ECONOMIC INCENTIVES, SOCIETY AND LAND DEGRADATION
The Case of Intensive Land-Use Practices in Lampung Province, Indonesia

by
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1. Introduction

Background of the Research

Land degradation in the uplands is a serious problem that threatens Indonesia's sustainable development. The high expectation on agriculture as a basis to overcome the current economic crisis has meant increased pressure for upland cultivation with intensive food-crop practices. One part of agricultural development strategy has become an expansion of the agricultural-area through land utilization, and other extensification policies with the goal of maintaining self-sufficiency in rice and in other food crops. Yet, area expansion has created pressure on marginal land and steeper slopes, thus inducing intensive-land use practices and soil-mining activities that may cause land degradation.

Land degradation in the sloping upland of Indonesia has drawn a significant decrease in agricultural productivity, and a worsening trend of declining income per capita from agricultural sector. Recent research results show that in aggregate terms, the determinants of land degradation in Indonesia over time have been identified as intensive land-use practices, population pressure, income per capita and transmigration programs as well as some regional characteristics of agro-ecological settings. In additions, the economic cost of the loss in crop productivity from land degradation indicate higher costs in regions with much marginal land and low levels of crop productivity, compared to regions with favorable production conditions (Arifin, 1995, 1997).

Meanwhile, in response to land degradation problems in upland area, the Government of Indonesia has initiated several soil conservation projects throughout the country. The goals of the projects are to increase farm production and income, while reducing land degradation. The projects are implemented through input subsidies and capital subsidies for terracing and related conservation

measures. Persuading farmers to adopt terracing, alley cropping, agro-forestry and other conservation practices through capital and input subsidies is believed to be a panacea to minimize land degradation. However, these agronomic policies alone cannot steer the process of land degradation unless complemented by economic and price policy. Recent evidence regarding the sustainability of such conservation projects in Indonesia indicates that the effects of the operating subsidies are not sustainable (see Arifin, 1997). The altered management practices are neglected once the projects and the subsidies are terminated. High dependence on input subsidies is cited as the main cause of the failure of the conservation projects. The effects of the capital subsidies may persist longer for capital effect fixed in place of the land. But these effects are probably not sustainable either. If farmers lack the financial means to sustain the use of improved inputs, they may also lack the means and motivation to maintain the terraces.

Therefore, it is important to document and examine the nature of farm-level economics of land degradation, particularly concerning farmers' decision to allow intensive land-use practices and to invest in land conservation measures. The case of intensive land-use practices in the sloping uplands of Lampung Province, Indonesia would provide an exemplary opportunity to devote a village-level analysis on land degradation issues, under conditions typical of many Indonesian uplands and in other developing world as well.

Objectives

The objective of this research is to examine the incentives for upland farmers to allow intensive land-use practices that could lead to land degradation and to invest in land conservation measures as a means to control land degradation and improve agricultural productivity in Lampung Province, Indonesia. More specifically, the study intends to:

(a) empirically analyze intensive land-use practices as an important contributor of land degradation in the sloping uplands of Lampung Province,

(b) examine farmer's decision to invest in the control of land degradation on privately owned and operated land in Lampung uplands, and

(c) offer economic-policy reforms having short-run impacts on land degradation in the sloping uplands in Indonesia or other developing nations in general.

The remaining sections of the paper is organized as follows: Section 2 presents the nature of the research problems, literature review on land-use intensification that could cause land degradation, and farmers' decision on land improvement to prevent degradation. Section 3 exhibits the methodology, covering data collection and analytical framework. Section 4 presents the results of data analysis and economic estimates Section 5 presents summarized conclusion and Section 6 discusses the contribution of the study to the existing body of knowledge and policy implications of the results, particularly in the context of economic policy reforms.

2. Nature of the Research Problems

The population-development-environment nexus has received a renewed attention during the last decade. The population pressure hypothesis was advanced to relate land degradation directly to population pressure (Neo-Malthusian paradigm). On the other extreme, increased population density seen as a precondition to technological innovation and economic development leading to preservation and improvement in land resources (Neo-Boserupian paradigm).

In the Neo-Malthusian, land degradation and other environmental deterioration occurs as population pressure lead to an expansion of the cropping area, forcing the cultivator to move from the best lands available to more environmentally-fragile marginal land. As population grows, new land may be opened to cultivation. The most fertile land is cultivated and settled first, but the effect of this expansion is to allow for greater rates of population growth, such as the case of Java. Given a fixed amount of land and a fixed agricultural technology, as population increases the cultivable area per person will decline. In order to support the subsistence level of income, families are forced to expand the area cultivated to marginal land, such as sloping upland. As population pressures continue to increase, the cultivation of ever-more marginal land leads to increased land degradation. The scenario becomes more complex when farmers adopt new agricultural technology, including a decision to cultivate the land more intensively.

