Shifting Cultivation and "Deforestation"

A Study from Sumatra, Indonesia

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Summary:

About half of tropical deforestation is commonly explained by the expansion of traditional agriculture (shifting cultivation). This article first questions the share of responsibly assigned to traditional agriculture. Secondly, a simple framework based on a theory of land rent capture is developed to explain agricultural expansion. The framework is applied in the study of recent changes in shifting cultivators' adaptations in a lowland rainforest area in Sumatra, Indonesia. Increased rubber planting and expansion into primary forest are seen as a response to increased rubber profitability and (expected) land scarcity, and as a race for property rights. Government land claims have been important in initiating a self-reinforcing land race, and have therefore significant multiplier effects on forest clearing.

Sammendrag:

Omlag halvparten av tropiske avskogning blir ofte tillagt ekspansjon av tradisjonelt jordbruk (svedjebruk). Denne artikkelen stiller først spørsmålstegn ved dette anslaget. Deretter utvikles en enkel modell for å forklare ekspansjon av tradisjonelt jordbruk, basert på en teori om at bønder søker å tilegne seg all jordrente. Modellen anvendes på en studie av endringer i svedjebrukeres tilpasning i et lavlands regnskogsområde på Sumatra i Indonesia. Økt planting av gummitrær og ekspansjon inn i primærskog blir forklart som en respons til økt lønnsomhet av gummi og (forventninger om) økt knapphet på jord, og som et kappløp for å sikre seg eiendomsrettigheter. Statlige prosjekter som beslaglegger skog har vært viktige ved å initiere kappløpet, og har derved viktige multiplikatoreffekter på avskogningen.

Indexing terms:

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1 Introduction[1]

Agricultural encroachment by shifting cultivation occupies a central position in the debate on tropical deforestation.[2] Shifting cultivators are often seen as the primary agents of deforestation in developing countries; estimates of their share range as high as 45 percent (UNEP, 1992) to 60 percent (Myers, 1992). Most attempts to control and integrate them into national development schemes, and to replace the practice with more intensive sedentary systems have, however, not been very successful (Atal, 1984). The reasons for this failure are several, including an inadequate understanding of the logic behind shifting cultivation and factors influencing farmers' decision making.

The main objective of this paper is to analyze some basic factors and mechanisms behind the expansion of shifting cultivation into primary or old-growth forest, with the subsequent loss of ecological functions like biodiversity maintenance and carbon storage. Before entering into a discussion of the causes and dynamics of deforestation, some comments on the definitions, estimates and consequences of deforestation are in order, as documented in section two. There is no clear definition of "deforestation", neither are there reliable estimates of its extent nor its primary causes, and -- partly as a reflection of these -- there is no consensus on the underlying causes. We argue that even though the contribution made by traditional agriculture (mainly shifting cultivation) to the overall tropical deforestation, clearly, is an issue of concern, its magnitude in relation to other causes is sometimes put out of proportion. This is illustrated by recent data on deforestation in Indonesia, as well as field data from Sumatra. Moreover, the environmental consequences of traditional shifting cultivation, like global climate change, biodiversity, and soil erosion, are smaller compared to many other forestland uses.

1 This is an extensively revised paper originally presented at a conference on Environment and Development in Southeast Asia, Center for Southeast Asian Studies, University of Wisconsin-Madison, 9.-10. July, 1994. I would like to thank Bustanul Arifin, Ian Coxhead, Odd-Helge Fjeldstad, Johan Helland, Stein Holden, Jerry Shively, and Ussif Rashid Sumaila and other colleagues at CMI for constructive comments to draft versions of the paper. I claim exclusive property rights to remaining errors. The fieldwork which this article is based on was part of a larger interdisciplinary project - Norwegian-Indonesian Rain Forest and Resource Management (NORINDRA). Funding for the project was provided by the Norwegian Research Council (NFR) and the Norwegian Ministries of Foreign Affairs and Environment.

