

When agroforests drive back natural forests: A socio-economic analysis of a rice-agroforest system in Sumatra

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Abstract. In the Krui area, (South Sumatra, Indonesia), the damar agroforests (*Shorea javanica*, Dipterocarpaceae) are but one element of the farming systems which include several other cropping systems such as irrigated or rainfed rice cultivation, and coffee plantation.

Rainfed rice is cultivated in forest clearings, in order to meet rice requirements which cannot be met with irrigated rice crop only. In the forest clearings, coffee stands are established in rice crop, and later, Damar are planted among coffee plants. As a result of this cropping system, the damar agroforest spreads while the forest dwindles.

In one village, no more forest land is available for peasants' clearings. The resulting high land pressure causes cropping systems and farming systems to change or to be exported to neighbouring areas where forest land is still available.

Résumé. Les agroforêts à damar (*Shorea javanica*) ne sont qu'un élément du système d'exploitation agricole de la région de Krui, Sud Sumatra, Indonésie. Ceux-ci associent plusieurs systèmes de culture tels que la riziculture irriguée, la culture du riz pluvial et la plantation de cafeiers.

L'insuffisance des surfaces en rizières irriguées est compensée par la culture du riz pluvial, pratiquée en 'ladang', parcelle de forêt défrichée et brûlée. Sur les 'ladangs' se succèdent les cultures de riz, de café puis de damar, transformant ainsi la forêt naturelle en agroforêt à damar. On assiste à l'extension continue des agroforêts au détriment de la forêt naturelle.

Dans un des villages étudiés, la réserve de terres forestières communales est épuisée, déjà transformée en agroforêts. La forte pression foncière qui en résulte induit des transformations dans les systèmes de production agricole ou incite des agriculteurs à migrer dans des régions voisines encore riches en terres forestières. Dans ces régions, les migrants reproduisent un système agroforestier très proche de celui de Krui, dans la mesure où les conditions écologiques le permettent.

Introduction

This article is a complement to that of E. Torquebiau: 'Man made Dipterocarp forest in Sumatra' [4], in which the author deals with the damar agroforests (*Shorea javanica*, Dipterocarpaceae) of the Krui area, South-East of Sumatra. In [4], the damar agroforests are considered from an ecological point of view. The botanical composition, the structure of the canopy and the sylvigenesis aspects are studied from a profile diagram taken from the agroforest and compared to a profile diagram taken from the natural forest of Sumatra. Sylvicultural practices and resin tapping

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activities are described in detail. The article ends with a short economic analysis of the agroforest and, in its conclusion, points out the domains which remain to be investigated in view of the development and the improvement of *Shorea javanica* cultivation.

A multidisciplinary study carried out at a later date* in the same area, showed that these agroforests are but one element of the various farming systems of the Krui area. In fact, in these farming systems, the agroforests are associated either with irrigated ricefields or with dry rice fields and perennial cash crops (coffee or cloves). The extension and the set-up of the agroforests can be better understood through a study of the history and the functioning of the farming system as a whole. The present article sets the agroforests studied in [4] in the context of the rural landscape and defines the specific part they play in the agro-economic functioning of the various farming systems. The article also deals with the present evolution of the farming systems and of their agroforestry component. The evolution observed is related to local socio-economic characteristics.

I. General presentation of the area studied

1. The Pesisir area

The Pesisir area, where damar agroforests are found, is bounded on the West by the Indian Ocean and on the East by the Bukit Barisan range, the foothills of which lie within 4 Km of the coast (see Figure 1). The Western slope of the Bukit Barisan became a forest reserve in 1935 under the Dutch administration, and is still quite forested. This forest reserve, the 'Barisan Selatan Game Reserve' became a National Park in 1980. Cultivated lands stretch from the coast to the National Park boundaries between 400 and 1,000 m. altitude. The climate of the Pesisir area is humid, with 3,000 to 3,500 mm of rain per year, and rain falls throughout the year.

The Pesisir area, situated in the Lampung province, is divided into three subdistricts: North Pesisir (N.P.), South Pesisir (S.P.) and Central Pesisir (C.P.). Although the area has been settled for several centuries, in NP, and SP, the population density is quite low, while in CP, the population density is relatively high as shown in Table 1.

Table 1. Population density and surface of the subdistricts

Subdistrict	population density	surface of the area
North Pesisir	12 inhabitants/Km ²	67,239 Ha
South Pesisir	23 inhabitants/Km ²	210,033 Ha
Central Pesisir	83 inhabitants/Km ²	18,503 Ha
Town of Krui	6490 inhabitants	—
Lampung province	137 inhabitants/Km ²	3466,713 Ha

(Sources: Lampung dalam angka, 1982–1983 and Lampung Utara dalam angka 1983.)

* Study carried out by G. Michon, J.M. Bompard and S. Rietbergen (forest ecologists) and F. Mary (agricultural socio-economist) over a 4 month period in 1984.

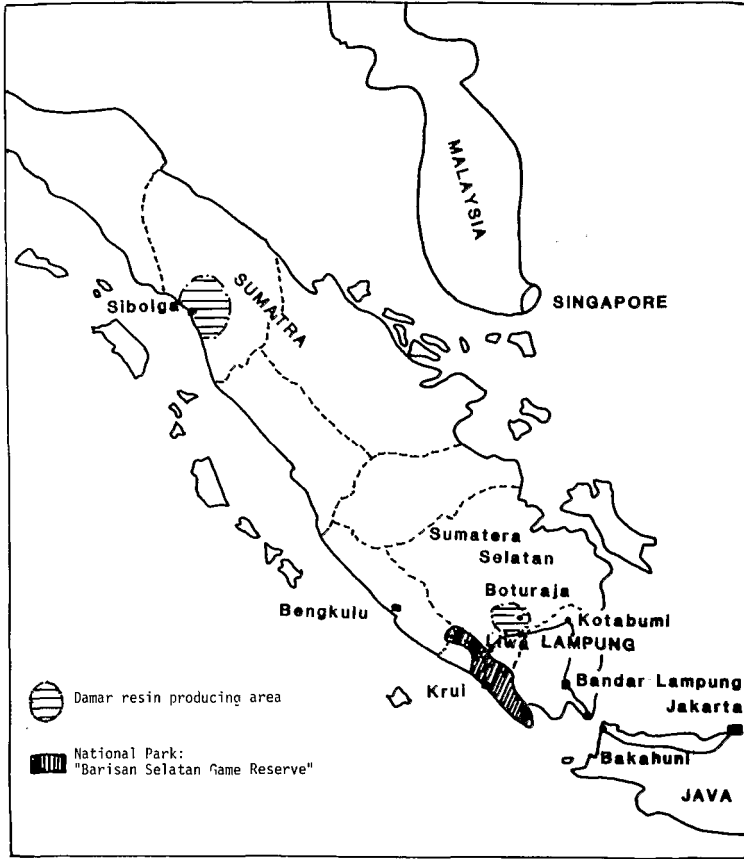


Figure 1. Situation map. Province boundary ----; Damar resin production area ▨; National Park area: "Barisan Selatan Game Reserve" ▩.

At one time, Singapore and Malaya were more accessible by sea than were the inland areas. Nowadays, Krui is connected by road to Bandar-Lampung (BL), the regional capital and a thriving international port, (see Figure 2), and road transport has to a large extent replaced sea transport. Out of the three subdistricts, the South Pesisir is still isolated from the rest of Sumatra and it is the only one directly connected to Java by Sea. North Pesisir and Central Pesisir rely on the Krui-BL road for commercial exchange, and especially for the damar resin transport to BL harbour, from where it is exported. The ports of North Pesisir and Central Pesisir are only used for coastal traffic which will soon give way to road traffic when the new northern road Krui-Bengkulu has been opened, in 1984 or 1985 (see Figure 2).

