their output. For this purpose, we use relevant data of wetland rice (*sawah* paddy) farming in the buffer zone of the LLNP. The aims would be reached through objectives as follows: (a) to describe social-economic aspects of wetland rice farms with and without land conservation, (b) to test econometrically the endogeneity of the farmers' decision to conserve their land, (c) to analyze simultaneously effects of output as well as farmers' social-economic conditions on decision to conserve (or not to conserve), and of this decision (together with uses of farm inputs) on the output, and (d) to draw policy implications related to results of analysis on factors affecting farmers' decision to undertake land conservation and its feedback to production that are relevant for the buffer zone. This would need also to consider the regional autonomy law that has just been enacted recently.

METHODS

Data

The data used in this study originates from the 2001/2002 farm household survey around the LLNP. The survey covered two villages (Watumaeta and Wuasa) in *Kecamatan* (Subdistrict) Watumaeta – *Kabupaten* (District of) Poso, and three villages (Maranata, Sidondo-2, and Pandere) in *Kecamatan* Sigibiromaru – *Kabupaten* Donggala. For the case of wet-land rice, the total number of sampled farmers is 173 farmers.[3] Eliminating missing observations and outliers leads to an effective sample size of 111. Variables constructed from the raw data, their mnemonics and definitions are presented in Appendix 1.

Conservation is measured by a dummy variable (DSOILCON), whose value is 1 for farmers applying any meaningful kind of soil conservation and 0

[2] Arifin (2002) applies this approach on farm level data from an upland area in the province of Lampung. His study, however, does not attempt to analyze simultaneously effects of the conservation decision on farm production.

[3] The samples domicile within the buffer zone of the LLNP, and undertake the cultivation on their own land in the zone. In other words, the status of the sampled farming plots is of private.

otherwise. The only type of soil conservation adopted by the sample is the simple terracing. Since farming activities in the sampling area are generally traditional, only a few farmers use modern chemical inputs. As such, the database generated from the survey contains no inputs data except farm area (PLOTSIZE). Employment (man-days) used in the farming process of production are also unavailable. Number of adults in each farmer household is, however, available and may be used as a proxy for the employment. As can be seen from Appendix 1, in total there are 25 relevant variables extracted or generated from the database.

The Model and Data Analysis

Uni-directional- and cross-tabulations are firstly made for variables describing social, economic, and institutional aspects of wet-land rice farms with and without land conservation. This aims to provide background information that would add to the discussions on results of the econometric analyses.

The next step is to carry out an endogeneity test for the farmers' decision to conserve their farmland. This is carried out by using the Hausman (1978) specification test, which can be used to check for endogeneity or exogeneity of an explanatory variable (Maddala, 1989, pp.437-439). In regard to undertaking this test, suppose a production function for the wetland paddy farming can be expressed as:

$$Y_i = \beta_0 + \Sigma_j \beta_j X_{ji} + \varepsilon_i \qquad (1)$$

where Y_i is output produced by farmer-i, X_{ji} is input-j used by farmer-i, β_j is marginal effect of changing the use of input X_j on output, and ε_i is error terms which does not correlate with any X_{ji}. If conservation is exogenous and a relevant factor affecting the output, then there is no reason to exclude DSOILCON from equation (1), so that it can be expressed as:

$$Y_i = \beta_0 + \Sigma_j \beta_j X_{ji} + \gamma Z_i + \varepsilon_i \qquad (2)$$

where Z_i is DSOILCON for farmer-i. Most empirical studies found that conservation affects (i.e. is relevant in determining) output. The endogeneity of Z_i is however subject to test. If Z_i is instrumental to X_{ji} and Z_i does not correlate with ε_i, then it is exogenous; but if it correlates with ε_i, then Z_i is endogenous. When Z_i is endogenous, we need to have an equation on conservation, which may be specified as a function of factors that affect farmers' decision to or not to conserve their farm land. On the model estimation aspect, the endogeneity of Z_i makes equation (2) cannot be estimated using the OLS which requires Z_i to be exogenous, and requires another estimation approach such as the two stage least square or instrumental variable.

Now we return to equation (1). In terms of variable mnemonics presented in Appendix 1, this equation, which may be seen as a restricted production function because it does not include DSOILCON, can be specified as follows:

$$PRODUCT_i = \beta_0 + \beta_1\ CRDAMOU_i + \beta_2\ PLOTSIZE_i + \beta_3\ DVARIETY_i + \beta_4\ DFARMORG_i + \beta_5\ FREQEXT_i + \beta_6\ NBRADLT_i + \beta_7\ DPROTRAI_i + \varepsilon_I \quad (1a)$$

In order to carry out the Hausman test, one needs to create an instrumental variable (Z_i). We do this by using DSOILCON specified as a function of the right hand side variables of equation (1a) and of a dummy variable for irrigation type (DIRRTYPE) as follows[4]:

$$DSOILCON_i = \alpha_0 + \alpha_1\ CRDAMOU_i + \alpha_2\ PLOTSIZE_i + \alpha_3\ DVARIETY_i + \alpha_4\ DFARMORG_i + \alpha_5\ FREQEXT_i + \alpha_6\ NBRADLT_i + \alpha_7\ DPROTRAI_i + \alpha_8\ DIRRTYPE_i + \nu_I \quad (3)$$

