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# Transmigration Settlements in Seberida, Sumatra: Deterioration of Farming Systems in a Rain Forest Environment

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## *ABSTRACT*

*This study of transmigration settlements in Seberida, Riau Province, Sumatra, Indonesia, attempts to analyse why there was a deterioration in the farming systems of transmigrants and what the consequences of this were for the settlers and the local environment. The analysis is of both an agroecological and a socioeconomic nature. The government-planned farming models were of the food crop and the tree crop (with rubber) types. None of the models performed according to expectations. It was found that the majority of the settlers were unable to meet the goal of self-sufficiency in food production. As much as 64% of the transmigration population was found to fall below the poverty line. This again resulted in transmigrants searching for off-farm sources of income, like waged work on neighbouring plantations, collection of forest produce, particularly rattan, and swiddening in the surrounding rain forest. More than 30% of the transmigrants had returned to Java.*

## 1. INTRODUCTION

The organized movement of people in Indonesia from the densely populated Inner Islands to the rain forest-covered Outer Islands was started by the Dutch early this century. The aim at that time was to provide cheap labour for the expansion of plantations. After independence, the Indonesian government continued this organized movement of people, now named transmigration, as an important official policy. The policy aimed at reducing the population pressure at Java, improving the people's standard of living, creating development in the Outer Islands, better utilization of natural and human resources, national unity and strengthening of national defence and security. The goals of economic development and national unity appear now to be the most central while the population goal is receiving less emphasis.

The Indonesian transmigration programme has been called the largest organized resettlement programme in the world (Leinbach, 1989). It is estimated that close to five million people have moved, including spontaneous transmigrants, during the whole period of the resettlement policy from 1905 to 1989 (Fasbender & Erbe, 1990). Most of these, approximately 3·7 million, were moved during the period 1979 to 1989. This movement of people still represents only a small fraction of the population growth on the Inner Islands where the annual population growth is close to two million people.

Close to 12 000 $km^2$ have been used for the establishment of transmigration settlements and this may be said to be a relatively small area. However, there has been a tendency for transmigrants to spread their activities far outside the original settlement areas, entailing considerable impact on the indigenous people. Sumatra has received the largest number of transmigrants so far. Most of the transmigrants have come from Java. In the early 1990s about 50 000 households were moved annually. This number is maintained in the next five-year plan and Irian Jaya is the main target for transmigration in the years to come.

Indonesia received considerable international technical and financial assistance from the World Bank, FAO, ODA and GTZ to plan and implement transmigration projects in the late 1970s and early 1980s. During the history of the transmigration programme it has been criticized from various angles (Anon., 1986; Otten, 1986; Leinbach, 1989). The poor performance in some of the settlements led the World Bank to participate in planning of a 'second stage' development programme (TSSDP) for some of the worst settlements. Seberida was one of eight areas selected for TSSDP. This work began in 1987 and plans were ready by 1988 (Ministry of Transmigration (MOT) 1988). In Seberida the plan recommended a partial conversion from food crops to rubber in the food crop model settlements. TSSDP was not implemented, however, and negotiations between the Indonesian government and the World Bank were still going on during the authors' research. New plans for a TSSDP were also made in 1991

(MOT, 1991). A new concept was established implying a closer linkage with the private industry.

Criticism has also been strong against the World Bank (WB) for its involvement in the transmigration programme. Finally, in 1992 financial assistance from the World Bank for TSSDP was cancelled. The criticism is likely to be one reason for WB's reluctance to be involved in TSSDP. However, involvement in TSSDP may also be seen as an attempt to repair damage already done and as an attempt to prevent further damage. The fairly strict conditionalities WB wanted were probably also an important influence on the Indonesian government choosing a more expensive loan from Japan with no conditionality. What the consequence of this will be for the plans in Seberida is not yet known.

This paper presents results from research on transmigration settlements in Seberida during 1991–1992. The objectives were to analyse causes and consequences of what was found to be a deterioration in the planned farming systems of the majority of settlers. This has been done from agroecological, agro- and socioeconomic perspectives. Section 2 of the paper gives a brief presentation of the study area, Section 3 gives an overview of the methodological approaches and Section 4 presents the causes of deterioration in farming systems. Section 5 presents and discusses the consequences of the deterioration for the behaviour and living conditions of transmigrants, the social organization and viability of settlement communities, and the potential threat to the local population and the surrounding environment.

## 2. THE CASE STUDY AREA: SEBERIDA

Seberida is a district in the regency Indragiri Hulu in Riau Province in Sumatra. The district of Seberida covers about 2800 $km^2$. A hill massif, the Tigapuluh Hills, reaching 700–800 m at the highest but with most of the area below 300 m, runs across the border of Jambi and Riau and covers approximately 1000 $km^2$ of the district. This area was designated as a Priority 1 Nature Reserve in the National Conservation Plan of 1982 but this has not yet been implemented. The rest of Seberida is covered by flat, swampy or undulating land. Transmigration settlements were established both in the flat and swampy land as well as the undulating lowlands.

Average annual rainfall is about 2800 mm and the mean temperature is about 26°C (Skarbøvik, 1993*a*). The climax vegetation in Seberida is lowland evergreen tropical rain forest but in large parts of the district various types of human activities have influenced or completely removed the vegetation (Whitmore, 1992).

The population in Seberida was about 12 000 in 1980. In the period 1981–1987, 15 transmigration settlements were established in the district. As a result the population was about 41 000 in 1991 and more than 60% were transmigrants predominantly from Java. In addition, a large plantation, six forestry companies and a mining company have started activities in the area. These activities have created few employment opportunities for the local people although some have been included in the transmigration settlements.