2 Shifting cultivation could be considered as an early stage in the evolution of agricultural systems. The system is based on cutting and burning the vegetation in the dry season, and planting crops in the ashes early in the wet season. Declining soil productivity and increasing weed problems lead farmers to abandon fields after a few, often only one or two, years of cropping. Other types of vegetation take over, and the field eventually grows into secondary forest, before the cycle is repeated. The length of this fallow period varies considerably -- 5-20 years is common. Shifting cultivation has low productivity in terms of output per hectare of total agricultural land (i.e., both cropping and fallow land) compared to most other ("modern") systems, but relatively high return to labour. As the population depending on shifting cultivation increases, "the system increasingly fails to satisfy the requirements for higher production per unit area" (FAO, 1974:3). This may result in shorter fallow and longer cropping periods, initiating an accelerating and self-reinforcing process of land degradation.

Section three develops a theoretical framework for the discussion, based on a theory of land rent capture. The open economy assumption in this framework is contrasted with a conventional subsistence or "full belly" approach, which may yield quite different responses from farmers to exogenous changes and policy recommendations. The framework is illustrated with some examples of the deforestation history in Southeast Asian countries.

In section four we use this framework to analyze forest encroachment by shifting cultivators in a lowland rainforest area in the Seberida district, Riau province, Sumatra, Indonesia, based on data collected during fieldwork in 1991-92. Increased rubber planting and agricultural expansion into primary forests are seen as the result of a number of factors which have increased the profitability of frontier farming relative to alternative employment opportunities. Increased tension between customary and national law has made it more important for local farmers to secure their claims to the land. Expectations about increased future land scarcity pull in the same direction. Section five provides some conclusions and policy implications.

2 The role of shifting cultivation in "deforestation"

2.1 Estimates of "deforestation"

Estimates of tropical deforestation entail great uncertainty. An authoritative source on resource degradation is the biannual report by the World Resources Institute (WRI). The following figures illustrate the uncertainty involved and how estimates can change with new information: The *World Resources 1990-91* report (WRI, 1990) estimated the annual tropical deforestation in the 1980s to 0.9 percent. The figures for the three main rainforest countries, Brazil, Zaire and Indonesia, were 1.8, 0.2 and 0.8 percent, respectively. Four years later in WRI (1994), based on a comprehensive study by FAO (1993), the estimate for overall tropical deforestation in the 1980s is more or less unchanged (0.8 percent). However, looking at the individual countries, the estimate for Zaire is tripled to 0.6 percent, whereas it is reduced to one third in the case of Brazil (0.6 percent)!

Part of the reason behind the wide range in estimates is variations in the use of the term. *Deforestation* is often taken to mean *destruction or removal of tree cover*, but the range of uses is great, from a complete and permanent removal of the tree cover to small alterations in the ecological composition. WRI (1992: 118) provides the following definition:

> *"The term deforestation describes a complete change in land use from forest to agriculture - including shifting cultivation and pasture - or urban use. It does not include forest that has been logged and left to regrow, even if it was clear-cut".*

This definition entails a contradiction since forest opened by shifting cultivation often would be secondary forest previously used for swidden agriculture, and then left for fallow. Thus, temporary clearing by logging is not classified as deforestation, whereas temporary clearing by shifting cultivators is included. Myers (1992) similarly assumes that shifting cultivation was largely replaced by permanently cleared land (Houghton, 1993: 26).

More precise definitions and a clarification of what is meant by the term deforestation would definitely advance the debate on causes, consequences, and solutions.[3] Much confusion arises because no distinction is made between permanent and temporary conversions, and between conversion and alterations (cf. the distinction between deforestation and forest degradation).

Unfortunately, the availability of data rarely allows for the use of very precise definitions of deforestation. Commonly cited estimates of deforestation in Indonesia during the 1980s include 1.3 million ha/year (FAO, 1991), 1.2 million ha/year (FAO, 1993) and 0.9 million ha/year (World Bank, 1990), compared to a forest stock of some 110 million ha in 1990 (FAO, 1993). These estimates may well be too high, according to a more critical study (Dick, 1991), which estimates deforestation to 0.6 million ha/year. According to Dick, earlier estimates have not made the distinction between temporary and permanent clearing, and they have assumed that all causes of deforestation are additive. No account has been made for the fact that smallholders usually occupy disturbed forest, or that shifting cultivators also may occupy land that has not been forested for decades. Moreover, some of the previous figures were "based more on wishful thinking by development agencies than on actual accomplishments" (Dick, 1991:30), thus overestimating forest conversion.