Since the dependent variable of equation (3) is a binary variable, then we use the logit model to specify this equation, and employ the maximum likelihood method to estimate it. The predicted value of equation (3) is then used as the instrument and inserted into equation (1a) to form the unrestricted production function as follows:

$$PRODUCT_i = \beta_0 + \beta_1\ CRDAMOU_i + \beta_2\ PLOTSIZE_i + \beta_3\ DVARIETY_i + \beta_4\ DFARMORG_i + \beta_5\ FREQEXT_i + \beta_6\ NBRADLT_i + \beta_7\ DPROTRAI_i + \gamma\ ZHAT_i + \varepsilon_I \quad (2a)$$

where ZHAT is the predicted value of DSOILCON. The Hausman test is then carried out by comparing the sum of squared error of equation (2a) and that of equation (1a).

As presented in Appendix 2, the null hypothesis that the instrumental variable does not correlate with the error term is rejected with the p-value 0.067, suggesting that soil conservation (DSOILCON) is endogenous. Therefore, in addition to a production function, it is necessary to specify another equation, i.e. on soil conservation, and both equations be estimated simultaneously.[5] The soil conservation equation is expressed as follows:[6]

$$DSOILCON_i = \alpha_0 + \alpha_1\ PRODUCT_i + \alpha_2\ CRDBANK_i + \alpha_3\ CRDGOVT_i + \alpha_4\ DIRRTYPE_i + \alpha_5\ DLANDQUA_i + \alpha_6\ PLOTHOUS_i +$$

[4] As presented in Appendix 1, DIRRTYPE=1 denotes that the source of irrigation is of technical, while DIRRTYPE=0 otherwise. This dummy variable is included in equation (3) in order to take into account that the irrigation types may (or may not) increase the probability of farmers to conserve their farm land.

[5] Equation (3) itself is only an auxiliary equation, specified and estimated in order to carry out the Hausman test. The same goes to equations (1a) and (2a).

[6] Discussion on the use of similar set of explanatory variables of the conservation equation can be found, for instance, in Lapar and Pandey (1997) and Arifin (2000).

$$\alpha_7 \text{ PLOTVAL}_i + \alpha_8 \text{ DPRBLAND}_i + \alpha_9 \text{ DPRBIRGN}_i +$$
$$\alpha_{10} \text{ FREQEXT}_i + \alpha_{11} \text{ FMLYSIZE}_i + \alpha_{12} \text{ HFMLYAGE}_i +$$
$$\alpha_{13} \text{ DSCHOOL1}_i + \alpha_{14} \text{ DSCHOOL2}_i + \alpha_{15} \text{ DOCCUPAT}_i + \nu_I \quad (4)$$

while the production function is specified as follows:

$$\text{PRODUCT}_i = \beta_0 + \beta_1 \text{ CRDAMOU}_i + \beta_2 \text{ PLOTSIZE}_i + \beta_3 \text{ DVARIETY}_i +$$
$$\beta_4 \text{ DFARMORG}_i + \beta_5 \text{ FREQEXT}_i + \beta_6 \text{ NBRADLT}_i +$$
$$\beta_7 \text{ DPROTRAI}_i + \beta_8 \text{ DSOILCONHAT}_i + \varepsilon_I \quad (5)$$

Equation (4) is specified so as to follow the logistic distribution (the logit specification) and will be estimated using the maximum likelihood. This is the first stage of the estimation. The predicted value of the dependent variable from the first stage will then be saved (i.e. DSOILCONHAT) and inserted into the production function, i.e. equation (5). Estimating this function (using OLS) serves as the second stage of this two-stage estimation approach, which is required for taking into account the simultaneity nature of both equations.

RESULTS AND DISCUSSION

Cross-Tabulations of Some Variables with Conservation

Before presenting cross-tabulations between some variables and conservation, it may be important to present descriptive statistics of the variables. As can be seen from Appendix 3, average plot size for wet land paddy cultivation in the survey area is 70.38 ares (or 0.7038 hectare) with average production of 806.32 kg. This suggests that the yield is approximately 1.15 tons/ha, which is considerably lower than the national yield of more than 4 tons/ha. This is understandable because, as mentioned earlier, the cultivation in the surveyed area is mostly conducted traditionally.

Out of 111 respondents, 15 farmers (i.e. 13.5%) applied the simple terracing (conservation) on their farming land (Appendix 3). Around 80 percent of these farmers own or operate farming areas of 50 ares or less (Table 1). As for farmers who do not apply any meaningful conservation method, 58.3 percent of them own or operate farming acreage of 50 ares or less, and almost 14 percent of them own the acreage of more than 100 ares (more than 1 hectare). In total, 61.3 percent of respondents have acreage of 0.5 hectare or less.

Consistent with the data on plot size, around 67 percent of the farmers who applied conservation produce 500 kg of paddy or lower, and none of them produce more than 1 ton (Table 2). Amongst farmers who applied no conservation, on the other hand, 24 percent of them produce paddy of more than 1000 kg. Since only 13.5 percent of these farmers owning farming plot of more than 1 hectare, this indicates that these farmers produce higher yield than those with conservation. This finding is consistent with Pakpahan and Syafa'at (1991).