### 2.1. Farming systems of transmigrants

Two production models were used for the transmigration settlements in Seberida: the food crop model and the tree crop model with rubber. The aim of the food crop model was that the transmigrants should first achieve self-sufficiency in food production and then start to produce cash crops for sale. It was estimated that with the resources that were provided, they should achieve a standard of living well above the poverty line. The transmigrant households were given a homegarden area of 0·25 ha around their house and a food crop area of 1·0 ha (*Lahan Usaha 1 (LU1)*), in a circle outside the settlement area. These areas were usually cleared at the time of their arrival. After a few years they were given another 0·75 ha each in a circle outside the food crop area. This area, *Lahan Usaha 2 (LU2)*, was intended for cash crop production. This model was used in 13 of the 15 settlements in Seberida. The other model, the tree crop model with rubber (PIR rubber), provided each transmigrant household with 0·4 ha homegarden area, 0·6 ha food crop area and 2·0 ha rubber garden. Unlike the food crop model settlements, however, the 'rubber transmigrants' were expected to pay back the investment costs for their rubber holdings. In 1992 the average rubber transmigrant household had a debt of about Rp. 8 million which they were expected to pay back through their rubber production. The tree crop based settlements were among the last to be established. Tapping of rubber had been going on for one year when the authors undertook the investigations.

## 3. METHODOLOGY

Methods applied during the field work which took place in the period from July 1991 to March 1992 included:

(a) rapid rural appraisal for problem identification and hypothesis formulation;

**TABLE 1**
Zoning and Survey Sampling

| *Zone* | *Trans area* | *Dominant farming system* | *Market access* | *Soil condition* | *General survey* | *Home-garden survey* |
|---|---|---|---|---|---|---|
| 1 | SPD | Food crop | Poor | Poor | x | x |
| 2 | SPA,DK2,DK5,DK3s | Food crop | Medium | Medium | x | |
| 3 | DU,DK1,DK3,DK4,DK6 | Food crop | Medium | Good | x | x |
| 4 | Blok A,B,D,E | Food crop | Good | Poor | x | x |
| 5 | Sibabat, P.Rumbai | Rubber | Good | Medium | x | |

(b) a population census and migration study (all settlements);
(c) village level structured interviews (all settlements);
(d) a stratified random sample general household survey (all settlements);
(e) a survey of homegardens in three settlements, including studies of soils, erosion, biodiversity, productivity and potential (multipurpose trees) (Zone 1, part of Zone 3 (DK3), part of Zone 4 (Blok A)).

The 15 settlement areas in Seberida were stratified in five zones based on dominating farming system, market access and soil conditions. The homegarden study covered the same households as the general survey for the three settlements being considered. These settlements were chosen as representing the best and worst conditions with respect to market access and soils in Seberida. Table 1 shows the five zones delineated with their dominating farming system, market access, soil condition and location of the various studies.

As part of the agroecological survey of homegardens, soil samples were taken for chemical analysis. The quantitative data analyses included simple summary statistics, multiple regression analyses and development of simple simulation models.

## 4. CAUSES OF DETERIORATION OF FARMING SYSTEMS OF TRANSMIGRANTS

### 4.1. Food crop model

Rapid rural appraisal techniques were used to identify the key constraints of transmigrants. The results of this analysis are summarized in Fig. 1. The major problems which transmigrant households faced in their land use were low and declining yields due to poor inherent soil fertility, weed

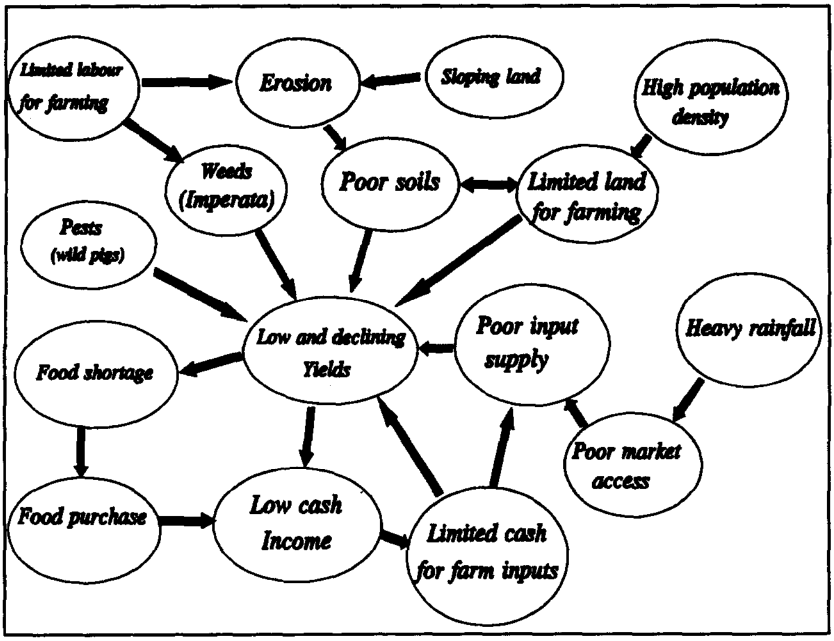


**Fig. 1.** Causes of poor performance of the food crop model in Seberida.

infestation (*Imperata* grass), pest damage (in particular, wild pigs, rodents and insects), and soil erosion. Very few households used fertilizer to alleviate the soil fertility problems. This was related to the high risk in production, unfavourable input–output ratios, the poor market access, and the limited cash resources of households. The situation had become worse in the years since their arrival in the area because of increasing weed and pest problems and declining yields.

Lannya (1993) found very high rates of erosion in a soil survey of settlements in Zones 1, 2 and 3. Average soil loss was estimated to be as high as 2 cm topsoil or about 200 tonnes $ha^{-1}year^{-1}$. The consequence of this was a rapid decline in rice yields from 1 to 2 tonnes/ha in the first cropping year to 0·5 to 1 tonne/ha in the second year. Rice production was usually given up after 2–5 years due to very low yields. In 1991 about 80% of the fields studied had been abandoned and were covered with *Imperata* grass (Lannya, 1993). The local population in Seberida usually grew only one crop of rice per rotation cycle in their swidden fields.