One of the most interesting findings in Dick (1991) is that programmes sponsored or explicitly encouraged by the Government of Indonesia account for 67 percent of all deforestation, whereas the share of traditional agriculture is only to 22 percent.[4] Furthermore, a large share of the latter would be in forest that has been in a rotation cycle for a long period. These findings have important policy implications. According to the latest World Bank (1994: 51) country study on environment and development in Indonesia, "this challenge the conventional wisdom, which holds that traditional shifting agriculture is the main agent of deforestation". This forms

[3] The debate between foresters and environmentalists on logging and deforestation is a case in point, where foresters claim that selective logging is not deforestation, whereas many environmentalists would include it.

[4] Spontaneous migration (*swakarsa* transmigrants), which is explicitly encouraged by the Ministry of Transmigration, is the single largest agent of land use change, counting for 178 500 ha (29 percent) of the total deforestation (623 300 ha). FAO (1991) and World Bank (1990) have included these migrants under "traditional agriculture", whose annual clearance was estimated to be 461 000 ha (35 percent) and 500 000 ha (56 percent), respectively. This compares to 134 500 ha (22 percent) in Dick (1991).

the background for a significant change in the policy focus of the World Bank when it comes to the main challenges for forest management, away from traditional agriculture to logging and government policies that encourage deforestation.

Data from the fieldwork in the Seberida district, Sumatra, further illustrate these points, not to claim that these are representative for Indonesia, but to show the importance of how the contribution of shifting cultivation to deforestation is measured. Forest clearing by shifting cultivators in 1991 is estimated at 2 400 ha, about 0.85 percent of the total land area of these villages. However, to account for net forest clearing one should primarily look at the *expansion* of shifting cultivation into forest previously not used for agriculture. For the period 1985-1991 only about 1/10 of the annual forest clearing represented an expansion of the system. Moreover, even for this share it is questionable whether it should be grouped as deforestation because the fields are left to recover into secondary forest, probably economically enriched with rubber.

Identification of the primary agents of deforestation are not politically neutral. Governments (and others) may have an interest in putting the blame on primitive, tradition-bound and ignorant farmers, beyond the control of the state (Bromley, 1991; Dauvergne, 1994). Nonetheless, the role of shifting cultivators remains important, but should be seen in perspective and compared with other sources of deforestation and government policies that influence farmers' decision-making.

2.2 Environmental effects of different types of "deforestation"

A distinction between the different types of forest conversions or alternations under the deforestation umbrella is important because the environmental effects and social costs may be very different. We consider three of the most important potential environmental effects of deforestation: Climate change due to the release of carbon, loss of biodiversity, and increased soil erosion. At the global level, tropical deforestation accounts for about 25 percent of heat-trapping emissions (Houghton, 1993). However, the net carbon flux from "deforestation" will be small if, as is the case in Seberida, most of the cleared forest is secondary/fallow forest which also regenerates into secondary forest. The distinction between temporary and permanent clearing is crucial. Typically, old growth forest converted to permanently cultivated land or pasture loose more than 90 percent of the initial carbon stock in the vegetation, whereas conversions to plantations or shifting cultivation may loose 30-60 percent.[5]

The biodiversity consequences may also be very different depending on the type of land use change. Estimates of biodiversity loss are often based on species-area curves, with an elasticity of the number of species with respect to area typically in the range of 0.15 to 0.35 (Connor and McCoy, 1979). Such crude measures are

[5] See for example Houghton (1993) for a more detailed discussion on the carbon release from different land uses.

inaccurate for at least two reasons. First, overall figures of deforestation does not account for the *fragmentation* of forestland, which magnify the impact of deforestation on biodiversity (WRI, 1994: 133). Second, there are significant differences in biodiversity between different land uses. Work by zoologists in the lowland rainforest of the Seberida district, Sumatra shows that the fauna diversity of long fallow forest (with or without rubber) is only slightly lower than for logged or unlogged primary forest, and well above that of plantations (NORINDRA, 1992).