Table 1. Plot Size (Ares) of Farmers with Conservation versus Those without Conservation

	≤ 50 Ares	50.1 – 100 Ares	≥ 100.1 Ares	Total
No Conservation	56	27	13	96
	(58.3)	(28.1)	(13.5)	(100.0)
Conservation	12	2	1	15
	(80.0)	(13.3)	(6.7)	(100.0)
Total	68	29	14	111
	(61.3)	(26.1)	(12.6)	(100.0)

Note: Figures in the parentheses are percentage of the total (last column).

Table 2. Production (kilograms) of Farms with Conservation versus Those without Conservation

	≤ 500 kg	501-1000 kg	> 1000 kg	Total
No Conservation	43	30	23	96
	(44.8)	(31.3)	(24.0)	(100.0)
Conservation	10	5	0	15
	(66.7)	(33.3)	(0.0)	(100.0)
Total	53	35	23	111
	(47.7)	(31.5)	(20.7)	(100.0)

Note: Figures in the parentheses are percentage of the total (last column).

There are two possible explanations on the above finding. First, the terracing applied by the farmers actually reduces the land surface which can be planted effectively. This decreases production and yield. In the long run, because the terracing minimizes erosion of the top soil, the yield would be higher than that of non-terraced farms. Second, as shown in Table 3, there are only about 7 percent of the farmers applying conservation who have access to technical irrigation system, whereas the figure for the farmers without conservation is much higher (approximately 33%). The limited access of the former farmers is due to location of their farming plots, which generally are quite remote from the technical irrigation system.

Around 73 percent of farmers adopting conservation have not used agricultural (production) credit (Table 4). For the farmers without conservation, the situation is similar but with a less percentage (approximately 58%). Around 30 percent of these farmers used credit amounted between Rp 100,000 and Rp

500,000 as compared to approximately 13% for farmers adopting conservation. Differing access to credit might also explain different yield between the two groups of sampled farmers.

Table 3. Types of Irrigation Accessed by Farmers with Conservation versus Those without Conservation

	Non-technical Irrig.	Technical Irrig.	Total
No Conservation	64	32	96
	(66.7)	(33.3)	(100.0)
Conservation	14	1	15
	(93.3)	(6.7)	(100.0)
Total	78	33	111
	(70.3)	(29.7)	(100.0)

Note: Figures in the parentheses are percentage of the total (last column).

Table 4. Amount of Credit (Rp) Used by Farmers with Conservation versus Those without Conservation

	No credit	100000-250000	250001-500000	500001-1000000	>1000000	Total
No Conservation	56	15	14	5	6	96
	(58.3)	(15.6)	(14.6)	(5.2)	(6.3)	(100.0)
Conservation	11	1	1	1	1	15
	(73.3)	(6.7)	(6.7)	(6.7)	(6.7)	(100.0)
Total	67	16	15	6	7	111
	(60.4)	(14.4)	(13.5)	(5.4)	(6.3)	(100.0)

Note: Figures in the parentheses are percentage of the total (last column).

In terms of the number of adults in the farmers' family –reflecting family labor, there is a tendency that farmers adopting conservation have more family labor than the other group of farmers. As can be seen from Table 5, 80 percent of farm households adopting the terracing consist of four adults or more, while the figure for the other group of households is approximately 58 percent. Such a higher availability of family labor enables the former group of households to undertake the conservation.

In terms of the use of seeds, both groups of the farmers mainly (around 93% to 98%) used non-improved or local/traditional varieties of paddy (Table 6). Among the farmers adopting no conservation, only around 5 percent of them used improved paddy varieties, whereas for the other group of farmers there is only a farmer adopting an improved variety.

Table 5. Number of Adults in the Family of Farmers with Conservation versus Those without Conservation

	1-3 Persons	4-6 Persons	> 6 Persons	Total
No Conservation	40	52	4	96
	(41.7)	(54.2)	(4.2)	(100.0)
Conservation	3	9	3	15
	(20.0)	(60.0)	(20.0)	(100.0)
Total	43	61	7	111
	(38.7)	(55.0)	(6.3)	(100.0)

Note: Figures in the parentheses are percentage of the total (last column).

Table 6. Types of Seed Variety Used by Farmers with Conservation versus Those without Conservation

	Non-improved Var.	Improved Var.	Total
No Conservation	91	5	96
	(94.8)	(5.2)	(100.0)
Conservation	14	1	15
	(93.3)	(6.7)	(100.0)
Total	105	6	111
	(94.6)	(5.4)	(100.0)

Note: Figures in the parentheses are percentage of the total (last column).

It is apparent from Table 7 that the farmers mainly consumed their own production. Around 80 percent of the farmers applying conservation use the paddy produced for their own consumption. More than 45 percent of the farmers without conservation, on the other hand, sold the paddy they produced in order to earn returns of more than Rp 200,000. This reflects that this group of farmers tends to be relatively more market oriented than the other group.

Table 7. Amount of Paddy Sold by Farmers with Conservation versus Those without Conservation

	Subsistence	20000-200000	200001-1500000	> 1500001	Total
No Conservation	46	6	34	10	96
	(47.9)	(6.3)	(35.4)	(10.4)	(100.0)
Conservation	12	2	1	0	15
	(80.0)	(13.3)	(6.7)	(0.0)	(100.0)
Total	58	8	35	10	111
	(52.3)	(7.2)	(31.5)	(9.0)	(100.0)

Note: Figures in the parentheses are percentage of the total (last column).

