## 4.4 Socioeconomic and Cultural Conditions

(1) Survey Structure

Several surveys of villages and local people were carried out in order to collect information related to the Social Forestry Project. The key points of these surveys were not only to collect and analyse basic quantitative information relating to the targeted villages and villagers but also to obtain qualitative information, such as the real conditions of local life and the needs of local people, particularly by listening to their true intentions. The participation of local people was, therefore, required from the initial stage of the surveys. Attached Appendix D-1 shows the survey structure and contents.

Based on the results of the outline survey in the Study Area in the first field survey (March, 1996), the problems in the region were clarified and the study method for the Project Area was decided with 10 villages being selected as the survey targets using the following five criteria.

a. Geographical distribution: the Project Area is divided into three areas, i.e. the upper, middle and lower streams of Musi River in terms of the geographical distribution of the villages in the Musi watershed.

b. Interaction of villagers with forests: among villages which are adjacent to or near forests and where local life is closely related to forests, priority was given to villages with a stronger interaction with forests.

c. Access to markets and main roads: in order to analyse differences in people's lives in terms of the distance to markets and main roads, villages with long and short access to markets or main roads were selected.

d. Economy: villages designated as poor villages and those without such designation were selected.

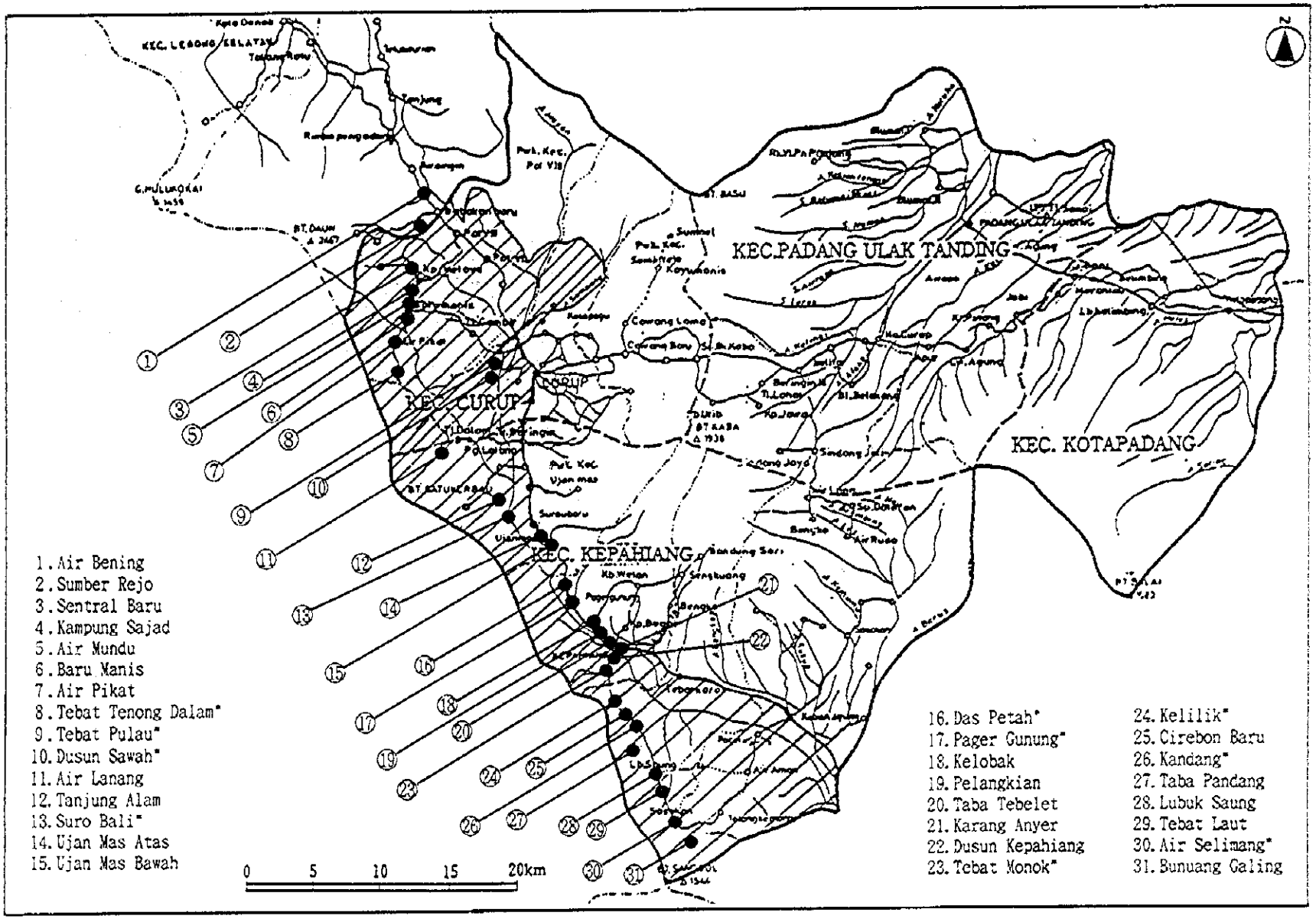
e. Ethnic composition: considering the variety of ethnic groups in the Project Area dominated by the Rejang people, villages with various ethnic groups were selected.

During the second field survey (November, 1996), these 10 villages were surveyed by a NGO and the regional characteristics, problems and local people's needs, etc. in the Project Area were analysed from the viewpoint of social forestry.

During the third field survey (July, 1997), in order to allow the exchange of opinions between local people and government officials in regard to the Social Forestry Project, a workshop in which 30 villages in the Project Area participated (including the 10 villages already surveyed during the second field survey) was held. (See 4.5 for details of the workshop.) Furthermore, in order to confirm and supplement the findings of the second field survey, an additional 20 villages in the Project Area were surveyed using the RRA (Rapid Rural Appraisal) method. In regard to the shortage of infrastructure which was pointed out as one of the local problems, the question of domestic water supply was mainly analysed because of its importance stressed by many villages in the second field survey.

(2) Surveyed Villages

Fig. 4-3 shows the 30 village which were surveyed. Table 4-8 shows the classification of these villages using the criteria described earlier.




Note: Villages with* are the surveyed villages in the 2nd field survey in 1996.

Fig. 4-3 30 Surveyed Villages

Table 4-8 Selection Criteria and Selected Villages

| Kecamatan/Desa | | | Criteria | | | | |
|---|---|---|---|---|---|---|---|
| No | Kecamatan | Desa | (1) Geographical Distribution | (2) Interaction of Villagers with Forests | (3) Access to Markets and Main Roads | (4) Village Designated as Poor | (5) Ethnic Composition |
| 1 | | Sumber Rejo | Upper | O (Coffee) | Far | X | Jawa, Rejang |
| 2 | | Sentral Baru | Upper | O (Construction woods) | Far | X | Rejang, Serawai |
| 3 | | Kampung Sajad | Upper | O (Coffee) | Far | O | Jawa, Rejang |
| 4 | | Air Mundu | Upper | O (Coffee) | Far | O | Jawa, Rejang |
| 5 | Curup | Baru Manis | Upper | △ | Far | X | Jawa, Rejang |
| 6 | | Air Pikat | Upper | O (Coffee) | Far | O | Serawai, Rejang |
| 7 | | Tebat Tenong Dalam 1) | Upper | O (Coffee) | Far | O | Serawai, Rejang |
| 8 | | Dusun Sawah 1) (including Tebat Pulau) 2) | Upper | O (Coffee) | Far | O | Rejang, Jawa |
| 9 | | Air Lanang 1) | Upper | O (Construction woods) | Far | X | Rejang |
| 10 | | Tanjung Alam | Middle | O (Coffee) | Far | X | Serawai, Jawa |
| 11 | | Suro Bali 1) | Middle | O (Coffee) | Near | X | Bali, Jawa |
| 12 | | Ujan Mas Atas | Middle | O (Coffee, Bamboo shoots) | Near | X | Rejang, Jawa |
| 13 | | Ujan Mas Bawah | Middle | O (Coffee) | Near | X | Rejang |
| 14 | | Das Petah 1) | Middle | O (Bamboo shoots) | Near | X | Rejang, Lemba |
| 15 | | Pager Gunung 1) | Middle | O (Bamboo shoots) | Near | X | Rejang |
| 16 | | Kelobak | Middle | O (Bamboo shoots) | Near | X | Rejang |
| 17 | | Pelangkian | Middle | △ (Not clear) | Near | X | Rejang |
| 18 | | Taba Tebelet | Middle | △ (Not clear) | Near | X | Rejang |
| 19 | Kepahiang | Karang Anyer | Middle | O (Fruits, Coffee) | Near | X | Jawa, Rejang |
| 20 | | Dusun Kepahiang | Middle | (Not clear) | Near | X | Rejang, Padang |
| 21 | | Tebat Monok 1) | Middle | O (Bamboo shoots) | Near | X | Rejang, Serawai, Lemba |
| 22 | | Kelilik 1) | Lower | O (Bamboo shoots) | Near | X | Rejang, Lemba |
| 23 | | Cirebon Baru | Lower | O (Coffee) | Far | X | Sunda, Jawa |
| 24 | | Kandang 1) | Lower | O (Coffee, Construction woods) | Far | X | Rejang, Lemba |
| 25 | | Taba Padang | Lower | O (Coffee) | Far | O | Jawa, Serawai, Rejang |
| 26 | | Lubuk Saung | Lower | O (Coffee) | Far | X | Rejang, Pasmah Serawai |
| 27 | | Tebat Laut | Lower | O (Construction woods) | Far | X | Jawa, Pasmah |
| 28 | | Air Selimang 1) | Lower | O (Coffee) | Far | O | Serawai, Lemba |
| 29 | | Bunuang Galing | Lower | O (Construction woods) | Far | O | Pasmah, Jawa, Sunda |
| 30 | Curup | Air Bening 3) | Upper | O (Coffee) | Far | X | Jawa, Rejang |

Note 1): Socioeconomic and Cultural Conditions Survey was conducted during the 2nd field survey (10 villages in all)

2): Tebat Pulau was a part of Dusun Sawah during the 2nd field survey and already become an independent village at the 3rd field survey. Tebat Pulau was already surveyed as Dusun Sawah during the 2nd field survey and not included during the 3rd survey.

3): This village is not located in the project area. However, there are many encroachers and has a large impact on forest and was included in the survey.

(3) Survey Results

1) Characteristics of Local People and Living Conditions

① Population, Sex and Religion, etc.

The population density is very high in Desa Das Petah (950 persons/km$^2$) and low in Desa Tebat Laut (13 persons/km$^2$). The former is 73 times higher than the latter. The share of women is high in five villages, including Desa Bunuang Galing and Desa Taba Padang, and low in Desa Dusun Sawah, Desa Kelobak and Desa Sumber Rejo (See Attached Appendix D-2). Hindus account for 58% of the total village population in Desa Suro Bali which is an exception as all other villages are almost 100% Muslim villages.

The ratio of landless households is high in Desa Air Selimang (56.0%), Desa Bunuang Galing (55.8%), Desa Tebat Laut (50%) and Desa Ujan Mas Bawah (50%), showing a large gap between villages without landless households (Desa Taba Tebelet) and those with some landless households (Desa Kelobak and Desa Baru Manis).

In regard to the ethnic composition (Attached Appendix D-3), the Rejang is the largest ethnic group in 15 villages. In contrast, the Jawa (58.3%) and Bali (38.3%) are the dominant groups in Desa Suro Bali while the Serawai is the largest group in Desa Tebat Tenong Dalam, Desa Air Selimang and Desa Tanjung Alam. Groups of immigrants tend to live together, concentrating on farming at the initial stage. Once they have sufficiently settled, they adapt to the indigenous Rejang culture.

② Immigration

Many immigrants come from Kab. Bengkulu Utara and Kab. Bengkulu Seletan with some coming from neighboring villages or even from South Sumatera and Jawa. Many people came to the surveyed villages to find new jobs and a better life.

In general, immigrants firstly become waged labourers or tenants of coffee fields owned by the original villagers. Some of them open up uncultivated land (mainly in forests) and commence farming, mainly coffee cultivation.

③ Infrastructure and Public Services

Access to cities from most villages and access to farmland for the transportation of people and crops are possible due to the availability of feeder roads and transport facilities (small vans and medium size trucks). Small vans operate every 30 minutes in most villages, providing an important means of local transportation to take villagers and agricultural products from villages to the markets and bus terminals in Curup and Kepahiang.

Many villages are dependent on wells for domestic water supply, especially drinking water, and some are dependent on springs and rivers as shown in Attached Appendix D-4. The Ministry of Public Works (PU) has recently begun to rapidly install water supply tanks and 10 villages among the surveyed villages already have one or two tanks. However, due to the shortage of water and poor maintenance, the water demand of the villagers is not sufficiently met by many of these tanks.

The fetching of water is important work for those villagers which depend on rivers and springs as water sources. Women and children fetch water in many households. In Desa Tebat Monok and Desa Suro Bali, many fathers conduct this work. While water fetching is conducted twice a day in Desa Air Lanang, Desa Tebat Tenong Dalam and Desa Air Selimang, it is conducted more than three times a day in other villages. This implies that the fetching of water is difficult for women in the former villages because of such geographical problems as a long distance to water sources and hilly topography. Wells sometimes dry up in dry season and become muddy in rainy season and, at some villages, the water quality of old wells is poor due to inadequate management.

2) Economic Conditions

Farming is the main occupation in all of the surveyed villages. While there are various kinds of side jobs, the employment opportunities are still limited due to population increase. The unemployment rate among the younger generation of 20 - 30% is high in Desa Sentral Baru, Desa Kelobak, Desa Tebat Tenong Dalam and Desa Kelilik. Many young people help their parents with farming soon after graduating from junior or senior high school. A few of them leave their villages as agricultural labourers and construction workers. Many young people hope to get a job in agriculture or agriculture-related industries in their own villages. However, due to the shortage of land, technology and capital, new employment opportunities are very limited. Attached Appendix D-5 shows the economic conditions of the surveyed villages.

The main side job is agricultural waged labour, followed by trader and construction worker. Newly married young people and landless farmers often become drivers of taxis and becak, construction workers and agricultural labourers and are particularly active in these types of work during the farming slack season and in years of a poor harvest. Employment is mostly inside villages and in the neighboring villages but a small number of villagers find work in Jakarta's industrial sector. Only men work outside their own village in the surveyed villages although Desa Ujan Mas Bawan is an exception.

Most of the household income in most villages originates from agriculture, especially from coffee production. There is a particularly high dependence on coffee in Desa Lubuk Saung, Desa Kelobak, Desa Pelangkian, Desa Pager Gunung, Desa Dusun Sawah and Desa Das Petah.

When villagers require funds, they first rely on their relatives and acquaintances and secondly borrow money from a cooperative. Banks are generally located far from the village and the procedures are so complicated that most villagers do not properly understand them. In comparison, money lenders and middlemen who are familiar with villagers lend money without complicated procedures. However, loans usually have a high interest rate and the villagers are burdened by a large debt. While repayment is made after the coffee harvest, the general expenditure is also large at this time of year and farmers with a low income soon have to borrow again. Farmers can also obtain funds by selling their products little by little when necessary and they may purchase daily goods and agricultural inputs in exchange for agricultural products. In the case of the former, the purchase price by middlemen is usually lower than the market price.

Villagers in most villages experience economic difficulties for 4 – 8 months (*paceklik*) after the coffee harvest until the next harvest season. During this period, many villagers work in the neighboring villages and/or sell some products and firewood but this is not enough.

Landless households become tenant farmers at coffee fields and/or rice fields and receive a share of the crop. The details of the contract between a landlord and tenant differ. If there is insufficient income, tenants borrow money from landlords and become waged labourers in the slack season.

3) Farming Patterns

① Cultivation Patterns of Farmland

Villages with large paddy rice fields are Desa Tanjung Alam, Desa Kelobak (200 ha), Desa Sentral Baru (173 ha), Desa Air Pikat, Desa Ujan Mas Atas (150 ha) and Desa Tebat Tenong Dalam. Many paddy rice fields are scattered in small lots and the average size per household is 0.5 – 1 ha. Desa Ujan Mas Bawah has no paddy rice fields. The average coffee field size per household is 1 – 2 ha and the largest is 8 ha in Desa Sumber Rejo. However, there are some villages where large parts of the coffee fields are owned by people outside the said villages. In this case, people come to the village only during the working period and return to their own village after work, failing to establish unity and cooperative relationships in the village. At all of the surveyed villages, the paddy rice field area is much smaller than the coffee field area, resulting in a low rate of rice self-sufficiency. As a result, many families buy 50 – 80 kg or rice per month (for a household of five family members).

