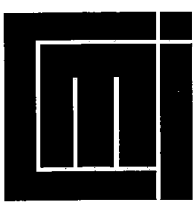
# Shifting Cultivation and "Deforestation"

## A Study from Sumatra, Indonesia

Arild Angelsen

WP 1994: 1



**Working Paper**
Chr. Michelsen Institute
Development Studies and Human Rights
Bergen Norway

ISSN 0804-3639

# Shifting Cultivation and "Deforestation"

## A Study from Sumatra, Indonesia

Arild Angelsen

**WP 1994: 1**

**Bergen, November 1994**

CHR. MICHELSEN INSTITUTE
Development Studies and Human Rights

Working Paper WP 1994: 1

# Shifting Cultivation and "Deforestation"

A Study from Sumatra, Indonesia

Arild Angelsen

Bergen, November 1994. 28 pp.

## 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:

Shifting cultivation
Agriculture
Deforestation
Indonesia

## Stikkord:

Svedjebruk
Jordbruk
Avskogning
Indonesia

*To be ordered from Chr. Michelsen Institute, Fantoftvegen 38, N-5036 Fantoft, Bergen, Norway. Telephone: +47 55574000. Telefax: +47 55574166*

## Contents



*Tables:*



*Figures:*

# 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:

---

[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]

---

[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.

[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).

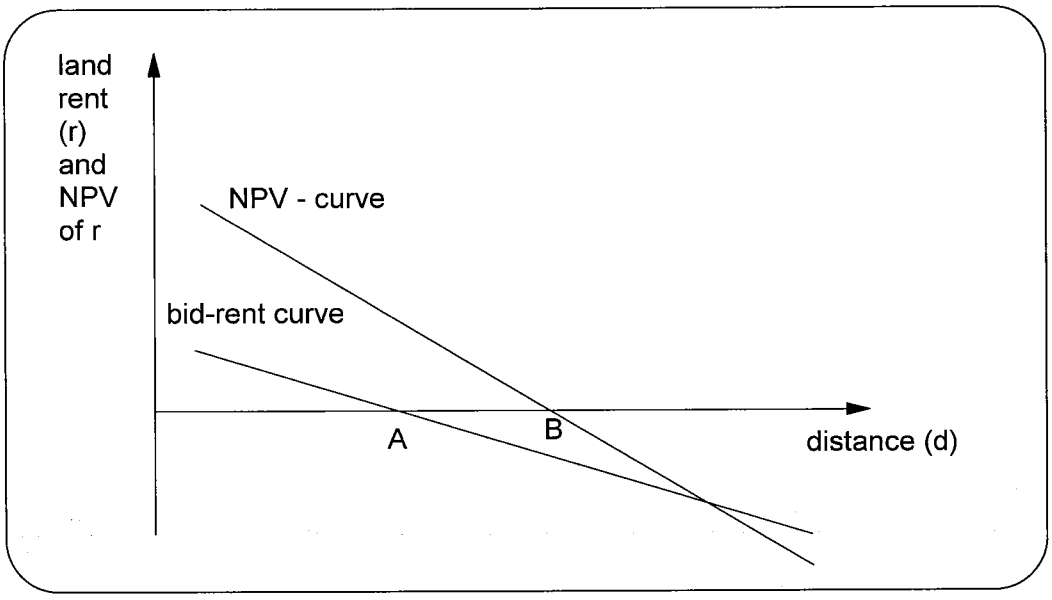



*Figure 1. Agricultural frontier under two different property rights regimes.*

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).

Reserve in the National Conservation Plan of 1982, but this has not yet been implemented. The north and east parts are covered by flat, swampy land, whereas the western part is dominated by the low undulating country of the Cinaku valley. The two main rivers in the district are the Cinaku river, draining into the Indragiri, and the Gangsal, which is a tributary of the Reteh river. The climate is characterized by abundant rainfall (about 2 800 mm annually), high humidity, and high temperatures.

The natural vegetation consists of lowland rain forest and swamp forest. Along the roads and rivers, the vegetation is a mosaic of secondary forest, swiddens, and traditional rubber forests. Traditional subsistence has been based on shifting cultivation and collection of forest products, but during this century forest collecting has increasingly been replaced by swidden-based rubber planting. Traditional shifting cultivation allows farmers to put land from the common forest into individual use, and obtain usufructuary rights according to customary (*adat*) law. These rights are strengthened by planting of perennials. Most of the shifting cultivation practice in Seberida can be defined as a *bush-fallow system* (fallow period from 5 to 10 years), but also with a significant share of *forest-fallow* (fallow length of more than 10 years, see Rutenberg, 1980). This demonstrates that the shifting cultivation system in Seberida is at a relatively early stage in its evolution, implying that the "degradation syndrome" has not (yet) occurred. Permanent cultivation is found in the transmigration settlements (Government sponsored migrants from Java and Bali) along the Cinaku valley. These are partly covered by *Imperata* grassland (*alang-alang*), a fire climax vegetation, because permanent rice cultivation has faced severe problems. The majority of transmigrants in many settlements depends on off-farm work outside Seberida for their survival, and a large share of them has returned to Java.

There are at present more than 41 500 inhabitants in Seberida. During the 1980s, the population in Seberida increased by an average of 13.1 percent per year, which is extremely high compared to other districts. The growth was mainly due to several large scale transmigration projects in the drainage area of the Cinaku river. The transmigrants now comprise more than 60 percent of the total population.