The tendency of being more market oriented perhaps associates with a slightly higher frequency of the farmers with no conservation in consulting agricultural extension workers (Table 8). Almost 67 percent of the farmers applying soil conservation never consulted any extension workers. And among those who consulted the extension workers in this group of farmers (the other 33%), all of them do the consultation by as few as 1 to 4 times a year.

Table 8. Frequency Meeting Extension Workers by Farmers with Conservation versus Those without Conservation

	Never	1-4 Times	5-9 Times	>= 10 Times	Total
No Conservation	60	28	5	3	96
	(62.5)	(29.2)	(5.2)	(3.1)	(100.0)
Conservation	10	5	0	0	15
	(66.7)	(33.3)	(0.0)	(0.0)	(100.0)
Total	70	33	5	3	111
	(63.1)	(29.7)	(4.5)	(2.7)	(100.0)

Note: Figures in the parentheses are percentage of the total (last column).

The above situation is quite consistent with the activity of farmers in farmer organizations. As can be seen from Table 9, amongst the farmers applying soil conservation, only around 7 percent attended farming related organizations, whereas that for the other group is about 17 percent. This and the evidence from Table 8 suggest that extension workers and organizations have not been employed optimally to induce farmers to conserve their land. Even though these institutions were optimally used to encourage or train farmers to carry out soil conservation, this would still be ineffective because the availability of labour to undertake that activity is considerably limited (mainly family sourced). Thus, unless there is an appropriate supporting program from the government or carefully designed credit to carry out such activity, it seems quite difficult for the farmers to apply soil conservation appropriately.[7]

Table 9. Types of Organisation Attended by Farmers with Conservation versus Those without Conservation

	Non-Farmer Org. or Non-Active	Farmer Org	Total
No Conservation	80	16	96
	(83.3)	(16.7)	(100.0)
Conservation	14	1	15
	(93.3)	(6.7)	(100.0)
Total	94	17	111
	(84.7)	(15.3)	(100.0)

Note: Figures in the parentheses are percentage of the total (last column).

[7] Sastrosoemardjo et al. (1995) propose a number of sustainable cultivation techniques (adopting soil conservation methods) that are feasible technically and financially for farms in the buffer zone of the LLNP. Most of them combine food and perennial crops, which would need credits for purchasing commercial inputs.

Factors Affecting Decision of Farmers to Adopt or Not to Adopt Conservation

Maximum likelihood estimates of the model depicted by equation (4) are presented in Table 10. The estimated model has a determination coefficient of 0.503, which is quite high for a model employing cross-sectional survey data. The model also has considerably high ability (around 92%) to predict the dependent variable (i.e. adoption of soil conservation) accurately.

Table 10. Maximum Likelihood Estimates of the Logit Model (Equation (4)) for Analyzing Factors Affecting Farmers' Decision to Conserve Their Land

VARIABLE NAME	ESTIMATED COEFFICIENT	ASYMPTOTIC STANDARD ERROR	ASYMPTOTIC T-RATIO	ELASTICITY AT MEANS	WEIGHTED AGGREGATE ELASTICITY
PRODUCT	-0.30126E-02	0.15891E-02	-1.8958*	-2.4288	-0.74996
CRDBANK	0.42138E-05	0.78184E-05	0.53896	1.5980	0.15279E-02
CRDGOVT	-0.29921E-04	0.54847E-03	-0.54553E-01	-0.43125	-0.60985E-05
DIRRTYPE	-1.4658	1.2463	-1.1761	-0.43573	-0.83387E-01
DLANDQUA	1.9056	1.0346	1.8418*	1.2874	0.84072
PLOTHOUS	-0.66742E-01	0.46731E-01	-1.4282	-1.5752	-0.52792
PLOTVAL	0.22197E-07	0.95886E-07	0.23149	0.16486	0.61385E-01
DPRBLAND	-1.2959	1.4212	-0.91182	-0.12841	-0.58876E-01
DPRBIRGN	-0.31461	0.82196	-0.38275	-0.13320	-0.65010E-01
FREQEXT	0.37270E-01	0.13503	0.27602	0.47002E-01	0.20001E-01
FMLYSIZE	0.34297	0.20695	1.6672*	1.9216	1.1091
HFMLYAGE	0.57031E-01	0.30585E-01	1.8647*	2.8800	1.7035
DSCHOOL1	-0.16279E-01	0.94704	-0.17189E-01	-0.10558E-01	-0.66250E-02
DSCHOOL2	-43.104	116.62	-0.36962	-6.6008	-0.10743E-03
DOCCUPAT	1.5138	1.5109	1.0019	1.2000	0.75927
CONSTANT	-6.5188	3.1468	-2.0716**	-6.5182	-3.5781

CRAGG-UHLER R-SQUARE = 0.50346
PERCENTAGE OF RIGHT PREDICTIONS = 0.91892

Note: * indicates that the estimate is significant under the 10% significance level,
** indicates that the estimate is significant under the 5% significance level.