② Main Crops and Livestock

Many agricultural products in the Project Area are commercialized and the monoculture of coffee is prominent. Coffee was firstly introduced by the Dutch government during its colonial era because the soil and climate of the area are suitable for coffee. The long history of coffee cultivation has established the sales route of sale to middlemen who visit villages and a marketing route to exporters. Coffee seeds and seedlings can be easily obtained and grown by farmers. The local coffee variety (*Ciki Ari*) can be harvested within three years and its maturing period is short compared to such other farm products as kayu manis, durian and nutmeg, etc. For these reasons, coffee has become a major commodity crop on which local farmers heavily depend. In the third field survey, the reasons for the preference of coffee among villagers were confirmed and the findings are given in Attached Appendix D-6.

Middlemen and wholesalers (Tauke, Anak Ulo) have significant influence in terms of marketing and the supply of information to farmers. Despite large fluctuations of the price and annual harvest volume, farmers continue to cultivate coffee.

Most coffee fields are managed by the traditional farming system. Coffee cultivation starts with development of land and farmers firstly clear the land. In

most cases, the farming method employed does not consider soil conservation and coffee field can be founds even on steep hillsides. During the first three years when the coffee trees are not mature enough to bear beans, mixed farming with seasonal crops is conducted. The crops used for mixed farming are mainly upland rice, ginger, onions, chili and maize. As the coffee tress bear beans after three years, these crops are not cultivated as cash crops any more but are grown for self-consumption purposes. Some villages, such as Desa Sumber Rejo, Desa Kampung Sajad and Desa Air Mundu try to prepare for the income fluctuations of coffee by harvesting maize and soybeans three times a year. As the market price of coffee for export has greatly fluctuated in the last five years, kayu manis has recently been given much attached as a new cash crop. This is because the price is good, management is easy and the labour cost is low. Some farmers in Desa Tebat Tenong Dalam, Desa Tebat Monok and Desa Kelilik are engaged in the mixed cultivation of coffee and kayu manis. Other cash crops which also contribute to the household income are petai, ginger, panili and pepper, etc. Fruit trees for cash include those of durian, papaya, banana, mangosteen and salak, etc.

Although rice is a staple food, it is not produced in sufficient quantity in most villages. According to many farmers, the shortage of land for paddy fields is one reason for this rice shortage. The monoculture of coffee has resulted in a monetary economy in villages and, accordingly, many daily necessities, including rice, must be bought with the limited cash income. During hard times, especially before the harvest, the possibility that villagers may run into debt becomes high. The shortage of or insufficient management of irrigation facilities is another reason for the low rice productivity.

The average number of livestock owned by the respondents is high in the case of such poultry as chicken and ducks and goats but low in the case of cattle and buffaloes. The reasons for the small number of large size livestock are the scarcity of land for grazing, long distance to foraging areas due to the decrease of usable forests, difficult collection of fodder due to time limitations and frequent diseases. Many farmers hope to conduct stock raising as a source of income and prefer feeding livestock within a fenced area or shed in view of easier management instead of conventional free grazing.

③ Marketing System

While coffee is usually sold in the two major markets at Curup and Kepahiang, it is mainly sold in villages in the case of Desa Tebat Tenong Dalam, Desa Dusun Sawah and Desa Air Selimang because of the long distance to the markets and poor state of the roads. Farmers generally take the transportation cost into consideration when marketing their products. If the transportation cost is higher than the product price, they sell in the village market or to middlemen. The transportation cost per person is 75 – 100 Rp/km and that for goods is 100 Rp/kg regardless of distance. If products are sold in the village, farmers can save the necessary labour required to carry them long distances. At the village market which is regularly once a week, traders from Kepahiang and Curup buy products and also sell daily necessities and agricultural materials, such as chemicals and tools. There is no visit by middlemen to Desa Dusun Kepahiang and Desa Taba Tebelet which are near town markets with easy access to such markets.

Small middlemen in villages (*anak ulo*) buy coffee beans from farmers at 2,000-2,100 Rp/kg and sell them to middlemen from Curup and Kepahiang after selecting beans of good quality. The price at the Kepahiang market is 2,250 Rp/kg. As the coffee bean quality is unstable, middlemen set the purchasing price in the villages as low as possible in order to avoid a decrease of their own profits. Another route is for local small processors to buy beans from farmers and to sell coffee powder to exporters. The sale price to exporters is 5,000 Rp/kg.

4) Use of Land and Forest Resources

① Problems Related to National Forests, Settlers and Boundaries

People in many villages believe that the shortage of land is caused by the incursion of protection forest boundaries which were established in 1988 (BHL) to village land compared to the old boundaries during the Dutch colonial time (BW). For example, 750 ha of land in Desa Air Selimang and 60 ha of land in Desa Air Lanang are said to have been lost due to this change.

There are some settlers from Kab. Bengkulu Selatan in protection forests in Desa Das Petah, Desa Kandang, Desa Kelilik, Desa Dusun Sawa (Tebat Pulau), Desa Ujan Mas Atas, Desa Sentral Baru, Desa Lubuk Saung and Desa Taba Padang. However, data estimating the conditions of land holding by local people in protection forests (Attached Appendix I-8) suggests that a large number of local people settle in protection forests. The number of settlers in Desa Tebat Pulau has

been increasing since 1994. Access to Desa Ruo Bali and Desa Ujan Mas Atas has become easier because of dam construction work and some people appear to have moved to these villages from nearby villages. The third field survey found three villages where the villagers themselves have settled in protection forests to cultivate coffee. Many of the interviewees responded that they harvest coffee and durian in protection forests which were planted earlier. Construction timber and non-timber products (bamboo and rattan) are collected in protection forests near Desa Tebat Tenong Dalam and Desa Air Lanang and firewood is collected near the forest boundary in Desa Tebat Monok. Ambiguous forest boundaries and the shortage of land may lie behind these activities.

② Collection of Firewood and Construction Timber

Most villages use firewood as domestic fuel. Almost all firewood is self-collected at coffee fields and is collected in forests in some villages. Few households buy firewood (Attached Appendix D-7).

The supply is adequate in most villages and surplus firewood is sold at 40,000 – 50,000 Rp per 6 sm (1 sm = 0.72 $m^3$), providing extra income. In some villages, however, such as Desa Air Mundu and Desa Kampung Sajad, the amount of firewood which can be locally obtained has recently declined and sometimes has to be bought. The firewood mainly comes from coffee trees and such shade trees as dadap, kayu res, lamtoro, johar, sengon and bamboo (Bambu tali) are also used. Pruned coffee branches and old coffee trees felled for replanting at coffee fields are also used as firewood. These can be easily collected at coffee fields and a large amount of firewood is produced every year. Coffee trees are preferred because of their easy carbonization and little smoke when burned.

Firewood is collected during or after farming work by women every day and is carried to their homes for storage under the floor. The long distance from farmland to their homes and the hilly topography make the collection and transportation of firewood difficult and increases the burden on women.

As shown in Attached Appendix D-7, meranti, cempaka and medan are mainly used to produce construction timber. While construction timber can be bought in most villages, some is collected in forests in the case of three villages. As the number of households increases in a village, the amount of housing construction work also increases, creating an ever increasing demand for construction timber.

③ Inheritance and Division of Land

a. Customary Land Use and Ownership Rights

The Rejang people conduct the clear cutting of stands (*menyusuk*) based on the adat (*imbo*), construct huts and develop farmland. A developer has temporary land use rights in the period from clear cutting to harvest. When the land is occupied or permanently cultivated as a homestead, rice fields or coffee fields, the question of land ownership arises. The ownership of land and trees may sometimes be separately recognised. Abandoned unirrigated land (ladang) is returned to communal management but those who planted trees on such land retain ownership of the trees.

b. Change of Ownership

Adat also approves a change of land ownership by lease, sale/purchase and inheritance. In the case of a lease, the share of the harvest between tenant and landlord is 1:2 or 1:3 depending on whether the farming expenses are entirely met by the tenant or landlord. While leasing and sale/purchase are mainly conducted among the same ethnic group, sale/purchase have recently become open to all Indonesian nationals. If crops fetching a good market price are grown, the land in question is highly valued.

While adat is still practiced, its control has weakened. Following the population increase, communal bonds have weakened and individual claims for land rights have increased. However, most people do not possess a land ownership certificate. Recognition of land ownership based on adat is made by means of a taxation form and letter of land certification issued by a village head (*SKT: Surat Keterangan Tanah*).

c. Problems Related to Land Ownership

In accordance with the increase of population, the size of individual land ownership has gradually become smaller. In particular, inheritance reduces the size of land-holding. As the average area of land owned per household decreases, the land cannot be divided among all children and is only given to those wishing to manage it. Children who are not provided with land receive compensation in the form of money to build their own lives.

d. Gender

The levels of access to and control of reproductive activities and food by women are high in many villagers. Here, "access" means the use of things while "control" means the ownership, use and change of things. Reproductive activities consist of the collection of firewood and water, cooking, washing, childcare and other housework. The productive activities (agricultural work) of women include weeding, pruning, harvesting and processing and women work jointly with men. Their work is, however, regarded as being complementary to that of men. Men are entrusted with marketing.

Women's access to capital, including land, household goods and agricultural tools, and income is relatively equal to that of men but men tend to have control. Men use various types of agricultural equipment compared to women because the design of such equipment assumes their use by men.

In general, men and women have equal access to education and training but men are superior in terms of control. The opinion is expressed in Desa Suro Bali that the high illiteracy rate among women and the few opportunities to participate in village activities leads to a lack of information and knowledge and limited access to and control of capital. In regard to the decision-making process, although men and women appear to discuss issues on equal terms in all ethnic groups, decisions are made by the husband or father as the head of the family. The necessity for women to be educated and to learn various skills should, therefore, be understood by both men and women.

From the geographical viewpoint, both men and women have equal rights of access and control in villages near Curup and Kepahiang. In remote villages, access is shared by men and women although the control is likely to rest with men.

5) Existing Local Organizations

① Types, Activities and Relationship

The interviewees were given a list of the main formal and informal organizations in villages and were asked to evaluate whether they were active or not, whether the villagers received beneficial services or not and whether their activities were important to the interviewees or not. Religious organizations as informal

organizations were found to be important and active in most villages. In general, farmers' groups, PKK, Pem Des, LKMD and LMD, etc. as formal organizations are not very active, possibly because of the poor relationship between the village head and villagers, the failure of formal organizations to reflect the wishes of villagers and the lack of cooperation between group members. Other causes include the ambiguous use of activity funds and failure to coordinate the interests of members.

There are some villages where the LKMD and PKK are functioning well. Comparison between villages with good activities and villages without such activities reveals certain positive characteristics of the former. For example, the village head exerts strong leadership and the villagers and members of the LKMD share a strong desire to improve their own village and frequently consult with each other. In addition, group activities and the use of funds are open and transparent to the villagers and *gotong royong* functions well. Despite wide recognition of the importance of the PPL and PLP, these hardly function in many villages.

② Participation of Local People

The level of participation by local people in formal organizations is generally low. Whether or not local people participate in the activities of such organizations depends on the existence of direct benefits from participation or the direct bearing of these activities on the economic, cultural and religious needs of local people. For example, the level of participation in the wild boar hunting group is high in Desa Kandang, Desa Tebat Tenong Dalam, Desa Air Lanang and Desa Suro Bali. This is due to the fact that agricultural crops are greatly damaged by wild boar and the hunting of wild boar by local people is essential. Meanwhile, the reasons why local people do not participate in formal organizations are that "there is not enough time as they have to concentrate on farming work and housework" or "there is no direct benefit from the activities of such organizations". It may also be the case that local people either do not know of the existence of such organizations or do not recognise the benefits.

6) Needs for Living Improvement of Villagers

The needs (problems) for the improvement of local life identified and analysed by the second field survey on 10 villages are summarised below (see Attached Appendix D-9).

① Local Characteristics

The level of local income is significantly affected by global price fluctuations of coffee and the size and quality of the harvest. Monoculture results in hardship over a long period, insufficient employment opportunities for women after the harvesting season and widespread unemployment among the younger generations. In regard to national forests, concern is expressed in regard to the lingering shortage of timber following the establishment of new national protection forest boundaries and the existence of settlers other than local villagers.

② Farming

The biggest problem faced by villagers in all villages is the lack of farmland caused by a decrease of village land following the introduction of new national forest boundaries. The second biggest problem is damage to coffee seedlings and young coffee trees by harmful creatures, such as wild boar, field mice, monkeys and ants, etc. The number of wild boar is increasing and an informal hunting group actively operates in many villages. In addition, many coffee trees suffer or even die from rotten roots caused by fungi. The frequent theft of crops also necessitates the watching of crops, increasing the labour burden of villagers.

③ Infrastructure

Many farming households buy rice due to the limited availability of land for paddy fields because of topographical reasons and because the shortage of irrigation facilities prevents increased rice production. The difficulty of fetching potable water increases the work burden of women.

The findings on the additional 20 villages surveyed in the third field survey were analysed in terms of infrastructure, agriculture and others based on the above results (Attached Appendix D-10). In terms of infrastructure, the introduction of a domestic water supply system is strongly hoped for by villagers. In terms of agriculture, the necessity for technology and agricultural inputs (agrochemicals and fertilisers) for improved productivity, stabilisation of product prices and market establishment are stressed. The assistance of KUDs and agricultural extension workers is required to improve local agriculture. Attached Appendix D-11 shows the main preferences of the 30 villages analysed.

In regard to the agricultural sector, there are 16 villages which require the supply of agricultural inputs and product sale by the KUD. Other priority issues include the need for agrochemicals, fertilisers and technology for a productivity increase.

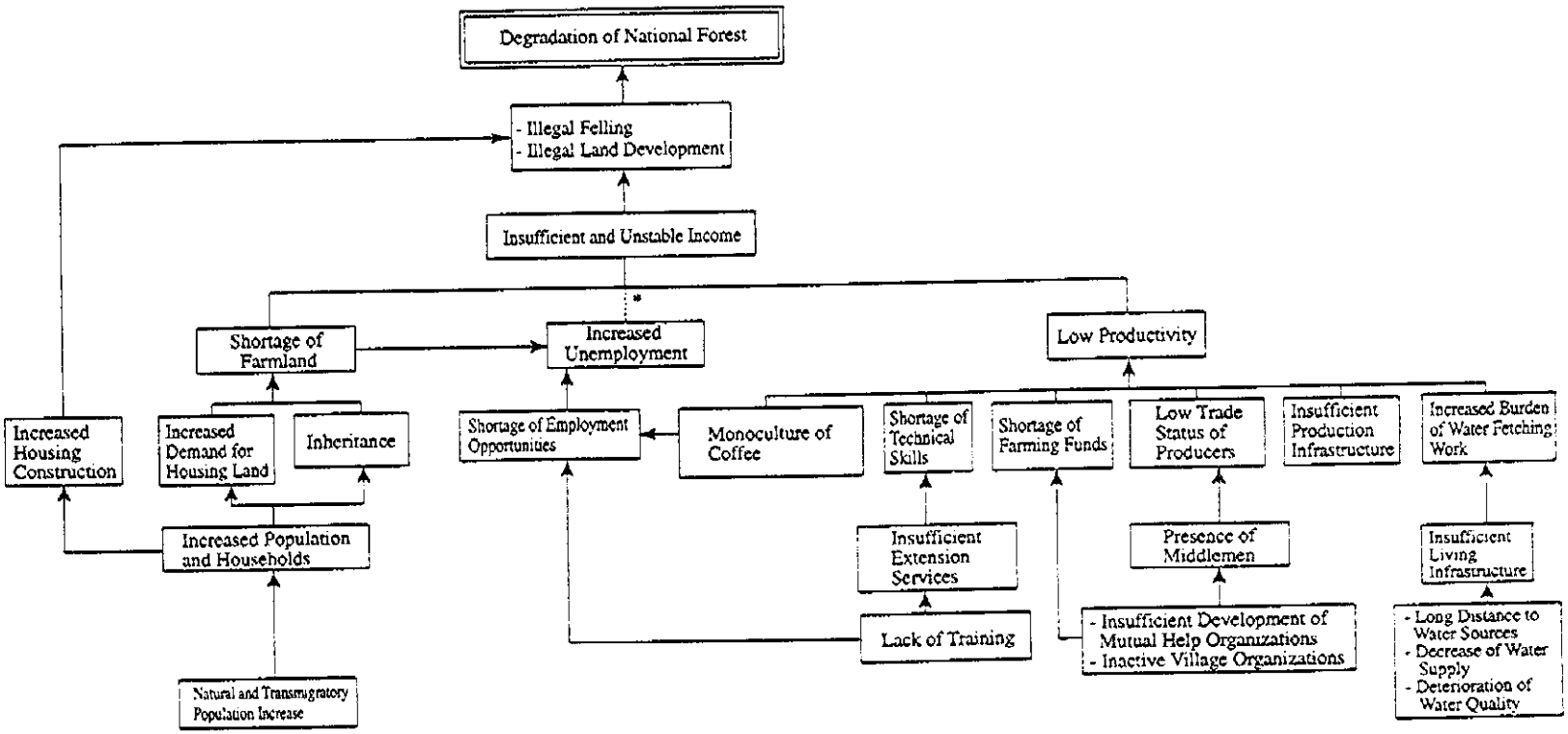
Unemployment appears to be another major problem, particularly the difficulty for young people to find jobs.