#### *4.1.1. Homegardens*

The homegarden areas were in general characterized by a higher level of utilization than the LU1 and LU2 areas. Rice, maize, tubers and pulses were commonly planted in the homegarden during the first year. Most of the farmers recalled the first rice harvest as a success, followed by sharply decreasing harvests in the following years. According to the farmers, this was caused by rapidly decreasing soil fertility. Other factors, like perennials starting to shade, and disturbance from wild pigs, also contributed to the low and falling productivity for annual crops. Table 2 shows the production history of rice, maize and cassava in the three settlements.

Rice production stopped normally after 3–4 years. In Blok A the wild pigs invaded the village in 1984–1985. The rice production had already collapsed in the homegardens at that time. Also, maize production declined after 1983. Competition from perennials was probably less important than the low soil fertility. The nutrient-demanding groundnut production was also abandoned after 2–3 years due to the soil constraints. Even the cassava production almost ceased from around 1990 due to poor soils, waterlogged conditions and attacks from wild pigs. Perennials dominated in 1991–1992.

In DK3 the wild pigs started to disturb production from 1985 and onwards, coinciding with the collapse of rice. Also SPD experienced a declining rice production after three years. The wild pigs made their

**TABLE 2**

Production History in Homegardens (Percentage of the Households Growing the Crop)

| *Settlement* | *1981–1982* | *1983–1984* | *1985–1986* | *1987–1988* | *1989–1990* | *1991–1992* |
|---|---|---|---|---|---|---|
| Blok A | | | | | | |
| Main problems | | Soils | Soils, wild pigs | Soils, wild pigs | Soils, wild pigs | Soils, wild pigs |
| Rice | 25 | 11 | 2 | 0 | 0 | 0 |
| Maize | 36 | 23 | 11 | 5 | 0 | 0 |
| Cassava | 36 | 50 | 30 | 16 | 16 | 7 |
| DK3 | | | | | | |
| Main problems | | | Wild pigs | Wild pigs | Wild pigs | Wild pigs |
| Rice | | 75 | 64 | 0 | 0 | 0 |
| Maize | | 25 | 39 | 23 | 27 | 27 |
| Cassava | | 48 | 66 | 68 | 70 | 68 |
| SPD | | | | | | |
| Main problems | | | Market | Soils, wild pigs, market | Soils, wild pigs, market | Soils, wild pigs, market |
| Rice | | | 38 | 33 | 17 | 13 |
| Maize | | | 8 | 42 | 60 | 33 |
| Cassava | | | 13 | 46 | 73 | 67 |

entrance in 1988, coinciding with the decline in rice production. This could indicate that rice faded out because of the pig invasion, which contributed to lower profitability and increasing risk in rice production. However, cassava, a crop tolerant of poor soils but highly exposed to wild pig attacks, increased in production in the same time span despite being highly favoured by wild pigs. Poor soil quality, favouring cassava to rice, probably influenced the homegarden strategy more than the presence of pigs. An increasing stock of chickens may also have disturbed the crops, probably more so with upland rice than was the case with maize, which was still grown in seven of the SPD homegardens.

High erosion rates were found in six erosion plots established in the homegardens although they were lower than those found in the rice fields (Hvoslef, 1992; Skarbøvik, 1993*b*). This implied that there was a net loss of nutrients in the homegardens as well.

## 4.2. Tree crop model

Rubber was successfully grown by the local people in their traditional rubber gardens where the rubber trees formed only a small part of the regenerating forest and where the actual number of rubber trees per hectare was low. This system yielded favourably in relation to the labour requirement but the yield per area unit was low (Angelsen, 1993). For that reason attempts have been made to intensify the rubber production to increase yield per area unit. This has been attempted by planting improved genetic material in dense stands in the rubber transmigration settlements (Zone 5) and the Smallholder Rubber Development Projects (SRDP) directed towards the local population. In the original TSSDP documents (MOT, 1988), the planting of rubber was also considered the best strategy to upgrade and improve the other transmigration settlements in Seberida. This made it particularly interesting to study the performance of the rubber settlements. The rubber holdings of these transmigrants resulted in them cultivating a larger proportion of their land than the transmigrants in the other settlements. Many of the transmigrants had, however, received rubber plots which were considerably smaller than the 2 ha they were supposed to get. The authors measured the size of the rubber plots of a random sample of 32 households. The mean area of rubber for the sample was 1·67 ha and the standard deviation of the mean was 0·062 ha.

Tree death due to a root disease (*Rigidoporus lignesus*) and poor management of the trees were likely to reduce their long-term productivity. The disease spread from tree to tree through root contact. More than 50% of the households interviewed stated that they tapped their rubber trees more often than was officially recommended by PTP, the governmental organization responsible for the settlements. PTP was supposed to provide the necessary inputs for the rubber production but many transmigrants claimed not to have received their allocation of fertilizer or the fungicides, to fight the root disease. On average, the transmigrants had received only 530 trees when the plots were distributed while they had been promised 900 trees. However, each household still had a debt of approximately Rp.8 million to pay back for the rubber. In early 1992, on average 450 of these trees were alive and of these about 360 were tappable. On average 80 trees had died from the time the farmers received their plots, most of them (60) from the root disease.

## 5. CONSEQUENCES OF THE DETERIORATION IN FARMING SYSTEMS

### 5.1. Food crop model

*5.1.1. Rice production*

The sustainability of the productivity of cropping systems was one of the authors' major concerns. Rice was considered as the most important food crop and change in rice yields over time may therefore be a good indicator of the performance or productivity of the production system. Transmigrants managed to some extent to sustain their total rice production by opening new land (LU2 and surrounding rain forest in Zones 1, 2 and 3). The extent of cultivation by land type and zone is presented in Fig. 2.