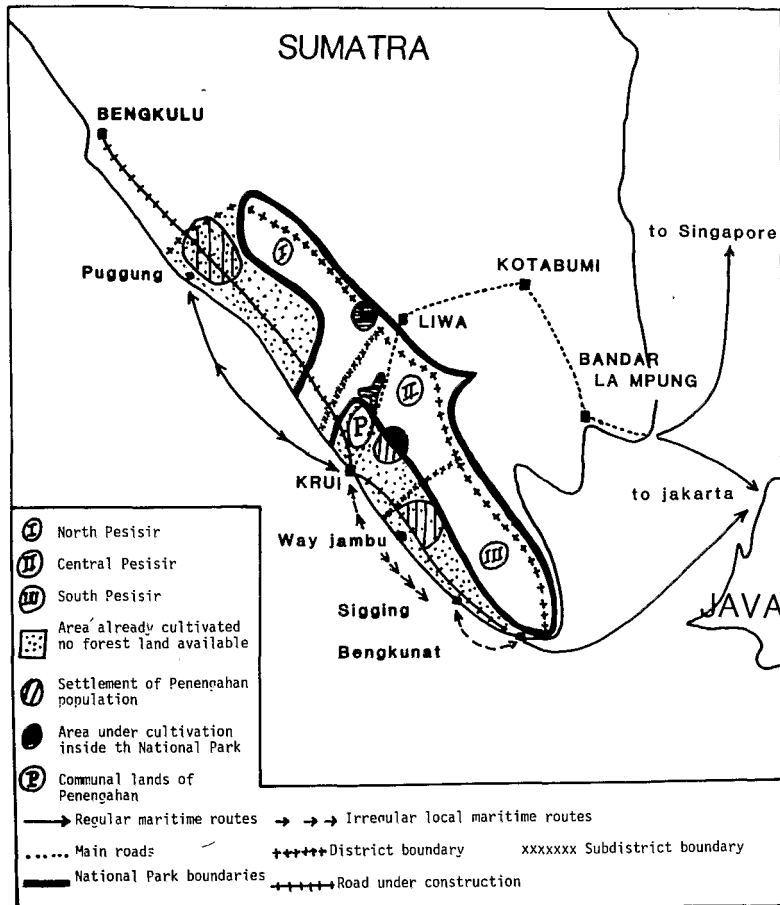


Figure 2. The Pesisir area.

2. The village of Penengahan

The study of rural landscape and farming systems was carried out in detail in the village of Penengahan, in Central Pesisir. The village, an administrative unit, is not a territorial unit suitable for the study of agricultural systems. Indeed, a considerable part of the population cultivates land outside the village boundaries, i.e. 40% of the households. The unit selected for the analysis is thus defined by the population living in Penengahan and the sum of land surfaces cultivated or owned by them inside or outside the village boundaries. Table 2 gives the characteristics of this unit which will be referred to as Penengahan.

Table 2. Demographic characteristics and land use at Penegahan. (O B = outside the village boundaries, I B = inside the village boundaries.)

Total population in 1983:	2,300 inhabitants		
Population over 15 years of age, as a percentage of the total population:	49%		
Working population, as a percentage of the total population:	50%		
Wage farm labourers, as a percentage of the working population:	3%		
Households, economically independent, (although sometimes still living with other households in the enlarged family's village house)	369 households		
Inhabited houses in the village:	285 houses		
Average rate of cohabitation in the village houses:	1.3%		
Peasant households, as a percentage of total households:	98%		
Peasant households with second non- farming activity, as a percentage of total peasant households.	25%		
	IB (Ha)	OB (Ha)	total (Ha)
Total surface of Penengahan.	1,640	290	1,930
National Park area	400	280	680
(% of land cultivated inside the National Park):	(15%)	(100%)	(50%)
Wastelands	255	0	255
Secondary forest	100	0	100
Irrigated ricefields	40	10	50
Other cultivated lands: dry rice, coffee and agroforests outside the National Park boundaries	665	280	1005

(Sources: village statistics and estimates drawn from interviews)

II. Land-use system in the subdistrict of Central Pesisir

A cross section of land-use types taken from East to West, running from the west coast to the eastern boundaries of the subdistrict is described below. After the description of each land-use type, its surface area and the area as a percentage of the total area is given in brackets for Penengahan.

1) *A narrow strip of coastal land* planted with cocoanut trees, a few hundred meters in width. (0 Ha, 0%).

2) *A strip of irrigated ricefields*, between 1 and 2 m wide, widening around the estuaries of the numerous rivers coming down from the Bukit-Barisan mountains. Extending the irrigated ricefields is impossible for topographic and hydrologic reasons (50 Ha, 2.8%).

3) *Villages*: groupings of between 50 to several hundred permanent households, (285 houses in Penengahan, housing 369 households, 55% of which live permanently in the village, and 45% alternate between the

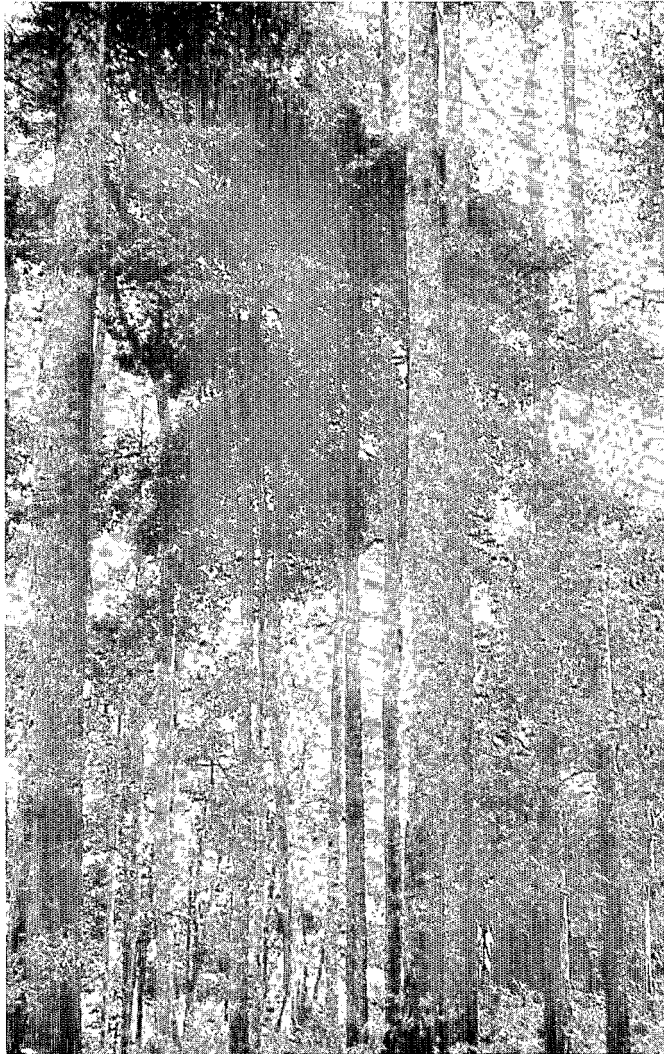


Photo 1. Inside the Damar agroforest of Krui area. See on the left the damar trunk with Roles.

village house and a house located in the coffee plantation or in the dry rice plot).