(4) Analysis of Survey Results

In order to examine the planning and implementation processes of social forestry, the survey results described in (3) are analysed from the following viewpoints.

1) Analysis of Causal Factors of Problems

Considering the survey results of the need of local people to improve their lives and the need to increase the standard of living of local people as one of the objectives of social forestry, it is clear that the biggest problem in the Project Area is the low and unstable income. The background of this poor income can be examined in terms of three factors, i.e. ① farmland shortage, ② low productivity and ③ increase of unemployment. The relationship between these factors is outlined in Fig. 4-4.




Note) *: Although neither the second field survey nor the third field survey confirmed the direct causal relationship between increased unemployment and forest destruction, it appears reasonable to assume a degree of causal relationship between the two.

Fig. 4-4 Relationship Between Causal Factors of Local Problems

① Shortage of Farmland

The shortage of farmland has resulted in insufficient agricultural production and is a serious problem in most villages. One manifestation of this problem is the purchase of rice and other staple foods for local consumption. The main cause is the decline of land per household due to the increased demand for housing plots and the progressive division of land through inheritance. The natural increase of the population/households has been fuelled by an increased number of settlers from outside.

② Low Agricultural Productivity

As the Project Area depends on agriculture as a major source of income, the level and stability of income are largely influenced by the agricultural productivity. Six direct reasons for low and unbalanced productivity are listed below.

a. Monoculture of Coffee

In the case of agriculture based on the monoculture of coffee, the income source is limited and farmers can only obtain cash income once a year. In addition, the annual fluctuation of the yield and market price of coffee makes income unstable. The background of the dependence of local farmers on coffee is described earlier.

b. Insufficient Technical Expertise

Insufficient technical expertise leads to the outbreak of diseases and pests, misuse of agrochemials and fertilisers, inappropriate management and out-of-date farming practices, etc., damaging factors that can directly improve productivity. The background for this is insufficient technical guidance by extension workers and insufficient opportunities for training by farmers to learn the necessary skills.

c. Insufficient Farming Funds

Farmers without enough capital cannot access and control the necessary agricultural inputs. As an appropriate fund supply system has not been developed and middlemen enjoy strong influence, farmers who borrow from middlemen may increase their debt.

d. Farmers' Low Trading Status in the Market

Under the coffee marketing system, large and small middlemen play a major role. While they can be beneficial to farmers, they also deprive farmers of the opportunity to access large markets in cities. They often manipulate the purchase price below the market price. This is partly because farmers' groups, such as the KUD and *Kelompok Tani*, have not been fully developed.

Farmers who conduct all work from planting to shipping and the sale of their products themselves can only sell a small amount of products each time and also find it difficult to buy expensive agricultural equipment, etc.

e. Insufficient Infrastructure for Production

As village roads, coffee collection, selection and drying facilities and irrigation facilities have not been developed or are inadequate, the efficiency of the collection and processing of coffee is low. Moreover, it is also difficult to increase the coffee productivity.

f. Low Level of Access to Domestic Water Supply Sources

The daily work of water fetching by women increases their workload and decreases the time for such productive activities as farming and waged labour. As the water quality deteriorates, the time required for access to clean water suitable for domestic use increases.

③ Increase of Unemployment

As local employment opportunities are limited for young people after leaving secondary or high school, many of them are unemployed or only help their parents with farming. In general, local people in the Project Area (Rejang people) do not like to go far from their own village to work. Accordingly, they obtain temporary income as agricultural waged labourers or construction workers in their own village or in nearby villages. The resulting income is, however, unstable and inadequate.

It can be concluded that the factors identified by the analysis in this Study cause insufficient and unstable income, promoting illegal tree cutting and forest clearance for farmland, in turn causing forest destruction.

2) Identification of Social Groups

There are many social groups in the Project Area. It is important to identify the target people and people to be affected among them. The following four criteria are feasible for this purpose, namely, land ownership, usage of land and forest resources, economic base and jobs, access to and control of social services. Based on these, six social groups are identified and the characteristics of each group, development level (resource ownership, access to services and income, etc.), needs level, level of feasibility of cooperation (organization and unification) and capacity level of acceptance (education and technology) are examined (see Table 4-9).

In implementing social forestry, these social groups should be carefully examined and the participants should be grouped in the most effective way.

3) Factors Necessary for Implementation of Social Forestry

Table 4-10 shows the factors necessary for local people for the implementation of social forestry and items related to such factors.

Table 4-9 Social Groups Related to Social Forestry

| Group | | | Development Level | Living Improvement Needs Level | Organizing Capacity Level | Acceptance Capacity Level | Remarks |
|---|---|---|---|---|---|---|---|
| Land Owner | Large size of land, enough to be self-supported | Heavy dependence on coffee (limitation of income sources) | High | High | Middle | Middle | Each group can be divided into men and women. |
| | | Mix-cropping (long farming season) | High | High | Middle | Middle | Land owned farbers can be divided into two types of farmers who want to expand land or not. |
| | Small size of land, not enough to be self-supported | Waged Labor | Middle | High | Low | Low | Waged labors can be categorized into those who are heavy dependent on waged labor (size-work farmers) or not. |
| Landless | | | Low | High | Low | Low | |
| | Tenants | | Low | Low | Low | Low | |
| | Illegal encroachers in the forests | | Low | Low | Low | Low | |

Note: This is prepared for estimation of beneficiary and unbenefited groups on Social Analysis.

Table 4-10 Factors and Their Evaluation for Implementation of Social Forestry

| Elements necessary for Social Forestry | Factors | Possible Conditions for Implementation |
|---|---|---|
| 1. Participation Will of Local People | a. Length of busy farming season | Short |
| | b. Length of Paceklic | Short |
| | c. Women's workload | Small |
| | d. Economic level | Low |
| | e. Interaction with forests | Strong |
| 2. Sustainability | a. Economic level | Low |
| | b. Access to markets | Good |
| | c. Employment opportunities of agricultural wageworkers | Small |
| | d. Women's access/control to resources | Good |
| | e. Level of technology and education | High |
| 3. Autonomy of Local People | a. Activity of formal organizations | Active |
| | b. Existence of leaders to be reliable | Exist |
| | c. Inhabitants' participation to extension services | Active |
| 4. Organizing Capacity of Local People | a. Activity of formal/informal organizations | Active |
| | b. Existence of mutual help among villagers | Strong |
| | c. Influence of adat | Strong |

## 4.5 Workshop

In order to stimulate the participation of local people in the Social Forestry Project at the planning stage and to reflect their opinions on the Project (see 4.4), a workshop with local people's participation [Workshop on Social Forestry Development in the Management Area of Upper Musi Watershed] was held.

(1) Basic Issues

1) Purpose

The policy on social forestry and the contents of the Interim Report, including the findings of the second field survey, were explained. In addition, opinions were exchanged among the participants and the ideas of local people regarding the Social Forestry Project for the Project Area were clarified.

2) Policy of Workshop Management

As the Study is a feasibility study conducted with the cooperation of two countries based on the S/W, the workshop was prepared based on the workshop management

policy issued by the Directorate of Planning and Programming, Directorate of Reforestation and Land Rehabilitation, Ministry of Forestry[1] while taking the following points into consideration.

① The JICA Study Team should reflect local people's opinions on the Social Forestry Project within the framework of the present rules, regulations and policies enforced in Indonesia.

② Within the limited period of preparation and the duration of the workshop itself, the workshop should be organized and run so that participating people can exchange opinions, actively focusing on themes related to social forestry.

(2) Participants

1) Target Villages

Thirty villages which were judged to have very close relationship with protection forests in the Project Area were selected from among the villages located in the Management Area of the Upper Musi Watershed based on the following criteria (the names of the villages are given in 4.4).

① Villages through which the boundaries of the "protection forest of Bt. Daun" in the Project Area run.

② Villages where the central dwelling site of the village is located within 3 - 5 km of the said protection forest boundaries.

2) Representatives of Local People

Two representatives, i.e. the village head and one from the leading group of farmers, were selected for each village with the assistance of the through Assistant Bupati of Kab. Rejang Lebong and the Camat (district head) of Kec. Curup and Kepahiang.[2]

(3) Method of Workshop Management

The workshop was held for two days using the management method based on the experience and customs of the Ministry of Forestry, relevant local government agencies and NGOs[3] which were the sub-contractors of the socioeconomic and cultural conditions

[1] Document of Head of Technical Cooperation Division,745/v/BP-3/1997
[2] Document of Assistant Bupati, 5224/330/Bag.4
[3] Bina Swadaya: Located in Jawa, WARSI: Located in Bengkulu and Jambi Provinces

survey (see Table 4-11). The Directorate of Planning and Programming, Directorate General of Reforestation and Land Rehabilitation, Ministry of Forestry and Kanwil Kehutanan of Bengkulu Province planned and prepared the workshop. Local government agencies were in charge of inviting participants and holding the workshop. In advance of the workshop, a pre-workshop at the provincial level was held in order to uniformatise understanding of the social forestry policies among the members of the management side (BAPPEDA of Propinsi Bengkulu, June 24, 1997).

Table 4-11 Outline of Workshop on Social Forestry Development in the Management Area of Upper Musi Watershed

| Date | Program | Moderator |
|---|---|---|
| July 8, 1997 (The First Day) | - Explanation of social forestry policies and summary of the Interim Report<br>- Questions and answers | - Agencies related to forestry in Propinsi Bengkulu<br>- NGO (Bina Swadaya) |
| July 9, 1997 (The Second Day) | - Group discussion of the participants<br>- Presentation of the results of group discussion and joint discussion<br>- Summary of the discussion results by NGOs | - NGO (WARSI) |

Note: 1) Outline of the program is referred to Attached Appendix D-12
2) Venue: Training Centre of Ministry of Education and Culture (*Sanggar Kegiatan Belajar*, Desa Suro Mucar in Kec. Kepahiang)
3) Themes of Group Discussion: Group I-"Deforestation", Group II-"Trees Species Suitable for Sosial Forestry", Group III-"Organization".

(4) Feedback to Social Forestry Project

The opinions of local people and the replies of relevant agencies to the questions of the participants during the workshop were fully analyzed and examined to decide how to reflect them on the Project during the socioeconomic and cultural conditions survey and the survey to formulate the Social Forestry Project (see Attached Appendix D-13). Moreover, opinions that are difficult to consider at the planning stage, such as opinions reflecting special local conditions and the feelings of some local people, will be considered at the preparation stage of implementation in relation to environmental control and monitoring measures, etc.

# CHAPTER 5.

# FORESTRY

# CHAPTER 5. FORESTRY

## 5.1 Forest Survey

The forest survey was conducted to identify the state of forests in the Project Area.

(1) Survey Method

Forests in the Project Area were classified into the categories of natural forest I (crown density of 71% or more), natural forest II (crown density of 31 – 70%), natural forest III (crown density of not more than 30%), secondary forest and shrub land. The actual survey was then conducted in the following manner at survey plots considered to represent the standard features of each category based on the aerial photograph interpretation results.

– Plot size : 0.1 ha

– Plot shape : rectangular (20 m × 50 m)

– Survey items : species, DBH (those with a DBH of at least 6 cm), height

(2) Number of Survey Plots

A total of 18 plots were surveyed in the Project Area as shown in Table 5-1.

Table 5-1 Number of Plots by Forest Category

| Forest Category | Number of Plots |
|---|---|
| Natural Forest I | 3 |
| Natural Forest II | 4 |
| Natural Forest III | 3 |
| Secondary Forest | 5 |
| Shrub Land | 3 |
| Total | 18 |

(3) Survey Results

The results of the forest survey conducted in the Project Area are described below.

1) Species Observed

① Natural Forests

For the forest survey in question, the survey team was assisted by the members of the Faculty of Agriculture of Bengkulu University to identify the scientific names of the trees observed. Given the slow progress in the field of tree identification in the Study Area, however, the scientific names of only 46 species out of the 132 species observed in natural forests I, II and III were identified. For 85 species, only the local name was established (neither the scientific nor local name was established for the remaining one species).

Of those species of which the scientific names were identified (258 individual trees in total), those with a relatively large number are Ihis (*Eunonymus javanica*) (37 trees), Medang (*Litsea* sp.) (36 trees), Gelam (*Eugenia* sp.) (33 trees) and Kandis (*Garcinia* sp (16 trees).

In the case of those species (222 individual trees in total) with only the local name, those with a relatively large number are Atoe (21 trees), Kodok (20 trees), Sobut (10 trees) and Ongoi (10 trees). Further details of the trees observed during the forest survey can be found in Attached Appendix E-1.

② Secondary Forests

Sixty species were observed in secondary forests, of which 28 were given scientific names and 32 species were given only local names. Of those species of which the scientific names were identified (165 individual trees in total), those with a relatively large number are Semantung (*Ficus toxicaria*) (65 trees), Medang (*Litsea* sp.) (21 trees), Melung (*Macaranga* sp.) (7 trees) and Sapat (*Macaranga diopenthorstii*) (7 trees). Further details can be found in Attached Appendix E-2.

③ Shrub Land

Twenty-one species were observed in shrub land, of which 13 were given scientific names. Of those species of which the scientific names were identified (77 individual trees in total), those with a relatively large number are Melung (*Macaranga* sp.) (41 trees), Johar (*Cassia siamea*) (8 trees) and Semantung (*Ficus toxicaria*) (7 trees). Further details can be found in Attached Appendix E-3.

2) Volume Totalisation for Sample Plots

Because of the absence of a volume table for local species, the single tree volume at the sample plots was estimated using the following formula.

$$V = 0.4d^2h \times \left(\frac{\pi}{4}\right)$$

Where,

d : DBH (m)

h : total tree height (m)

The totalisation results, assuming a standard land area of 0.1 ha, are 42.368 $m^3$ for an average of 55 trees in natural forest I, 20.775 $m^3$ for an average of 54 trees in natural forest II and 8.381 $m^3$ for an average of 33 trees in natural forest III. Secondary forests have an average of 56 trees with a volume of 8.159 $m^3$ while shrub land has an average of 29 trees with a volume of 2.163 $m^3$ (see Attached Appendix E-4-(1) for further details).

3) Stand Structure

The survey data for natural forest, secondary forest and shrub land are compiled below to show the stand structure of each forest category.

① Natural Forests

a. DBH

The DBH distribution of the surveyed trees (see Table 5-2) shows that large diameter trees with a DBH of 42 cm or more account for 10.8% of the total with 52 trees out of 481 trees, medium diameter trees with a DBH of 22 – 40 cm account for 22.0% with 106 trees and small diameter trees with a DBH of upto 20 cm account for 67.2% with 323 trees, indicating the overall picture of the growing stage of the stands.