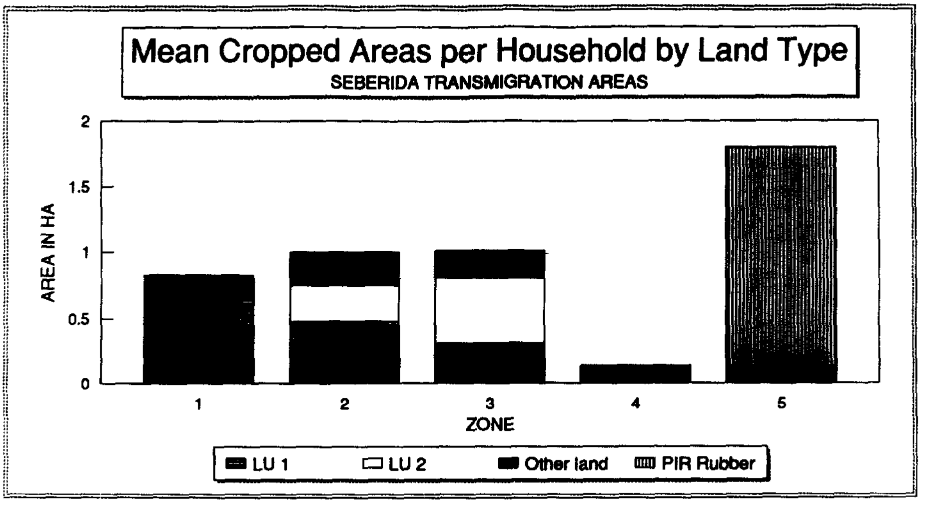


**Fig. 2.** Areas cultivated by transmigrants.

**TABLE 3**
Mean Rice Production per Household and Mean Yields by Zone (Standard Deviations are in Parentheses)

| *Zone* | *Rice production as kg raw rice* *1990* | *1991* | *Mean yield(ha⁻¹)* *1991* |
|---|---|---|---|
| 1 | 294 | 273 | 752 |
| | (331) | (361) | (108) |
| 2 | 215 | 107 | 311 |
| | (252) | (155) | (171) |
| 3 | 453 | 387 | 772 |
| | (626) | (569) | (192) |
| 4 | 59 | 68 | 1850 |
| | (140) | (226) | (142) |
| 5 | 17 | 35 | 1404 |
| | (61) | (168) | (108) |

Encroachment on the surrounding forest was, therefore, likely to increase. The settlements in Zones 2 and 3 were reported to be surplus producers in the period 1985–1989. After that they became deficit producers. Average rice production per household in 1990 and 1991 is presented in Table 3. It can be seen that the production level in general was low. The majority of households had to buy most of their rice requirement. The average rice production was highest in Zone 3 where the best soils are located but the mean rice yield was highest in Zone 4 where the poorest soils are. This was due to the fact that only a very small area was grown with rice in Zone 4 and it was wet rice grown with intensive management. The same was the case in Zone 5.

**TABLE 4**
The Relative Importance of Some Food Crop Species found in the Homegardens (Measured in Calories and Proteins based on Standard Values (FAO, 1982))

| *Species* | *Percentage of total kcal production* | *Calorie ranking* | *Percentage of total protein production* | *Protein ranking* |
|---|---|---|---|---|
| Banana | 9·9 | 2 | 7·7 | 4 |
| Jackfruit | 3·4 | 4 | 1·8 | 11 |
| Cassava | 52 | 1 | 30 | 1 |
| Chicken | 2·7 | 5 | 5·5 | 6 |
| Sweet potato | 8·1 | 3 | 8·4 | 2 |
| *Canna edulis* | 2·2 | 8 | 7·4 | 5 |
| Groundnuts | 2·5 | 7 | 8·2 | 3 |
| Rice | 1 | 15 | 1·3 | 14 |

**TABLE 5**
Nutrients Produced Annually in the Homegarden versus the Minimum Household Requirement

| *Settlement* | *Percentage of household food energy requirement* | *Percentage of household protein requirement* |
|---|---|---|
| Blok A | 9·9 | 20·4 |
| DK3 | 47·2 | 60·6 |
| SPD | 36·4 | 43·6 |
| Average | 30·0 | 40·1 |

### *5.1.2. Homegarden production*

Homegardens contained a mixture of annuals and perennials. In order to get a picture of the relative importance of some of the most common food crop species in the homegardens, an overview is given in Table 4. Cassava was the major source of both calories and proteins, followed by banana. Sweet potato and chicken were also relatively important sources of nutrients.

Table 5 shows the average annual production of calories and proteins in each settlement versus the requirement for the average household. Despite the weak foundation for agricultural activities, the homegardens proved to be quite productive, covering from 9 to 38% of the calory requirement and from 20 to 47% of the minimum protein requirement. DK3 had the highest food production, followed by SPD. Blok A had a low output of nutrients from the homegardens. The above results indicate that the homegarden was an important source of food in the settlements with better soils. In SPD, people had converted to species which were disliked by the pigs. Species diversification seemed to be a strategy which ensured a more sustainable utilization under the existing agroecological conditions.

The homegardens provided average cash incomes varying from 4 to 20% of the total household income in the three areas. The market access varied between the sample settlements. Tables 6 and 7 show the most common species in the homegardens and their relative importance as cash income sources. In Blok A and SPD chicken sale was most important. In DK3 cassava was the dominant cash crop, closely followed by chicken and groundnuts. From Table 7 we see that cash income from the homegarden was highest in DK3 where the best soils were found and lowest in Blok A which had the best market access but poorest soils.

