DETERMINANTS OF FARMERS' BEHAVIOR TOWARDS LAND CONSERVATION PRACTICES IN THE UPPER CITARUM WATERSHED

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Introduction

❖Background

- In Indonesia, one of the most debated soil degradation issues is one that is found in the Citarum Watershed, especially in Upper Citarum Watershed (UCW).
- Government programs have promoted various soil and water conservation techniques. However, not all farmers participate in the conservation program. Some participant farmers only practice partial conservation and do not sustain.
- Effective policy to motivate farmers practicing conservation on their farming requires comprehensive and in-depth understanding of the behavior of farmers in applying soil and water conservation in their farming. This is the primary motivation to conduct this research.

❖Objectives

- This study mainly aimed to identify the main factors of farmers' behaviors in practicing conservation on their farms which oriented directly or indirectly toward reducing soil erosion.

Methodology

Conceptual Framework

- The definition of “practicing” conservation in this study includes the manufacturing or maintenance activities carried out by the farmer in the observation period, namely the last one year.
- The conservation practices considered in this study include eight types which are directly or indirectly oriented to soil and water conservation, mainly erosion control: terrace, beds, ditch, drainage, mulch, grass, ponds, and cultivation of trees in the farmlands cultivated seasonal crops.
- This study is focused on samples of owner-operator farmers who grow food crops and vegetables. The justifications are: (a) decision makers in conservation are farmers who own the land they are working on, because (i) conservation requires a lot of cost and labor, and (ii) the benefits of conservation tend to be long-term so that conservation is generally applied to land with tenure status and relatively permanent property, and (b) land cultivation on plots of seasonal crops is generally more intensive so that land and water quality degradation take place more quickly, and plots with steep slopes are prone to erosion.

Methodology

Study site and Household sample

- This study is a part of the ACIAR-funded research project entitled “the Agricultural Policy Research to Support Natural Resource Management in Indonesia’s Upland Landscapes” (Indogreen’s Research). The Research was conducted using household survey in Upper Citarum Watershed (Fig 1).
- In the Upper Citarum Watershed the survey area includes 2 districts:
  - Bandung : 9 Subdistricts (14 villages)
  - West Bandung : 5 Subdistricts (8 villages)
- Total farm household sample of Indogreen’s Research: 500 households
  - Farm HHs’ growing seasonal crops cultivate seasonal crops on their owned land: 244.