Table 5-2 Number of Trees by DBH Class (Natural Forest)

| DBH Class | Number of Trees | Ratio (%) |
|---|---|---|
| 10 cm or less | 169 | 35.1 |
| 12 - 20 | 154 | 32.1 |
| 22 - 30 | 72 | 15.0 |
| 32 - 40 | 34 | 7.0 |
| 42 - 50 | 33 | 7.0 |
| 52 - 60 | 11 | 2.3 |
| 60 or more | 8 | 1.5 |
| Total | 481 | 100.0 |

b. Tree Height

The tree height distribution (see Table 5-3) shows that upper story trees (31 m or more) account for 7.6% with 37 trees while middle story trees (11 – 30 m) account for 59.1% with 284 trees. Lower story trees account for 33.3 % with 160 trees.

Table 5-3 Number of Trees by Tree Height Class (Natural Forests)

| Tree Height Class | Number of Trees | Ratio (%) | Remarks |
|---|---|---|---|
| 10 m or less | 160 | 33.3 | Lower story trees |
| 11 - 20 | 222 | 46.2 | Middle story trees |
| 21 - 30 | 62 | 12.9 | 〃 |
| 31 - 40 | 27 | 5.6 | Upper story trees |
| 40 or more | 10 | 2.0 | 〃 |
| Total | 481 | 100.0 | |

② Secondary Forests

a. DBH

The DBH distribution (see Table 5-4) shows that large diameter trees with a DBH of 42 cm or more account for a mere 1.1% with 3 trees and medium diameter trees account for 15% with 42 trees. The characteristic of local secondary forests is well illustrated by the overwhelming ratio of 83.9% of small diameter trees (DBH of 20 cm or less).

Table 5-4 Number of Trees by DBH Class (Secondary Forests)

| DBH Class | Number of Trees | Ratio (%) |
|---|---|---|
| 10 cm or less | 137 | 48.9 |
| 12 - 20 | 98 | 35.0 |
| 22 - 30 | 34 | 12.1 |
| 32 - 40 | 8 | 2.9 |
| 42 - 50 | 1 | 0.4 |
| 52 - 60 | 2 | 0.7 |
| Total | 280 | 100.0 |

b. Tree Height

The tree height distribution (see Table 5-5) shows a predominance of trees upto 15 m in height of 88.6% (248 trees) while trees with a height of 16 m or more account for 11.4% (32 trees).

Table 5-5 Number of Trees by Tree Height Class (Secondary Forests)

| Tree Height Class | Number of Trees | Ratio (%) |
|---|---|---|
| 5 m or less | 3 | 1.1 |
| 6 - 10 | 137 | 48.9 |
| 11 - 15 | 108 | 38.6 |
| 16 - 20 | 20 | 7.1 |
| 21 - 25 | 9 | 3.2 |
| 26 or more | 3 | 1.1 |
| Total | 280 | 100.0 |

③ Shrub Land

a. DBH

The DBH distribution (see Table 5-6) shows a predominance of small diameter trees of upto 20 cm with 92% (80 trees), illustrating the characteristic of shrub land.

Table 5-6 Number of Trees by DBH Class (Shrub Land)

| DBH Class | Number of Trees | Ratio (%) |
|---|---|---|
| 10 cm or less | 50 | 57.5 |
| 12 - 20 | 30 | 34.5 |
| 22 - 30 | 6 | 6.9 |
| 32 - 40 | 0 | 0.0 |
| 42 - 50 | 1 | 1.1 |
| Total | 87 | 100.0 |

b. Tree Height

The tree height distribution (see Table 5-7) shows a predominance of trees upto 15 m in height of 94.3% (82 trees).

Table 5-7 Number of Trees by Tree Height Class (Shrub Land)

| Tree Height Class | Number of Trees | Ratio (%) |
|---|---|---|
| 5 m or less | 12 | 13.8 |
| 6 - 10 | 44 | 50.6 |
| 11 - 15 | 26 | 29.9 |
| 16 - 20 | 4 | 4.6 |
| 21 or more | 1 | 1.1 |
| Total | 87 | 100.0 |

## 5.2 Afforestation Survey

A man-made forest survey was conducted to establish the current state of man-made forests. The survey featured three species; i.e. *Acacia mangium*, *Pinus merkusii* and *Swietenia macrophylla* (Mahoni). The survey method was similar to that employed for the national forest survey and three sample plots were established for each species. The list of the sample plots is given in Attached Appendix E-4-(2).

(1) *Acacia mangium*

1) Average number of surviving trees : 290 trees/ha
   Survival ratio : 26.1%
   (original planting density: 1,110 trees/ha)
2) Average stand volume : 172 $m^3$/ha

3) Tree age : 9 years old
4) Planting season : September - November
5) Origin of seeds : East Java

(2) *Pinus merkusii*

1) Average number of surviving trees : 800 trees/ha
Survival ratio : 47.9%
(original planting density: 1,670 trees/ha)
2) Average stand volume : 109 $m^3$/ha
3) Tree age : 8 years old
4) Planting season : September - November
5) Origin of seeds : unknown

(3) *Swietenia macrophylla* (Mahoni)

1) Average number of surviving trees : 380 trees/ha
Survival ratio : 34.2% (original planting density: 1,110 trees/ha)
2) Average stand volume : 394 $m^3$/ha
3) Estimated tree age : 45 years old
4) Planting season : unknown
5) Origin of seeds : unknown

## 5.3 Social Forestry Survey

(1) Agroforestry Survey

An agroforestry survey was conducted to identify the cultivation techniques, etc. of local products which could be incorporated in the Social Forestry Project for the Project Area.

1) Coffee (Kopi: *Coffea* spp., *Rubiaceae*)

① Coffee Cultivation Techniques in the Project Area

a. Coffee Varieties

Two varieties of coffee, i.e. *Coffea robusta* and *Coffea arabica*, are grown in the Project Area. The former is by far the predominant variety and cultivation of the latter is carried out by private companies such as Dinas Perkebunan (Estate Bureau), etc. Comparison of *Coffea robusta* and *Coffea*

*arabica* shows a similar unit yield although the latter has a longer harvesting season. *Coffea arabica* also seems to fetch a higher price but has a marketability problem due to the lack of local market except for the estate operation.

While the propagation of coffee trees generally relies on natural seedlings, a private company tries to graft *Coffea arabica* to *Coffea robusta* of at least three years of age.

The coffee harvest lasts for more than 20 years, commencing in the third year after planting. The harvesting season is April through July for *Coffea robusta* (mainly April and May in Kec. Kepahiang and June and July in Kec. Curup). The annual unit yield is said to be 0.5 - 2 tons/ha in terms of the raw bean weight. The harvesting season for *Coffea arabica* is May and June at the Dinas Perkebunan.

b. Planting Method

The coffee trees are generally planted in either September or October but can be planted all year round if necessary. The planting distance is 1.5 – 2 m by 1.5 – 2 m for coffee trees and 4 – 15 m by 5 – 15 m for shade trees which are usually grown from cuttings. As coffee trees and shade trees are often planted simultaneously in the Project Area, there tends to be insufficient shading at the early stage of coffee tree growth due to the low height of shade trees. Supplementary planting is also conducted to replace trees with poor growth and trees of which the yield has declined. The intercropping of dry crops field rice, maize, chili, ginger, sweet potatoes and pulses is conducted in the first couple of years after coffee tree planting.

*Coffea arabica* is planted in the Project Area in the following manner. A private company grows *Coffea arabica* on some 290 ha of land in Desa Sentral Baru (El. 970 m). The trees are planted in November through January with a planting distance of 2 m by 2.5 m for coffee trees and 6 m by 4 m for shade trees (Kayures and Albizia). The coffee trees are currently 2 – 4 years old and are beginning to produce a yield.

The Dinas Perkebunan has a 0.5 ha coffee estate growing *Coffea arabica* in Desa Pal Delapan. The trees are planted in January with a planting distance of 2 m by 2.5 m for coffee trees and 4 m by 5 m for shade trees (Kayu res). The existing trees are 11 years old.

c. Shade Tree Species

The main tree species used as shade trees for coffee in the Project Area are listed in Table 5-8 and mainly belong to pulses (Leguminosae).

The most popular species is Kayu res (*Gliricidia maculata*). The popularity of shade tree species varies from one desa to another. For example, Dadap (*Erythrina fusca*) accounts for some 70 % in Desa Air Selimang with Kayu res accounting for the remaining 30%. Insect damage to the stems of Dadap is observed.

The findings of the survey on the conditions of trees planted together with coffee trees on the coffee fields in the Project Area are compiled in Attached Appendix E-5.

Table 5-8 Main Shade Trees for Coffee

| Local Name | Scientific Name | Remarks |
|---|---|---|
| Kayu res | *Gliricidia maculata* | Small crown; easy to grow from cuttings |
| Dadap | *Erythrina fusca* | Suitable for high altitudes; high humidity leading to disease |
| Lamtoro | *Leucaena glauca* | Fast growing |
| Albizia | *Albizia falcataria* | Fast growing to become huge trees |
| Johar | *Cassia siamea* | Slow growing |
| Kaliandra | *Caliandra calothyrsus* | Slow growing; rare |
| Cengkering | *Erythrina* sp. | – |

d. Management of Shade Trees

The management of shade trees involves pruning and regeneration by sprouting. In some cases, farmers appear to have let large shade trees die by barking around the base. The pruned branches and accompanying leaves are used as animal fodder, green manure, firewood, etc.

e. Forming of Coffee Trees

As far as the forming of coffee trees in the Project Area is concerned, application of the regular single or multiple stem systems as described in ②-e. is quite limited. Almost all local coffee trees are formed by the traditional system. In some cases, regeneration by sprouting is used to replace those trees of which the yield has declined around the eighth year after planting. In

other cases, regeneration by sprouting is used every four years or so. In either case, the trees are formed into a natural shape. Sprouting is encouraged by over-turning the stem without cutting it at a height of some 30 cm above the ground but harvesting continues for a year until sprouting takes place. After regeneration, the over-turned trees are cut to mainly produce firewood.

In the case of *Coffea arabica* grown by the Dinas Perkebunan, the single stem system is adopted with annual topping being conducted at a height of 1.5 m above the ground.

f. Fertiliser Application

Various types of chemical fertilisers are used to assist coffee cultivation in the Project Area, including urea (N = 46%), phosphate (SP-36: $P_2O_5$ = 36%), potassium chloride (KCℓ : $K_2O$ = 60%), composite fertiliser (NPK: N = 15%; $P_2O_5$ = 15%; $K_2O$ = 15%) and ammonium sulphate (ZA: N = 21%; sulphur = 24%). There are many coffee fields in the Project Area where neither chemical (fertilisers) nor organic fertilisers is used for cultivation.

g. Weeding

Weeding is conducted two or three times a year at coffee fields with the aid of farming tools and/or herbicides. There is an increasing trend of the use of herbicides. The types of herbicides used for coffee cultivation in the Project Area are listed in Table 5-9.

h. Pest and Disease Control

The main diseases and harmful insects associated with coffee trees in the Project Area are listed in Table 5-10. The main diseases are Penyakit cendawan akar coklat (caused by *Phellinus lamaensis*) and Penyakit karat daun (caused by *Hemileia vastatrix*). The main harmful insects are Bubuk buah (*Stephanoderes hampei*) and Pengerek batang (*Zeuzera* sp.). The agrochemicals used for coffee cultivation in the Project Area are listed in Table 5-9.

Table 5-9 Agrochemicals Used for Coffee Cultivation

| Type | Product Name | Ingredients | Remarks |
|---|---|---|---|
| Germicide | Dithane M-45 | Mankozeb 80%<br>(Karbamat 62%) | for *Hemileia vastatrix* |
| | Antrachol | Propineb 70.5% | – |
| Insecticide | Diazinon 60EC | Diazinon 600 g/litre | for *Stephanoderes hampei* |
| | Tiodan 35ec | Endosulfan 352 g/litre | penetrant |
| | Azodrin | Monokrotofos 150/litre | – |
| Nematocide | Curaterr 3G | Karbofuran 3% | for *Agromyza phasedi* |
| Herbicide | Gramoxone | Parakuat diklorida 276 g/litre | for monocotyledon |
| | Polaris | Iso propilamina glafosat 240 g/litre | for both monoctyledon and dicotyledon |
| | Spark | Iso propilamina glafosat 160 g/litre | as above |

Note: The table is compiled based on the findings of the interview survey in the Project Area.

Table 5-10 Main Diseases and Harmful Insects Adversely Affecting Coffee Cultivation

| Type | | Symptoms | Prevention |
|---|---|---|---|
| Disease | Penyakit cendawan akar coklat (*Phellinus Lamaensis* )<br>Polyporaceae | Tends to occur from September to November when the humidity is high. Invades the tree from the roots. White spots on the stem and yellowing of the leaves. Often seen in Sumatera (Aceh) with rubber trees. | Burning of the entire plant including the roots, and disinfection of the soil with sulphur. (Refrain from new planting for 1 - 2 years). Spraying of a germicide. |
| | Penyakit karat daun (*Hemileia vastratrix* )<br>Pucciniaceae | Round, light yellowish spots on the leaves which eventually become completely yellow. Rarely occurs but observed throughout Indonesia. | Burning and the spraying of a germicide. |
| Harmful Insect | Bubuk buah (*Stephanoderes hampei* )<br>Scolytidae | Small beetle which eats the fruit from the inside. Significantly reduces the yield and quality. Observed throughout Indonesia. | Spraying of an insecticide. |
| | Pengerek batang (*Zeuzera coffee* ) | Invades the core of a young branch and eats the branch. Observed in Sumatera. | Spraying of an insecticide. |

Source: Dinas Perkebunan, Curup dan Kepahiang

② Coffee Cultivation Techniques at a Research Organization

The findings of the survey on the coffee cultivation techniques at the Indonesian Coffee and Cocoa Research Institute (Pusat Penelitian Kopi dan Kakao, Jember) are described below. These findings are believed to be useful to improve the quality of coffee fields in the Project Area.

a. Coffee Varieties

It is generally believed that *Coffea robusta* is suitable upto El. 800 m while *Coffea arabica* is suitable for above El. 800 m.

The use of cutting or grafting is said to be better than natural seedlings for the propagation of coffee trees. The stock used for grafting is *Coffea excelsa* which is resistant to nematodes.

The harvesting of coffee commences in the third year after planting and the peak yield generally lasts from the tenth to the twentieth year. The harvest comes to an end around the twenty-fifth year. The yield of *Coffea arabica* at the peak yield period is said to be 1.5 tons/ha for raw beans.

b. Planting Method

The appropriate planting distances for coffee trees are roughly 2 m by 2 m for *Coffea arabica* and 2.5 m by 2.5 m for *Coffea robusta*. The recommended planting distance for shade trees is 3 – 6 m by 3 – 6 m (5 m by 5 m). It is recommended to plant shade trees a year earlier than to plant coffee trees.

Pulses are believed to be preferable for intercropping purposes on coffee fields. It is said that crops such as cassava, etc. with a strong fertiliser absorption performance are unsuitable as intercrops on a coffee field. The root system of a coffee tree penetrates to a depth of approximately 1.5 m and many fine roots are found upto 30 cm below the ground surface.

c. Shade Tree Species

Lamtoro (*Leucaena glauca*), Kayu res (*Gliricidia maculata*), etc. are used locally as permanent shade trees while Moghania (*Moghania macrophylla*) and banana are used as temporary shade trees. Lamtoro is said to be the best species for shading purposes as Kayu res tends to lose its leaves during the dry season. The much more difficult management of Kayu res due to its fast growth is another reason for the preference for Lamtoro. In short, species which are easy to care for and manage are preferable for shading purposes.

d. Management of Shade Trees

Shade trees must be distributed in an appropriate manner and their branches must be pruned in order to maintain the relative light intensity of a coffee field at 75%. Pruning should be conducted once a year at the beginning of the rainy season so that the section around 3 - 4 m from the ground accounts for some 50 % of the total. The pruned branches and leaves are used as green manure or animal fodder.

e. Forming of Coffee Trees

There are two forming methods for coffee trees; i.e. the single stem system and the multiple stem system.