A third area of environmental concern is related to soil erosion, but deforestation figures are poor indicators of the magnitude of the problem. Surface erosion is reduced proportionally to the density of the ground cover. "The ground cover rather than the tall tree canopy must command our attention, even though popular myth dwells on the importance of tree crowns in reducing raindrop impact and hence particle detachment through splash erosion" (Hamilton, 1994: 5). Comparing surface erosion from different land uses with tree cover, Wiersum (1984) finds the median value for shifting cultivation to be 0.15 (fallow period) and 2.78 (cropping period) tonn/ha/year, compared to 0.30 for natural forest. Tree crops or forest plantations where the ground cover is removed have soil losses of about 50 tonn/ha/year. Forest cover, due to its root system, is more important for mass erosion, e.g., landslip.

Overall figures of deforestation are therefore at best a very crude measure of the actual environmental changes. The concern for global climate change indicates a focus on biomass; biodiversity should guide our attention to forest composition and fragmentation, in addition to overall size; whereas the problem of soil erosion is mainly due to changes in ground vegetation and root structures. Hamilton (1988) has even suggested that the term "deforestation" should be abandoned, or if used carefully defined and qualified by a description of the real nature of the change. A fruitful approach -- in line with economic theory -- would be to first describe and, to the extent possible, quantify the variety of ecological functions provided, including the three discussed above. Second, the social desirability of different land uses should be evaluated based on a valuation of the changes in these functions or environmental services (see for example Winpenny, 1991). For analytical purposes, and to get a handle on the causes of problem and its solutions, the term "deforestation" is of limited value.

3 Land rent capture and agricultural expansion

3.1 Model assumptions

To develop policy handles to deal with the problems discussed above, one needs a clear understanding of tropical agriculture decision making and factors influencing the outcomes. Economic models in this area can be categorized along a number of axes, in particular the behavioural and market assumptions (of which the labour, product, and credit markets are the most important). Three important and somewhat stylized categories, which especially relates to the labour market assumptions, are:

1. Subsistence models

In the extreme case, no markets exist. Farmers produce only for their own consumption, with family labour as the only input in addition to land. The area of cultivation would in such models be determined by factors like population size, soil fertility, and technology. A common version of the subsistence model is the *"full belly"* case[6] (e.g., Dvorak, 1992); farmers' objective is to meet a basic subsistence requirement, and they do so by minimizing their labour efforts or maximizing leisure).[7]

2. Open economy models

Markets exist, and all prices (including the wage rate) are taken as parametrically given. An intuitive interpretation is that the shifting cultivation sector is small compared to the rest of the economy. In addition to the simplification made by exogenous prices, a further simplification is due to the recursive property of such models: If labour can be sold or hired at a constant wage, the production decisions by a utility maximizing household can be studied as income or profit maximizing production behaviour (Singh et al., 1986). The area of cultivation will in the open economy case be determined by the relative profitability of farming.

3. General equilibrium models

Models where markets exist, and prices are determined endogenously, would in most cases provide a more realistic description than subsistence or open economy models, but a price is paid in terms of complexity. Coxhead and Jayasuriya (1994) provide one of the very few applications of this approach to environmental degradation in developing countries.

The subsistence and open economy models provide the extreme cases, and give the range of possible adaptations and farmers' responses. The effect on deforestation of changes in exogenous economic variables and policies may be very different in the two models, as illustrated by the following examples:

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[6] The term "full belly" is due to Fisk (1962).

[7] The Chayanov (1966) model is a more general formulation. The household acts as if maximizing a utility function, with consumption and leisure as the arguments. They reach a subjective equilibrium with a shadow wage rate reflecting the rate of substitution between consumption and leisure. Holden (1993) compares the "full belly" and Chayanov formulation in a study of shifting cultivation in Zambia.

1. Population growth

Population growth has no effect in the open economy model, as the size of the agricultural sector (and its expansion into virgin forest) is determined by its relative profitability. In a subsistence model population growth is a critical variable in determining variables like forest clearing. Whereas population is endogenous in the first, it is exogenous in the second model.