## *4.2 Swidden-rubber cultivation*

The main focus of my study was on the non-transmigrant part of the population, their adaptations, and resource use. An extensive survey of 196 randomly selected households in eight representative villages provides most of the data used. Even within this relatively limited geographical area, there is considerable variation in economic adaptations. Almost half of the overall income is from off-farm sources. Income from rice and other annual crops planted on the swidden fields counts for 16 percent. Smallholder rubber has increasingly become the main agricultural crop, now representing 23 percent of total income, and being the largest income source in the remote areas. Forest products play a minor role in the overall economy, but

are the single most important income source for the ethnic group of *Talang Mamak* (35 percent). However, also for these traditional forest dwellers rubber is increasingly taking over as the main source of income.

The output from "tree crops swidden cultivation" (Barlow, 1991) can be divided in three groups: Rice, other annual food crops, and rubber. Rice is the main short term output, and considered the main reason to open swidden. A number of other food crops are also planted during the first year. Cassava is cultivated by a large share (particularly the Talang Mamak population), and has advantages over rice in terms of pest and drought resistance. Other plants include maize, sweet potatoes, and a variety of vegetables for consumption. When rubber is planted on the swiddens, this is done during the first year as there is little competition between rubber seedlings and annual crops.

7 out of 10 households cleared forest for swidden cultivation at least one of the last two years (1990-1991), the share being close to 100 percent in some remote villages. This reflects the better availability of other income and employment opportunities in central areas, whereas land is generally more abundant in the remote areas. The average rice yield per swidden is very low, only around 480 kg paddy per swidden or 400 kg/ha in 1991 (average swidden size is 1.2 ha), and with huge variations (high yield risk).[19] This is sufficient for only 4-5 months consumption on average. The average local market value of rice and other annual crops from one ha swidden is about Rp 250 000 (USD 125). The low yield for Seberida is a reflection of the poor soil quality (acidity) in the area, as well as problems related to pests, particularly wild boar (forest pig).

If rice cultivation is both a highly risky as well as low-yielding activity, why do people continue? First, it is a reflection of limited availability of alternative income sources, implying a low opportunity cost of labour. Second, opening of swiddens is necessary to plant new rubber, and rubber has much higher profitability. Third, whereas a large majority of the farmers in the survey agreed that growing rice was the most risky activity, with low income compared to the work involved, they also like the work. 75 percent said this was the type of work they preferred. Rubber showed the opposite picture: The risk is low, 69 percent of rubber tappers consider this the most profitable activity, but only 20 percent rank this as the work they preferred. Finally, farmers also have preferences for producing their own food.

8 out of 10 households have rubber gardens, more than 97 percent being planted with traditional, low yielding trees (*karet rakyat*). The share that has mature rubber gardens that can be tapped is much lower, about 46 percent, reflecting limited rubber planting up to the mid 1980s. The average size of rubber holdings per

[19] This compares to 1 926 kg/ha for Riau and 2 110 kg/ha for Indonesia for dryland paddy in 1990 (Central Bureau of Statistics, 1991: 179).

household for those who have rubber gardens is 2.5 ha for mature rubber (46 percent of the households), and 3.4 ha for immature traditional rubber (64 percent). In addition 11 percent had immature, high yielding rubber planted through the World Bank and Government funded Smallholder Rubber Development Programme (SRDP), with an average of slightly more than 1 ha per household. The area of rubber holdings by the non-transmigrant population is about 12 000 ha, which is about 1/4 of the secondary forest and 4.3 percent of the total area of these villages.

An average of about 600 rubber trees are planted per ha. The mortality rate is, however, very high: 2/3 of the original trees have died for mature gardens, and 1/3 for immature gardens. Thus, the present rubber production system is quite extensive, and has considerable potential for intensification. The reported average yield per ha is 366 kg dry rubber, close to the average for Indonesia (364 kg).[20] The farm gate price of this would be about Rp 340 000 (USD 170). The yield per ha is significantly higher in the land scarce than land abundant areas - 445 and 286 kg, respectively. The average annual yield from one ha of tappable rubber garden (Rp 340 000) exceeds the income from the annual crops (mainly rice) planted on the first year on the swidden (Rp 250 000). Moreover, rubber can be tapped about 3/4 of the years in a rubber garden's life cycle, whereas rice presently is harvested in only one out of about every nine years.

## *4.3 Recent changes in the exogenous environment*

Whereas some of the basic features have been more or less constant over several decades, the last decade has brought a number of significant changes in the exogenous environment of the shifting cultivators, as summarized below:

*1. Increased land claims from external users, i.e., government sponsored projects*

Land claims have come from mainly three sources: First, *logging* operations started in the area in the 1970s. Generally, the effect of logging on land scarcity for swidden cultivation has been limited; partly because logging is located to primary forest, whereas most swiddens are reopening of secondary (fallow) forest. Moreover, logging roads provide access to new areas, and may actually increase land availability. Some farmers have in recent years opened swiddens along logging roads. Second, 15 *transmigration* settlements have been established since 1980, occupying about 26 000 ha. The transmigration establishment has several impacts on the traditional economy: (a) Increasing land scarcity where fallow forest and rubber gardens were appropriated to the transmigration development. (b) Improved infrastructure, particularly roads. (c) Competition for forest based resources, particularly rattan. (d) Increased availability of consumer goods. Third, the establishment of *plantations* (oil palm) is of more recent date, but may become

[20] Central Bureau of Statistics, 1991: 212-214. This figure includes all types of smallholdings, whether planted with traditional or more high-yielding rubber varieties. The latter type covers about 15 percent of the total rubber area of smallholders.

the most important external land claim in the future. The majority of workers on the plantations are likely to be drawn from the transmigration settlements.