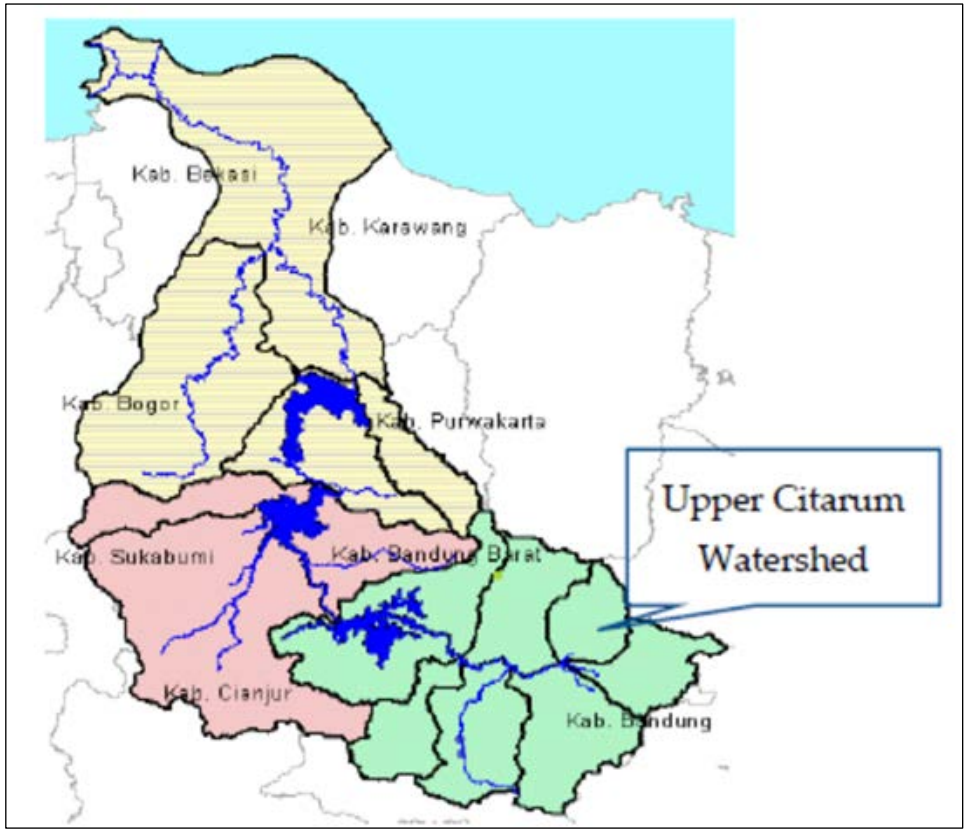

Fig. 1. Map of Citarum Watershed

Empirical Model

- The farmer's decision to conserve includes two stages:
  - The first stage is the choice to perform or not perform conservation.
  - For those who decide to perform conservation, the second stage is choosing what conservation techniques and their level of intensity.
- Therefore, to identify determinants of farmers' participation and intensity in applying conservation practices we apply double-hurdle model:

Suppose: $y_i = \sum_{k=1}^{K} \sum_{l=1}^{L} C_{kl}$ k: type of conservation, l: number of plot

Cont. ===➔

➔ **then:**

(a) Participation equation (practicing conservation techniques in farming):

$$d_i^* = \alpha_0 + \alpha_1 \text{age}_i + \alpha_2 \text{educ}_i + \alpha_3 \text{educ}_i^2 + \alpha_4 \text{DMJ}_i + \alpha_5 \text{r\_lbf}_i + \alpha_6 \text{lown}_i + \alpha_7 \text{lhold}_i + \alpha_8 \text{l\_annual}_i + \alpha_9 \text{avg\_plot}_i + \alpha_{10} \text{plot\_all}_i + \alpha_{11} \text{s\_f\_inc}_i + \alpha_{12} \text{Inv}_i + \alpha_{13} \text{DIST}_i + u_i \quad (1)$$

$$\text{where } d_i^* = \begin{cases} 1, \text{if participate in conservation practices} \\ 0, \text{if not participate in conservation practices} \end{cases}$$

(b) Quantity equation (intencity of practicing conservation activity)

$$y_i^* = \beta_0 + \beta_1 \text{age}_i + \beta_2 \text{educ}_i + \beta_3 \text{DMJ}_i + \beta_4 \text{r\_lbf}_i + \beta_5 \text{r\_farm}_i + \beta_6 \text{lown}_i + \beta_7 \text{lhold}_i + \beta_8 \text{l\_annual}_i + \beta_9 \text{plot\_all}_i + \beta_{10} \text{r\_stplot}_i + \beta_{11} \text{inc\_cap}_i + \beta_{12} \text{Inv}_i + \beta_{13} \text{DIST}_i + v_i \quad (2)$$

$$\text{where } y_i = \begin{cases} y_i^* \text{ if } y_i > 0 \text{ and } d_i^* > 0 \\ 0 \quad \text{otherwise} \end{cases}$$

$$y_i^* = \text{amount (intensity) of conservation activities}$$

$$\begin{pmatrix} u_i \\ v_i \end{pmatrix} \sim N(0, \Sigma), \Sigma = \begin{pmatrix} 1 & \sigma_{12} \\ \sigma_{12} & \sigma \end{pmatrix} \quad (3)$$

(the explanation of those variables is presented in the result of parameter estimation)

Results and Discussion

- Of the total farmed land plots, less than half (49%) of the land is owned. The average size of owned plots is about 0.36 hectares, while non-owned plots are 0.20 hectares.
- Description of owned plots:

Table 1. Distribution of owned plots by type and slope.

Plot Slope	Distribution by Type of Plot (%)			All
	Dry Land	Irrigated	Rainfed	%
Flat	11.05	10.37	5.61	27.02
Slightly steep (15–30%)	23.94	18.47	13.65	56.06
Steep > 30%	10.62	3.46	2.83	16.92
Total	45.61	32.29	22.09	100.00

Table 2. Total owned plots by slope and use (hectare).