Neo-Boserupian argues that the adoption of intensive land-use practices can result in the "mining" of soil. In fragile areas, agricultural production may destroy soil structures and thin the topsoils so that the capacity to reduce erosion and moisture is decreased. Land use-practices on marginal land may involve changing vegetation with deeper rooting systems to a food crop with a more shallow rooting, which is more susceptible to erosion. More importantly, the availability of

essential nutrients for plant growth declines as the soil is degraded. The natural process of soil formation is far too slow in relation to the rate of "mining", especially given the rapid growth of population. In Indonesia's outer islands, soil "mining" occurs on a large scale, causing much more irreparable damage than would be the case with soils in temperate climates which tend to have a "better" structure. In this case, the role of government policy in encouraging the intensive practices, but not the soil conservation, is important in explaining land degradation in the upland. The existing scenario is actually about the same as that postulated by Neo-Malthusian model.

Intensive land use practices generally refer to change in practices from slash and burn to long and short fallow system and eventually to more permanent cropping (*autonomous process*) and to the increased role of the state in enhancing productivity through encouragement of intensification practices (*policy-led process*). *Autonomous process* of intensive land-use practices occurs as population increases over time, causing fallow periods between cropping activities gradually shorten. In the upland, adverse environmental effects of autonomous intensive land use would arise when the positive effects of population pressure are superseded by the detrimental effects of continuous cropping. This is especially serious for soils which are fragile in nature, very much dependent on vegetative cover for moisture and stability. *Policy-led process* of intensive land-use practices refers to the encouragement by the state to adopt a package of intensive practices, usually implemented through government programs. Intensive-land use practices on these fragile areas may involve altering the vegetation cover from tree crops to food crops which is more susceptible to erosion, holding other factors constant. In addition, intensive land-use practices are associated with a rapid population growth, implying that population pressures of the relatively constant resources endowment are higher.

Furthermore, empirical studies to evaluate the effect of land improvement on productivity are often faced with the problem of identification (Capalbo and Antle 1988). That is, the pure effect of adoption may be spuriously correlated with factors that affect the adoption decision. Hence, the observed positive differential in output between adopters and non-adopters of a soil conservation technology, which suggests a positive relationship between adoption and productivity, may overestimate the productivity effect attributed to adoption alone. This is usually true in cases of sample self-selection where data is generated by the choices made by individuals. In the case of adoption, the choice to adopt or not to adopt is not a random process but rather an individual decision of whether to adopt or not to adopt based on some utility-maximizing criterion (Pitt 1983). Failure to account for the self-selection bias would result in biased estimates of the productivity effect of adoption of soil conservation.

The evaluation of the effect of soil conservation on yield in the foregoing case studies, however, was problematic in the sense that the estimated productivity effect may not be due to adoption alone but to some other factors that are correlated with adoption. For example, farmers who choose to adopt contour terracing may also be those farmers who have higher income and hence are able to finance the initial investment requirements of constructing the structures, as well as the optimal input requirements which could result in higher yield as compared to non-adopters. Or adopters may also be just better farmers than non-adopters and, hence, would be more likely to be more productive even without them adopting a soil conservation technology under similar biophysical conditions. This is an important empirical issue that has significant policy implications. If indeed there is a differentiation in productivity attributes between adopters and non-adopters of a particular soil conservation technology, this suggests that the promotion of specific conservation practices may be more effective when targeted to potential users who have the comparative advantage in using that particular technology.

3. The Methodology

Two periods of field survey and grounded interview with farmers have been conducted in August and September of 1997 and on February-March of 1999. The surveys were focused on collecting primary data on agricultural activities in Way Rarem watershed of Lampung Province, Indonesia for the 1996-1997 crop season and 1997-1998 crop seasons. These include activities in agricultural production, i.e. the use of land, labor, capital and the yield, amount of works spent on on-farm and off-farm, and other physical and socio-economic information. A total of 74 sample respondents were included in the survey, of which 28 were from village of Pekurun and 46 were from village of Subik, all in the subdistrict of Abung Barat of North Lampung.