2. Technological progress

In an open economy model technological progress will increase the profitability and therefore expand the agricultural sector. In a subsistence model technological progress implies that the subsistence requirement can be met by cultivating less land.

3. Increased risk

In the open economy case increased risk makes risk-averse farmers reduce the scale of the risky activity, i.e., farming. This hypothesis is supported by, among others, Elnagheeb and Bromley (1994) in a study from Sudan. In the subsistence case, on the other hand, increased risk implies a larger area under cultivation as risk averse farmers would aim to be on the safe side of the subsistence requirement.[8]

The underlying assumptions are often not clearly spelt out, and they turn out to be more significant than it may appear. Many policy recommendations and arguments in the popular and partly also the academic debates are grounded on the subsistence (or even "full belly") assumption, and policies based on this may produce results contrary to their intention. The lesson is twofold: First, one should be explicit about the assumptions employed. This paper will develop a framework based on the open economy assumption, and explore the effect on deforestation of different exogenous changes and policies under this approach.

Second, which model gives the most realistic description of farmers' adaptation and responses for the area of study? It is commonly argued that the subsistence model may be the most appropriate for traditional societies, whereas the open economy models give a better description of a modernized society (e.g., Stryker, 1976). Definite tests of the subsistence versus the open economy hypothesis are difficult to formulate, and are rarely undertaken in empirical work (López, 1992). One should keep in mind that these models are stylized descriptions, and it is often necessary to draw on elements from several approaches. We would, nevertheless, argue that *in our case* the open economy approach gives the best explanation and has more predictive power; therefore we use this as the *main* framework in the discussion.

[8] One possible behavioural assumption for subsistence farming under risk is that farmers minimize the probability of yield below a subsistence requirement, or that they minimize labour input, given a predetermined acceptable probability for output falling below subsistence (safety first models). See for example Roumasset (1977) for a more detailed discussion.

Moreover, one could argue that this approach is becoming increasingly applicable also for other areas of frontier agriculture in Asia and elsewhere for several reasons: Traditional agrarian societies are increasingly being integrated in the larger market economy, and commercialization of village life creates increased cash income "needs". Moreover, if one also considers *migration*, the open economy assumption would clearly give a more realistic description of frontier agricultural systems like shifting cultivation. A key variable in decisions concerning migration is the difference in expected income between the old and new location.

3.2 A simple framework for land rent capture

To organize some of the arguments in the deforestation debate into a more consistent framework, we develop a simple economic framework to explain agricultural expansion and deforestation. In spite of its simplicity, which means that some possibly relevant factors are not included, it yields insights into important mechanisms behind agricultural expansion, and gives some results and policy implications that reverse widely held perceptions based on a subsistence approach.[9]

Land rent is defined as the surplus or profit from agricultural production to the landowner, that is the gross value of production minus all costs of production, except for land.[10] In particular we want to include costs related to the location of the land, for example transport of output, and walking back and forth to the fields. Naturally, the location or distance costs are directly related with the distance from, say, the village centre, thereby making land rent to increase with accessibility. Given that people are free to move and open new land, the basic premise is that *all forest land with a positive land rent will be cleared and transformed to agricultural production.*[11] We will now look in greater detail at what determines land rent and how changes in these variables can explain deforestation. More formally, we can define land rent as:[12]

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9 A more comprehensive and formal treatment of different models based on the open economy assumptions is found in Angelsen (1994).

10 The discussion of land rent has a long history in economics, and goes back to the work of Ricardo and von Thunen during the first part of the 19th century. The presentation here is based on the von Thunen approach, where *location* is the key variable for differences in land rent. Ricardo focused on the *quality* of land.

11 There are land rent functions for other activities (logging, plantations, etc.), but we consider only the choice between agricultural production and virgin forest here.