As shown in Table 10, variables that have significant effects on the decision to conserve the land are level of production (PRODUCT), dummy variable for perceived land quality (DLANDQUA), family size (FMLYSIZE), and age of the household head (HFMLYAGE). Consistent with Pakpahan and Syafa'at (1991), production has a negative effect on the decision.[8] Empirical justification of this negative effect is that the paddy production in the sample areas is very low, with the average yield of only 1.15 tons/ha. Under this

[8] Negative short run effect of conservation on rice-wheat production is also found by Malik (2000) in Indian states of Punjab and Haryana.

situation, the resulting income is on average insufficient to be invested into the land conservation. So the conservation in general is adopted only if the farmers still have available time ('spare time').[9] Now if the production is higher, this must be originated from utilization of more inputs, especially working hours. As such, spare time decreases, and this would in turn reduce the willingness of farmers to conserve the farm land.[10]

The weighted aggregate elasticity for the production is approximately -0.75 (inelastic), indicating that an increase in paddy production or returns by 10 percent would decrease the probability of undertaking soil conservation by a farmer by 7.5 percent. It is this negative effect that perhaps makes most of the sample farmers tend to ignore or obscures positive long-run effects of the soil conservation. This may be seen as evidence that most of the sample farmers are shortsighted in regard to view the possible benefit of soil conservation. Liquidity constraint, limited accesses to credit and output markets may have forced them to be shortsighted. As suggested by Kasryno et al. (2001) and Saragih (1998), proper government interventions are required in order to avoid or overcome negative externalities which may become a case when the farming areas will have become more intensive in the surrounding area of the LLNP buffer zone.

Perceived quality of land has a positive effect on the decision to conserve the farming plot. The significance of this estimate suggests that when farmers have perceived their land as to have a low quality, they would tend to intensify its use in order to make up the production. That is to ignore its sustainability by neglecting soil conservation. This seems to be possible given constraints mentioned in the previous paragraph.

Family size also has a significant positive effect on the decision to undertake soil conservation. This significance and elastic magnitude (1.11) suggests that indeed the probability of conserving own land would be higher when the availability of labor increases. The age of household has the highest elasticity (1.70) amongst the significant variables. This indicates the importance of accumulating experience in order to undertake soil conservation. The importance of these two factors is consistent with the finding of Arifin (2002).

Frequency of consulting with extension workers (FREQEXT) has a positive effect on the probability of adopting soil conservation. Such an effect is, however, statistically insignificant. This is also the case for credits obtained by farmers from commercial banks (CRDBANK), which reflects that the credits may not be specifically use to support sustainable production process. The regression coefficient on distance from farmer's house to his/her land farm

[9] The authors thank the referee for pointing on this reason. Unfortunately the survey did not collect data on working hours, so quantitative justification cannot be presented along the reason.

[10] In the case of India, as argued by Malik (2000), the negative effect of conservation on rice-wheat production might relate to the output price which is under-priced.

(PLOTHOUS) also has the negative sign as expected, but is statistically insignificant as is the case in Arifin (2002).

Feedback of Conservation and Effects of Some Factors on the Production

Before estimating equation (5), one might pose a question on the possibility of the credit amount being an endogenous variable.[11] Anticipating this question, the possibility for credit to be endogenous is also statistically tested, i.e. jointly with DSOILCON (which was already supported). We use an equation the same as equation (3)—but without CRDAMOU—and a credit (CRDAMOU) equation, which is a function of the same set of explanatory variables as in the former equation, in order to create instrumental variables. The first equation, which uses the logit specification, is estimated by using the maximum likelihood method as before, and the second one is estimated by employing the OLS. Predicted values of these equations are then inserted into equation (2a), which now serves as an unrestricted production function. The restricted version of this function is the same as equation (1a) but without CRDAMOU. The error sum of squares of the restricted and the unrestricted equations are 0.46659E+08 and 0.45462E+08, respectively, with the degrees of freedom v_1=2 and v_2=104. The resulting F-statistic is 1.3691 with the p-value of 0.259. This suggests that, jointly with DSOILCON, CRDAMOU is not endogenous. Therefore, we use only DSOILCON, whose estimation results have been discussed above, in addition to production (PRODUCT) as endogenous variables of the system.

Now we continue to discuss estimation results of the production function. The results are presented in Table 11. Estimating the model depicted by equation (5) using the OLS, it is found that the dummy variable for the conservation (DSOILCONHAT) has significant negative effect on quantity of the output (paddy) produced. The reason for this negative effect is similar to that in the previous section as follows. Devoting significant amount of working hours (and money if any) for soil conservation is very costly for the farmers. Since land and labor are in general the only inputs used in the farms, too many times used for treating the land would result in less working hours available for direct farming activities. As a result, the output decreases.

Moreover, it is suggested in the literature that in the short run conservation results in lower level of output, whereas in the long run the output will be higher than that without the conservation. The notion that DSOILCONHAT has negative effect on the production indicates that the farmers are shortsighted. In agricultural economic studies, this assertion is not uncommon. Therefore, if farmers are encouraged to conserve, there is a need to provide them with a kind of incentive as a premium for accepting a lower level of

[11] This possibility becomes more relevant when the concept of derived demand for credit is asserted to take place. In this case, demand for credit increases as production or expected output gets higher.

current output in order to obtain a higher future production.[12] A probable kind of this incentive is to provide land certificates for land owners, who have not yet had such a certificate and undertake soil conservation, limited in the LLNP buffer zone.