Plot Slope	Estate Crops	Horticulture	Rice	All
Flat	1.55	13.36	10.15	25.06
Slightly steep (15–30%)	17.61	20.47	13.92	52.00
Steep > 30%	5.95	7.96	1.78	15.69
Total	25.11	41.78	25.86	92.76

Results and Discussion

- Most of the farmers cultivate seasonal crops twice a year, namely in the rainy season and dry season 1. On some lands with sufficient water, some farmers cultivate three times per year.
- Deal with seasonal commodities cultivated, the top ten are rice, chili, corn, tomatoes, potatoes, leeks, cabbage, sweet potatoes, shallots, and carrots.
- Most of the conservation activities in the UCW are performed manually

  ➔ More than 78 percent of the farmers said it was “easy” and about 20 percent said it was “very easy” to perform conservation.
- Less than half (48%) of the seasonal crop farmers were performing conservation, but it differs across districts. In the Bandung District, those who participated were comparable to those who did not participate, whereas in West Bandung Regency, it was around 45%.

Results and Discussion (cont.)

Distribution of farmers by their participation in conservation and type of the conservation practices

Table 3. Participation and its intencity

	Bandung	West Bandung
Does not participate	49.7	55.3
Participates	50.3	44.7
The intensity of participation:		
1	14.2	18.5
2	18.4	11.7
3	7.8	5.8
4	3.6	2.9
5	2.8	1.0
6	2.8	1.9
7	0.7	-
8	-	2.9
N	141	103

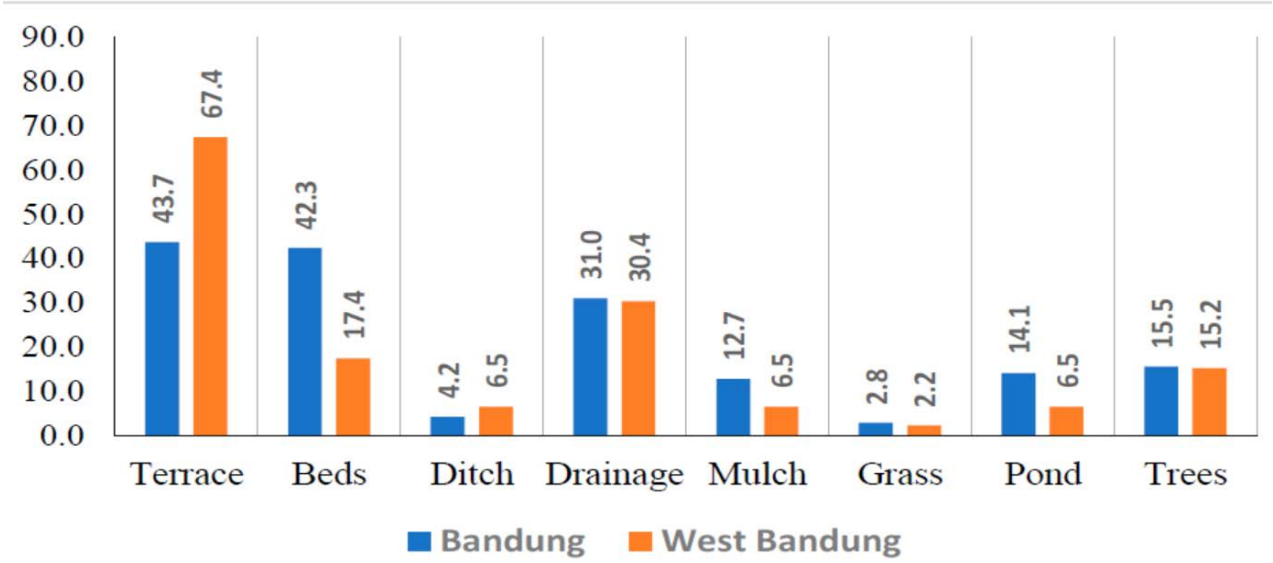

Fig 2. Type of the conservation practices

Results and Discussion (cont.)