4) *Productive agroforests*: situated nearby the villages they are of several types:

Type a: Damar and fruit trees combined: the 'Repong' garden: it is the typical traditional garden, well tended and still unmodified. It is the most widespread garden type in the area surrounding the village. The commonest fruit tree species are *Durio zibethinus* Murr. *Bombacaceae*



Photo 2. Damar and clove trees agroforest — the damar canopy occupies the upper level up to 30–35 m, while clove trees grow underneath.

(Durian), and *Lansium domesticum* Corr. *Meliaceae* (Duku). The agroforest studied in [4] belongs to this type.

Type b: Damar trees, fruit trees, wood species, bush and herbaceous plants: The latter are used as a vegetable and for medicine. These gardens share some of the features of type a, but are not so well tended and include more wild plants.

Type c: Damar and/or clove trees (*Eugenia caryophyllata* Thunb. *Myrtaceae*) Other fruit tree or wood tree species are occasionally used in

combination with damar. The damar canopy occupies the upper level; the clove trees yield good results under a light damar canopy. (a + b + c = 350 Ha; 20%)

Type d: former clove plantations recently brought back into production after the substantial rise of the price of clove in 1973. The considerable damage resulting from the 'Sumatranese disease' which has affected the clove trees since 1979, encourages farmers to enrich their former monospecific clove plantations with other species. Thus, damar plants have recently been planted between the already productive clove trees. (d = 20 Ha; 1.2%)

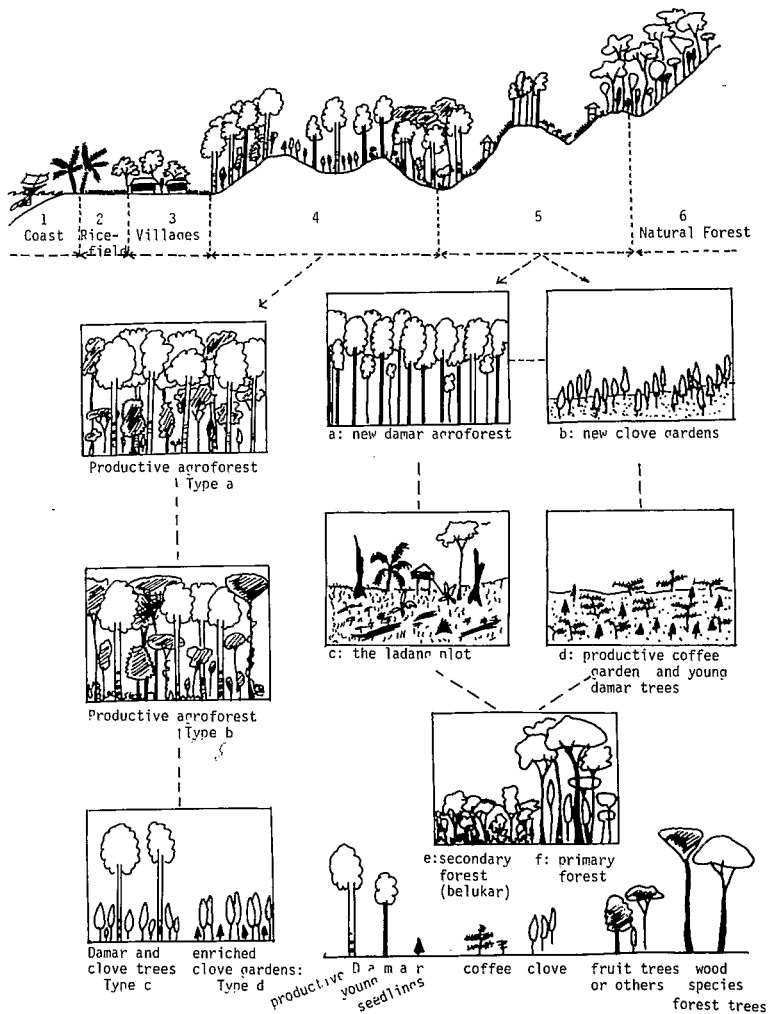


Figure 3. A cross section of the landscape.

5) *An heterogenous combination, further away from the village, with the following composition:*

a) new damar agroforests not yet productive: due to the distance from the villages, there is a tendency to plant more damar trees and fewer fruit tree species. (310 Ha; 18%)

b) newly planted clove stands: these clove stands are situated on the hill tops and very few fruit tree species are interplanted with the clove trees. (35 Ha; 2%)

c) the 'Ladang': 'ladang' is an Indonesian word which is generally used to refer to shifting cultivation i.e. swidden plots. Here, the term also applies to a plot of cleared forest planted first with rainfed rice and later with perennial plants (coffee and/or clove, and then *Shorea javanica*). The ground occupation is permanent and forest fallow is therefore impossible. The Krui land-use system then cannot be referred to as shifting cultivation. However, we retain the term 'ladang' used locally. The ladang cropping system, from forest to agroforest, is described in the next section: Functioning of the ladang cropping system. A 'ladang plot' refers to a plot at dry rice stage.

d) young productive coffee stands (*coffea canephora* Pierre, Rubiaceae) interplanted with damar and fruit trees at growing stage. (c + d = 290 Ha; 16.5%)

e) plots abandoned after dry rice cultivation, and gained by secondary forest. These are mostly plots with less fertile soils and topographic conditions unfit for damar growing.

f) some remains of natural primary forest intended to be turned into ladang in the near future. (e + f = 100 Ha; 5.7%)

6) *Natural primary forest under state control in the Barisan Selatan Game Reserve.* This protected forest is a source of conflict between the peasants and the National Park administration. (6 = 340 Ha; 19.4%)

A cross-section effected through P. and the neighbouring area is shown in Figure 3.

III. Functioning of the ladang cropping system

The ladang cropping system is the subject of this section. The functioning of the agroforests of the Krui area and that of irrigated rice have already been described elsewhere, [3], so these cropping systems will not be dealt with here.

The 'Tumpangsari' principle

The Indonesian word 'Tumpangsari' refers to successive crops on a single plot, where the first crop is annual or bi-annual, the second is perennial, while the third, whenever it takes place, is also perennial, but its growing phase takes longer than that of the second crop. In the Krui area, the crops



Plot boundary

Primary forest

Rice crop

Forest trees cut down and burned

Coffee, damars and fruit trees seedbeds

Coffee young

Damar and fruit trees young

Housing

Fast growing trees: banana and papaya trees



coffee

Damar and fruit trees

young

productive



Figure 4. Ladang cropping system in the Pesisir area.

are rainfed rice as the first crop, coffee and/or cloves as the second crop, and *Shorea javanica* combined with fruit trees the third and ultimate crop.

In Krui, a similar working plan as in the Taungya system [2] has been adopted, although the peasants are responsible for it and the plantations obtained (here coffee stands and damar agroforests) remain the planter's property.

Figure 4 describes the ladang cropping functioning as it was observed up to 1980. Since 1980, this system has been changed as a result of several influences described in section VI.

2) Succession of crops on a given plot, historical evolution and more recent change

If we consider a plot of Figure 4, for example plot a), the succession of crops on this plot is as follows

- year 1: dry rice interplanted with vegetable and fast-growing trees (Papaya and Banana trees); seedlings of coffee, *Shorea javanica* and slow-growing fruit trees (Duku, Durian . . .) are grown in seedbeds. Average rice yield is 1.2 ton/Ha.
- year 2: planting of the coffee saplings in the second rice crop at a high density: 2500 saplings per Ha. The rice yield decreases due to the increased amount of space occupied by coffee plants. Rice yield is 0.73 ton/Ha
- year 3: planting of damar and fruit tree saplings among coffee stands. The average density amounts to 100 damar trees per Ha and 25 fruit trees per Ha. No harvest on the plot.