Under the single stem system, topping is conducted at a height of 80 cm above the ground in the first year after planting, followed by further topping at a height of 120 cm above the ground 2 - 3 months later so that the lateral branches form 3 - 4 layers at a height of 60 - 120 cm above the ground.

In the case of the multiple stem system, topping is conducted at a height of 60 cm above the ground six months after planting to select 3 - 4 sprouting branches for further growth. In subsequent years, those branches of which the yield has declined are regenerated at an interval of some five years. Pruning is also conducted after harvesting.

The single stem system is employed by estates. The multiple stem system is easier to employ even though it demands a wider planting distance than in the case of the single stem system.

f. Fertiliser Application

Fertilisers are applied twice a year at the beginning and end of the rainy season.

Weeds, hedge crops and the pruned branches and leaves of shade trees produced on a coffee field are laid around the base or buried in holes dug between individual coffee trees. As it is said that the top soil at coffee fields must maintain its organic content at the 2 - 3% level, the laying or burial of weeds, pruned branches, etc. helps to resupply organic matters to the soil. In addition, it has mulching effects in terms of the microclimate such as the temperature and humidity around the roots of coffee trees, and also in terms of the soil structure.

At Jember, the organic cultivation of coffee is also conducted.

g. Weeding

Weeding at a coffee field is conducted approximately three times a year for the first 2 - 3 years after planting. The collected weeds are used to produce green manure.

h. Pest and disease control

Damage by Bubuk buah (*Stephanoderes hampei*) can be prevented by spraying a germ called *Beauveria bassiana*, cultured from maize, at a rate of 1.5 – 2 kg/ha for 2 – 3 times.

Effective ways of preventing damage by nematodes (*Pratilenchus coffeae*, *Radophalus similis*, etc.) include grafting, the use of organic manure and resistant varieties, and the use of such plants as *Trypsacum laxum*, *Tagetes patula*, *Crotalaria* spp., etc.

Locally, the use of agrochemicals, including herbicides, with a strong residual toxicity is avoided as much as possible. Biological and ecological methods are popularly used instead to fight diseases and harmful insects.

i. Terracing and Perimeter Planting of Hedge Crops

The soil conservation effects of terracing and hedge crops as part of coffee cultivation (*Coffea arabica*) are shown in Table 5-11. At the testing site, Teras Bangku is used for a slope gradient of 15% or more while Teras Guludan is used for a slope gradient of less than 15%. As Teras Bangku is capable of containing the soil loss to approximately 6%, it is an efficient weapon to ensure soil conservation at coffee cultivation sites.

The line planting of hedge crops at perimeters, especially dense cover by herbaceous plants is also effective to reinforce such terraces. The use of Vetiver grass (*Veti veria zizanioides*) does not compete with coffee as its roots grow deep vertically and not laterally. The roots can be used to produce Vetiver Oil while the leaves can be used as animal fodder. Elephant grass, Guatemala grass, King grass, etc. have the advantage of fast growth but Setaria grass is said to be unsuitable as a hedge crop because it is a host plant for nematodes.

Table 5-11 Soil Conservation Effects of Terracing and Hedge Crops in Coffee (*Coffea arabica* ) Cultivation

| Measure Applied | Annual Soil Loss (1995/96) (tons/ha) |
|---|---|
| None | 17.750 |
| Teras Bangku | 1.174 |
| Teras Bangku and Vetiver Grass | 0.611 |
| Teras Bangku and *Leucaena glauca* | 1.185 |
| Teras Bangku and *Moghania macrophylla* | 0.332 |

Notes:

1) Hedge crops mean those plants covering the perimeter of a terrace for terrace reinforcement purposes.
2) Vetiver Grass: *Vetiveria zizanioides*

Test Plot

| | | |
|---|---|---|
| Location | : | Andungsari, Desa Bondowoso, Pusat Penelitian Kopi dan Kakao, Jember |
| Year of Planting | : | 1994 |
| Planting Distance | : | 2 m by 1.5 m for coffee trees; 30 cm for Vetiver grass; 6 m for *Leucaena glauca*; 30 cm for *Moghania macrophylla* |
| Annual Rainfall | : | 1,500 - 2,500 mm |
| Gradient | : | 30% |
| Elevation | : | 1,000 - 1,400 m |
| Soil | : | Andosols |

③ Upper Trees and Relative Illuminance

The mixed planting of upper trees as well as those placed to act as shade trees is a common practice at coffee fields. To determine the species suitable for upper trees at coffee fields and their management method, a survey was conducted on the relative illuminance below the crown density of these upper trees. The results are as follows (see Attached Appendix E-6).

When differences in the relative illuminance under the crown are compared across species, it becomes obvious that the leguminous species (*Leguminosae*) often used as shade trees have high relative illuminance values. Petai, a leguminous species, also has a high under-crown relative illuminance value and presents itself as a possible shade tree. In comparison, kayu manis, mangosteen, durian and aren etc. have significantly low values. When planting species with low under-crown relative illuminance value, it is necessary to avoid the central part of a plantation in favour of locations that have little effect on the development of coffee trees, such as border areas. However, since tree species with a high bole height have high values, even those species with low under-crown relative illuminance values may be used as upper trees at coffee fields to a certain extent,

provided that they are cared for by the regular removal of branches, etc.. With regard to shade trees, the present trees are mainly uncared for by regular branch removal and, with the exception of a few plantations, shade trees are left in their natural state. The adequate pruning of the upper trees is necessary in order to sustain a relative illuminance level suitable for coffee growth.

Kayu bawang (*Disoxylum molliscimum, Meliaceae*) has a high under-crown relative illuminance value due to regular pruning. These kayu bawang trees were planted as upper trees at coffee fields in Desa Karang Tinggi in Propinsi Bengkulu Utara as a part of a regreening project of the Sub-Balai RLKT, Ketaun. These can be used as coffee shade trees for upto 5 years after planting provided that the bole height is raised by pruning and other measures.

2) Panili (*Vanilla planifolia/fragrans*, Ochidaceae)

Panili is cultivated in the Project Area in Desa Suro Bali and at a demonstration field of the Kelobak Agricultural Extension Centre. Panili was introduced to the Project Area from Bali. At Desa Suro Bali, one farming household with 10 years experience of panili cultivation was interviewed and the following panili cultivation method was identified.

Kayu res is the main shade tree species for panili and is planted at a distance of 1.25 m by 1.25 m. Panili uses a shade tree for support and a panili cutting is placed at the base of a shade tree. A shade tree attracting panili vines is cut at around a height of 1.5 m above the ground every six months for regeneration by sprouting. The branches and leaves cut from shade trees are used as firewood or to produce green manure. The aerial roots are cut to facilitate flower bearing. Flowering commences in the second year after planting and harvesting takes place in the same year. The harvested capsules are collected by dealers and sent to markets in Central Java.

At Desa Suro Bali, panili is cultivated in combination with coffee and kayu manis, etc. There is currently a problem of disease affecting the panili leaves and stems.

At the Kelobak Agricultural Extension Centre, kayu res is also used as a shade tree species with a planting distance of 2 m by 1.5 m. One year after panili has been planted, a shade tree is bent at a height of some 1.5 m above the ground without cutting it and the panili vines are guided to the bent shade tree branches. The favourable relative illuminance for panili is said to be 60 – 70% and harvesting lasts for approximately eight years after the first harvest.

3) Salak (*Zalacca edulis*, Palmae)

In the Project Area, only one farmer in Desa Pasar Ujung grows salak. The seeds used are the Java variety introduced from Surabaya in East Java. The planting of an area of some 4 ha was conducted in 1985 and 1991. The cultivation method of salak is outlined below.

The seeds germinate one month after sowing and four month old seedlings are planted. The planting distance is 0.5 – 0.7 m by 3 m and cassava is used as an intercrop for the first year. Harvesting commences in the third year after planting and peaks in the fifth year. As salak is a dioecious plant (50% male and 50% female), pollination is required. Once harvesting commences, it continues throughout the year. Weeding is conducted in the first three years after planting and KCℓ fertiliser is applied to female salak once a year. In order to strengthen the sweet taste, table salts are applied to the base of the tree three days before the planned harvesting. The new buds, fruit and stem, etc. of salak attract harmful insects. The harvested salak is delivered to the Kepahiang Market (Pasar Kepahiang).

The Bali variety introduced from Bali Island is cultivated at Desa Suro Bali.

4) Aren (*Arenga pinnata/saccharifera*, Palmae)

Aren cultivated at Desa Sindang Jaya in Kec. Curup was originally introduced from Jogjakarta in Central Java more than 50 years ago and is now cultivated on more than some 600 ha of land.

In general, one year old seedlings are planted at a distance of 5 – 8 m by 8 m. Flowering commences in the tenth year after planting to allow harvesting in the same year. Replanting is conducted in the fifteenth year. After the initial planting, kayu manis and some crops are cultivated as intercrops for seven years and 3 - 4 years respectively. The sap collected from the flower stems is refined at home and the resulting brown sugar (muscovado) is collected by middlemen.

Bamboo (Betung) is used to make the ladder and tube used to collect the sap and lamtoro and bamboo are used as firewood for refining purposes. There is an aren site of some 2 ha which has been planted by the Dinas Perkebunan since 1988 at Desa Pal Delapan in the Project Area but this site has not yet reached the harvesting stage. The planting distance is 5 m by 10 m and crops are cultivated in the first three years after planting as intercrops.

5) Kemiri (*Aleurites moluccana*, Euphorbiaceae)

Kemiri is cultivated in Desa Kebanagung, Desa Embang Ijuk, Desa Talang Pito and Desa Pagaragung, etc. in the southern part of the Project Area.

The interview survey at Desa Talang Pito revealed that there are some 150 ha of land in this village where Kemiri is grown. The cultivation of Kemiri became particularly popular around 1990. The common cultivation method is outlined below.

One to two month old seedlings are planted in October at a distance of 10 m by 10 m. Harvesting commences in the third year after planting and peaks in the fourth year, followed by many years of harvesting thereafter. The harvested nuts are collected by middlemen and transported to markets in Java.

6) Kayu manis (*Cinnamomum burmanni*, Lauraceae)

As observed in connection with such greening projects as the Kebun Rakyat development and village nursery development projects conducted by the Kab. Rejang Lebong Dinas PKT, there is a strong demand by local farmers in the Project Area for the planting of kayu manis which is, therefore, popularly planted as an intercrop at coffee fields and dry crops field [see 5.6-(3)-②]. It is assumed that the reasons for the popularity of kayu manis among farmers include the high potential for cash sale, low production cost and quick harvest.

There are two kayu manis cultivation methods in the Project Area, i.e. the single harvesting method after planting and the multiple (3 – 4 times) harvesting method by means of regeneration by sprouting. Harvesting is conducted at a tree age of 4 -- 8 years. The planting distance varies from one grower to another. In Desa Lubuk Saung, kayu manis is intercropped at coffee fields and is cut at some 30 cm above the ground in the sixth year for continuous regeneration by sprouting. A six year old kayu manis tree has a DBH of 18 - 20 cm, a tree height of 15 m and a crown diameter of 4 - 5 m. Drying of the peeled bark of kayu manis by the sun produces some 5 kg of dry kayu manis from a six year old tree. The dry kayu manis is sold at the village market and the remaining wood is used as firewood. Construction timber is sometimes produced by lengthening the cutting period.

A fairly large Hutan Rakyat of kayu manis is observed at Desa Air Bening. According to the caretaker, the trees were planted in 1990 and 1996 at a planting distance of 2 m by 3 m and the site is not yet ready for harvesting. There has been a major outbreak of hairy caterpillars which eat the leaves, indicating the risks associated with the monoculture of kayu manis .

7) Damar mata kucing (*Shorea javanica, Dipterocarpaceae*)

Social forestry incorporating the cultivation of damar mata kucing is currently being practiced in national forests (protection forests and production forests) as well as at privately owned land in Kec. Krui of Kab. Lampung Barat. 200 damar mata kucing per ha and 20 other trees (such as durian, petai and duku) per ha are planted in a mixed state. Wildings (approximately six months after germination) taken from the forest, temporarily potted, then acclimatised over one year at a nursery were used. Resin harvesting is initiated 30 years after planting and continues for the next 70 years. Resin production is around 4~5kg/month/tree, and after final cutting, the trees are sometimes used for timber. Resin is collected, sorted and exported from Lampung to Singapore.

Damar mata kucing cultivation can also be seen in the Kerinci Sebrat National Park located in the Study Area. This cultivation site is approximately 25 ha in size at El. 900 m and merkussi pine is mixed-planted. The trees were planted from 1954 to 1955 and measure approximately 20m in height with a DBH of 55~60 cm. No harvesting of resin has taken place so far but the state of growth is excellent. The wildings were originally brought from Bogor and Bandung. It is conceivable that wildings may be taken directly from this site if the natural growth of seedlings is confirmed.

8) Bamboo

The sampling survey and interview survey confirmed the presence of 12 bamboo varieties, i.e. Apus, Aur, Betung, Dabuk, Kuning, Lemang, Manyan, Pancing, Selepah, Serik, Suling and Wulung. The findings of the sampling survey are compiled in Attached Appendix E-7. In terms of the habitat location, Betung, Lemang and Aur, etc. are often observed on steep slopes while Manyan, Serik, Dabuk and Selepah are observed at the boundaries of dry crops field and paddy fields. In general, many varieties grow naturally along river channels.

The findings of the interview survey conducted in the Project Area indicate that, in all the villages listed, Betung is the predominant variety, followed by Manyan, Serik, Selepah and Lemang in that order. Betung and Manyan grow throughout the Project Area, Serik in the central part of the Project Area and Selepah and Lemang mainly in the central and southern parts of the Project Area.

All varieties are easily propagated by means of such vegetative propagation as the separation of the subterranean stem and cutting of the stalk in rainy season.

9) Mushrooms (Jamur)

While mushrooms are not cultivated in the Project Area, local people pick naturally grown mushrooms for their own consumption. It is said that mushrooms grow on dead mangoes, Puput, Terap and Bungin trees, etc. At Desa Rimbo Recap, naturally grown mushrooms (Jamur Merang) on three week old straw which is piled up in the paddy fields after harvesting are picked by local people for their own consumption. Jamur kayu which grow naturally on rubber trees are transported from the city of Bengkulu to the Kepahiang Market for local consumption. Due to the existence of a local demand, mushroom culture using cut coffee, shade and other trees appears to be highly viable in the Project Area.

10) Apiculture (*Apis* spp.)

Apiculture is not conducted in the Project Area although apiculture on a minor scale is observed in other parts of the Study Area, including Desa Karang Jaya, Desa Sumber Urip and Desa Sumber Bening, etc. in Kec. Curup, providing a source of side income for local people. The apiculture techniques used in these villages were originally mastered by one apiculturist in Desa Karang Jaya who taught himself in 1981.

Apiculture in Desa Karang Jaya involves the placing of wooden beehives made by the Ministry of Forestry around ponds and on dry crops field. The bee species used for apiculture are an indigenous species (*Apis javanica*) and a species imported from Australia. The honey production volume per wooden beehive is approximately 6 litres/year for the indigenous species and approximately 40 litres/year for the Australian species. The honey gathered from the wooden beehives is sold in the city of Curup. Plants constituting sources of pollen are Kaliandra, apokat, coffee, chili, maize and flowering plants found in local forests and at coffee fields and dry crops field, etc. The radius of activity for the bees is said to be 1.2 km for the indigenous species and 3 km for the Australian species.

(2) Biological Resources Survey

At the 10 villages selected for the socioeconomic and cultural conditions survey, the wives of standard families recommended by the village heads were interviewed to name the biological resources available around their homes for practical use. A total of some 80 items, including vegetables, coffee, fruit trees and medicinal herbs, were identified. (The subject area around the home was an average of some 60 $m^2$.)

Many of the medicinal herbs are used for gastrointestinal disorders, malaria, skin diseases and the treatment of fever during childbirth and that of children. The high degree of dependence on at-home care employing traditional remedies on the part of many is thought to be due to the distance from urban areas (see Attached Appendix E-8).

## 5.4 Development of Forestry Infrastructure

The current conditions of roads, which comprise the most important infrastructure to support social forestry, are described below.