Table 11. OLS Estimates of Factors Affecting Production (Equation (5))

VARIABLE NAME	ESTIMATED COEFFICIENT	STANDARD ERROR	T-RATIO 102 DF	P-VALUE	PARTIAL CORR.	STAND. COEFF.	ELASTICITY AT MEANS
DSOILCONHAT	-937.45	317.2	-2.955***	0.004	-0.281	-0.2565	-0.1571
CRDAMOU	0.64964E-04	0.4098E-04	1.585#	0.116	0.155	0.1297	0.0400
PLOTSIZE	6.3913	1.245	5.135***	0.000	0.453	0.4469	0.5579
DVARIETY	143.83	274.0	0.5250	0.601	0.052	0.0431	0.0096
DFARMORG	-13.612	174.6	-0.7794E-01	0.938	-0.008	-0.0065	-0.0026
FREQEXT	-2.9519	21.16	-0.1395	0.889	-0.014	-0.0116	-0.0046
NBRADLT	51.478	45.14	1.140	0.257	0.112	0.1041	0.2640
DPROTRAI	-153.17	138.0	-1.110	0.269	-0.109	-0.0979	-0.0702
CONSTANT	292.69	189.5	1.545#	0.125	0.151	0.0000	0.3630

R-SQUARE=0.3330 F (ANOVA)=6.366 P-value=0.000 Normal Statistic=1.068 P-value =0.225

Notes: *** indicates significant under the 1% significance level
# denotes significant under the 13% significance level.

Development of accessible credit sources (e.g. micro-credit schemes) seems to be an important factor in inducing the production to increase, which may partially offset the negative effect of DSOILCONHAT on short run production. This is supported by the effect of credit amount (CRDAMOU) on output that is significant under the 13 percent significance level. However, it is important to note that, under the current production technology, the output elasticity with respect to the amount of credit is low (0.04).

It can be seen from Table 11 that the most important factor affecting production is farming acreage (PLOTSIZE), which is statistically significant under any conventional significance level. This factor has the highest elasticity (0.56), indicating that a 10 percent increase in the plot size would increase the output by 5.6 percent. The significance of this factor –and the insignificance effects of other factors including types of seeds variety and labour on output– may have become a pushing factor for the farmers to extend whenever possible their plot size within the buffer zone of the Lore Lindu National Park. Establishing clear zone boundaries and enacting/acknowledging property rights on

[12] In regard to this incentive, on the regulation side, Wibowo (1999) suggests that the sustainability of the farming and its environment can be maintained by using a type of eco-labeling by the appropriate institution on outputs to be traded. Setiadi and Hutabarat (1999) discussed broader strategies for future sustainable agricultural development.

individuals' land or communal land appropriately are therefore important in order to avoid unwanted externalities.[13]

CONCLUSIONS AND IMPLICATIONS

There is only 13.5 percent of the respondents (sampled farmers) applying conservation (i.e., simple terracing) on their farm plots. This group of farmers, as well as the other 86.5 percent who do not conserve their farm land, are mainly traditional farmers in the sense that they employ almost no modern inputs, and that they mostly use the produced output (paddy) for their own consumption. In general, farmers who apply no soil conservation have a slightly better farming performance (yield) than the other group of farmers.

The Hausman test suggests that decision to undertake soil conservation is found to be endogenous, indicating that conservation cannot and should not be treated as a given factor that is exogenously designed and implemented uni-directionally, such as a top-down government program or project. We found that a decision to (or not to) conserve the soil is affected by a number of social-economic factors intrinsic in the farming or farmers. The current limited (low) level of output resulted from the farms, a considerable liquidity constraint and other limitations may have led farmers to maximize their short term returns over possible long run gains. This shortsightedness is reflected by as many as 86.5 percent of the farmers who have decided not to conserve their farm land.

Results of econometric analysis imply that farmers who adopt no conservation seem to understand the trade off between conservation and short run output level. If agricultural sustainability is considered as a crucial issue that must be handled appropriately, then conservation practices need to be promoted accordingly. This could be promoted among others by providing proper agricultural extension services, in order to assure the farmers that the negative effect of conservation on the production accrues only in the short run, while in the long run the effect is positive. Relaxing the liquidity constraint (opening farmers' access to micro-credit) and overcoming limitations that hinder the farmers to utilize modern farm inputs are also important in order to improve the yield which is as low as 1.15 tons/ha. It is expected that a higher yield to some extent would decrease the probability of farmers to 'mine' the land.

Related to the enactment of Law 22/1999 and Law 25/1999 on regional autonomy and the fiscal balance—which have been revised recently, it can be seen as a good momentum for the regional government to expand the issuances of land rights. Certainty in these rights, particularly on farm plots limited only in

[13] Discussion on the importance of property rights and land consolidation for agricultural sustainability in the Indonesian case can, for example, be found in Uphoff and Rasahan (1999) and Setiyanto (2001).

the buffer zone, is necessary in avoiding further encroachment into the LLNP. In addition, it would broaden the basis for the government to collect appropriate land and property taxes. Besides this positive point, it is nevertheless worth noting that the enactment of the laws in some districts has led to imposition of retributions collected from trucks delivering outputs across districts. When this is the case, the positive benefits resulted from the above program may be offset by social costs accrued through this retribution.