Determinants of participation

- The determinants of farmers' behavior in conservation include two dimensions: (i) factors that affect the probability of farmers for conservation (participation equation) and (ii) factors that affect the intensity of participation (quantity equation). The parameter estimation results using the double-hurdle model, as presented in Table 4, show that the determinants of participation and the intensity of the application of conservation lie in several aspects related to (i) control and utilization of farmland, (ii) farming land conditions, (iii) contribution of farming to household income, (iv) farmer's ability to finance conservation with indicators that include income per capita and proxy variable of farmer household's potential in investing, and (v) regional characteristics (locality aspect).

Results and Discussion (cont.)

Table 4. Double-hurdle parameters estimates of farctors affecting farmers on conservation practices

	Participation		Intensity	
	Coef.	P > |Z|	Coef.	P > |Z|
age of HH head (year)	0.0002	0.987	−0.0056	0.705
education of HH head (years)	−0.0303 *	0.071	−0.0944	0.374
education of HH head * (years square)	0.0046 ***	0.006		
the main job of the household head (0=agric., 1=others)	0.1847	0.673	−0.2648	0.780
share of HH members aged 15–64	0.0534	0.614	−0.7098	0.553
share of HH member work in farming			0.0047 ***	0.000
total farmland owned (hectare)	1.2040 ***	0.002	−1.1066 ***	0.000
total land holding (include perennial crops) (hectare/year)	0.8266 **	0.015	−1.4942 ***	0.000
total land holding of seasonal crops (hectare/year)	−1.1228 ***	0.004	1.8950 ***	0.000
the average size of plot hold (hectare)	−0.0098 **	0.016		
amount of all plots owned	−0.1255 **	0.027	1.4499 ***	0.000
share of (moderate + steep) plots (%)			0.0143 ***	0.000
share of farm income (%)	0.0058 ***	0.000		
the income per capita (IDR million)			0.0345 ***	0.000
potential capacity to invest	0.0016 *	0.063		
district (0 = Bandung, 1 = West Bandung)	−0.1145 ***	0.009	0.4022 ***	0.000
_cons	−0.1141	0.845	0.4103	0.765
/Sigma	1.9321			
/Covariance	−1.4479	0.000		

log likelihood = −337.30644; N = 244. ***, **, and *: significantly different at α = 0.01, 0.05, and 0.1.

Results and Discussion (*cont.*)

- Regarding household characteristics, the only influencing factors are the level of education and the share of household members who work in agriculture, which are conditional. Farmer's age, farmer's primary occupation, and share of the family workforce do not affect the probability and intensity of participation.
- The level of education only affects the context of the probability of participating, even if the incremental is large enough.
- The share of household members who work in farming is the number of household members who work in farming divided by the number of working-age household members. In the group of farmers who carry out conservation, this variable positively affects the number of conservation activities carried out.

Results and Discussion (cont.)

- In this study, the land tenure aspect used to determine the effect on farmers' probability for conservation and the intensity of conservation includes the following three variables, namely: (i) area of land ownership, (ii) total arable area in a year, including arable land for perennial crops, and (iii) the total area of cultivation per year specifically for seasonal crops.
    - In the context of the probability of participating, the larger the land owned or cultivated, the greater the probability of participating. With more land, farmers have flexibility in trying to implement conservation activities and face the risks that may. This risk can be in the form of reduced land area for constructing terraces, ditches, and other conservation buildings, which will affect the results in the short term. The problem is that the number of farmers with large land tenure in this research site is relatively small and the distribution is unequal. As an illustration, the Gini index of land ownership is 0.56, where the cumulative area of land owned by the top 10% of farmers is around 43%.

Results and Discussion (cont.)

- The effect of cultivated area for seasonal crops on the probability of participating in conservation is negative, but for farmers who perform conservation, the effect on conservation intensity is positive. Regarding the availability of the existing family labours, the larger the farming of seasonal crops, the less labour that can be devoted to carrying out conservation activities. However, for farmers who have decided to perform conservation, the larger the size of seasonal crop farming, the more conservation activities they have to perform, particularly for the maintenance of beds and ditches.
- The average plot size has a significant effect on the probability of conservation. The larger it is, the lower the chance to apply conservation.
- The number of plots negatively affects the probability of conservation but positively affects the intensity of the participating farmer groups. The more plots of agricultural land they control, the less likely farmers will participate. However, for the farmers who participate, the more plots they control, the more conservation activities they carry out.