There are four trunk roads totalling 79.3 km and 16 branch roads totalling 85.8 km in the Project Area and its neighbouring area. Roads with proper paving are classified in the category of "trunk road" here, excluding some roads under improvement, while those with simplified paving and gravel roads are classified in the category of "branch road". Only three roads (one national road, one dam construction road and one village road) run through the national forests and are clearly inadequate (see Attached Appendix E-9).

## 5.5 Damage to Forests

(1) Forest Fires

The massive smoke-related damage caused by the 1994 forest fire attracted a great deal of attention. The report on the forest fire issued by the Ministry of Forestry in October, 1994 did not list the area of the forest lost in Propensi Bengkulu to the fire. The Project Area is high in humidity throughout the year and has a weak tendency towards dehydration even in the dry season. Dry fallen leaves, often a cause of natural combustion and continued burning, are notably few and the degree of land use by local people is high. The latter, combined with the absence of large-scale tracts of privately-owned land (such as concessions and estates), appears to account for the infrequency of reckless slashing and burning. For these reasons, no specific measures to prevent forest fires appear to be necessary in the Project Area.

(2) Damage by Insects

No concrete data are available on insect damage to natural forests, secondary forests, shrub land or man-made forests in the Project Area. Moreover, the field surveys did not find any conspicuous insect damage although some *Acacia mangium* trees in man-made forests were found to be dead due to Kumbang (Coleophera ).

## 5.6 Extension and Training Activities

A survey was conducted on the state of the activities of extension workers mainly in the Project Area, the state of training activities vis-a-vis forestry-related administration officials and local people and the state of awareness and extension activities vis-a-vis local people by means of demonstration plots, etc.

(1) Extension

① Extension Activities

There are various types of forestry extension workers operating in the Project Area, i.e. afforestation-oriented forestry extension workers (PLR: Penyuluh Lapangan Reboisasi), regreening-oriented middle-ranking forestry extension workers (PMP: Penyuluh Madya Penghijauan), ordinary forestry extension workers (PLP: Penyuluh Lapangan Penghijauan) and check dam-oriented forestry extension workers (PLDP: Penyuluh Lapangan Dam Pengendari). Forestry extension activities regarding national forests are mainly conducted by PLRs. The PLR in the Project Area is stationed at Ranting Dinas and the extension activities mainly consist of (i) the training of farmers on afforestation techniques for national forests, (ii) coordination work with village heads, (iii) extension and local development activities and (iv) reporting on the progress of afforestation.

Forestry extension activities regarding private forests are conducted by PMPs, PLPs and PLDPs. The PMPs, PLPs and PLDPs operating in the Project Area are stationed at the Dinas PKT of Kab. Rejang Lebong. All forestry extension workers working on private land meet twice a month with extension workers in other fields at an agricultural extension centre (BPP: Balai Penyuluhan Pertanian). In the Project Area, one PMP and four PLPs are assigned to the PAL VIII Agricultural Extension Centre in Kec. Curup while one PMP, four PLPs and one PLDP are assigned to the Kelobak Agricultural Extension Centre in Kec. Kepahiang. The extension activities of these PMPs, PLPs and PLDP mainly consist of (i) the development of demonstration plots, check dams and Hutan/Kebun Rakyat at private land, (ii) extension techniques regarding village nurseries and other regreening projects, (iii) the preparation and distribution of pamphlets on various regreening projects and (iv) discussions with farmers. The common methods used for extension purposes are local meetings with farmers' groups and circuit guidance sessions directly with individual farmers. Meetings with farmers are organized twice a month per PLP and each meeting lasts for two days. The PMPs coordinate various activities at the agricultural extension centres.

A village hall is used as the base for the activities of forestry extension workers and each forestry extension worker is responsible for at least four villages.

The PAL VIII Agricultural Extension Centre currently has 51 extension workers stationed there, covering various fields, such as food, fruit and horticulture, livestock, fish culture and forestry.

② Extension Facilities and Equipment

The Dinas PKT of Kec. Rejang Lebong provides the PMPs, PLPs and PLDPs with a travelling allowance and uniform, etc. but not with a motorcycle.

The findings of the survey on the extension facilities and equipment of the Pal VIII and Kelobak Agricultural Extension Centres in the Project Area are described next.

Both centres have similar types and quantities of extension facilities and equipment. Each centre has an office building with a director's office, common room for extension workers and meeting room, etc., totalling some 64 $m^2$ and at least one motorcycle (100 cc class). The office equipment includes one manual typewriter, bookshelves, desks, chairs and tables, etc. In the opinion of both forestry and agricultural extension workers, further development of the extension facilities and equipment is essential to facilitate a positive response to and a proper understanding of extension activities among local farmers.

The Kelobak Agricultural Extension Centre has an experimental field of approximately one ha where panili, kayu manis, cacao and tea, etc. are cultivated.

(2) Training

The training of forestry-related administrative officials in the Project Area includes three months training for senior high school leavers recruited as forestry extension workers at forestry training institutes in Bogor and other places on such subjects as afforestation and regreening techniques and extension techniques, etc. Local people undergo training designed to facilitate regreening projects. This training is provided through lecture courses at agricultural extension centres, on-site explanatory meetings in association with regreening projects and meetings held in each village. In the case of a demonstration plot project for example, a three day training session is held at the village hall for farmers prior to project commencement.

Interviews with forestry extension workers and local farmers revealed that there is a need among the former to learn soil conservation and yield enhancing techniques. Extension workers also pointed out that the development of extension facilities, farmer education and clarification of the project benefits would be required to facilitate a positive understanding of projects by farmers. In contrast, local farmers appear to be less interested in soil conservation and soil productivity than they should be. The level of understanding of the importance of projects appears rather poor among women. All these observations suggest a strong necessity for the provision of training for not only forestry extension workers but also for local farmers.

(3) Regreening (Penghijauan)

Regreening projects were formerly controlled by the Sub-Balai RLKT, Ketahun but were transferred to the Dinas PKT of Kec. Rejang Lebong in fiscal 1994/95.

The level of understanding of regreening projects is generally low on the part of local people in the Project Area and the farmers in some villages do not even know of the existence of demonstration plots, etc.

The activities conducted in the Project Area under regreening projects are described below. To be more precise, the activities in question are demonstration plots, the development of Hutan/Kebun Rakyat, village nurseries and awareness/extension activities for local people (see 6.4 for check dams).

① Demonstration Plots

A demonstration plot is classified as either a natural resources conservation project model unit (UP-UPSA) or a settled agricultural project model unit (UP-UPM). A UP-UPSA is a demonstration plot for various farming methods with emphasis on soil conservation and each plot consists of 10 ha, serving 10 families. Such civil engineering works as terracing and channel works, etc. are demonstrated for a standard project period of three years.

A UP-UPM is a demonstration plot designed to facilitate settled farming instead of shifting cultivation. Each plot consists of 20 ha, serving 20 families and terracing is conducted. No UP-UPM has been established in the Project Area since fiscal 1994/95.

The existing UP-UPSAs in Desa Kampung Melayu located in the Project Area and Desa Air Bening, Desa Air Duku and Desa Sember Bening located outside the Project

Area were surveyed and the findings are outlined below. The commonly used types of terraces are Teras Guludan and Teras Bangku and the intercrops grown are maize, soybeans, ground nut, chili, cabbages and Chinese cabbages, etc. The cultivation of vegetables is seldom observed in the Project Area. The management practices include fertiliser application and the spraying of agrochemicals. Some trees, including apokat, lambutan, kayu manis and citrus, are planted along the farmland boundaries while the hedge crops for terraces include Lamtoro, Kaliandra, Setaria grass and King grass, etc. Using these hedge crops, efforts are being made to raise goats at Desa Kampung Melayu and to establish apiculture at Desa Sember Bening. The working schedule at a demonstration plot varies from one plot to another.

At Desa Air Duku, the performance of the soybeans and lambutan introduced at the demonstration plot is said to be poor so far. It appears to be extremely important to pay careful attention to the natural conditions, socioeconomic conditions and concrete needs of the local people before selecting crops for farming, tree species and new varieties/species to be introduced.

According to the forestry extension workers operating in the Project Area, there has been active participation by farmers in the demonstration plots in the area and the demonstration plots are said to have produced such positive results as improved land productivity and improved soil conservation skills on the part of farmers. The knock-on effects of demonstration plots in terms of terracing, suitable crops and trees and cultivation methods, etc. are also being felt although the progress is gradual.

The conditions of the demonstration plots in Kec. Curup and Kec. Kepahiang, including those in the Project Area, are summarised in Table 5-12.

② Hutan/Kebun Rakyat

Hutan/Kebun Rakyat are created to achieve soil conservation, improved soil fertility and the provision of new income opportunities for farmers by grouping smallholding farmers and conducting the mixed planting of trees and fruit trees at degraded land. The standard planting density is approximately 3 m by 2 m for Hutan Rakyat and approximately 5 m by 5 m for Kebun Rakyat. Kebun Rakyat have been created in the Project Area since fiscal 1994/95 with each site covering 250 - 500 ha. The trees to be planted are selected in view of the local conditions and the seedlings are supplied by the Dinas PKT of Kab. Rejang Lebong. Kayu manis is currently planted in the Project Area. The standard project period is one year.

At Desa Air Pikat, kayu manis is planted in an area of some 0.4 ha at a coffee field owned by a family. Stump seedlings, which have their above ground growths as well as subsurface growths (the main root) trimmed at approximately 8 months after the sowing, are used. Eight month old stump seedlings are planted in January at an approximate planting density of 5 m by 5 m. The survival ratio is said to be 90%.

The state of the Hutan/Kebun Rakyat in Kec. Curup and Kec. Kepahiang, including those in the Project Area, is summarised in Table 5-12.

③ Village Nurseries (Kebun Bibit Desa)

Village nurseries are established to select suitable species for local planting and to culture seedlings for regreening work.

Village nurseries in the Project Area have been established since fiscal 1994/95 with each nursery covering an approximate area of one ha. The seeds and pots are procured through the Dinas PKT of Keb. Rejang Lebong. Local farmers in the Project Area are currently producing kayu manis seedlings. Although the standard project period is one year, a nursery may be kept after the completion of the initial project period. The nursing work schedule varies from one village nursery to another.

In general, village nurseries are of a temporary nature and are established near a river or settlement. The standard nursery bed size is 1 m by 5 m and black plastic pots (10 cm in height and 6 cm in diameter, containing some 250 g of soil each) are used for nursing. The management work includes fertiliser application, weeding and the spraying of agrochemicals. The germination rate is said to be more than 60%. Some eight months after sewing when the seedlings have grown to a height of some 50 cm, they are delivered for planting. Bamboo is used as the nursery construction material. Farmers in Desa Tanjung Dalam hope to establish a nursery again following completion of the project period if sufficient finance can be raised.

The state of the village nurseries in Kec. Curup and Kec. Kepahiang, including those in the Project Area, is also summarised in Table 5-12.

Table 5-12 State of Regreening Projects in Kec. Curup and Kec. Kepahiang

| Kecamatan | 1980/81 - 1993/94 | | | 1994/95 | | | 1995/96 | | | 1996/97 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | UPSA | UPM | H/KR | UPSA | H/KR | KBD | UPSA | H/KR | KBD | UPSA | H/KR | KBD |
| Curup | 20 | 1 | 4 | 2 | 2 | 4 | 6 | 2 | 5 | 3 | 2 | – |
| Kepahiang | 13 | 4 | 8 | 2 | – | 2 | 4 | 1 | 2 | 1 | – | 3 |

Notes:
1) UPSA : UP-UPSA, UPM: UP-UPM
H/KR : Hutan/Kebun Rakyat, KBD: village nursery (Kebun Bibit Desa: KBD)
2) KBD data for the period from 1980/81 to 1993/94 are not included.
Source: Ketahun Sub-Balai RLKT and Kab. Rejang Lebong Dinas PKT

④ Sericulture

Sericulture was first introduced by the Ketahun Sub-Balai RLKT, Ketahun in fiscal 1980/81 and has since been conducted in the following manner.

There were multiple purposes for conducting sericulture, ranging from the enhancement, intensification and extension of farming activities to increased income for local people and the provision of new working opportunities for farmers. The concrete targets were (i) stabilisation of the income and lives of local people, (ii) expanded labour market for farmers and craftsmen, (iii) assistance for the resettlement programme, (iv) diversification of agricultural production and (v) supply of silk to meet the local demand. The selected area for sericulture was Kec. Kepahiang which is characterised by a forest area with a high population density, good access and suitable climate for mulberry (*Morus alba*) growth. Villages with a strong willingness to grow *Morus alba* were selected as sericulture areas. In general, mulberry was intercropped at coffee fields and dry crops field but the planting method varied from one farmer to another. The silkworm eggs were purchased in Central Java.

The actual practice of sericulture was introduced in Desa Kelobak, Desa Ujan Mas Bawah, Desa Das Petah, Desa Taba Tebelet, Desa Suka Sari, Desa Bandung Baru and Desa Bukit Sari, etc. in fiscal years 1980/81 through 1985/86, 1991/92 and 1993/94 to 1995/96 but has been completely withdrawn due to problems of market availability and financing.

# CHAPTER 6.

# WATERSHED CONDITIONS

# CHAPTER 6. WATERSHED CONDITIONS

In the Sixth 5-Year Development Plan, the Directorate General of Reforestation and Land Rehabilitation of the Ministry of Forestry classifies the entire country into Watershed Management Units. Within each unit, individual watersheds are classified into high, intermediate and low priority categories based on the managerial priority of each watershed. The Musi Watershed Management Unit consists of the high-priority Musi watershed, the intermediate-priority Banyuasin and Lalang watersheds, and the low-priority Teluk Lenggulang watershed. Much of the Project Area is a part of the Musi watershed.

## 6.1 Devastation Survey

(1) Landslide Sites

Many landslide sites, assumed to result from the earthquake in 1979, are observed near the summit of Bt. Daun located in the northwestern part of the Project Area and along the ridgeline stretching southwards. The largest site has a maximum width of 210 m and a maximum length of 1,330 m, covering an area of 16.84 ha. There are seven landslide sites in the Project Area of varying sizes and the largest site has a maximum width of 110 m and a maximum length of 480 m, covering an area of 4.69 ha (see Attached Appendix F-1).

All the landslide sites in the Project Area are located in natural forests on national forest land and are distributed between El. 1,700 m and El. 2,500 m with a gradient range of 27 – 38°. These sites now look like shrub land due to the invasion of natural vegetation, illustrating the ongoing recovery of the vegetation. As they are some 7 – 10 km away from the nearest settlement, no property damage, etc. has been reported. The fact that these landslides occurred inside natural forests may well be another factor of the absence of any tangible damage.

No landslide site of a comparable size exists in other parts of the Project Area. In general, there are few landslide sites although relatively minor landslides have occurred outside national forest land which can be seen at Desa Pal Tujuh, Desa Temdak and Desa Segurin and have a length of 21 – 37 m, a maximum width of 14 – 35 m and an area of 200 - 700 $m^2$. These landslides have occurred on slopes with a gradient of 25 – 50° and at dry crops field, shrub land, bare land and sites of young coffee trees (at the time of disaster). It appears that the landslide hazard increases when a slope with a gradient of more than 25° has become bare land (see Attached Appendix F-2).

(2) Torrent Streams

Although there are not many torrent streams in the Project Area, bank erosion is observed along the main course of Musi River at around Desa Tanjung Alam and Desa Suro Bali. Near Desa Tanjung Alam, bank erosion is occurring at many sites on both banks of the 600 m long torrent section of Musi River. Near Desa Suro Bali, bank erosion is occurring on both banks but mainly on the left bank of the 500 m long torrent section. These torrent sections are bordered by paddy fields and coffee fields on both banks and bank erosion is believed to take place every year. The size of the erosion at each site is approximately 0.5 m in width, 1.5 – 2 m in height and 2 – 5 m in length. These bank erosion sites are included in the reservoir area of the dam of the Musi Hydroelectric Power Project currently in progress.