The study synthesizes Neo-Malthusian and Neo-Boserupian models of land degradation. The Neo-Malthusian model maintains an assumption that production function exhibits diminishing marginal returns to land and to labor. An addition one unit of land (and labor) can increase the output at a diminishing rate after a certain point The Neo-Boserupian sees land degradation is a function of intensive land use (I) -- which is a function of population presuure (P) and government policy (G) -- and other factors (Z). These other factors can be the history of land use, income per capita and a more fixed physical factors such as rainfall, topography, and soil properties and other regional characteristics. The land degradation function can be written as:

$$E = h(I, Z) \quad \text{.....} \quad (1)$$

$$E = h[f(P,G), Z] \quad \text{.....} \quad (2)$$

Suppose the government policies (G) to increase crop production are implemented through agricultural colonization, land area expansion and intensive use of modern inputs, or their combinations. The higher the degree of government policies, the higher the index of intensive land use practices (I), or $\partial I/\partial G > 0$. Since I is also a main component of land degradation, E, an increase in intensive land use practices will therefore result in an increase in land degradation, holding other factors constant. Taking a first derivative of land degradation (E) with respect to population pressure and government expenditure and will result in the following condition:

$$dE/dG = (\partial f/\partial G).(h/f) \quad \text{.....} \quad (3)$$

$$dE/dP = (\partial f/\partial P).(h/f) \quad \text{.....} \quad (4)$$

It then implies that the role of population pressure on land degradation can be direct; but it can also be indirect, manifested through the effects of intensive land-use practices. Direct causal relationship refers to the condition where the higher the pressure, the higher the land degradation; indirect relationship refers to the higher the population pressure, the higher the degree of intensive land use practices -- either autonomous or government-induced scenario. This argument actually is also consistent with the soil science theory about land degradation.

A microeconometric framework based on the concept of cost-benefit is used to explain the farmer's decision to adopt a soil conservation technology as or land improvement measure. The underlying theoretical basis for the approach is that a net positive benefit results in a higher utility level to the farmer. Hence, a farmer decides to adopt a soil conservation technology if the net benefit is positive, which implies a higher level of utility. Assuming a net benefit function, B, the empirical model to be estimated is:

$$B = \delta'\omega + \varepsilon, \text{ where}$$

$$B = \begin{cases} 1 \text{ if an adopter,} \\ 0 \text{ otherwise} \end{cases} \quad \text{.....} \quad (5)$$

where δ is a (1xk) vector of unknown parameters, ω is a (kxn) vector of independent variables including farmer, farm, and market characteristics, and ε is a (1xn) vector of the error terms. This empirical model can be estimated using the probit model (Maddala 1983, Greene 1990).

A number of variables are hypothesized to affect the farmer's decision to invest in land improvement or to adopt the contour terracing technology. These variables are classified into four categories: (1) personal factor, such as: age and, education; (2) economic variables such as: household size, livestock income, non-farm income, distance from road, discount rate, and availability of credit; (3) institutional factors such as tenurial status, (former) membership in the natural resources conservation project (UPSA) and access to technical assistance; and (4) the degree of soil erosion potential such as slope and cropping intensity. A more detailed disccussion about the relevance of these variables in the literature of land degradation is available in Arifin (1997) and Lapar and Pandey (1997a, 1997b).

4. Analysis of Data and Empirical Estimations

The sub-district of Abung Barat in the District of North Lampung consists of 37 villages. The total population of this subdistrict are 53,953 (27,618 men and 26,335 women) and the total households are 11,451, most of which are involved in agricultural activities. The area of the whole subdistrict is about 390.91 square kilometer, implying that population density of Abung Barat is about 138 per square kilometer (Lampung Regional Office of Statistics, 1997), which is quite high for an outside-Java standard. Abung Barat is located exactly in the critical locations of Way Rarem watershed, mostly north-facing slope of Bukit Barisan mountain. The study sites Pekurun adn Subik have two different scenes and characteristics of intensive-land-use practices in the two villages of study sites. The land-use patterns in the village of Pekurun are dominated by upland crops such as secondary foodcrops: upland rice, corn, and some beans; and treecrops such as pepper and coffee. In the village of Subik, land use patterns was dominated by lowland rice and upland rice and secondary foodcrops in the sloping land, adjacent to the area of conservation forest. The degree of intensive land-use practices in the study area are interlinked with resource endowments and social economic endowments.

Subik have relatively better access to markets and, hence, are able to easily supply the market demand for these crops than those in Pekurun. Farmers in Subik cultivate farms that are almost twice the area of farms in Pekurun. Despite the relative difference in farm size in the two survey sites, the average farm area with contour terracing is about the same (approximately 0.6 ha.) in both

sites. Farms in some sites in Subik have relatively steeper slope than farms in Pekurun. A relatively larger proportion of adopters are owners in Subik than in Pekurun. Adopters in Subik have been practicing the technology for twice as long as adopters in Pekurun. Two separate probit equations were estimated for each site after an F-test conducted on the data set turned out significant for the null hypotheses of no structural differences between the data from the two sites. The results of the estimation are shown in Table 1.