12 Some of the simplifications behind this definition are: (1) We only include two types of costs: labour and location costs, which are the most important in frontier agriculture. (2) X and L are assumed to be fixed per ha. Thus, we do not discuss the decision of optimal labour input, nor decisions on cropping and fallow periods. The rotation aspect of shifting cultivation ignored here, to keep the presentation simple. These assumptions are relaxed in Angelsen (1994). (3) We consider one homogenous agricultural product, which may be thought of as a single crop or a fixed combination of crops. (4) Finally, land has the same quality. Differences in fertility would add another dimension to land, in addition to location. The x-axis in the figure below would then be an index of fertility and distance.

$$r = pX - wL - qD$$

{land rent = gross value of production - labour costs - distance costs}

r	land rent per hectare (ha);
p	price per unit of output;
X	quantity of output per ha (reflecting, among other things, the technological level);
w	opportunity cost per unit of labour (wage in alternative employment);
L	labour input per ha;
q	costs per ha and km related to distance or location of field (transport of produce, walking to the field, etc.);
D	distance in km from the village or regional centre to the field.

From this simple equation we see the various ways to influence land rent. First, the gross value of production is given by the agricultural price (p), and the output per ha (X) as determined, *inter alia,* by the technological level. The labour cost is given by the labour inputs requirement (L), which, again, would be determined by the technology. The opportunity costs of labour (w) should be thought of in a broad sense. Opportunity cost is in general defined as the best alternative use of a resource (here: labour). This would include other types of self-employment, wage labour, or -- in the case of potential migrants -- the income from farming or other occupations at their present place of residence. Travel cost is determined by distance from a centre (D), and the travel efficiency as reflected in the costs per ha and km (q). This would particularly be influenced by the availability of roads and other infrastructure.

The relationship between land rent and distance is illustrated by the left curve in figure 1. Keeping the other factors constant, land rent declines as distance increases, and eventually reaches zero. This is often labelled the *bid-rent curve*[13] *or rent gradient.* The distance at which land rent is zero defines the *agricultural frontier* or *margin of cultivation* (point A).

The figure can be given both a micro (local) and a macro (regional) level interpretation. At the micro level, one may think of a village surrounded by forest. The main distance costs would be to walk back and forth to the field, and locations more than, say, 3-4 km may have too high distance costs to make cultivation worthwhile. A macro level, and more abstract, interpretation would be to let the x-axis in the figure represent all forest land within a larger area, ranked according to accessibility.

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[13] The bid-rent function (or curve) refers to the maximum price (or rent) someone would be willing to pay (or bid) for land at a given distance in a competitive market.

The policy lessons from this model is straightforward: Any changes in the variables which increase the profitability of frontier agriculture (i.e., move the curve to the right) will augment deforestation: Higher output price (p), technological progress (X up and/or L down), lower opportunity cost of labour (w), and lower transport costs (q).