Results and Discussion (cont.)

- The more land plots with moderate and steep slopes, the higher the intensity of conservation activities are carried out.
- The role of farming in the household economy of farmers determines many aspects related to farmer decisions regarding farm management. The same applies to farmers' decisions to undertake soil and water conservation. Thus, household income is one of the main determinants of farmer participation in conservation. The parameter estimation results show that the greater the share of the farmer's income obtained from farming, the greater the probability for conservation. This result implies that one way to encourage farmers to perform conservation is by creating incentives conducive to increasing farm income. For this purpose, a feasible step is to increase the added value of production; for example, by increasing the quality of their products to increase selling prices, using high-yielding varieties, and using a more precise application of fertilizers to reduce production costs.

Results and Discussion (cont.)

- The parameter estimation results show that the higher the income per capita, the higher the conservation intensity carried out by farmers. There is an indication of a positive impact of the proxy variable on the ability to invest, meaning that its effect on the probabilities for farmers to participate in conservation is positive.
- The incorporation of regional dummy variables (Bandung and West Bandung) in the double-hurdle model in this study has a dual function. First, treating districts as clusters in the clustered-robust estimator method is effective, as seen from its significant effect. Second, the parameter estimation results show that the participation of the farming community in the research site of the West Bandung Regency is lower than that in the Bandung Regency. However, the number of conservation activities carried out by the farming community in theWest Bandung Regency is greater than that of the Bandung Regency.
- Refer to the positive trend in the coffe farming of social forestry farmers, managing profitable coffee-based agroforestry is suggested as an alternative for sustainable land use practice in upland area. The prospect of income earned by farmers and its contribution to land conservation, the popularity of coffee as a mainstay commodity in agroforestry occurs in this research location and several other PHBM locations.

Results and Discussion (cont.)

- Some problems in promoting erosion reduction through the conversion of vegetable crops toward coffee farms on the farmers' land in the upland Citarum watershed are: (i) very small farm size and (ii) low average household income. Around 66% of sample farmers mentioned "agree" and around 16% "strongly agree" that vegetable crops will significantly improve their household income. On the other hand, based on the statement "I prefer to cultivate seasonal crops, such as vegetable and rice, compare to tree crops", around 56% farmers chose "agree" and 12% chose "strongly agree". However, based on the statement "Coffee is an important cash crop for my family", around 53% of farmers mentioned "agree" and around 14% mentioned "strongly agree". One of the feasible strategies to promote conversion of vegetable crops toward perennial crops is a policy and program to increase productivity and quality as well as the value added by coffee processing.

Results and Discussion (cont.)

- Designing breakthrough policies and programs requires interaction, advocacy, and focus group discussions (FGDs) involving the central and local governments with all relevant stakeholders. There needs to be a comprehensive understanding that: (1) the benefits and multiplier effects of conservation are even more significant if carried out collectively, synergistically, and systematically; (2) the benefits of conservation, both direct and indirect, are not limited to the perpetrators but also the wider community; and (3) conservation is one of the actions that converge with the principles and objectives of sustainable development, and therefore the benefits are inter-generational.

Conclusions and Recommendation

- The determinants of participation and intensity of conservation application lie in several aspects related to: (i) control and utilization of farmland, (ii) condition of farmland, (iii) contribution of farming to household income, (iv) farmer's ability to finance conservation, and (v) regional characteristics (locality aspects).
- Breakthrough policies and programs that are considered effective in increasing farmer participation in the application of soil and water conservation in this area need to focus on facilitating, creating, and providing economic incentives.
- Conservation techniques that need to be accelerated in their application are vegetation- based conservation techniques. One way to do this is by expanding coffee and fruit farming. Facilitation efforts to increase the productivity and added value of the coffee are imperative to make farmers in the UCW willing to voluntarily change the land use from vegetables and other seasonal crops to coffee farms. The policy instrument used as an entry point to expand farmer participation in conservation is creating financial incentives. Several strategies can be pursued, for example, through the "green box" category of subsidies, for instance, the establishment of public infrastructure and the environment payment mechanism.

Thank you