## 6.2 Study on Soil Erosion Volume

### 6.2.1 Estimation of Soil Erosion Volume in the Project Area

In evaluating the operations of the Social Forestry Project, it is necessary to have on hand a value representing the difference between the volumes of soil loss sustained with and without the Project. Therefore, a rough estimate was made as to the extent of soil erosion using the USLE (Universal Soil Loss Equation) method which allows for a fairly simple estimate of the amount of soil erosion according to changes of the land use conditions. As the margin of error is assumed to be large due to the lack of raw data needed to calculate the local value of the factors used to conduct the estimate and as the applicability of the USLE method is not adequately proven when the surface gradient exceeds 20 degrees, further encouragement and support for Indonesian research dealing with these issues are desirable.

The soil loss volume can be obtained by the following equation using the USLE method.

$$A=R \bullet K \bullet LS \bullet C \bullet P$$

where A: annual soil loss volume per unit area (tons/ha/year)

R: rainfall factor (Joules/$m^2$)

K: soil erodibility factor

LS: slope length and gradient factor

C: cropping-management factor

P: erosion control work factor

The Project Area was divided into 1 × 1 $cm^2$ cells on the topographical map (scale: 1/25,000) prepared during the course of the Study and sample of cells were randomly selected. The rainfall factor, soil erodibility factor, slope length and gradient factor, cropping-management factor and erosion-control work factor were obtained for each sampled cell and the soil loss volume was estimated using the above equation. Every fifth cell on both the horizontal and vertical axes was extracted as samples using the systematic sampling method. There were a total of 334 samples and the extraction rate was 4 %.

(1) Rainfall Factor (R)

The rainfall factor (R) was determined using Hudson's equation as follows.

$$R = 38.5 + 0.35P$$

where, P: annual rainfall (mm)

The annual rainfall in the Project Area was obtained from the isohyetal map and the rainfall factor was determined using the above equation as shown in Table 6-1.

Table 6-1 Rainfall Factor (R) for the Project Area

| Code | Annual Rainfall (mm) | Rainfall Factor (R) |
|---|---|---|
| 1 | 2,000 ~ 2,500 | 826 |
| 2 | 2,500 ~ 3,000 | 1,001 |
| 3 | 3,000 ~ 3,500 | 1,176 |
| 4 | 3,500 ~ 4,000 | 1,351 |
| 5 | 4,000 ~ | 1,526 |

(2) Erodibility Factor (K)

The erodibility factor (K) was determined from the nomograph (Fig. 6-1) using the soil survey results (see Attached Appendix C-6). The soil erodibility factor (K) by soil class is shown in Table 6-2.

Table 6-2 Soil Erodibility Factor (K) for the Project Area

| Code | Soil Class Symbol | Soil Class | Value of Soil Erodibility Factor (K) |
|---|---|---|---|
| 1 | AC | Acrisols complex | 0.29 |
| 2 | ACC I | Acrisols-Cambisols complex I | 0.40 |
| 3 | ACC II | Acrisols-Cambisols complex II | 0.35 |
| 4 | CM I | Cambisols complex I | 0.28 |
| 5 | CM II | Cambisols complex II | 0.53 |
| 6 | CM III | Cambisols complex III | 0.34 |
| 7 | CM IV | Cambisols complex IV | 0.38 |
| 8 | ANC | Andosols-Cambisols complex | 0.44 |
| 9 | AN I | Andosols complex I | 0.50 |
| 10 | AN II | Andosols complex II | 0.49 |
| 11 | LPR | Leptosols-Regosols complex | 0.45 |
| 12 | WS | Wettish soils or Swampy soils | 0.69 |

(3) Slope Length and Gradient Factor (LS)

The slope length and gradient factor (LS) was determined using the following equation:

$$LS = \lambda^{0.5} (0.0138 + 0.00965s + 0.00138s^2) \qquad (s \leq 20)$$

$$LS = (\lambda/22.1)^{0.6} (s/9)^{1.4} \qquad (20 < s \leq 50)$$

$\lambda$: slope length (m)

s: slope gradient (%), $s = \sin\theta \times 100$

$\lambda$ is established as 100m based on the field survey results. The value of LS when the value of s is larger than 50 uses the value of LS when the value of s is 50.

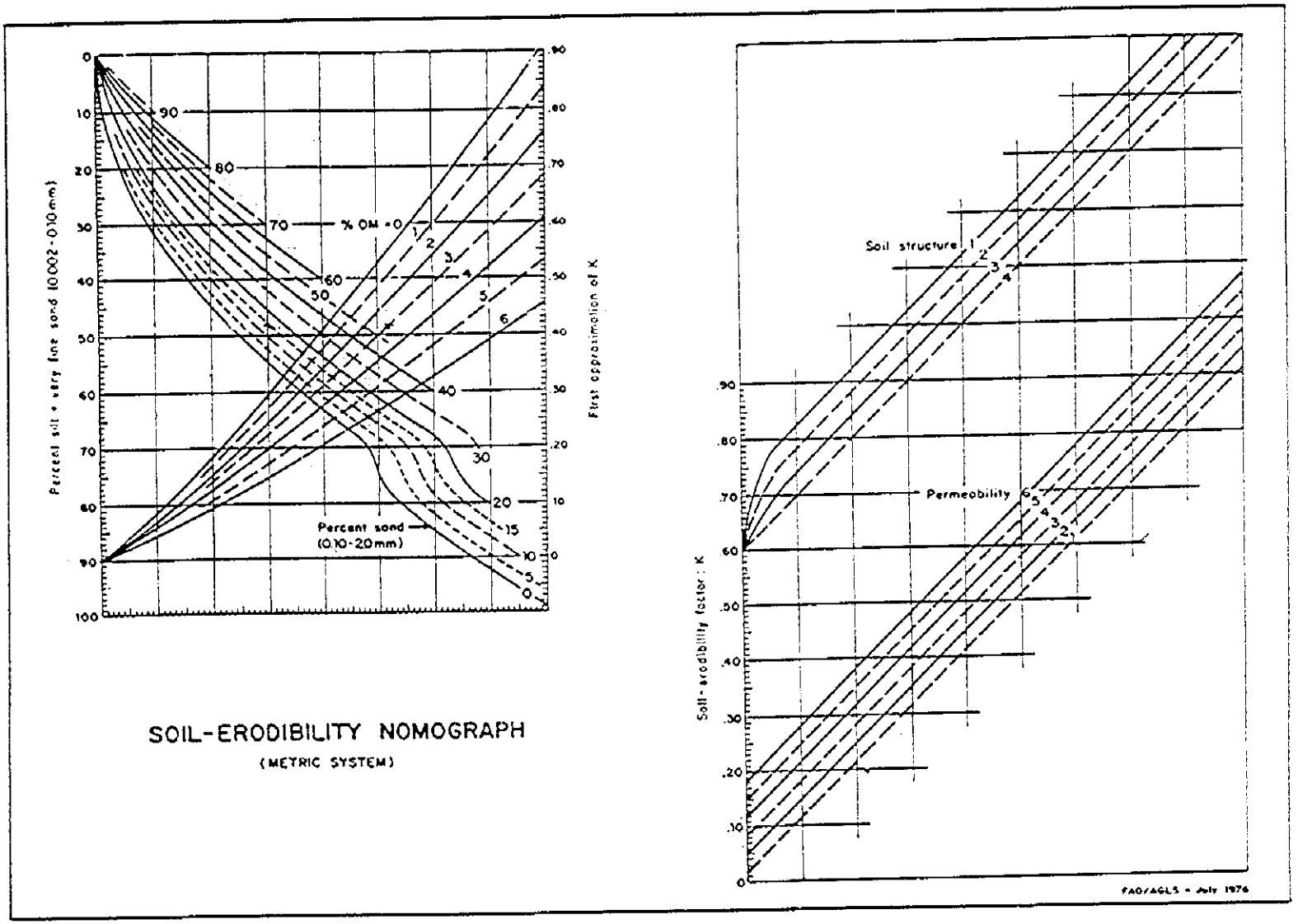



Fig.6-1 Nomograph of Soil Erodibility Factor (K Value)

Source: H. M. J. Arnoldus 1977. Predicting soil losses due to sheet and rill erosion. FAO Conservation Guide 1

(4) Cropping-management Factor C

The cropping-management factor (C) was determined based on the C value used by the Ministry of Forestry and is shown in Table 6-3.

Table 6-3 The Cropping-management Factor (C) for the Project Area

| Code | Symbol | Land Use / Vegetation Class | Particulars | Cropping-management Factor Value |
|---|---|---|---|---|
| 1 | Ha1 | Natural forests | less than 30% crown density | 0.01 |
| 2 | Ha2 | Natural forests | 31 ~ 70% crown density | 0.005 |
| 3 | Ha3 | Natural forests | over 71% crown density | 0.001 |
| 4 | Hs | Secondary forests | | 0.01 |
| 5 | Hta | Man-made forests | *Acacia mangium* | 0.001 |
| 6 | Htp | Man-made forests | Merkusi pine | 0.001 |
| 7 | Hts | Man-made forests | Mahogany | 0.001 |
| 8 | Sb | Shrub land | | 0.01 |
| 9 | Bb | Bamboo forests | | 0.005 |
| 10 | Sp | Irrigated fields | | 0.01 |
| 11 | Sh | Natural paddy | | 0.27 |
| 12 | Ldg | Dry crops fields | terracing | 0.421 |
| 13 | Ldt | Dry crops fields | no terracing | 0.421 |
| 14 | Lkt | Coffee field | upper trees have less than 10% crown density | 0.015 |
| 15 | Lkb11 | Coffee field | upper trees are less than 5m in height, with 11~30% crown density | 0.015 |
| 16 | Lkb12 | Coffee field | upper trees are less than 5m in height, with 31~70% crown density | 0.012 |
| 17 | Lkb13 | Coffee field | upper trees are less than 5m in height, with more than 71% crown density | 0.009 |
| 18 | Lkb21 | Coffee field | upper trees are more than 5m in height, with 11~30% crown density | 0.015 |
| 19 | Lkb22 | Coffee field | upper trees are more than 5m in height, with 31~70% crown density | 0.012 |
| 20 | Lkb23 | Coffee field | upper trees are more than 5m in height, with more than 71% crown density | 0.009 |
| 21 | Kb | Orchards | | 0.6 |
| 22 | Kc | Mixed farms | | 0.3 |
| 23 | Lm | Kayu manis plantation | | 0.01 |
| 24 | Pk | Estates (coffee) | | 0.015 |
| 25 | Pr | Graassland | | 0.02 |
| 26 | Lt | Exposed land | | 0.95 |
| 27 | Pm | Settlement | | 0.35 |
| 28 | Rw | Wettish land | | 0.01 |

Notes:

1. The C value used for "Undestroyed Shrub Land" by the Ministry of Forestry was employed as the C value for natural and secondary forests with a crown density of less than 30%.
2. The median of the C values for the crown density of less than 30% and the crown density of more than 71% was used as the C value for natural forests with a crown density between 31~70%.
3. The C value used for "Undestroyed Forests" by the Ministry of Forestry was employed as the C value for natural forests with a crown density greater than 71%.
4. The C value used for "Undestroyed Forests" by the Ministry of Forestry was employed as the C value for man-made forests.
5. The C value for natural forests with a crown density between 31~70% was used as the C value for bamboo forests.
6. The median of the C values used for "Irrigated Fields" and "Dry Grain Fields" by the Ministry of Forestry was used as the C value for natural paddies.
7. The C value used for "Maize+Upland Rice+Cassaba-Soy Beans/Ground nut" by the Ministry of Forestry was used as the C value for dry crops fields.
8. The C value for coffee fields with an upper tree crown density of greater than 71% was calculated by a joint use of the results of the soil erosion experimental study conducted by the Indonesian Coffee and Cocoa Research Institute (Pusat Penelitian Kopi dan Kakao, Jember) and the USLE method indices (excepting the C value) from this present study. The C value for other coffee fields was estimated based on this value.
9. The C value used for "Bananas (isolated monoculture)" by the Ministry of Forestry was used as the C value for orchards.
10. The median of the C values used for "Mixed Farms (concentrated)" and "Mixed Gardens (sparsely planted)" by the Ministry of Forestry was used as the C value for mixed gardens.
11. The C value used for "Undestroyed Shrub Land" by the Ministry of Forestry was employed as the C value for kayu manis plantations.
12. The C value for coffee fields with an upper crown density of less than 10% was used as the C value for estates (coffee fields).
13. The C value for "Fixed Alang alang grasslands" used by the Ministry of Forestry was used as the C value for grasslands.
14. The C value for "Uncultivated Exposed Lands" used by the Ministry of Forestry was used as the C value for exposed lands.
15. The C value for settlements was calculated from the C value for "Mixed Farms (isolated)" used by the Ministry of Forestry, with a 30% allocation for building areas.
16. The C value for "Irrigated Fields" used by the Ministry of Forestry was used as the C value for wetlish lands.

### (5) Erosion Control Work Factor (P)

The erosion control work factor (P) was determined based on the results of the soil erosion experimental research (see Table 5-11) conducted by the Indonesian Coffee and Cocoa Research Institute (Pusat Penelitian Kopi dan Kakao, Jember) as well as the P value used by the Ministry of Forestry. The results are as follows in Table 6-4.

Table 6-4 Erosion Control Work Factor (P) for the Project Area

| Code | Symbol | Land Use / Vegetation Class | Erosion-control Practice Factor P Value |
|---|---|---|---|
| 1~3 | Ha | natural forests | 1 |
| 4 | Hs | secondary forests | 1 |
| 5~7 | Ht | man-made forests | 1 |
| 8 | Sb | shrub land | 1 |
| 9 | Bb | bamboo forests | 1 |
| 10 | Sp | irrigated fields | 0.07 |
| 11 | Sh | natural paddies | 0.07 |
| 12 | Ldg | dry crops fields (with terrace) | 1 |
| 13 | Ldt | dry crops fields (without terrace) | 0.15 |
| 14~20 | Lk | coffee fields | 1 |
| 21 | Kb | orchards | 1 |
| 22 | Kc | mixed farms | 1 |
| 23 | Lm | kayu manis plantations | 1 |
| 24 | Pk | estate (coffee) | 1 |
| 25 | Pr | grasslands | 1 |
| 26 | Lt | exposed lands | 1 |
| 27 | Pm | settlements | 1 |
| 28 | Rw | wettish lands | 1 |

Notes:

1. The P value for irrigated fields as well as natural paddies was determined based on the P value for bench terraces calculated from the results of the soil erosion experimental research conducted by the Indonesian Coffee and Cocoa Research Institute (Pusat Penelitian Kopi dan Kakao, Jember).
2. The P value for bench terraces (regular) used by the Ministry of Forestry was used as the P value for dry crops fields (with terrace).

(6) Correction of USLE Method

Corrections were made so that the soil erosion volume, calculated by the USLE method using the above factors, suited the Project Area.

The frequency distribution was checked for samples for which the soil loss volume was calculated. When the minimum and maximum soil loss volumes are defined as the soil loss volumes where the accumulated percentages of the frequency distribution is 5% and 95 % respectively, the minimum soil loss volume is 0.74 tons/ha/year while the maximum soil loss volume is 530 tons/ha/year.

Meanwhile, the actual soil loss volume in the Project Area was determined through a quantitative survey on the accumulated sediment in check dams. The minimum volume was determined to be 0.5 tons/ha/year and the maximum volume was determined to be 60 tons/ha/year (see 6.3.1).

A cross-coordinate with the soil loss volume estimated by the USLE method as the $x$-axis and the corrected soil loss volume as the $y$-axis was then assumed and the following equation showing the curvilinear relationship most closely corresponding to the line passing through the origin (0,0) and punctual coordinates of (0.74, 0.5), and (530,60) was determined and used to make corrections.

$$y=[8.0916(x+4.0687)]^{0.5}-5.7378$$

$y$: corrected soil loss volume (tons/ha/year)

$x$: soil loss volume by USLE method (tons/ha/year)

(7) Estimation of Soil Loss Volume

The Project Area was divided into the main watersheds and the soil loss volume was calculated for each watershed using the above corrective equation. Depending on the watershed, the soil loss volume ranged from 8.7 tons/ha/year ~ 24.5 tons/ha/year. Air Pikat Kering, Air Lanang, Air Dendan and Air Mundu showed comparatively high soil loss volumes. For the entire Project Area, the annual soil loss volume per ha was estimated to be 17 tons/ha/year and the total annual soil loss was estimated to be 900,000 tons/year (see Table 6-5 and Fig. 6-2).