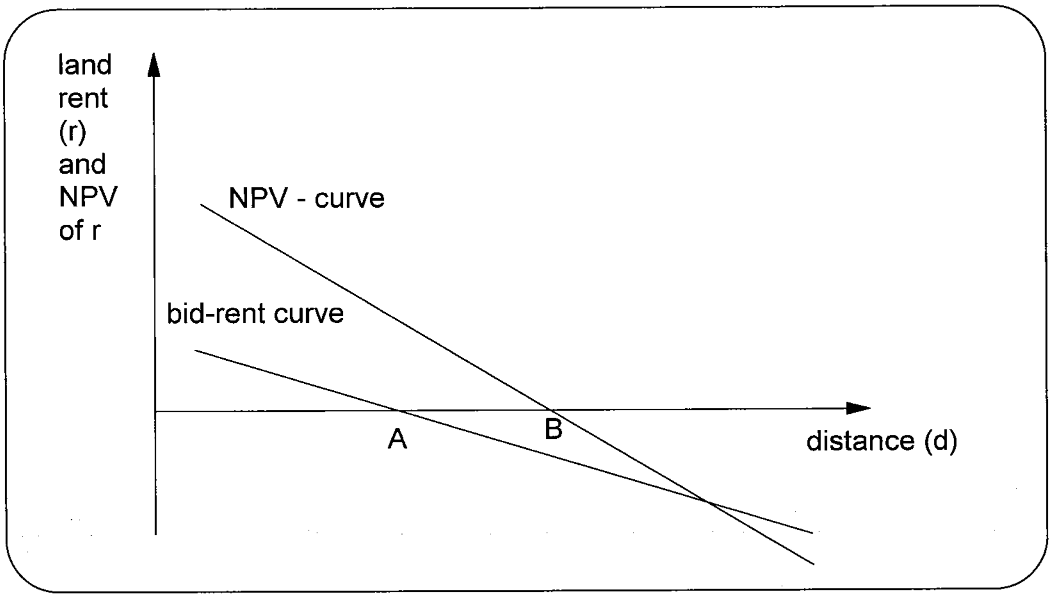

Figure 1. Agricultural frontier under two different property rights regimes.

So far we have neglected the issue of *property rights*, which has a prominent position in the debate on resource degradation in developing countries in general (e.g., Bromley, 1991). The description above corresponds to a situation of open access, that is with free entry and no restrictions on land use. This applies *de facto* to most frontier areas, even though 4/5 of the closed forest in developing countries is formally owned by the state. Moreover, a common feature in many areas is that forest clearing gives the farmer claims to the cleared land, particularly if perennials are planted or the land "improved" in some other way. The protection of these rights in customary or national law varies considerably, but to make the argument simpler we assume that forest clearing gives *secure* private property rights to the land. How would this modify the discussion above?

Consider the following situation: The land rent at any distance is expected to increase over time (the bid-rent curve moves to the right in the figure), for example due to technological progress or lower transport costs.[14] As clearing gives property rights, farmers not only look at the immediate benefits, but also the future surplus from production, as summarized in the net present value (NPV) of present and

[14] This may not necessarily always be the case. Land degradation may for example reduce land rent over time.

future land rents. The expected NPV, at a particular time k, of an infinite stream of expected rents (r_t^e) is given by:

$$NPV_k^e = \Sigma_{t=k}^{\infty} \frac{r_t^e}{(1+i)^t}$$

This is illustrated by the right curve in figure 1, which gives a snapshot of the situation at time k. The NPV-curve intersects the x-axis to the right of the bid-rent. The reason for this is straightforward: Consider point A, where $r_k = 0$. Because rent is expected to increase over time, the NPV at distance A of future rents must be positive, i.e., the NPV-curve lies above (or to the right) of the bid-rent curve.

Competition among farmers for new land will ensure that all forest with a positive NPV is cleared. The agricultural frontier will now be where the NPV is zero (point B). Forest is cleared even if it has a negative rent the first years (i.e., forest between A and B in the figure). This loss will, however, be outweighed through a positive land rent some time in the future. Early clearing is necessary to establish property rights (otherwise the land would be taken by others). We can therefore conclude that a system where clearing gives property rights will move the agricultural frontier beyond a pure open access regime (point A), and therefore stimulates deforestation.

This situation has been described as "the race for property rights" (Anderson and Hill, 1990). Such a land race is unproductive from a social viewpoint because it gives a negative contribution to the production in society (as land rent will be negative for the first years).[15] The principle reason for the inefficiency is the link between resource use (forest clearing) and allocation of property rights.

In addition to the factors included in the equation for land rent above, we have now added two others: Property rights regime, and farmers' expectations about the variables that determine future land rent.[16] The factors influencing the NPV and thereby the extent of forest clearing for agriculture are summarized in the table below.

[15] Thus, we have a case of true rent seeking, as defined in the literature: "Rent seeking is defined as attempts by individuals to increase their personal wealth while at the same time making negative contribution to the net wealth of their community" (Eggertsson, 1990:279).

[16] Another factor which is important in determining the NPV is the discount rate, that is the variable to weigh present and future values together into a common yardstick -- the NPV. Within our model a higher discount rate would actually reduce forest clearing, as relatively more weight is put on the present (and negative) land rent. We have not included this in the further discussion as it is hard to find empirical evidence on the role of different discount factors in determining forest clearing.

Variable	*Effect on land rent, agricultural frontier and deforestation*
1. Higher agricultural price (p)	Increase
2. Technological progress (X up or L down)	Increase
3. Higher opportunity cost of labour (w)	Decrease
4. Higher transport (access) costs (q)	Decrease
5. Property rights regime - clearing gives property rights	Increase
6. Expectations about higher land rent	Increase

Table 1: Factors affecting the NPV of future land rent.