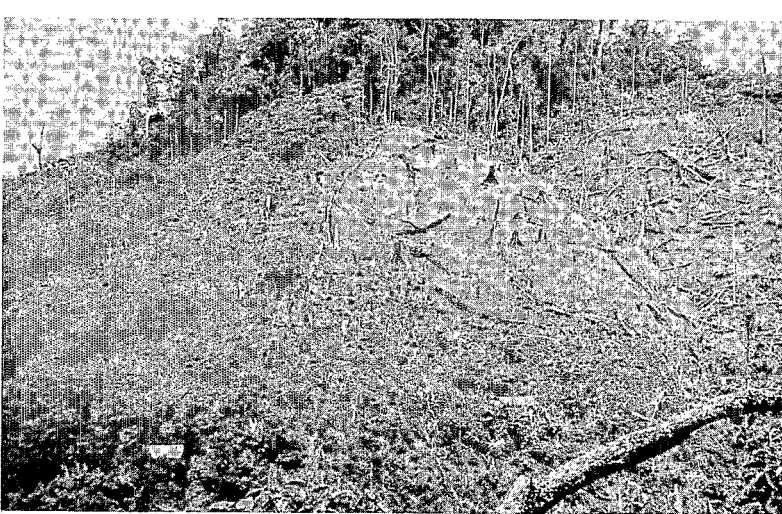


Photo 3. Ladang cropping system in Krui are (inside the National Park = Barisan Selatan Game Reserve): rice crop upward, young coffee stands downward, productive coffee stands on the left. Natural forest in the background.

– year 4, 5, 6: coffee is tended and harvested.

1st harvest of a 4 year old coffee stand: 6 q/Ha;

2nd harvest of a 5 year old coffee stand: 2 q/Ha;

3rd harvest of a 6 year old coffee stand: 1 q/Ha.

The causes of the decrease in coffee yields have not been stated clearly. It may be caused by excessively high plant density, coffee diseases, or the shading out of the coffee trees by the growing damar and fruit trees.

– years 7 to 25: the coffee crop and the plot itself are abandoned until the damar trees are ready to be tapped, as described in [4].

This crop sequence has not always followed the same pattern. Its historical evolution and the more recent changes are described in Figure 5.

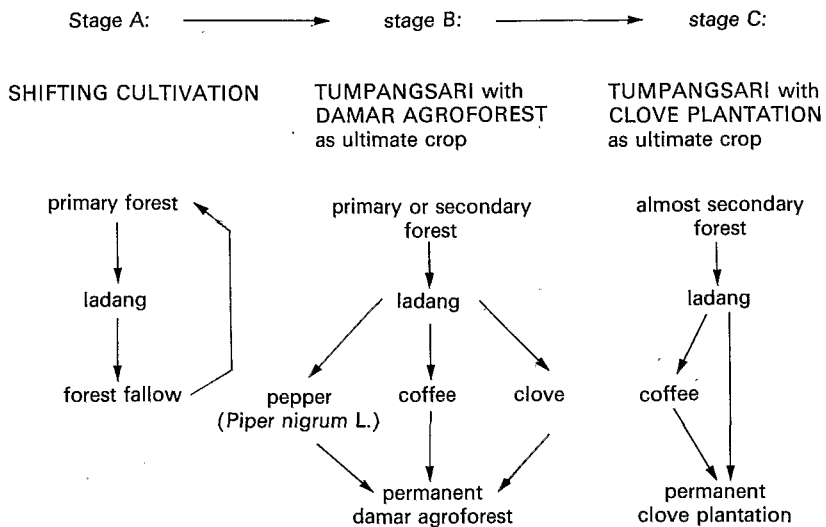


Figure 5. Evolution of ladang cropping system.

Whichever system is adopted, dry rice is always found in the course of the first two years, combined with vegetables and fast growing fruit trees. This production aims at achieving food self-sufficiency. The occasional surplus of vegetables is sold at the local market.

The second crop, pepper, coffee or clove is always a speculative crop which can give high but uncertain returns. The products are destined for the domestic market (clove), or export (pepper and coffee), and the planters are therefore price-takers lacking bargaining power. Finally, the last crop, *Shorea javanica* provides a regular monthly income over a long period, with 1/3 of damar resin sold at the domestic market and 2/3 sold

at the international market. (Damar resin is used for the fabrication of 'batik'¹, paints and frankincense.)

Therefore, the most recent evolution in the ladang cropping system leads to an economic and ecological disruption of the system: in replacing damar with clove, the producers lose the regular income from tapping, and the clove plantations do not have the same positive ecologic features as the damar agroforests [4]. Whereas it was once quite rare to stop at the second speculative crop, it has now become quite common. For the various causes of this evolution, see section VI.

IV. Farming systems in Penengahan

At Penengahan, irrigated ricefields provide only 1/3 of the rice necessary to achieve food self-sufficiency in the village. Of the remaining 2/3, 1/3 is produced in the ladang plots, and 1/3 is in general bought from Way-Jambu in South Pesisir. This rice imported from South Pesisir is produced by migrants and emigrants from Penengahan. Due to the kin relationships between the two villages, the rice is sold at a relatively low price.

Animal production, including buffalos and goats, is very poorly developed, although the village covers most of its meat requirements, which forms a very small part of the diet anyway. On the other hand, fish is a very important part of the diet, being consumed at least once a day. Fish is either bought from the market of Krui, or taken from the river nearby the village.

The survey carried out in Penengahan shows the existence of two farming systems corresponding to two different types of farms. The first system, S_1 , features a productive damar agroforest, and irrigated ricefields, with the farmer living in the village permanently. The second system, S_2 , features a productive agroforest and ladang cultivation. This second system requires two houses: one temporary on the ladang, the other in the village. Forty-nine percent of farms have adopted system S_1 — agroforest and irrigated ricefields — and 42% system S_2 — agroforest and ladang — 9% practise both simultaneously. 25% of peasant households have a second non-agricultural income.

These two types of farming systems have already been described as part of the world wide survey of agroforestry systems under the direction of P.K. Nair. The main results are shown below, in Tables 3, 4 and 5.

1) *Resource input and utilisation*

a) S_1 farming system:

- Permanent, irrigated ricefields: 0.42 Ha; 2 harvests a year; no bottleneck in labour availability due to employment of temporary migrants from Java, working in the irrigated ricefields at harvest and ploughing time. Capital is very small, only needed to meet expenses for fertilizer, some seeds and wages.

- Productive agroforest: 0.6 Ha; on the same plot are planted an average of 60 *Shorea javanica*, 25 fruit trees; family labour force only; no other input. Damar resin harvest needs three days each month.
- Young agroforest: No input, no labour force needed.

b) S_2 farming system:

- ladang: 0.8 Ha planted with dry rice; 1 harvest a year; family labour force only; No bottleneck in labour availability, because the size of the ladang is dependent upon the family labour force availability. Capital very little, for some vegetable seeds and fertilizer. Rice is grown two years in a row on the same plot.
- coffee plantations: on average, each family has two coffee stands separated in age by 2 years, i.e. 3 and 5 year old coffee stands or 4 and 6 year old coffee stands. Family labour force only; no other external input. The total size of the coffee stands amounts to 1.6 Ha.
- damar agroforest: 0.4 Ha; usually family labour force only; wage labourers for damar resin harvest in case of high family labour force demand in ladang plots and coffee plantation. Damar resin harvest requires four days each month.
- Young agroforest: no input, no labour force needed.