*2. Improved infrastructure and market access, and changes in relative prices*

There has been a substantial improvement in roads during the 1980s, primarily due to the logging and transmigration projects. Several weeks of transport by river has been replaced by a few hours transport by road. Better market access means higher prices for cash crops, whereas consumption commodities become cheaper. Thus, it will be more profitable, *ceteris paribus*, to move from production based on self-consumption toward cash-crops and more specialized production. Still, local market prices of rubber vary by 25-30 percent between the central and remote areas of Seberida. Moreover, world market rubber prices increased steadily from 1985 to mid 1988, after which they levelled off and stabilized at the 1985-86 level. The increase, even if temporary, may at the time have given a strong incentive for rubber planting and expectations about high rubber prices in the future.

*3. Declining profitability of non-timber forest products*

Collection of forest produce has traditionally been a significant income source. Rattan collection was a major source of cash income 5-10 years ago, particularly in the more remote areas where as much as half of the households were engaged in rattan collection. Today very few find it attractive: There has been an over-exploitation of the resource, not by the local Malay (and Talang Mamak) population alone, but by the combined effect of the collection by these people, the transmigrants in the area and people from outside Seberida. Furthermore, the export ban on raw rattan, introduced in July 1988, caused the farm gate price to drop by around 50 percent.

*4. Population growth*

The population in the 20 traditional (non-transmigrant) villages grew from 11 413 in 1980 to 15 406 in 1991, that is an annual growth rate of 2.8 percent. Whereas the household survey shows a substantial male immigration, we do not have data to determine the *net* immigration. However, a growth rate of 2.8 percent is comparable to (slightly above) the natural population growth rate in rural Indonesia, implying that the net migration was low.

*5. Centralized, legal land rights system replacing customary (adat) law*

The tension between the customary (*adat*) system of usufruct land rights and a centralized, legal system, uniform to all Indonesia, has increased. All forest in Indonesia is *de jure* state property according to the Basic Act on Forestry of 1967, but lack of management and enforcement makes large parts of forests *de facto* open access, unless some forms of communal management exist.[21] The *adat* law gives usufruct rights to forested land planted with perennials after clearance. Even in the

[21] See Bromley (1991) for a categorization and description of different land right regimes.

case where no perennials are planted, those who cleared the forest initially have a priority for later clearance. Indonesian law states that any plot cleared and overrun by secondary forest through lack of tending for more than two years becomes communal property and can be handed over to a third party on request, given the agreement of the village head (Mary and Michon, 1987:46). What is more important, customary rights have *not* been respected by logging, transmigration, and plantation projects.[22] The result is a movement towards an open-access-like situation.

Related to our definition and discussion of land rent in section 3, the recent development clearly provides an example where land rent has risen: The rubber price has increased, and transportation or travel costs have decreased. The opportunity cost of labour has also decreased, because of declining profitability of forest produce, and population growth not absorbed in the off-farm economy.

## *4.4 Shifting cultivators' response and changes in adaptation*

The changes above have resulted in significant modifications in the shifting cultivators' adaptations. We employ a number of indicators to illustrate these changes, which - when added up - have resulted in a transition from a relatively stable rice based shifting cultivation system to a smallholder rubber system increasingly encroaching on previously unused old-growth forest. The trends are summarized in figure 2.

### *1. Increasing share of households opening swidden*

About 42 percent of the households opened swidden in 1985; this share increased to 61 percent in 1991. The rise has been sharper in the land abundant villages. The increase essentially took place between 1987 and 1989, whereas the proportion opening swidden was stable during the periods 1985-1987 and 1989-1991.

### *2. Increased rubber planting*

The other apparent trend is a sharp increase in rubber planting on swiddens after rice and other annual crops have been harvested for one year. During 1985-1986 about 1/3 of the swiddens were planted with rubber. This has increased steadily to more than 90 percent in 1991.

### *3. Fallow period*

The increased proportion of households opening swiddens and the increased rubber planting have an impact on the land availability and therefore other characteristics

[22] Indonesian law distinguishes between *hak milik* (rights of ownership) and *hak ulayat* (rights of avail). Whereas the Basic Agrarian Laws of 1960 explicitly acknowledge the *hak ulayat*, it also states that this recognition must be in accord with national interests and unity. Swidden fallow land is normally classified as *hak ulayat*, and this right has routinely been overridden when in conflict with any government supported project (see Dove, 1987).

of the swidden system. A slight downward trend can be observed up to 1989 (8 years) in the fallow period, after which it increases to about 12 years. Data about the farmers' plans for 1992 shows a further increase in average fallow period to 18-20 years, a reflection of an increasing share to be opened in old secondary forest of more than 35-40 years (*belukar tua* or *kerimbaan*).