3.3 Deforestation in Southeast Asia

How does this framework compare with the deforestation history of Southeast Asia? We discuss very briefly two of the above factors: Opportunity cost of labour and distance costs (accessibility). Other factors will be dealt with in relation to the case study from Sumatra.

Agricultural expansion in the uplands is often caused by *push-migration* from the lowlands. In the Philippines, about 1/3 of the population is located in the uplands, of which about 50 percent farm on forestland (World Bank, 1989). The basic push-factor is the limited sources of income (low w) for a large portion of the people in the lowlands, caused by factors like high population growth and inequitable land distribution and landlessness.

Population growth may therefore be included in our framework as far as it has an impact on the opportunity costs of labour (or other variables in the model for that matter). It can be argued that a high rate of population growth lowers the opportunity cost of labour, thus making more forest conversion profitable. The root of the problem is that frontier agriculture may act as an employment residual. Thus, the solution to the problem of deforestation is to be found as much outside the upland agricultural sector in providing attractive alternative employment opportunities for potential migrants. This is the 25 year old wisdom of the Harris-Todaro (1970) migration model: The solution to the migration problem is not as much in the immigration sector, where the most pressing problems are, as in the emigration sector.

Poverty is often cited as the main cause of environmental degradation in developing countries. The most typical characteristic and cause of poverty are a low value of the most valuable -- and often only -- asset of the poor: Labour. The lower the opportunity cost of labour is, the further away people would be willing to clear forest. In this context, the poverty of people cultivating on marginal forest land is a reflection of their limited alternative income opportunities rather than the conditions on site.

The *logging-shifting cultivation tandem* is also frequently used to explain deforestation. Selective logging is a very extensive activity, providing access to previously inaccessible areas by its network of roads. Grainger (1993) and others argue that agricultural expansion following the logging frontier has been one of the main vehicles of deforestation in Asia. Norman Myers has even estimated, somewhat speculatively, that for every cubic metre of harvested timber 0.2 ha of forest is destroyed by migrating farmers (Colchester, 1993:7). This contrasts with the situation in Amazonia, where logging follows the farming frontier.

Variations in accessibility (q) is a very significant variable in a cross-section analysis of deforestation in Southeast Asia. Thailand has halved its forest cover over the last three decades (53 percent in 1961 to 26 percent in 1991), one of the most rapid deforestation rates of any country for any period of history. A large share of this loss can be assigned to state-promoted agricultural expansion facilitated by large scale road construction (Hirsch, 1994[17]). One should note that a major goal of this road construction was to link the periphery of the Northeast with the rest of the country due to national security concern (communist insurgency), and the agricultural expansion was -- at least in part -- an unintended consequence.

Laos, at least until recently, provides an instructive contrast to Thailand. Large areas of the country remain inaccessible, and the country has a relatively good forest cover (slightly less than 50 percent). The situation over the past decades could be described as lack of "development", in the conventional sense. However, economic reforms since 1986 include stimuli of smallholder commercial agriculture and an extensive programme of road construction. Thus, it may only be a matter of time before Laos repeats the Thai experience.

4 A case study from Riau, Sumatra

4.1 Background to the study area

This part of the paper is based on data collected during one year field work in 1991-1992 in the district (*kecamatan*) of Seberida in the regency (*kabupaten*) Indragiri Hulu in Riau province, Sumatra, Indonesia.[18] Seberida is 2 800 km^2 in extent. In the south, a hill massif, the Bukit Tigapuluh, runs across the border of Jambi and Riau, and takes up approximately 1 000 km^2 of the district. The elevation of this hill massif is mostly below 300 m, but the terrain is rugged, and some of the hills reach 7-800 m. This area was designated as a Priority 1 Nature

[17] A comparison of Thailand, Vietnam and Laos is found in Hirsch (1994).

[18] The fieldwork was part of a larger interdisciplinary project - Norwegian-Indonesian Rain Forest and Resource Management Project (NORINDRA). This section is based on NORINDRA (1992).