In both systems, there is an alternation of labour between damar agroforest and other cultivations because of the monthly harvest of the damar resin.

2) *Production and economic results*

The value produced in agroforests as part of the total production value can be as high as 50% in S_1 system, and up to 30% in S_2 system, as shown in Table 3. (Moreover, the value of wood and fruit production, also produced in the agroforests, is not included in the estimated share of the agroforests in the total production value.)

In S_1 , all revenues come from the agroforests, (damar resin and fruits) and for S_2 , revenues come from agroforests, ladangs and coffee plantations, up to 51%.

Besides, agroforests provide a monthly income; although this income fluctuates during the year, periods of low resin price are known by the peasants. Fruit trees in the agroforests provide uncertain income, due to irregular fruit production and lack of market organisation favourable to peasants. Coffee plantations provide a variable and uncertain income due to lack of intensive care (no use of fertilizer and plant protection products), see Table 4.

One of the most important advantages of the farming systems of the Krui area is the possibility for the peasants to get different types of income, which are used in different ways in order to meet the various objectives of the peasants. Table 5 shows the objectives of the peasants in Penengahan and the manner in which the objectives are met, according to farming systems S_1 and S_2 .

Table 3. Production of agricultural commodities

Commodity	size of plan- ted area	yield	production	mean price	value of production	percentage of total value	marketed pro- duction as % of total prod.	rate of crop self-suffi- ciency ^c	value of marketed production	percentage of marketed value
Units	Hectare	Ton Ha ⁻¹ per year	Ton	Roupies	Roupies × 1,000	%	%	%	Roupies × 1,000	%
Irrigated rice	0.42	2	1.68	280	470	46	0	100	0	0
Damar resin	0.6	3	1.8	275 ^a	496	54	100	—	496	100
Fruits from AF.		nil	nil	—	nil	—	70	100	nil	—
Fuelwood		nil	nil	—	nil	—	0	100	0	—
Wood for building		nil	nil	—	nil	—	0	40	0	—
Rainfed A rice B	0.8	1.2 0.725 ^b	0.96 0.58	300	288 174	37 16	0	120 80	0 0	—
Vegetable A B	intercropped with rice		0.5	200	100	13	only surplus	50	50	12
			0.75	150	13	75	9			
Coffee A B	0.6(5) + 0.6(3) 0.6(4) + 0.6(6)	^d	0.16	1,000	160	21	90	100	144	35
			0.56	560	51	97	543	65		
Damar resin	0.4	2	0.8	275	220	29 20	100	—	220	53 26
Fruits from AF		nil	nil	—	nil	—	50	100	nil	—
Fuelwood		nil	nil	—	nil	—	0	100	nil	—
Wood for building		nil	nil	—	nil	—	0	50	0	—

These are estimated means observed in the fields, which have been confirmed by a further indepth survey, the complete analysis of which is still in process.

^a 275 Rp/Kg is the price received by farmers for bulk unsorted damar resin, in 1983.

^b A) is the first rice crop on a ladang plot. B) is the second rice crop on the same ladang plot. As coffee stands are set up in the second rice crop, the second dry rice harvest is smaller than the first one.

^c Rate of crop self-sufficiency: Self consumption includes that imposed by social obligations. In general, these obligations are more important in system I (see section V: land tenure system . . .)

^d Size of coffee stands: usually, during year A) two plots of coffee are cultivated: one of 0.6 Ha of 5 year old coffee trees, and one of 0.6 Ha of 3 year old coffee trees, not yet productive. During year B), one plot of 0.6 Ha of 4 year old coffee and one plot of 6 year old coffee are cultivated. For yields in coffee stands see section III above.

3) *Relations between S₁ and S₂ farming systems*

The two systems are not contradictory, rather complementary. In the course of its life, a family shifts from S₁, living permanently in the village, to S₂, living alternatively in the village and in the ladang, according to the stage of its evolution. There are very few households which have only practiced the S₂ system. On the other hand, most of the households practicing the S₁ system have a second non-agricultural activity which keeps them in the village. Families change from S₂ to S₁ in order to be able to live permanently in the village. The reasons that traditionally require the families to live in the village include the following:

- illness or death of a parent: generally, the eldest son is responsible for the extended family. (More details about the social organization are given in the next section: Inheritance law and land tenure system).
- Children's education; especially in the case of a first born child the parents leave the ladang for a period of 1 to 3 years.
- Widowhood, search of a new spouse.
- Shortage of forest land available for ladang creation and recent tensions existing between the National Park administration and peasants who farm land within the Barisan Selatan Game Reserve are two new motivations to stop cropping in ladang and to change from S₂ to S₁.

4) *Long term continuation of S₁ and S₂ farming systems*

The continuation of S₂ requires the availability of forest land to be opened for ladang cultivation. In fact, the main reason for ladang cultivation and consequently forest clearing is not the wish to enlarge the coffee or *Shorea javanica* plantations, but the very need of dry rice cultivation in order to achieve rice self-sufficiency for the family. Clearings for rice cropping are almost always made in primary forest because ladang plots are not left to become fallow but they are planted with perennials and peasants are reluctant to cut down agroforests which are still productive. The results are on the one hand, a steady spread of the agroforests on the Bukit Barisan Slopes, moving ever further away from the village, while primary forest dwindles, and on the other hand, the necessity for ladang cropping and perennial plantations to adapt to new ecological conditions the results of which are discussed in section VI.

The S₁ system, contrary to that of S₂, requires access to irrigated ricefields. Land suitable for irrigated rice production is very limited and poses management difficulties at the village level. The land tenure system developed to handle these difficulties is the subject of the next section.

V. Land tenure system and inheritance law

In the Krui region, the ownership of trees and land is inseparable. There are three ways to achieve land ownership appropriation through 'creation', by inheritance or by purchase.

Table 4. Capital availability during a year, for an average size farm of S1 and S2 types, in 1983. Unit: Roupies (rp); 1,000 rp = 1 us dollar in 1983

Income source	Jan.	Feb.	March	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
irrigated rice		270,000						200,000				
damar resin	37,500	52,500	52,500	45,000	45,000	31,500		41,250	42,000	37,500	22,500	36,000
Mean resin price ^a	250	350	350	350	300	300	210	275	280	250	150	240
Rainfed A rice	288,000											
rice B	174,000											
damar		25,000	35,000		30,000			25,000		28,000	20,000	24,000
coffee												
						A 160,000 B 560,000						
Vegetables		20,000		20,000	20,000						20,000	20,000

Sources: field estimations taken from interviews with the head of the village and with several peasants

^a Prices of damar resin are affected by peasants' yearly peak demand for cash coinciding with the festival of 'Lebaran' (Muslim festival), resulting in local surplus of resin and thus low prices. Equally, there is a lull in trading in Singapore during November and December, which also obviously affects local prices.