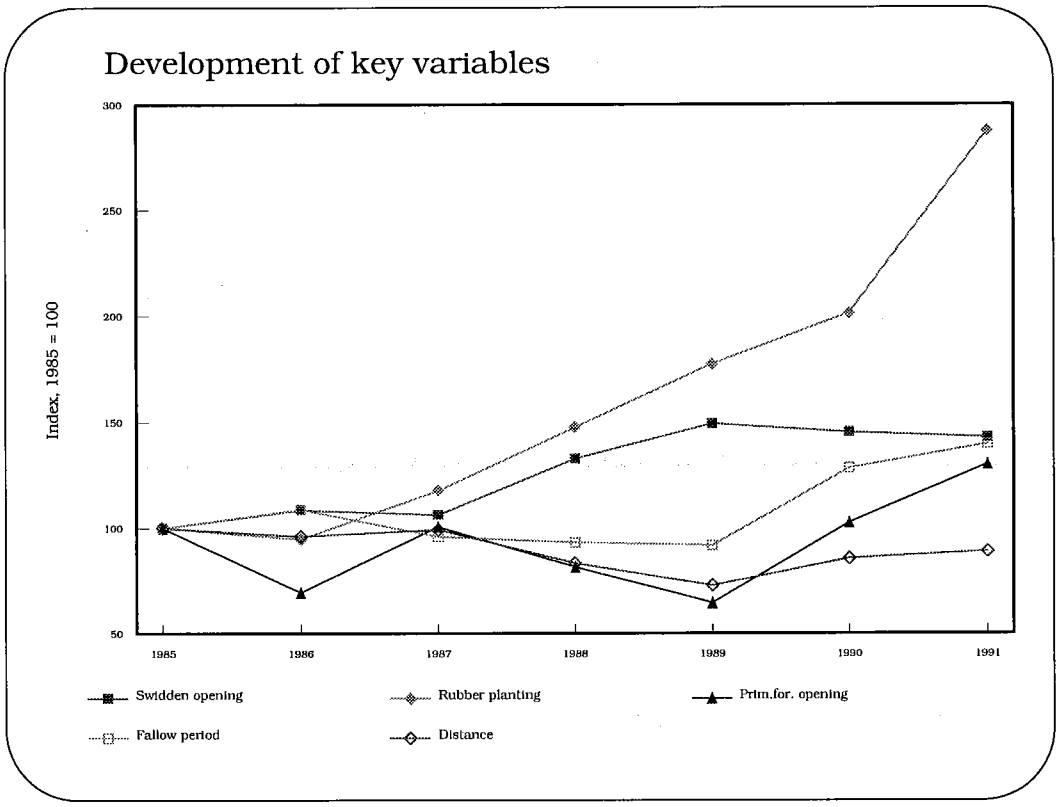



*Figure 2. Development in key variables of the shifting cultivation system in Seberida.*

*4. Type of forest cleared*

Primary forest clearing decreased from 1987 to 1989, whereas it increased substantially from 7 percent in 1989 to 13 percent in 1991. Data about the farmers plans for 1992 confirms the trend of increased clearing of primary forest. As there, almost by definition, is much less primary forest left in the surroundings of the land scarce villages, the increase mainly takes place in the land abundant (and remote) areas. On average, almost 19 percent of the swiddens here were opened in primary forest, the share in one village being 44 percent.

*5. Distance from village to swidden*

Distance from village to swidden is positively linked to the fallow period and type of forest cleared. Thus, from the two previous figures we should expect to find a

decrease in the distance up to 1989, and increase thereafter, which is exactly what the data shows. Data for 1992 indicates a further increase from 1.9 km in 1991 to 2.4 km in 1992. We may have expected a sharper increase after 1989. However, the desire to plant rubber on the swiddens means that land located far away from the village (more than 3-5 km) will be less valuable, given that the tapper has to go back and forth every tapping day and carry the rubber to the village.

*6. Size of swiddens*

The average size of the swiddens has not changed much during the period between 1985 and 1991. It has varied between 1.1 and 1.2 ha. There is no clear trend, maybe with the exception of a sharp increase from 1990 to 1991. Generally, the size of the swiddens is higher in land abundant areas (1.3 ha in 1991) than in land scarce areas (1.1 ha). We also find a significant difference in size between swiddens opened according to type of forest opened: In 1991 the average size of swiddens opened in primary forest was 1.65 ha.

The above factors increased the total forest cleared by shifting cultivators from about 1 400 ha in 1985 to 2 400 ha in 1991. A further breakdown of these figures may shed some light on the causes behind the increase in forest clearing (first order explanation). Annual forest clearing can (by definition) be written as the product of three factors:

*Total area cleared*
*= Average size of swidden (7 percent)*
** proportion of households opening swidden (70 percent)*
** total population (households) (23 percent)*

The relative importance of these factors in explaining the increase in total forest clearing between 1985 and 1991 is given in parentheses. The main factor is the increasing share of households that open swiddens. Population growth, often supposed to be the main factor behind (increased) forest clearing, accounts for "only" 23 percent.

The primary forest clearing increased from 160 ha to 420 ha in the period from 1985 to 1991. In a similar way as for the total area cleared, the direct factors behind the increase can be broken down into four factors:

*Primary forest cleared*
*= Average size of swidden (19 percent)*
** proportion of households opening swidden (30 percent)*
** proportion of swiddens opened in primary forest (39 percent)*
** total population (households) (13 percent)*

Here we find the main factors to be the higher share of swiddens opened in primary forest combined with the general increase in the share of population opening swiddens. We also note that the size of the swiddens opened in primary forest has increased substantially, contributing to 19 percent of the increase. Again, population growth cannot explain much, only 13 percent.

Population growth may obviously have indirect effects, i.e., it affects farmers decisions on whether to open swiddens or not, and the size and location of swiddens. Nevertheless, the implication of these figures is that the direct effect of population growth is relatively small, and the increased (primary) forest clearing should be explained by changes in other factors. The subsistence approach therefore seems less appropriate to explain the development in Seberida. Deforestation models like the one used by FAO (1993), where population density is the only explanatory variable, may produce very inaccurate predictions.[23]

## *4.5 Discussion*

The exogenous changes described in 4.3 can be summarized as an increase in land rent, complemented with a weakening of customary land rights. The main response of farmers (4.4) has been increased (primary) forest clearing and increased rubber planting. Figure 2 shows two phases in the swidden cultivators' response. During the period 1987-1989, swiddens closer to the village with shorter fallow period were opened. Returning to our framework in section 3, land rent in Seberida increased due to higher rubber price, lower opportunity costs of labour, and lower transport costs. In particular, the boost in land rent will be highest for land close to the village, making it the most profitable and important land to secure rights to. Moreover, the increase in the relative profitability of rubber to rice made a location close to the village more important, as rubber will be tapped from these plots almost daily for decades and therefore have higher distance costs. The relative importance of rice production, depending positively on the length of fallow, declined. A closer location was traded for a shorter fallow and lower rice yield. However, land close to the village is limited, and a large part has now been occupied with rubber. The development after 1989 shows that farmers had to start going further away from the village to find forest that can be cleared, thus the increase in distance, fallow period and primary forest clearing observed.