A study was conducted to investigate the production potential of nitrogen-fixing agroforestry tree species. The transmigrants had knowledge of how to use multipurpose trees and had therefore explored their

TABLE 6
Relative Importance of Different Cash Crops in the Homegarden (Percentage of Total Cash Income from Sale of Homegarden Produce)

| *Species* | *Blok A* | *DK3* | *SPD* |
|---|---|---|---|
| Banana | 20·3 | 6·7 | 3·1 |
| Coconut | 8·6 | 0·9 | 0 |
| Rambutan | 10·3 | 0·4 | 0·1 |
| Cassava | 0 | 34·4 | 1·1 |
| Chicken | 46·5 | 21·3 | 87·2 |
| Sweet potato | 0 | 8·3 | 0 |
| Groundnuts | 0 | 20·6 | 2·3 |
| Rice | 0 | 1·2 | 0 |
| TOTAL | 85·7 | 93·8 | 93·8 |

TABLE 7
Mean Cash Income per Household by Settlement from Sale of Homegarden Produce in Rp. and as a Percentage of Total Cash Income

| *Settlement* | *Cash income (Rp. year$^{-1}$)* | *Percentage of total cash income* |
|---|---|---|
| Blok A | 34 416 | 3·9 |
| DK3 | 73 879 | 20·1 |
| SPD | 54 654 | 4·8 |

potential. Most of the tree species developed shallow root systems when soil conditions were poor, creating competition for water and nutrients between the trees and the food crops. The shallow root systems made the trees inefficient as nutrient pumps. Poor nodulation and nitrogen fixation on the very acid soils made them also inefficient as nitrogen contributors. The agroecological conditions were too poor for the multipurpose trees to perform as desired, and it would require considerable amounts of lime and mineral fertilizers to upgrade the physical and chemical conditions sufficiently for these trees to function well. These trees still provided some useful products to the settlers as can be seen from Table 8. For more detailed information, refer to Hvoslef (1992).

### *5.1.3. Alternative survival strategies*

In 1991 approximately 70 households in SPD (zone 1), the most marginal and poor of all settlements in Seberida, cultivated in the surrounding forest and more than 90 households (almost 50%) had planted rubber in their LU1. Most of the transmigrants had given up the intensive farming strategy and had either adopted the land use strategies of the local people

**TABLE 8**
Presence and Use of Multipurpose Trees (Percentage of the Households Using the Various Species for the Specific Purpose)

| *Species* | *No. of households* | *Percentage of households which use the species as* | | | | | |
|---|---|---|---|---|---|---|---|
| | | *Green manure* | *Fodder* | *Inter-crop* | *Fuel wood* | *Food* | *Medicine* |
| *Erythrina* | 24 | 16 | 9 | 13 | 12 | 0 | 10 |
| *Gliricidia* | 16 | 7 | 4 | 6 | 7 | 0 | 0 |
| *Leucaena* | 75 | 51 | 53 | 46 | 53 | 50 | 13 |
| Stinkbean | 24 | 13 | 4 | 4 | 16 | 18 | 3 |
| *Albizzia* | 10 | 7 | 6 | 1 | 9 | 0 | 0 |

(swiddening, rubber planting and rattan collection), sought employment on plantations in neighbouring districts, or returned to Java. The village headman (*Kepala desa*) and others were, however, actively searching for better opportunities. There were rumours that an oilpalm plantation was to be established in the neighbourhood providing better off-farm employment opportunities, making the transmigrants more optimistic about the future.

Transmigrants started collection of rattan and *gaharu* (a harpix from the *jelutung* tree (*Dyrea costulata*)) from the surrounding forest in 1986–1988, but even by 1991–1992 the rattan resource had been seriously depleted and the transmigrants had to travel a long distance to look for it. Swiddening and work on neighbouring plantations started in 1989 and appeared as dominant strategies in the years that followed. Through these strategies it was possible for the households to avoid falling far below the poverty line (Holden & Simanjuntak, 1994).

About 80% of the houses were inhabited and more than 30% of the transmigrants who had arrived in the settlement area had left. Most of these had gone back to Java. The decision to stay or leave was influenced by several factors, including ecological, economic, social and cultural factors. One finding was that large households were less likely to return to Java (Holden & Simanjuntak, 1993). There may be several reasons for this: first, the larger the family, the more expensive it is to return; second, the larger the part of the family which has moved to the settlement area, the fewer may be left in Java and the less opportunities there may be to return to Java; third, a large family may be more able to diversify its income sources and thus become more successful than smaller households. This indicates that there was a danger of getting trapped in the settlement area for poverty reasons. If such a trap really existed, it may imply large

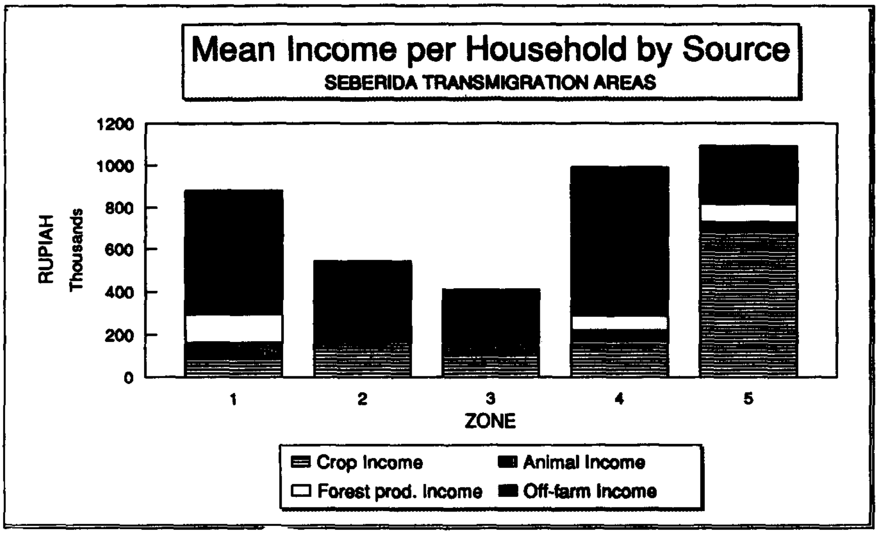


**Fig. 3.** Income sources of transmigrants.

income disparities as others may stay on because they are more successful and not interested in returning. A relatively large proportion of the households are at an early stage in their development cycle with small children and a high consumer/producer ratio making the poverty trap a plausible description of the situation for many households. The following section discusses poverty in more detail.