Table 5. Resources, products, destination and use of the products

Farming system S ₁			Peasant's objectives	Farming system S ₂		
Resources	Product	Destination		Destination	Product	Resources
River	Fish	→ Subsistence	Satisfaction of food requirement produced by peasants	Subsistence ← fish		River
Animal breeding Husbandry	Goat Chicken	} Subsistence		Subsistence ← Chicken		Husbandry
Irrigated ricefields	Rice	→ Subsistence		Subsistence	{ Rice Vegetables Fruit	Ladang
Agroforest	Damar	→ International market	Satisfaction of other food needs not produced by peasant	International market ← Damar		Agroforest
				Local market ← Vegetables		Ladang
Agroforest	Medicinal plants Fuelwood	} Subsistence	Satisfaction of daily and weekly non food needs	Subsistence	{ Medicinal plants Fuelwood	Agroforest
	Damar	→ International market		International market ← Damar		
				Subsistence ← Fuelwood		
				Local market ← Vegetables		Ladang

Agroforest	Clove } Durians } Dukus }	Domestic Market	Satisfaction of income needs for annual expenses	Domestic Market { Clove Durians Dukus Local market ← Vegetables	Agroforest Ladang
Agroforest	Land →	Mortgage to other villagers	Satisfaction of income needs for exceptional expenses	Mortgage to other villagers {	Agroforest
Agroforest	Trees →			Land	
Agroforest	Wood for building →	Subsistence		Trees	Agroforest
Forest				Subsistence ← Wood for building	Forest
				International market ← Coffee	Ladang
Agroforest	Clove →	Storage	security	Storage ← Clove	Agroforest
				Storage ← Coffee	Ladang

1. Appropriation through 'creation'

According to traditional law, anyone clearing a plot of communal land becomes owner of this plot. This law applies to ricefields as well to ladang plots. A recent Indonesian law states that any plot cleared and then overrun by secondary forest through lack of tending for more than two years becomes communal property again and can be handled over to a third party who requests it, with the agreement of the head of the village. This law has only begun to be applied in 1983, when the head of the Penengahan village undertook to enforce the law, the application of which could affect a substantial hectareage, up to 100 Ha. However, the land concerned is of low agronomic value, being situated on the hilltops. Plots cleared in the state forest remain state property.

2. Inheritance law

Although the Lampung society is muslim, it follows its own inheritance law. According to this local law, the eldest son inherits the family property, i.e. the property already inherited by his parents. The remaining property, created or purchased by the parents is shared among the other children, according to the owner's will only. The children who have renounced inheritance rights at their wedding do not receive any part of their parents' property.²

The eldest son is above all the holder of the family property. He is responsible for it, he enjoys a permanent cultivation right, he is allowed to rent it or to mortgage it. As a counterpart, he is in charge of his extended family. (No information was collected concerning the right to sell the family property.) Custom also defines the share each head of family must contribute to the expenses resulting from social and religious festivals. The eldest son's share is always larger than that of his younger brothers. Besides, his social responsibility traditionally requires him to stay in the village and therefore inhibits his participation in the ladang cropping system which is practised at a great distance from the village (up to 30 Km). The difficulty of participating in the ladang cropping system is greatly regretted by the eldest son as the ladang cropping system, which includes coffee and clove cash crops, is considered to be a very profitable cropping system. As a consequence of the economic restriction and the social responsibilities imposed on the eldest son, his position is not considered to be desirable by either the eldest son himself or his younger brothers. Although no formal inquiry was carried out on this aspect of the social structure, it became apparent that the constraints of the present system call the traditional law of property inheritance into question.

3. Land market

The land market seems to be rather slack for ricefield, and non-existent for ladang and coffee plantation.

Table 6. Land tenure system

Type of land	Land tenure type	Hectarage as percentage of total cultivated land		
		Land cultivated by the owner	Sharecropping	'Gadaï'
Irrigated ricefields		60	15	25
Damar gardens		76	12	12
Coffee stands		100	0	0
Ladang plots		100	0	0

(Sources: Survey about land tenure, March 1984)

4. Land tenure system

As shown in Table 6, land cultivation by the owner is the most common form of land tenure although there are exceptions which vary with the crop cultivated.

a) The 'Gadaï': the Indonesian term 'Gadaï' refers to a loan secured with a land collateral in which the principal is paid in money and the interest is the use of the land during the period required to pay back the principal. The length and the amount of gadaï is determined between borrower and lender, both of whom are peasants, though the loan maturity, exact time when the gadaï ends may later vary according to the ability of the borrower to reimburse the principal.

Ricefields and agroforests are the only land used in gadaï, to the exclusion of coffee stands and ladang plots. The borrower and the lender prefer to exchange in gadaï the damar agroforests, as shown in Table 7. For the lender, damar agroforests provide a steady income and do not require a large labour input. For the borrower, the priority is to assure his rice supply which means he is reluctant to use his ricefields in gadaï unless he cultivates dry rice in ladang. In case of agroforests used in gadaï, the loan value amounts from 3.5 to 10 time the monthly income, with an average of 5. If cloves are found in the same parcel as damar trees, they usually are not included in the gadaï, the owner keeping his production rights. The money loaned in gadaï is seldom reinvested, but rather used for social expenses, house improvement or the construction of a new house in the village.

b) Sharecropping: In ricefields, 1/3 of the crop is for the owner, 2/3 for the sharecropper. In the damar agroforest, if the garden is situated near the village, the monthly harvest is equally shared among the owner and the sharecropper. If the garden is situated within more than half an hour's walking distance from the village, the sharecropper gets 2/3 of the harvest.

In contrast to the gadaï system which responds to an urgent need for money, sharecropping is often the response of the land owner to a labour

Table 7. Number of agreements between land owner and cultivator

Type of land	Type of agreement	Gadai	Sharecropping	Total
Irrigated ricefields		18	20	38
Damar agroforests		12	31	43
Total		30	51	91

Sources: Survey about land tenure; March 1984

shortage for irrigated rice cultivation, or the result of the land owner's choice to adopt the S_2 farming system with dry rice cultivation. The case of damar agroforest sharecropping is more complex as agroforest requires little labour input. Often agroforest sharecropping is a result of the owner's migration or his response to economic needs of other members of his enlarged family.

5. Land holding patterns

a) Distribution of land property among households: the very low rate of rice field distribution among households, 15% of which hold the total hectareage, can be accounted for by the enforcement of the inheritance law of the Lampung area up to the present day, transferring the property from father to eldest son. This is even more obvious when it is considered that the village was initially settled and the ricefields established by only four families. 10% of the households later became owners of ricefields through purchases from the neighbouring villages, for a total of 10 Ha, or through the setting up of new ricefields on the edge of agroforests to a total of 5 Ha.

On the other hand, the distribution of agroforests among households is quite different: 73% of households own an agroforests, the hectareage of which was found to vary from 0.1 to 0.5 Ha.

b) Distribution of S_1 and S_2 farming systems among households: although each household adopts alternately each of the two systems, it is more common for the eldest son to adopt S_1 , and for the younger brothers to adopt S_2 . In fact, 58% of the younger sons cultivated in Ladang in 1984, against 21% of the eldest sons, as a result of the social organisation in the Krui area. (See section V 2, above.)

VI. Factors of change and evolution of farming systems

1. Land pressure

One of the main factors of change is the necessity of clearing a continuously increasing amount of forest land for dry rice cultivation. Several consequences are the result of that.

a) Ecological limitations: As the damar agroforests spreads, it reaches new areas where ecological conditions differ. In area 2 (See Figure 6), which covers the Bukit Barisan slopes at an altitude close to 1,100 m, the peasants didn't find damar trees in the natural forest. As a result they did not go with the traditional ladang system, but instead they have adopted a farming system combining flooded ricefields in the depressed areas and permanent coffee plantations on the hills. In areas 1 and 4 which are also on the slopes of the Bukit Barisan at a similar altitude, the damar grows naturally in the forest although the yields are quite low and uncertain. Nonetheless, farmers preferred to continue the traditional plantation pattern as described in section II, but this has changed recently with the increase in future uncertainty.