Last but not least, for further research, it is recommended that similar analysis with the one in this study should be repeated using longitudinal data. Using this kind of data, long term effects of undertaking soil conservation on production and the other way around can be evaluated more accurately. Furthermore, a proper analysis on factors affecting the needs of farmers for production credits and institutional analysis on this issue is considered important.

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Appendix 1: Definitions of Variables and Their Measurements

No. / Mnemonics	Definition	Measurement Unit
1. PRODUCT	Output (paddy) produced	Kilogram.
2. DCRGOOD	Dummy variable for harvest condition	1 = average or better, 0 = below average.
3. DSOILCON	Dummy variable for soil conservation	1 = apply soil conservation, 0 = no soil conservation.
4. DCRDBANK	Dummy variable for credit obtained from bank	1 = credit obtained from bank, 0 = otherwise.
5. DCRDGOVT	Dummy variable for credit obtained from a government program	1 = credit from government program, 0 = otherwise.
6. CRDAMOU	Amount of credit obtained	Rupiah.
7. DCRDREAS	Dummy variable for reason to apply credit	1 = for agricultural inputs, 0 = otherwise.
8. PLOTSIZE	The size (area) of the paddy farm	Ares.
9. DIRRTYPE	Dummy variable for irrigation type	1 = technical irrigation, 0 = otherwise.
10. DVARIETY	Dummy variable for paddy variety	1 = improved variety, 0 = otherwise.
11. PLOTHOUS	Distance from house to paddy farm	Minutes walk.
12. DLANDQUA	Dummy variable for perception of farmers on their lands' fertility	1 = fertile, 0 = otherwise.
13. PLOTVAL	Farmer's estimate on values of their land	Rupiah.
14. SAVALUE	Value of output (paddy) sold by farmer	Rupiah.
15. DFARMORG	Dummy variable for type of organization in which the farmer is active	1 = farmer organizations, 0 = other kinds of organizations.
16. DPRBLAND	Dummy variable for problems related to farming plot	1 = the plot is too steep, poor, or has unclear property right, 0 = otherwise.
17. DPRBIRGN	Dummy variable for problems related to irrigation	1 = irrigation is a problem, 0 = otherwise.
18. FREQEXT	Frequency of meeting with extension workers	Times a year.
19. NBRADLT	Number of adults in the farmer's family	Persons.
20. FMLYSIZE	The size of farmer's family	Persons.
21. HFMLYAGE	Age of the head of farmer's household	Years.
22. DSCHOOL1	Dummy variable for formal basic education of the head of farmer's household	1 = completed primary school up to attended (not completed) high school, 0 = otherwise.
23. DSCHOOL2	Dummy variable for formal higher education of the head of farmer's household	1 = completed high school or higher, 0 = otherwise.
24. DPROTRAI	Dummy variable for professional training	1 = attended, 0 = never.
25. DOCCUPAT	Dummy variable for main occupation	1 = self employed in agriculture, 0 = otherwise.

Appendix 2: The Hausman Test for Endogeneity of DSOILCON

1. Estimating the Instrumental Variable (DSOILCON or Z, Eq. (3)) Using the Logit Specification

VARIABLE NAME	ESTIMATED COEFFICIENT	ASYMPTOTIC STANDARD ERROR	ASYMPTOTIC T-RATIO	ELASTICITY AT MEANS	WEIGHTED AGGREGATE ELASTICITY
CRDAMOU	0.16217E-07	0.16759E-06	0.96762E-01	0.73716E-02	0.74950E-02
PLOTSIZE	-0.14181E-01	0.95769E-02	-1.4808	-0.91439	-0.56144
DVARIETY	0.50201	1.3277	0.37810	0.24860E-01	0.23032E-01
DFARMORG	-1.0212	1.1997	-0.85125	-0.14329	-0.56945E-01
FREQEXT	-0.78831E-01	0.15833	-0.49790	-0.91090E-01	-0.44507E-01
NBRADLT	0.25859	0.20996	1.2316	0.97964	0.89612
DPROTRAI	0.48111	0.68184	0.70561	0.16281	0.15221
DIRRTYPE	-1.9102	1.0798	-1.7691	-0.52028	-0.12179
CONSTANT	-1.8515	1.0546	-1.7556	-1.6962	-1.3927

2. Estimating Restricted Production Function (PRODUCT, Eq. (1a)) Using the OLS:

VARIABLE NAME	ESTIMATED COEFFICIENT	STANDARD ERROR	T-RATIO 102 DF	P-VALUE	PARTIAL CORR.	STAND. COEFF.	ELASTICITY AT MEANS
CRDAMOU	0.57328E-04	0.4240E-04	1.352	0.179	0.132	0.1145	0.0353
PLOTSIZE	7.2588	1.254	5.788	0.000	0.495	0.5075	0.6336
DVARIETY	139.99	284.1	0.4928	0.623	0.049	0.0419	0.0094
DFARMORG	-16.055	181.1	-0.8867E-01	0.930	-0.009	-0.0077	-0.0030
FREQEXT	3.6435	21.81	0.1670	0.868	0.016	0.0144	0.0057
NBRADLT	15.251	45.05	0.3386	0.736	0.033	0.0308	0.0782
DPROTRAI	-132.85	142.9	-0.9299	0.355	-0.091	-0.0849	-0.0609
CONSTANT	243.30	195.7	1.243	0.217	0.122	0.0000	0.3017