The sharp increase in rubber planting could be viewed from at least three perspectives found in the literature. These are complementary and, in fact, all fit into the framework discussed in section 3. First, it can be viewed as a rational

[23] The farmers' response in our case is consistent with the open economy hypothesis, *but not necessarily inconsistent* with the subsistence hypothesis: One may argue that the response is due to a decline in other food or income sources in the period. However, the average income level among the local Malay population is substantially (about 50 percent) higher than for the transmigrants, and for most households above the poverty line. There are also substantial income differences between households. This indicates that their objectives go beyond a pure subsistence requirement.

response to increased profitability of rubber compared to other crops because of relative price changes and declining rice yield due to pest problems. There is abundant evidence throughout the developing world of peasants' responsiveness to changes in relative prices (e.g., Godoy, 1992).

Second, increased land scarcity is generally seen as a major driving force for agricultural intensification (Boserup, 1965; Rutenberg, 1980). The two most common evolutionary paths of land use intensification for the humid tropics are shortening of the fallow period and/or increasing the cropping period, and introducing perennial crops. The first option will eventually lead to a permanent cultivation system, which "is technically possible and ... balanced systems can be achieved, but only at a high cost, and the question is whether these systems are economic from the point of view of the farmer" (Rutenberg, 1980:67). The recent experience with permanent rice cultivation in the transmigration areas in Seberida illustrates the difficulties with this option. The transition from a shifting system with largely annual crops to perennial crops is relatively simpler and cheaper, and has in our case both environmental and financial advantages. The sharp increase in the rubber planting, combined with the fact that the fallow period is increasing, indicate that the major development in the system is not towards intensification by shortening of the fallow period, but rather by introduction of perennials. Compared with our framework in section 3, increased land scarcity could be regarded as a case of declining opportunity cost of labour.

Third, the switch to rubber and increased land clearance can be viewed as a way to obtain and secure land rights, both according to customary and national law. The importance of this factor has increased for several reasons: Increased competition for land (land has become more scarce), both among traditional farmers themselves and from outsiders, and the increased land rent. This approach is in line with the demand-induced models for development of more secure and individualized property rights (Hayami and Ruttan, 1985), where this development is a function of the value of land and how well this value can be captured under existing property rights arrangements. The situation described above is one of simultaneous intensification and development of individual property rights. This is a widely observed phenomenon when land increases in value (Feder and Feeny, 1993:243). The security provided by customary rights is to a large extent determined by government policy. Thus, the lack of respect for *adat* law by the state drives farmers to establish claims that are more likely to be protected. Besides planting of rubber, farmers are now increasingly obtaining written titles to their rubber holdings, but this is a rather expensive option for the average farmer.

As noted in the discussion in section 3, expectations about future land rent may be as important - or more important - than actual land rent. Expectations about future increased land scarcity, and therefore higher land values, seem to play an important role in our case. More than 3/4 of the households expected increasing difficulties in

finding suitable land for swiddens. The most common reasons as to why the households in the survey expected this development was increased rubber planting (89 percent), population growth (72 percent), the establishment of transmigration areas (32 percent), establishment of plantations (14 percent) and logging activities (7 percent). We note the dominance of internal factors, i.e., the increased demand for land from the local population.

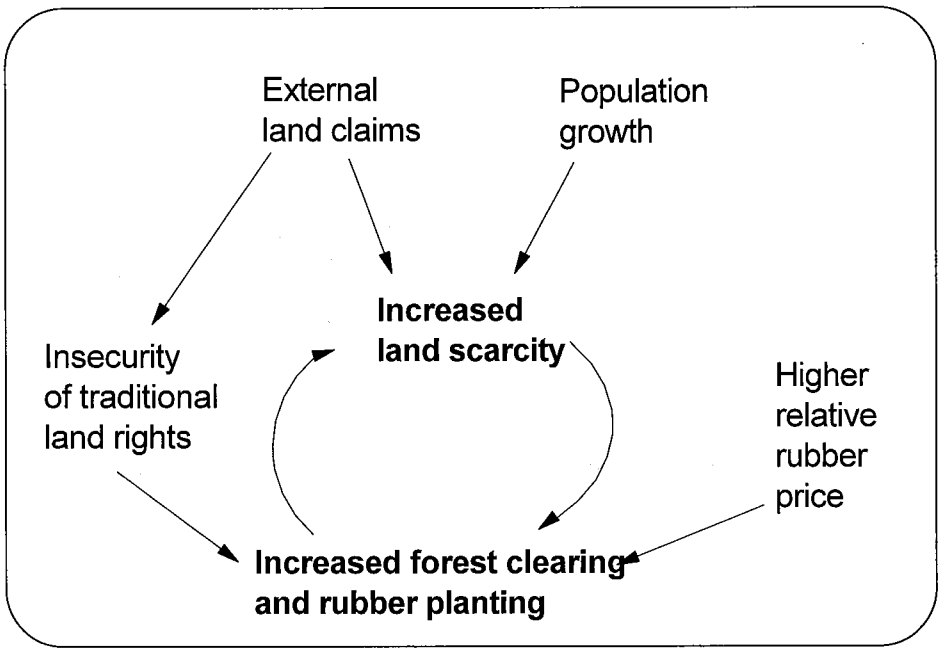



*Figure 3: Explanation and dynamics of increased forest clearing and rubber planting.*

The interrelations between the various explanations of the recent development are summarized in figure 3. Population growth and external land claims have been important factors leading to increased (expectations about) land scarcity. The scarcity has led to an intensification and securing of land rights through increased forest clearing and rubber planting. This development is spurred by the boosted profitability of rubber, and the decreasing respect for customary law by outside user groups and the state. Moreover, increased rubber planting in itself has a snowball effect on land scarcity, at least in the short run. Planting of rubber implies that farmers cannot practice a normal fallow cycle of 5-10 years, as the plots have been occupied by rubber trees. Thus, the land race or race for property rights is self-reinforcing. Land is becoming scarce now because people expect it to become scarce. The answers by farmers regarding factors behind land scarcity indicate that the internal dynamics now play the most important role in increasing scarcity of forest for agriculture, whereas external factors have been relatively more important in initiating the land race.