In area 3, the soils are less fertile and are unsuitable for growing damar. Here the system evolved towards the plantation of cloves combined with a few fruit trees. Now, the farmers wish to develop the potentialities of these latter.

b) Transportation problems: As the ladang plots are established ever further away from roads, transportation becomes a determining factor in species selection for the agroforest stage. The market price of damar resin is often too low to compensate the exertion of transporting it to the main roads. As a result, farmers are looking for a substitute that would reach a higher price per kilo. In particular, clove has been substituted for damar.

c) Land shrinkage: as early as 1960, agroforests had reached the boundaries of the forest reserve in which cultivation was not allowed except with a permit. One response to this land shortage was to clear plots in the reserve using a temporary permit; another response was the use of fertilizer to increase yields and therefore reduce the forest clearing progression. In addition, there was a migration of peasants to S. Pesisir. The relatively weak pressure on land was abruptly increased in 1982, with the upgrading of the Bukit Barisan Game Reserve into a National Park, which brought with it a stiffening of the forest clearing controls. From that time on, some peasants have continued to cultivate in the National Park though with much less future security; others have gone back to formerly cultivated ladang plots while still others have migrated towards S. and N. Pesisir.

– Ladang within the National Park: (areas 1, 2, 3 and 4 in Figure 6) in 1983; any new clearing was forbidden and the temporary cultivating permit obtained by some peasants was questioned. The Indonesian government specified that all cultivation inside the Natural Park should be stopped to be replaced eventually by forest tree plantation under the control of Forestry Services. The date of closure had not yet been decided though peasants had been given the right to harvest crops in progress during the two years following the date of closure.

As the damar needs 20–25 years to become productive, it requires a certainty in future land tenure to justify its inclusion in the farming system.

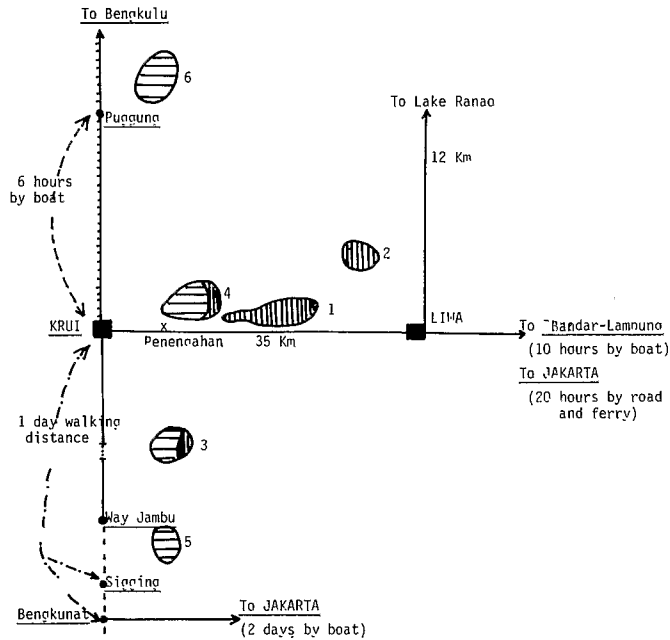


Figure 6. Situation of land cultivated by the population of P. Roads —; Road under construction - - - - -; Walking path - - - - -; Regular maritime route - - - - -; Irregular maritime route - - - - -; Area cultivated within the National Park boundaries ■; Area cultivated outside the National Park □;

The increased uncertainty in land tenure has resulted in a premature termination of the cropping system progression at coffee stage, coffee taking only three years to become productive. In 1983 and 1984, some peasants lacking new forest plots to be cleared, went on with dry rice crop on the same plots for the third or fourth year in a row. This practice might endanger through erosion the chances of further crop or tree plantations. In order to increase yields and income, peasants have also been investigating the possibility of a secondary vegetable crop between two rice crops.

– Migration towards the South: migration started in the mid forties and grew in impetus around the mid sixties. The areas of settlement in S. Pesisir by migrants coming from C. Pesisir are located within two to three days' walking distance from the village of origin. The remoteness and the absence of roads bar out the continuation of the monthly tapping of damar in the village of origin. As a result, only bachelor younger sons and families who own no irrigated ricefields and just a little agroforest migrate. This migration starts by being seasonal and becomes permanent with the wetting up, in S. Pesisir, of irrigated ricefields, coffee stands and damar agroforests, which go with the building of a house. The migrants' property in the village of origin is first sharecropped and then later put up for sale.

In South Pesisir, the hectareage suitable for rice growing is still plentiful and the area yields rice surpluses which are sold at a low price in Central Pesisir. In the ladang plots, the cropping system applied is identical to the traditional ladang cropping system of C. Pesisir. Forest clearing on the foothills of the Bukit Barisan mountains became a widespread practice in 1982 only, following the drought which seriously impaired the irrigated rice crop.

– Migration towards the North: this migratory flow started in 1982 as a result of the stiffening of the regulations applied to the National Park. The families concerned generally own some property in C. Pesisir and they do not want to migrate for good. This problem is resolved by moving to N. Pesisir, only a day's walk away, which allows them to return to C. Pesisir for the monthly damar harvest. Moreover, N. Pesisir will be connected to C. Pesisir in the near future. In 1983, 40 households moved to N. Pesisir to clear forests. According to interviews, the area offers good opportunities for coffee and damar plantations, but the hectareage available is rather limited and these lands might run out within the next 5 or 6 years.

– Return to plots formerly under crop: these hilltop plots not suitable for growing damar had been cleared for rice production some 10 or 20 years ago, planted with clove trees, and then abandoned. In 1983, fertilized dry rice was cultivated under clove trees, after a recent new clearing. This was a new system locally in which producers did not know how long they would be able to grow rice intercropped with cloves. Nonetheless, it was known that in other regions rice cropping in clove plantation was no longer possible after less than a decade. The producers in this system having no other riceplot, it is an open question as to how they will meet their rice requirements when this happens to them, too.

2. *Other factors*

The continued existence of damar production is increasingly called into question by the stagnant market outlook, the worsening terms of trade between damar resin and rice, as well as the increasing revenue demand from changes in consumption patterns and expectations.

a) Terms of trade: peasants usually compare the price of 1 kg of damar resin (price received by peasants from village traders) to the price of 1 kg of hulled rice (retail price). This damar price/rice price ratio (D/R ratio) was stable and averaged 1 from 1964 up to 1980 with several exceptions due to the devaluation of the Rupiah, and rice shortage, (1968, D/R = 1/12) or due to very weak export trade with Singapore as shown in Figure 7. Since 1981, there has been a downward movement in damar prices while rice prices fluctuate greatly, resulting in a reduction of peasants' standards of living. (1982, D/R = 0.98, 1983, D/R = 0.8)

b) Damar resin market outlook: 1/3 of the damar resin is sold at the

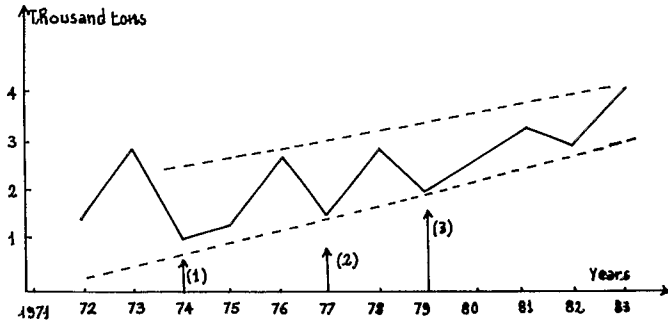


Figure 7. Damar resin exports from Tanjung-Karang to Singapore. (1) Lull in trading activity of Singapore due to sudden raise of oil prices (1974). (2) Temporary breach in export trade from Indonesia to Singapore. (1977). (3) Local bankruptcy in Krui. (1979).