## 5.2. Household income and equity

The income sources of households in 1991 are presented in Fig. 3. It can be seen that only in Zone 5 was the income from farming constituting more than 50% of the total cash income. This was due to the fact that the rubber had started to yield. We can further see that incomes from off-farm activities were highest in Zones 1 and 4 which had the worst soil conditions. The total income was lowest in Zones 2 and 3 where the best soils are located but the value of the production for home consumption was then excluded. The larger degree os subsistence production in these zones may explain their lower cash income. Only very recently did they have a considerable contraction in their crop production which has also put them in this unfavourable income situation. It was found that the transmigrants used as much as 60–70% of their income on food purchases.

The estimated incomes per capita per household in 1991, corrected for home-produced rice in 1990, are presented in Fig. 4 together with estimates

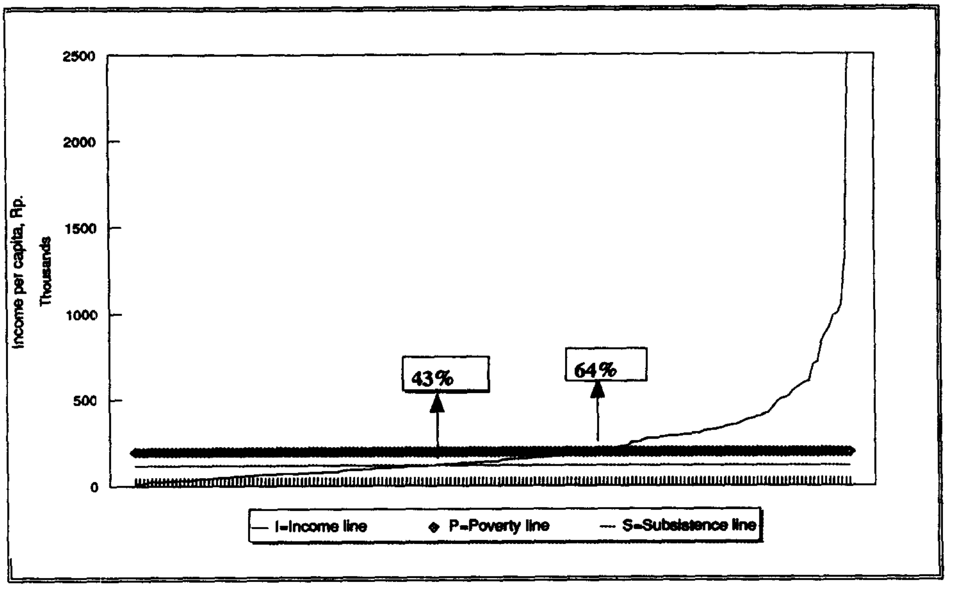


**Fig. 4.** Income per capita per household in Seberida transmigration areas as compared to estimates of the poverty and subsistence lines (households are ordered according to increasing income per capita from left to right in the graph).

of the poverty and subsistence lines as these have been estimated in Indonesia (Holden & Simanjuntak, 1993). It was found that as much as 64% of the households fell below the poverty line and 43% fell below the subsistence line. This compares unfavourably to estimates of 38 and 16% for transmigration settlements in East Kalimantan (Fassbender & Erbe, 1990). The authors calculated the Gini-coefficient to be 0·50 for all settlements which implies a very uneven distribution of income (Holden & Simanjuntak, 1993). The drought in 1991 caused the rice yields to drop even further, thus reducing the income measure of the transmigrants for the following year.

### 5.3. Tree crop model

The large variation in holding sizes and tree numbers among the rubber transmigrants caused considerable variation in their incomes. They could, however, increase the rubber production and incomes in the short run by intensifying the tapping of their rubber trees. We may assume that poverty influences tapping behaviour. Rubber represented the main source of income in these settlements. We may expect that those with few rubber trees had stronger incentives to tap their trees more intensively to increase their income in the short run. However, if the tree number becomes very low, they may have to look for other sources of income and there may be less incentive to tap the rubber intensively or to tap it at all. This implies a nonlinear relationship between tree number ($T$) and tapping intensity ($I$). The death rate ($D$) may also influence the intensity of tapping. It is hypothesized that a high death rate may result in more intensive tapping since the trees are dying anyway. The authors expected that if the household had other sources of income ($O$) than rubber, the household would have less incentive to tap the rubber very intensively. It was also assumed that the larger the household size ($H$), the more intensively the households may have to tap their rubber in order to satisfy their income needs. The following model was therefore developed:

$$I = F(T, D, O, H).$$

We used a logarithmic model as follows:

$$\mathrm{Ln}I = a + b\ln T + c(\ln T)^2 + d\ln D + e\ln OA + f\ln OO + g\ln H + r$$

where $OA$ is income from animal production, $OO$ is off-farm income and $r$ is the error term. The tree number rather than the income from rubber was preferred because the rubber income would also be a function of the intensity of tapping (a potential chicken–egg problem) while it is assumed that the tree number has not yet been influenced by the tapping practice since it is the first year of tapping. The model was run with a backward selection procedure eliminating variables not significant at the 10% level. The results are presented in Table 9. The model could explain as much as 67% of the variation in tapping intensity. It can be seen that only the tree

**TABLE 9**
Regression Analysis: Factors Influencing the Intensity of Rubber Tapping among PIR Transmigrants

| *Variable* | *Parameter estimate* | *Standard error* | t-*value* | *Probability* > \|t\| |
|---|---|---|---|---|
| Intercept ($a$) | −29·09 | 6·92 | −4·204 | 0·0006 |
| Treeno ($\ln T$) | 10·81 | 2·62 | 4·125 | 0·0007 |
| Treenosq $(\ln T)^2$ | −0·957 | 0·246 | −3·885 | 0·0012 |
| Animinc ($\ln OA$) | −0·031 | 0·0175 | −1·775 | 0·0939 |

Dependent variable: Tapping intensity. $R^2 = 0{\cdot}67$. $F$-value of model = 11·7 (Prob > $F$:0·0002).