A crucial question is what will happen when farmers start receiving income from the presently immature rubber gardens? Will the proportion of farmers opening swidden decline and the expansion into primary forest area stop, or will the present trends continue? This will depend on a number of factors: The availability of land for expansion (influenced by, *inter alia,* the establishment of new plantations, conservation areas, etc.); the availability of off-farm employment; the rubber price; and immigration to the area. The recent completion of the East Sumatran Highway through the area is likely to fuel immigration and increase the pressure on the largest remaining lowland rainforest area on Sumatra.

## 5 Summary and concluding remarks

We have argued that changes in land rent is the single most important factor to understand and explain agricultural expansion. The land-rent-capture approach provides an alternative to the subsistence approach, and yields conclusions for policy design which differs from generally held views in the popular debate:

*1. Technical progress (e.g., intensification programmes) in frontier areas may increase forest clearing.*

Intensification programmes in a subsistence model have the potential for reducing forest clearing, as people can get a reasonable income from fewer ha of land. However, increased profitability of farming will attract more people, both through a shift from alternative income generating activities among those already living in the area, and through inmigration.

*2. The development of off-farm jobs is crucial in determining future forest clearing.*

The profitability of agricultural expansion is to a large extent determined by the availability and conditions of alternative employment.

*3. Improved infrastructure and roads reduce transport costs, thereby increasing land rent and forest clearing.*

This has been a significant pattern of deforestation in several countries throughout Southeast Asia, most commonly as a side-effect of logging or other large-scale projects.

The case study from Seberida, Sumatra shows a development in accordance with the land rent capture approach. In addition to the points mentioned above, which are all valid to the study area, some additional lessons can be learned:

*4. The transition from a rice based shifting cultivation system to a smallholder rubber system has several positive features.*

Smallholder rubber gardens provide an annual income per ha which is several times higher than the traditional rice based shifting cultivation system. The

experience from Malaysia and elsewhere shows that even very intensive rubber production can be sustainable, in the sense that yields are maintained over time. The traditional smallholder rubber gardens preserve most of the ecological functions of natural forest. The development in Seberida should be seen in light of the accelerating land degradation occurring elsewhere as a result of non-sustainable attempts at intensification of shifting cultivation systems. If the present expansion into primary forest also could be limited, the transition from rice to rubber would clearly be a step towards more sustainable resource use. Indeed, introduction of tree crops in farming system is often seen as an essential part in the development of more sustainable agricultural systems in the humid tropics. We should note that in our case, the transition is not a result of any deliberate government policy. The development of a local economy heavily dependent on a single crop and its price fluctuations on the world market remains a concern, and some diversification of the tree crops would be desirable.

*5. A large potential for sustainable intensification exists, but the incentives for intensification are limited.*

Rice production per ha (cropping and fallow land) could be increased by shortening the fallow period[24] and by growing rice (and other crops) twice on the same plot before fallow. Rubber production per ha could be augmented by increasing the number of trees per ha, and by planting more high yielding rubber varieties. However, as long as land is relatively abundant, the incentives for intensification are limited. The situation in Seberida could be described as one where the *expected* land scarcity is clearly higher than *actual* land scarcity. This provides incentives for securing future land rights by forest clearing and rubber planting, whereas the incentives for intensification of rice or rubber production, mainly determined by *actual* land scarcity, are more limited. The incentives at this stage are more to secure rights to new land than to intensify production on already cleared forest.

*6. Government sponsored land claims have a multiplier effect on forest clearing.*

Government sponsored projects (transmigration, plantation, logging and mining) have several effects on the land use in the area. The direct effect on forest clearing is obviously the amount of forest being cleared by the project. A commonly observed indirect effect is increased forest clearing by shifting cultivators as a result of road construction. This has been of some importance in our study area, but less so than the weight given to this phenomenon in the general debate on tropical deforestation in the region. The main multiplier effect of external land claims has been in changing the expectations about future land scarcity, thereby increasing present forest clearing and rubber planting. The land race initiated is self-reinforcing, and is spurred on by the decreasing respect of customary land rights by the state.

---

[24] There are limits to how short the fallow period could be before the "degradation syndrome" starts. Although area specific data on this are not available, we believe there still is room for a sustainable intensification through shorter fallow period.

## References


Anderson, Terry L. and Peter J. Hill. 1990. "The Race for Property Rights". *Journal of Law and Economics*, XXXIII, April: 177-197.

Angelsen, Arild. 1994. "Shifting Cultivation Expansion and Intensity of Production under Alternative Labour Market Assumptions and Property Regimes. The Open Economy Case." Bergen: Chr. Michelsen Institute. Working paper (forthcoming).

Atal, Yogesh. 1984. "Swidden Cultivation in Asia: The Need for a New Approach". *Nature and Resources* (UNESCO), XX (3), July-September: 19-26.