domestic market for batik, frankincense and paint manufactures. Due to changes in batik processing, the demand from batik factories is falling off while the damar demand from paint and frankincense factories is not increasing. 2/3 of the damar resin is exported via Singapore for paint, linoleum, varnish and glass factories. The average growth rate of exports, in volume, has been 3 to 4% during the last 8 years. This, if it continues, will just absorb the damar production increase from recently established damar agroforests. Damar resin is used as the sticky agent in low quality water paints while synthetic resins are used in its place in higher quality oil paints. The oil paints have only recently begun to be produced in Indonesia and therefore the effect of their competition on the demand of water-based paints, and then on damar demand, is still unknown. It seems unlikely, at the least, that there will be an increase in damar prices at the local level, even with a growth in total paint demand.

c) Need of money income: the demand on money income has grown strongly partly due to the increasing number of children attending secondary school in Krui. This recent development has been possible since the opening of the Krui-Penengahan road in 1978 which has facilitated the daily transport of children. Children's education is both a hope for parents to push their children out of the peasant condition, and a non-negligible expense which amounts to 1,500 to 3,000 Rupiah per week and per child for secondary school. Other expenses such as materials for house building, water pumps, and motorbikes are also becoming more common. These increasing expenses have not been compensated by increasing revenues and moreover, the damar revenue is even showing a downward trend.

This in itself is not enough to call continued damar cultivation into question, but where this coincides with high land pressure and/or ecological constraints, the cultivation of new species is more and more considered. For example, in S. Pesisir, where land availability is still adequate

there is no question of changing the cropping system. This is in contrast to the situation in C. Pesisir where land and revenue pressure has stimulate a great interest in investigating alternative crops. The desired alternative crop would be a fast growing tree crop with high value per Kg of product, and a better return per Ha than damar. The first fundamental change in the traditional cropping system has been the introduction of clove as the ultimate crop in the ladang progression. This change represents a new economic perspective in which greater risks are undertaken in order to obtain higher average revenues. Even if there is a diversification in the ultimate ladang crop, for example with fruit trees, it is probable that the tendency towards speculative crops will continue.

Conclusion

An agroforestry system, such as the Lampung agroforest has a number of economic and ecological advantages:

- It replaces the natural forest with a similar ecosystem which fulfills many of the same ecological functions.
- The agroforest provides wood to meet the villagers' fuel and construction needs.
- A number of food products, contributing to a diversification of the diet are produced in the agroforests.
- Agroforests provide several complementary revenue sources: the regular revenue obtained in the monthly sale of damar resin increases the financial security of peasants; the sale of seasonal agroforest products (cloves and fruits) are often used to finance large expenditures either of a social or a productive nature.

The agroforestry system is not the only cropping system observed in the Krui area. There are two types of farming systems, one which associates irrigated rice cultivation with damar agroforest, S_1 , and another which associates dry rice cultivation in ladang with coffee stands and damar agroforest, S_2 . The first type of farming system, S_1 , requires access to land suitable for irrigated rice cultivation, access which is limited to a small part of the population in the Krui area. Those without land suitable for irrigated rice cropping are forced into the second farming system, S_2 , meeting their rice needs from rainfed rice cropping in the ladang.

The functioning of the second system, S_2 , necessitates the continued clearing of natural forest land which is put under cultivation indefinitely. The succession of crops planted on the cleared land starts with rainfed rice which is rapidly replaced by perennial plantations of coffee and damar, one of which, generally damar, is the ultimate crop. The system is not cyclic because forest land, once cleared, is not left to become forest fallow again. The result is that new land must continually be cleared to meet peasants' rice needs. Little by little agroforests are expending at the

expense of the natural forest, which will eventually jeopardize the reproduction of the S_2 system.

The first difficulties with the continued reproduction of the S_2 system have already begun to appear. The nearby remaining forest is entirely situated within the National Park, the 'Barisan Selatan Game Reserve', in which cultivation and harvest of natural product is not allowed. The local population has developed a number of strategies to deal with the problem of limited natural forest suitable for ladang cropping: emigration and exportation of the cropping system to other areas where ecological conditions are favourable and private land ownership possible; modification of the system through intensification of dry rice cultivation; increased use of marginal soils which were until now left uncultivated, the use of these soils resulting in a replacement of damar by clove in the cropping system. These solutions seem to be only temporary.

The analysis of the situation in Krui brings into question the manner in which an agroforestry system should be evaluated. One agroforestry cropping system evaluated individually can give rise to an entirely different analysis than that obtained by considering the same cropping system as part of the farming system as a whole. The damar agroforest of Krui is an example of how this analysis can change according to the level of evaluation. The damar agroforest as described by Torquebiau, offers the ecological and economic advantages expected in agroforestry systems, given that: there is not a problem of long term reproduction; agroforests do not require heavy capital investments; the local population is in charge of land-use management; they provide food, wood and revenues for peasants; they ensure the protection of the soil.

The damar agroforest, when considered as a part of the farming system, including rice cultivation, ladang practice and speculative cash crops, shows that the long term continuation of this farming system and of agroforests is nowadays questioned. The dynamic of transformation of the damar agroforests has its origin outside of the agroforests, in the functioning of the ladang cropping system, ending with perennial crops, in the limited supply of forest land suitable for ladang, and in the limited prospects for the damar resin market. At this level of evaluation, the analysis focuses on the transformation and the possible disappearance of the damar agroforests as the result of, on the one hand, land shortage, and on the other hand the competition between the farming system S_1 , irrigated rice and agroforest, in which speculative crops are absent or play a very limited role, and the farming system S_2 , in which the speculative crops such as coffee and clove are becoming essential.

This global approach indicates that the value of an agroforestry system depends on demographic and socio-economic conditions under which it is practised. The shifting cultivation can be in perfect equilibrium under appropriate conditions, and so, too, can the farming systems of Krui if the

rice needs can be met by other means than that of dry rice cultivation in ladang:

– either by an intensification of the agroforests or by a better valorisation of the agroforest products; in Central Pesisir, the potential for the intensification of the agroforests and the possibilities of local products valorisation have not yet been well evaluated, although, when viewed from the regional level, there seem to be some possibilities.

– or with more irrigated rice: a further study might examine whether this will be the case in the South Pesisir district, where there is still an important amount of land suitable for the establishment of irrigated ricefields considering also the still low population density of the region.

Notes

1. 'batik': Traditional technic of printing cloth.

2. When a wedding takes place, either the husband or the wife becomes part of the other family, which entails giving up his/her inheritance rights and in return receiving a dowry fixed by the families. A large percentage of women are observed to join their husbands' families, but this is not an absolute rule. The decision depends on the situations of the families involved; wealth, social ranking, and birth order of each spouse are involved. In case of widowhood or divorce, he or she can go back to his/her family but cannot take the children along as they are considered to belong to the other family.

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