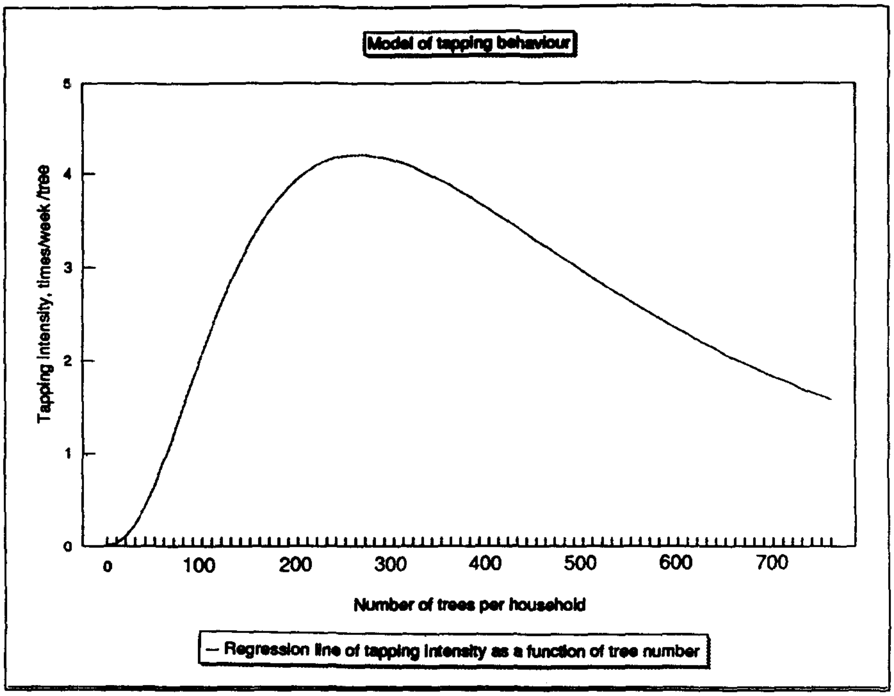


**Fig. 5.** Tapping intensity as a function of tree number.

number and tree number squared variables were significant and they were significant at 0·1% and 1% levels, respectively. The animal income variable was significant at a 10% level with a negative sign as would be expected. The small sample size may be the reason for lack of significance of the income and household size variables (Type II error). The regression line of the estimated model is presented in Fig. 5, and is very similar to the theoretical expectation. The tapping intensity increases as the tree number goes down from the planned number of 900 trees. When the tree number is getting down to 200 or lower, the rubber can no longer be the main source of income. Households then have to find other sources of income. The authors believe that this curve is a good illustration of the impact of poverty on rubber tapping behaviour. Poverty forces people towards nonsustainable management practices.

The authors sought to predict the levels of rubber production and income of the transmigrants in future years. In this prediction average figures were used for the tree population, the death rate (assuming it to be constant), a limited replanting of rubber seedlings as was currently practised by the transmigrants, and standard tapping yields per tree (MOT,

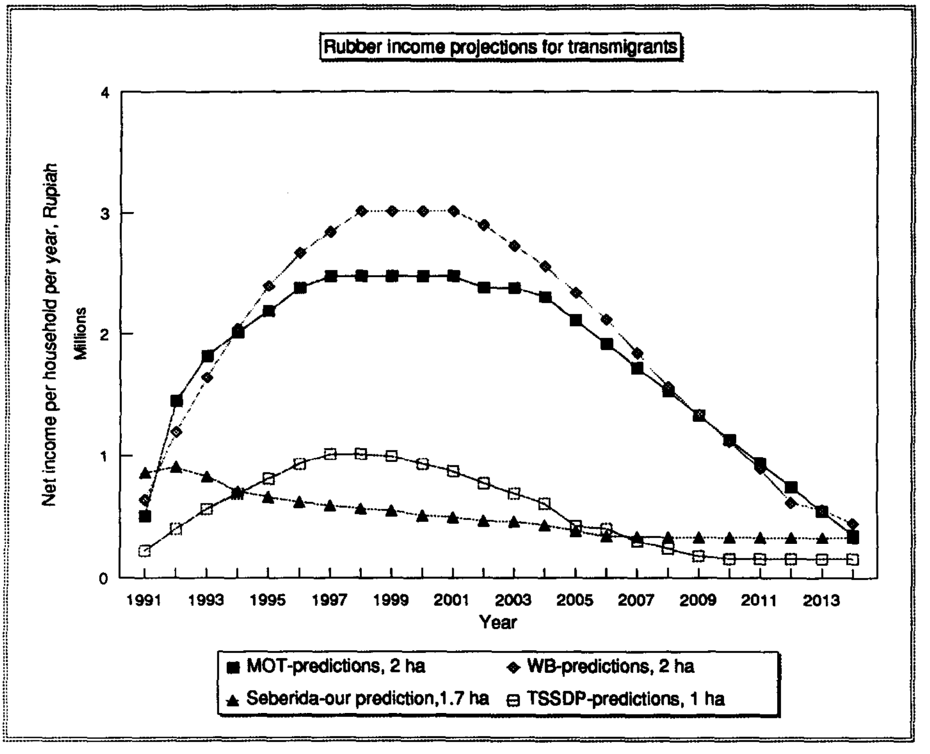


**Fig. 6.** Predicted production of standard models (2 and 1 ha) and average rubber holdings in Seberida (1·7 ha).

1988; World Bank, 1988) (see Fig. 6). The predictions for the average holding in Seberida are compared with predictions by Ministry of Transmigration (1988) and World Bank (1988). The prediction was based on the assumption that no further organized investments would take place and that the transmigrants would continue the current management practices. If actions were taken at central or local level, however, it would take many years before there was likely to be any impact on the income of the transmigrants and in this period they would continue to have strong incentives to tap their rubber too hard. It was found that most transmigrants would fail to pay back their credit.