Barlow, Colin. 1991. "Developments in Plantation Agriculture and Smallholder Cash-crop Production". In Joan Hardjono (ed.): *Indonesia. Resources, Ecology and Environment,* pp. 85 - 103. Singapore: Oxford University Press.

Boserup, Ester. 1965. *The Conditions of Agricultural Growth.* London: George Allen & Unwin Ltd.

Bromley, Daniel W. 1991. *Environment and Economy. Property Rights and Public Policy.* Oxford and Cambridge: Blackwell.

Central Bureau of Statistics, Indonesia. 1991. *Statistical Year Book of Indonesia. 1990.* Jakarta.

Chayanov, A.K. 1966. *The Theory of Peasant Economy.* Eds.: D. Thorner, B. Kerblay and R.F. Smith. Homewood, Illinois: Irwin.

Colchester, Marcus. 1993. "Colonizing the Rainforests: The Agents and Causes of Deforestation". In M. Colchester and L. Lohmann (eds.): *The Struggle for Land and the Fate of the Forests,* pp. 1 - 15. Penang: World Rainforest Movement, with The Ecologist and Zed Books.

Connor, Edward F. and Earl D. McCoy. 1979. "The Statistics and Biology of the Species-area Relationship." *American Naturalist*, 13: 791-833.

Coxhead, Ian and Sisira Jayasuriya. 1994. "Land Degradation in Developing Countries." *Land Economics,* 70 (1), February: 20-37.

Dauvergne, P eter. 1994. "The Politics of Deforestation in Indonesia." *Pacific Affairs*, 66(4): 497-518.

Dick, John. 1991. "Forest Land Use, Forest Zonation and Deforestation in Indonesia: A Summary and Interpretation of Existing Information." Background paper to the UNCED conference, prepared for Ministry of Environment (KLH) and Environmental Impact Management Agency (BAPEDAL), Jakarta.

Dove, Michael R. 1987. "The Perception of Peasant Land Rights in Indonesian Development: Causes and Implications." In J.B. Raintree (ed.): *Land, Trees and Tenure,* pp. 265 - 271. Nairobi and Madison: International Centre for Research on Agroforestry (ICRAF) and Land Tenure Center.

Dvorak, K.A. 1992. "Resource Management by West African Farmers and the Economics of Shifting Cultivation." *American Journal of Agricultural Economics*, 74 (August): 809-815.

Eggertsson, Thráinn. 1990. *Economic Behaviour and Institutions.* Cambridge: Cambridge University Press.

Elnagheeb, Abdelmoneim H. and Daniel W. Bromley. 1994. "Extensification of Agriculture and Deforestation: Empirical Evidence from Sudan." *Agricultural Economics,* 10: 193-200.

FAO. 1974. *Shifting Cultivation and Soil Conservation in Africa.* Rome: FAO.

FAO. 1991. *Indonesian Tropical Forestry Action Programme.* Jakarta: Ministry of Forestry, and Food and Agricultural Organization of the United Nations (FAO).

FAO. 1993. *Forest Resource Assessment 1990. Tropical Countries.* Rome: FAO. Forestry Paper 112.

Feder, Gershon and David Feeny. 1993. "The Theory of Land Tenure and Property Rights". In K. Hoff, A. Braverman and J.E.Stiglitz (eds.): *The Economics of Rural Organization. Theory, Practice. and Policy,* pp. 240 - 258. New York: Oxford University Press (for the World Bank).

Fisk, E.K. 1962. "Planning in a Primitive Economy: Special Problems of Papua New Guinea." *Economic Record,* 38: 472-478.

Godoy, Ricardo A. 1992. "Determinants of Smallholder Tree Crops Cultivation". *World Development,* 20 (5): 713-725.

Grainger, Alan. 1993. *Controlling Tropical Deforestation.* London: Earthscan.

Hamilton, L.S. 1988. "Semantics, Definitions and Deforestation." *IUCN Special Report Bulletin,* 18 (4-6): 8-9.

Hamilton, L.S. 1994. "Does "Deforestation" Always Result in Serious Soil Erosion?" Paper presented at the International Symposium on Rain Forest in Asia. Centre for Environment and Development, University of Oslo, 23 - 26 March 1994.

Harris, John R. and Michael P. Todaro. 1970. "Migration, Unemployment and Development: A Two Sector Analysis." *American Economic Review,* LX, March: 126-142

Hayami, Yujiro and Vernon W. Ruttan. 1985. *Agricultural Development. An International Perspective.* Baltimore and London: Johns Hopkins University Press.

Hirsch, Philip. 1994. "Deforestation and Development in a Comparative Perspective: Thailand, Laos and Vietnam." Paper presented at the International Symposium on Management of Rainforest in Asia. Centre for Environment and Development, University of Oslo, 23 - 26 March 1994.

Holden, Stein. 1993. "Peasant Household Modelling: Farming Systems Evolution and Sustainability in Northern Zambia." *Agricultural Economics,* 9: 241-267.

Houghton, Richard A. 1993. "The Role of the World's Forest in Global Warming." In K. Ramakrishna and G.M. Woodwell (eds.): *The World Forests for the Future,* pp. 21 - 58. New Haven: Yale University Press.

López, Ramón. 1992. "Environmental Degradation and Economic Openness in LDCs: The Poverty Linkage". *American Journal of Agricultural Economics*, 74(5): 1138-1143.

Mary, Fabienne and Geneviève Michon, 1987. "When Agroforests Drive Back Natural Forest: A Socio-economic Analysis of a Rice-agroforest System in Sumatra". *Agroforestry Systems*, 5: 27-55.

Myers, Norman. 1992. "Tropical forests; The Policy Challenge." *Environmentalist*, 12(1): 15-27.