Table 1. Probit estimates of the likelihood of adoption

Variable	Subik		Pekurun	
	Coefficient	Standard Error	Coefficient	Standard Error
Constant	-2.07386	0.83954	-9.27378	2.78047
Age of household head	-0.01114	0.00930*	0.00240	0.03138
Distance from the road	0.03881	0.06136	0.05978	0.22158
Education (years)	-0.02671	0.02604	0.13389	0.10412*
Household size (numbers)	0.00285	0.07845	0.47631	0.35621*
Farm size (hectare)	0.00639	0.05838	0.10788	0.34398
Non-farm income (Rp 000)	0.00012	0.00006**	0.00011	0.00018*
Tenure (dummy)	0.00509	0.38462	0.38860	0.87901
UPSA Member (dummy)	-0.35937	0.56495	-0.22394	1.77177
Tree cropping (dummy)	0.45320	0.24619*	1.15228	0.90411*
Chi-square	260.43		15.124	
Degree of freedom	42		13	

Note: *** Significant at the one percent level,
** Significant at the five percent level,
* Significant at the ten percent level.
a - 1 for owner, 0 otherwise
b - 1 for former UPSA member, 0 for non-UPSA member
e - 1 for those practicing, 0 otherwise

Adoption in Subik is significantly influenced by age of head of the household, tree crop availability and the amount of non-farm income of the household. The results suggest that younger farmers with some tree crops availability in the farm is more likely to adopt the erosion control technology. The other variables except for UPSA members have the expected signs although they turned out to be statistically not significant. The UPSA member dummy variable also has a negative sign, despite its significance, implying problems of the implementation of somewhat too technically oriented natural resouce management project in the last ten years.

For Pekurun, adoption is significantly influenced by education, household size, non-farm income of the households and tree crop availability in the field. Education has a positive influence on adoption and this is consistent with the results of Lapar and Pandey (1997a). Both nonfarm income and household size positively affect the likelihood of adoption. Strip cropping is shown to be a complementary conservation practice as those farmers who practice strip cropping are also more likely to adopt the terracing technology. Probably, the adoption of contour terracing also allows the simultaneous cropping of different types of crops in one parcel.

Lapar and Pandey (1997b) reported in the Philippines upland, that the average yield of foodcrop from parcels with and without contour terracing suggest a positive relationship between adoption and farm productivity. By segregating the effect of latent productivity attributes between farmers cultivating contoured and non-contoured parcels, the output differentials could be analyzed further. That is, adoption of contour terracing could potentially increase the yield of non-adopters. Nevertheless, the present study results suggest that latent productivity attributes are homogeneous across all farmers in Lampung upland areas covered by the study. This implies that the adoption of the contour terracing technology does not require specific productivity skills, and hence, it can be effectively undertaken by a farmer with average productivity skills.

5. Summarized Conclusion

The study results suggest that land-use patterns based on intensive practices of modern inputs and labor allocation are prone to mismanagement that leads to land degradation. However, where governments have neglected to intensify agricultural production through the use of modern technology, the continuing pressures of population growth has worsened poverty and unemployment, which might be accelerated during the current crisis. This has driven rural people to expand cultivation into less favored, often environmentally fragile areas, conservation forests and steeply sloping upland, where land productivity is declining. The policy strategies should be directed towards reducing poverty and promoting economic diversification in rural areas.

Microeconometric estimates show that certain socioeconomic variables significantly affect the likelihood of adoption of a soil conservation technology in the uplands. For example, biophysical factors like age and education or perception of the incidence of soil erosion are positive influences on the likelihood and extent of adoption. Hence, targeting conservation programs to areas

that are highly eroded and/or have high potential of degradation would be an effective strategy. In addition, there is merit in increasing the farmers= awareness of soil erosion and its consequences, as well as the provision of information on the most effective soil conservation practices for farms with certain topographic and slope characteristics.

6. Contribution to The Existing Body of Knowledge

The study results have contributed to the improvement in analytical frameworks of land degradation literature. The study emphasizes on farm-level analysis generally applicable to land degradation problems arising from sedentary upland cultivation in developing economies rather than those arising from shifting cultivation and open-access degradation of forests. The potential for economic policy reforms having short-run impacts on land degradation problems are almost certainly co-requisites of the project-based conservation efforts that generally have positive long-term effects. The micro nature of the present study can be used to confirm some findings of aggregated analysis of previous land degradation studies in Indonesia. It is also possible that the results of the present study could be used to evaluate and to improve the approaches and analytical tools employed in the previous studies of land degradation in general.

Strategies to improve the education and technical knowledge of upland farmers would be more likely to increase the adoption of contour terracing. Ownership of the land did show up to be a positive and significant influence to adoption in Subik but not in Pekurun (although it exhibited a positive sign). This suggests that the effect of tenure status could be site specific. It appears that ownership of the land may not be the issue in Pekurun but rather the security of access to the land. It was observed that while the majority of farmers are non-owners in Pekurun, they do have security of access and land use. Recent government policy changes have provided non-owners who cultivate public lands an opportunity to obtain a land certificate of ownership.

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