TSSDP implied a conversion to tree crops in the food crop settlements in Seberida where it was planned that each household should get a tree crop area of 1 ha. If rubber were to be introduced, this was likely to produce a similar problem as in the PIR transmigration areas since an area of 1 ha would probably not create sufficient income to reduce the incentives to tap the rubber too intensively (see Fig. 6).

## 5.4. Future perspectives and policy implications

### *5.4.1. Intersectoral and world market dependency*

As a result of the failure of the production systems to provide sufficient and secure standards of living for the transmigrants, they have been forced to look for off-farm activities. The main strategy has been to take up work as plantation labourers on neighbouring plantations. This was usually done by one or some of the household members for periods of the year. This work provided a low but fairly secure income and caused family members to have to stay away from home for longer periods. This had negative effects on family life and social organization in the settlement areas. Communal work (*gotong royong*) had deteriorated due to this absence of a large proportion of the labour force.

The plantation sector in Indonesia has expanded rapidly during the last 10 years and there has therefore been a high demand for labour in the sector but the wage rates have remained low. Indonesia has comparative advantages in the world markets for the various tree crops due to its low production costs (cheap labour). Increased production and market shares may therefore be obtained but there is a risk of falling world market prices and price fluctuation. The demand for rubber depends on the car industry since most of the rubber is used in tyre production. Future demand for palmoil will depend on the economic growth in Asia where the oil consumption is still low. A world recession would have serious effects both for the car industry and the purchasing power of the Asian population and this would have serious consequences for the Indonesian plantation sector. With a stop in the expansion of the plantation sector there would also be a considerable contraction in its demand for labour. This could have drastic consequences for the transmigration population which has become increasingly dependent on this type of employment.

### *5.4.2. State and locality, authority and responsibility*

The responsibility for the transmigration settlements in Seberida was in 1991 transferred from the Ministry of Transmigration (MOT) to the local authorities. This was in accordance with the Indonesian policy. Local administration should also be financed through taxation of people in the district. Even with the quadrupling of the population in 10 years, the severe poverty problem has left very little taxable surplus for extraction by the local authorities. Another problem is the localized population imbalance which has been introduced where the population densities of the transmigration villages are 10–20 times that of the local villages. Does the transfer to the local authorities imply that the same rules should apply to the transmigrants as to the local population with respect to access to forest resources? MOT imposed stricter rules when they had the responsibility for the transmigration settlements. How applicable are the traditional laws (*adat*) to the new situation? Traditional land tenure regulations are also vague and flexible. Village borders were not considered as fixed but were varying according to the needs of the village population.

Land use conflicts between local people and transmigrants in Seberida have so far been solved in a fairly peaceful way but some of these conflicts have not yet been formally settled and new conflicts are likely to occur.

The local authorities may also have little interest in, for example, protecting biodiversity and conserving forests in their district. They may themselves get part of the rent which is obtained by extracting these resources. The environmental consciousness among local bureaucrats in Indonesia is still very weak, even more so than among central government officials.

In the case of Seberida one may say that the state has imposed a poverty-environment problem on a local community. The local authorities lack the capability to tackle the problem. At the same time Riau is the richest of the provinces in Indonesia due to its oil resources. Oil mining was even being established in and around the transmigration settlements in Seberida but almost nothing of the income from this oil seemed to trickle down to the people living near these oil resources. There is a need for further assistance from the state and/or other institutions or organizations because the local authorities seem unable to handle the problems of alleviating the poverty and securing conservation and sustainable management of the rain forest resources in the area. A more equitable distribution of the resources is required to stop the resource degradation (Holden, 1993).

## 6 CONCLUSIONS

The policy of self-sufficiency in food production ('food first') which emphasized food crops, has failed in Seberida and has not succeeded in alleviating hunger. The non-sustainability of production activities, particularly upland rice production, has within 10 years changed Seberida from a rice-surplus to a rice-deficit area. Poor market access, poor performance of service institutions, and limited collective action only reinforced the breakdown of the production systems.

Tree crops, like rubber, have the potential to become a sustainable production alternative for the transmigrants. The rubber transmigration settlements in Seberida, however, faced serious management problems. Too small plots and poor stands of trees created incentives to tap the young trees too hard and this will shorten the life of the trees and reduce the future production. Most of the transmigrants will fail to pay back their debts.

To reduce the poverty, and to reduce the threat this poverty implies to the surrounding rain forest resources in Seberida, action should be undertaken to rehabilitate the transmigration settlements. Transmigrants should be allowed to establish tree crops in both their LUl and LU2 plots. It would also be better to redistribute abandoned plots to present transmigrants to allow larger plots per household rather than to encourage the settlement of new transmigrants. Land should be redistributed to households which show incentives to utilize the land. It is possible to see the contours of a possibly sustainable and sufficiently productive production system based on rubber, cattle and homegardens but the area requirement per household would be considerably larger than 2 ha.

Also the rubber settlements needed rehabilitation through an organized replanting program. Only households which show incentives to rehabilitate their plots should be allowed to stay on in the area. There is a need to increase the plot size for rubber also, at least for those with plots of less than 2 ha.

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