NORINDRA. 1992. *End of Fieldwork Report.* Pangkalan Kasai, Sumatra, 20. March 1992. Centre for Environment and Development, University of Oslo.

Roumasset, James A. 1976. *Rice and Risk. Decision Making among Low-income Farmers.* Amsterdam: North Holland Publ. Comp.

Rutenberg, Hans. 1980. *Farming Systems in the Tropics. 3rd. ed.* Oxford: Clarendon Press.

Singh, I., L. Squire and J. Strauss (eds.). 1986. *Agricultural Household Models. Extensions, Applications and Policy.* Baltimore: Johns Hopkins University Press.

Stryker, J.D. 1976. "Population Density, Agricultural Technique, and Land Utilization in a Village Economy." *American Economic Review,* 66 (June): 347-358.

UNEP. 1992. *The World Environment 1972-1992.* Nairobi: United Nations Development Programme.

Wiersum, K.F. 1984. "Surface Erosion under Various Tropical Agroforestry Systems". In C.L. O'Loughlin and A.J. Pearce (eds.): *Proceedings from Symposium on Effects of Forest Land Use on Erosion and Slope Stability*, pp. 231 - 239. Honolulu: East West Center.

Winpenny, J.T. 1991. *Values for the Environment. A Guide to Economic Appraisal.* London: HMSO

World Bank. 1989. *Philippines. Environment and Natural Resource Management Study.* Washington, D.C.: World Bank.

World Bank. 1990. *Indonesia: Forest, Land and Water: Issues in Sustainable Development.* Washington D.C.: World Bank.

World Bank. 1994. *Indonesia. Environment and Development.* Washington D.C.: World Bank.

World Resources Institute (WRI). 1990. *World Resources 1990-1991.* New York & Oxford: Oxford University Press.

World Resources Institute (WRI). 1992. *World Resources 1992-1993.* New York & Oxford: Oxford University Press.

World Resources Institute (WRI). 1994. *World Resources 1994-1995.* New York & Oxford: Oxford University Press.

# Recent Working Papers

D 1991: 4 KAPADIA, Karin
*Discourses of gender and caste in rural South India: An analysis of the ideology of impurity.* Bergen, September 1991, 43 pp.

D 1991: 5 PAUSEWANG, Siegfried
*Rural conditions for democracy in Ethiopia. Peasant self-determination and the state.* Bergen, December 1991, 18 pp.

D 1991: 6 OFSTAD, Arve, Arne Tostensen and Tom Vraalsen
*Towards a "Development Contract". A new model for international agreements with African countries?* Bergen, December 1991, 13 pp.

D 1992: 1 EADI - European Association of Development Research and Training Institutes. Working Group on Information and Documentation
*Strengthening cooperation in documentation for development. A seminar on networking with special emphasis on NGOs.* Bergen, March 1992, 214 pp.

D 1992: 2 SKRAMSTAD, Heidi
*"Kvinner i utvikling" i Gambia. Nye kjønnsrelasjoner med hjelp fra Verdensbanken?* Bergen, mars 1992, 25 s.

D 1992: 3 CHERU, Fantu and Siegfried Pausewang
*Economic reconstruction and the peasants in Ethiopia. Two papers presented at the symposium on the Ethiopian economy, with a postscript.* Bergen, May 1992, 66 pp.

D 1992: 4 FJELDSTAD, Odd Helge
*Økonomisk velferdsteori og fordelingsaspektet.* Bergen, august 1992, 22 s.

D 1992: 5 FJELDSTAD, Odd Helge
*Multiple inflasjonslikevekter og deres stabilitet: En drøfting av stabiliseringsprogrammene i Argentina, Brasil og Israel på midten av 1980-tallet.* Bergen, august 1992. 21 s.

D 1992: 6 NORBYE, Ole David Koht
*EF og bistanden. Virkninger på norsk bistand av et eventuelt norsk EF-medlemskap.* Bergen, august 1992, 21 s.

D 1992: 7 CHERU, Fantu
*Constraints for a conservation-based agricultural development policy in Ethiopia. A baseline study in Fedis Awraja.* Bergen, September 1992, 37 pp.

D 1992: 8 TJØNNELAND, Elling Njål
*Universitet og forsking i Sør-Afrika. Utfordringar etter apartheid og akademisk boikott.* Bergen, oktober 1992, 16 s.

D 1992: 9 OFSTAD, Arve
*Afrikas økonomiske krise - finnes det grunnlag for reformer?.* Bergen, desember 1992, 15 s.

D 1992: 10 ALAM, Mahmudul
*Secondary and higher secondary education in Bangladesh. Its growth and state expenditures: A time-series analysis of 1981-90.* Bergen, December 1992, 23 pp.

D 1993: 1 EADI - European Association of Development Research and Training Institute. Working Group on Information and Documentation
*Development policy, research and information: Isolation or interaction? Tilburg, The Netherlands, 1-4 September 1992.* Bergen, February 1992, 167 pp.

D 1993: 2 TJOMSLAND, Marit
*"The educated way of thinking". Individualisation and Islamism in Tunisia.* Bergen, April 1992, 15 pp.

WP 1993: 1 GRANBERG, Per
*Macro-economic effects of development plan expenditures. A framework for analysis, with special reference to Uganda.* Bergen, July 1993, 51 pp.

WP 1993: 2 DANEVAD, Andreas
*Hvorfor har militæret fortsatt makten i Burma?* Bergen, september 1993, 27 s.

WP 1993: 3 BØRHAUG, Kjetil
*From policy guidelines to problem solving. A critical assessment of the national conservation strategies of Botswana and Zambia.* Bergen, November 1993, 61 pp.

WP 1993: 4 ANGELSEN, Arild
*Individual choice under uncertainty.* Bergen, December 1993, 27 pp.