SUM OF SQUARED ERRORS-*SSEr*= 0.45846E+08

3. Estimating Unrestricted Production Function (PRODUCT, Eq. (2a)) Using the OLS:

VARIABLE NAME	ESTIMATED COEFFICIENT	STANDARD ERROR	T-RATIO 102 DF	P-VALUE	PARTIAL CORR.	STAND. COEFF.	ELASTICITY AT MEANS
CRDAMOU	0.68746E-04	0.4236E-04	1.623	0.108	0.159	0.1373	0.0423
PLOTSIZE	5.7415	1.486	3.865	0.000	0.357	0.4014	0.5011
DVARIETY	182.94	281.7	0.6494	0.518	0.064	0.0548	0.0123
DFARMORG	-102.33	184.9	-0.5533	0.581	-0.055	-0.0488	-0.0194
FREQEXT	-5.5632	22.13	-0.2514	0.802	-0.025	-0.0219	-0.0087
NBRADLT	71.222	53.81	1.324	0.189	0.130	0.1440	0.3653
DPROTRAI	-83.993	143.6	-0.5847	0.560	-0.058	-0.0537	-0.0385
ZHAT	-1404.5	758.1	-1.853	0.067	-0.180	-0.2295	-0.2354
CONSTANT	307.24	196.5	1.564	0.121	0.153	0.0000	0.3810

SUM OF SQUARED ERRORS-*SSEu*= 0.44353E+08

4. Conducting the Test:

H_0: No contemporaneous correlation between Z_i and ε_i

H_1: Non-zero contemporaneous correlation between Z_i and ε_i.

F = [(*SSEr* – *SSEu*) / h] / [*SSEu* / (n – Ku)]

= [(0.45846E+8 – 0.44353E+8) / 1] / [0.44353E+8 / (111-9)]

= 3.4335 which has the p-value of 0.067.

Therefore, H_0 is rejected under the 10% significance level, i.e. DSOILCON is endogenous.

Appendix 3. Descriptive Statistics of Variables of the Models

NAME	N	MEAN	ST. DEV	VARIANCE	MINIMUM	MAXIMUM
PRODUCT	111	806.32	758.67	0.57558E+06	75.000	4000.0
DCRGOOD	111	0.68468	0.46675	0.21785	0.00000	1.0000
DSOILCON	111	0.13514	0.34342	0.11794	0.00000	1.0000
DCRDBANK	111	0.72072E-01	0.25978	0.67486E-01	0.00000	1.0000
DCRDGOVT	111	0.27027E-01	0.16290	0.26536E-01	0.00000	1.0000
CRDAMOU	111	0.49617E+06	0.15147E+07	0.22943E+13	0.00000	0.80000E+07
DCRDREAS	111	0.20721	0.40714	0.16577	0.00000	1.0000
PLOTSIZE	111	70.380	53.047	2813.9	12.500	350.00
DIRRTYPE	111	0.29730	0.45914	0.21081	0.00000	1.0000
DVARIETY	111	0.54054E-01	0.22715	0.51597E-01	0.00000	1.0000
DLANDQUA	111	0.67568	0.47024	0.22113	0.00000	1.0000
PLOTHOUS	111	23.604	51.171	2618.5	1.0000	360.00
PLOTVAL	111	0.74279E+07	0.86198E+07	0.74301E+14	0.30000E+06	0.50000E+08
SAVALUE	111	0.57558E+06	0.10906E+07	0.11893E+13	0.00000	0.59500E+07
DFARMORG	111	0.15315	0.36177	0.13088	0.00000	1.0000
DPRBLAND	111	0.99099E-01	0.30015	0.90090E-01	0.00000	1.0000
DPRBIRGN	111	0.42342	0.49634	0.24636	0.00000	1.0000
FREQEXT	111	1.2613	2.9931	8.9584	0.00000	24.000
NBRADLT	111	4.1351	1.5344	2.3543	1.0000	8.0000
FMLYSIZE	111	5.6036	2.0462	4.1869	2.0000	11.000
HFMLYAGE	111	50.505	14.264	203.47	22.000	83.000
DSCHOOL1	111	0.64865	0.47956	0.22998	0.00000	1.0000
DSCHOOL2	111	0.15315	0.36177	0.13088	0.00000	1.0000
DPROTRAI	111	0.36937	0.48482	0.23505	0.00000	1.0000
DOCCUPAT	111	0.79279	0.40714	0.16577	0.00000	1.0000
CRDBANK	111	0.37928E+06	0.15266E+07	0.23304E+13	0.00000	0.80000E+07
CRDGOVT	111	14414.	92291.	0.85176E+10	0.00000	0.80000E+06
SVALPROD	111	637.87	1057.4	0.11181E+07	0.00000	6900.0