Table 6-5 Soil Loss in the Project Area

| Watershed Area | Name of Represented River | Watershed Area Inside the Project Area (ha) | Annual Soil Loss Per ha (tons/ha/year) | Total Annual Soil Loss (tons/year) |
|---|---|---|---|---|
| 1 | Air Lanang | 5,709 | 24.2 | 138,158 |
| 2 | Air Pikat Kering | 4,916 | 24.5 | 120,442 |
| 3 | Air Ketapan | 1,450 | 12.4 | 17,980 |
| 4 | Air Teretik | 5,289 | 12.8 | 67,699 |
| 5 | Air Mundu | 8,174 | 18.7 | 152,854 |
| 6 | Air Dendan | 3,850 | 20.2 | 77,770 |
| 7 | Air Musi | 18,267 | 14.3 | 261,218 |
| 8 | Air Selimang | 3,746 | 13.6 | 50,946 |
| 9 | Air Dingin | 1,432 | 8.7 | 12,458 |
| Total | | 52,833 | 17.0 | 899,525 |

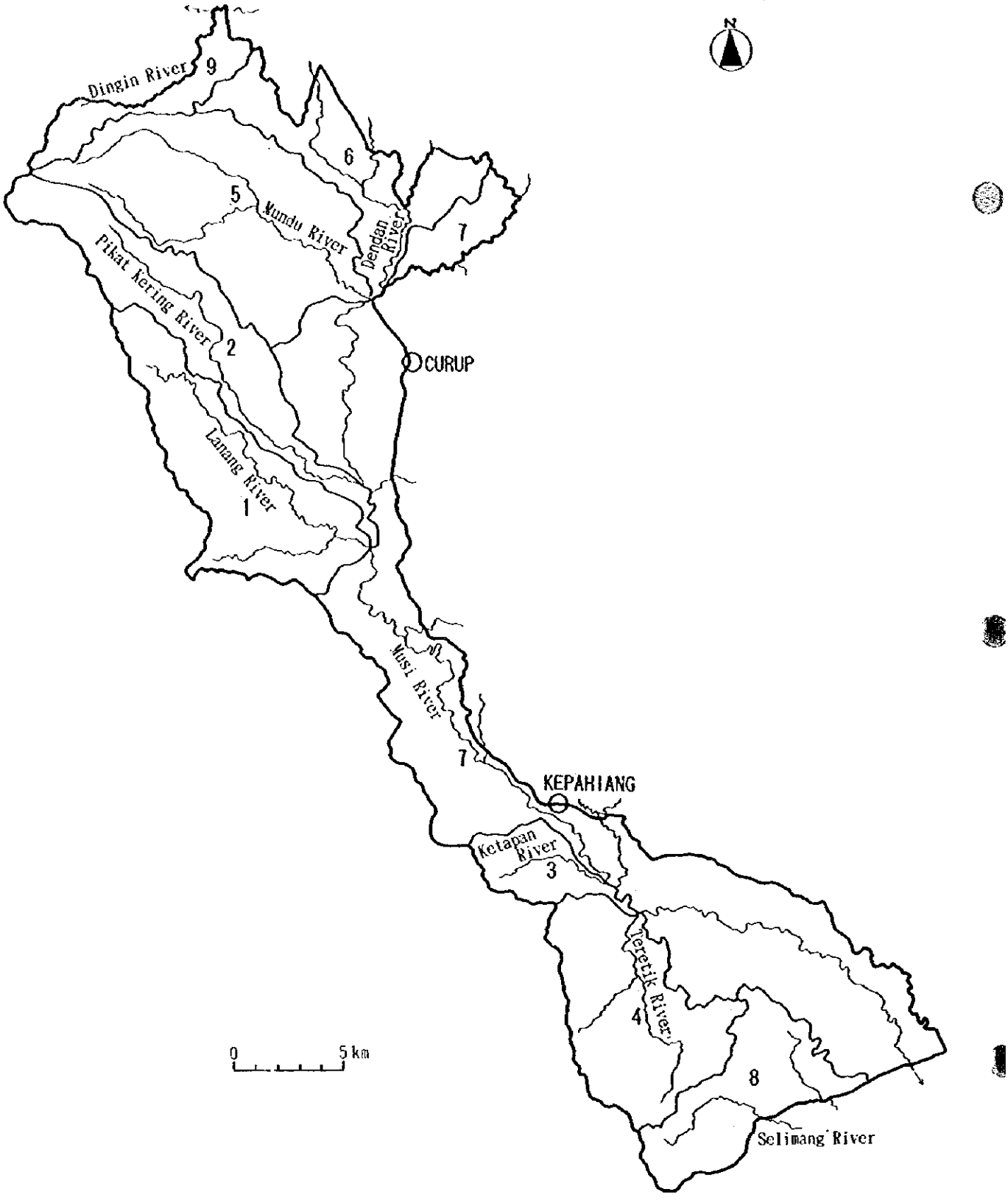



Fig. 6-2 Watersheds in the Project Area

## 6.3 Sediment Discharge Survey

### 6.3.1 Estimation of Sediment Discharge Volume Based on Deposited Sediment Volume at Check Dams

The deposited sediment volume was surveyed at 8 existing check dam sites located in the Project Area and its immediate surrounding area (see Table 6-6). The volume was calculated from the product of the mean deposit depth and sedimentation area. The reesults show that the annual sediment discharge for the catchment area of the 8 check dam sites surveyed is 0.3 ~ 45 tons/ha/year with a catchment area-weighted average of 2.3 tons/ha/year. The large difference in the deposited sediment volume from one site to another is attributed to the significant difference in the size of the catchment areas (ranging from 2.8 ~ 640 ha). In smaller catchment areas, the percentage of eroded soil reaching the dam site located at the exit of the catchment area is high whereas in larger areas, much of the eroded sediment is deposited before reaching the dam site. Therefore, a large sediment discharge tends to be recorded at the exit point of smaller catchment areas.

Since it can be assumed that the sediment discharge volume approaches the soil loss volume as the size of a catchment area decreases, the maximum value of the soil loss volume is assumed to be 60 tons/ha/year while a minimum value of 0.5 tons/ha/year is assumed based on the correlation between the catchment area and sediment discharge volume (see Fig. 6-3).

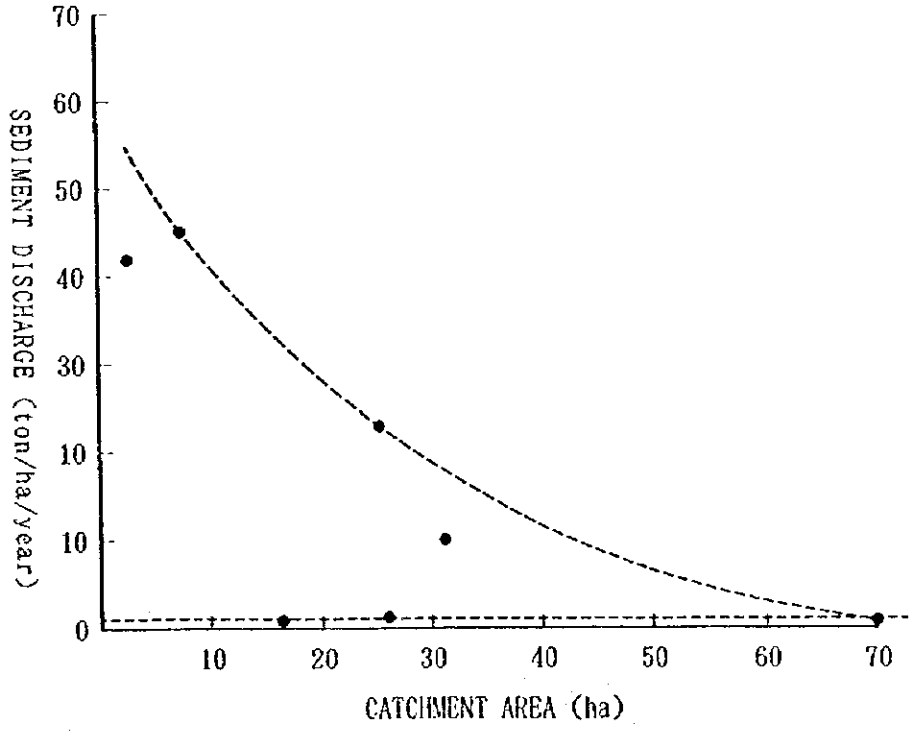



Fig. 6-3 Correlation Between Sediment Discharge Volume and Catchment Area

Table 6-6 Sedimentation Volume at Check Dams

| Site No. | | 1008-1 | 1008-2 | 1009-1 | 1009-2 | 1009-3 | 1010-1 | 1010-2 | 1011-1 |
|---|---|---|---|---|---|---|---|---|---|
| Survey Date | | 8 Oct., 1996 | 8 Oct., 1996 | 9 Oct., 1996 | 9 Oct., 1996 | 9 Oct., 1996 | 10 Oct., 1996 | 10 Oct., 1996 | 11 Oct., 1996 |
| Location | Kabupaten | Rejang Lebong | Rejang Lebong | Rejang Lebong | Rejang Lebong | Rejang Lebong | Rejang Lebong | Rejang Lebong | Rejang Lebong |
| | Kecamatan | Curup | Curup | Curup | Curup | Curup | Curup | Curup | Kepahiang |
| | Site | Pal VIII Air Dingin | Pal VIII | Taba Renah | Air Pikat | Purwodadi | Bandung Marga | Pal Seratus | Kelobak |
| Year of Construction | | 1980/1981 | 1992/1993 | 1984/1985 | 1992/1993 | 1982/1983 | 1986/1987 | 1987/1988 | 1983/1984 |
| Crown Length (m) | | 65 | 38 | 59 | 52 | 45 | 56 | 50 | 50 |
| Dam Height (m) | | 3.5 | 4.3 | 6.8 | 5.9 | 5.9 | 6.8 | 6.5 | 6.7 |
| Crown Width (m) | | 6 | 5 | 4 | 4.5 | 3.5 | 4.5 | 4.3 | 3.8 |
| Sedimentation Area ($m^2$) | | 860 | 4,300 | 7,600 | 2,900 | 1,200 | 2,400 | 2,400 | 3,900 |
| Sedimentation Volume ($m^3$) | | 400 | 1,500 | 5,700 | 1,200 | 60 | 2,600 | 800 | 200 |
| Catchment Area (ha) | | 70.6 | 640 | 25.6 | 8.3 | 16.8 | 31 | 2.8 | 26.2 |
| Annual Soil Discharge per Unit Area (ton/year/year) | | 0.4 | 0.7 | 22.9 | 44.9 | 0.3 | 10.1 | 41.7 | 0.7 |

Note: 1.2 tons/$m^3$ was used as the mass per unit soil.

Table 6-7 Evaporation Residual in River Water

| Site No. | | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|---|
| River Name | | Air Lanang | Air Pikat | Air Ketapan | Air Teretik | Air Mundu | Air Dendan | Air Musi |
| Location | Kabupaten | Rejang Lebong | Rejang Lebong | Rejang Lebong | Rejang Lebong | Rejang Lebong | Rejang Lebong | Lahat |
| | Kecamatan | Curup | Curup | Kepahiang | Kepahiang | Curup | Curup | Ulumusi |
| | Desa | Suro Bali | Bukit Barisan | Cirebon Baru | Temdak | Taba Renah | Taba Renah | Kunduran Baru |
| Sampling Date | | 28 Oct., 1996 | 29 Oct., 1996 | 29 Oct., 1996 | 30 Oct., 1996 | 31 Oct., 1996 | 31 Oct., 1996 | 1 Nov., 1996 |
| Sampling Time | | 10:00 | 10:00 | 12:30 | 10:00 | 10:00 | 12:00 | 11:00 |
| Mean Rainfall of Watershed (mm) | | 3,900 | 3,500 | 3,750 | 3,800 | 3,000 | 3,000 | 3,500 |
| Catchment Area Upstream of Sampling Site (ha) | | 5,690 | 4,896 | 1,381 | 5,276 | 8,124 | 13,294 | 114,568 |
| Flow ($m^3$/sec) | | 14.8 | 7.1 | 0.6 | 2.1 | 5.2 | 14.6 | 116.7 |
| Suspended Matters (mg/litre) | | 86.2 | 50.9 | 103.7 | 93.3 | 104.7 | 111.5 | 84.5 |
| Evaporation Residual (mg/litre) | | 26.3 | 26.4 | 26.1 | 14.2 | 26.3 | 14.4 | 14.3 |
| Total Residual (mg/litre) | | 112.5 | 77.3 | 129.8 | 107.5 | 131 | 125.9 | 98.8 |
| Annual Soil Discharge per Unit Area (Estimate) (ton/ha/year) | | 1.8 | 1.1 | 2.0 | 1.7 | 1.6 | 1.5 | 1.4 |

Note: A run-off coefficient of 0.41 was calculated using flow rate data recorded at the water level observation post of the Sub-Balai RLKT, Ketahun (river name: Air Mundu) from September 1995 to August 1996 as well as rainfall data recorded at the BBH Air Dingin Observation Station for the same period.

### 6.3.2 Estimation of Sediment Discharge Based on River Flow Rate Survey

River water samples were taken at seven sites in the Project Area and its neighbouring area (at A. Lanang, A. Pikat Kering, A. Ketapan, A. Teretik, A. Mundu, A. Dendan and A. Musi) to measure the amount of suspended solids and soluble evaporation residues (see Tabe 6-7). While the data is not totally reliable due to the lack of continuous observation over a long period of time, the recorded measurements were used to estimate the annual sediment discharge. The water level observation post of the Sub-Balai RLKT, Ketahun, established in 1994, is located in Desa Tabarenah on Mundu River and river surveys have been conducted there since 1995. In order to minimize the margin of error, the annual flow rate was calculated based on annual data from September 1995 - August, 1996. A run-off coefficient of 0.41 was obtained using rainfall data (BBH Air Dingin Observation Station) for the same period. The annual flow rate for each of the afore-menioned seven sites was determined using this coefficient. The total evaporation residue was defined as the suspended load and the annual sediment discharge was calculated as the product of the total evaporation residue and annual flow rate. Of the seven sampled rivers, the upper reaches of five rivers, except A. Dendan and A. Musi, are entirely included in the Project Area. In the case of A. Dendan and A. Musi, their upper reaches are mostly located outside the Project Area. The annual sediment discharge rate of the five rivers of which the catchment areas are entirely included in the Project Area is 1.1 – 2.0 tons/ha with a catchment area-weighted average of 1.6 tons/ha.

According to the study by the Musi Hydroelectric Power Project, the annual sediment discharge for the Musi watershed upstream of Desa Ujan Mas Atas is 99,000$m^3$ (catchment area = 587 $km^2$). When the discharge per ha is calculated, the result is 2.0 tons/ha/year (where soil density = 1.2 tons/ $m^3$) which does not significantly differ from the results of the present Study.

### 6.3.3 Proportion of Sediment Discharged Outside the Watershed

In 6.3.2, the sediment discharge is estimated for five rivers of which the watersheds are included in the Project Area. The soil loss volume is also estimated for each of these watersheds following the method described in 6.2. The result is that 8.2% of the soil lost from these watersheds is discharged outside the watersheds (see Table 6-8).

As the annual soil loss from the Project Area is estimated to be 900,000 tons/year (see 6.2), the annual sediment discharge out of the Project Area is calculated to be 74,000 tons/year.

Table 6-8 SDR (Sediment Delivery Ratio)

| Watershed Studied (No.) | Watershed Area (ha) | Annual Soil Loss per ha (tons/ha/year) | Annual Soil Loss (tons/year) | Soil Discharged Outside the Watershed per ha per annum (tons/ha/year) | Soil Discharged Outside the Watershed per annum (tons/year) | SDR |
|---|---|---|---|---|---|---|
| 1 | 5,690 | 24.2 | 137,698 | 1.8 | 10,242 | 0.074 |
| 2 | 4,896 | 24.5 | 119,952 | 1.1 | 5,386 | 0.045 |
| 3 | 1,381 | 12.4 | 17,124 | 2.0 | 2,762 | 0.161 |
| 4 | 5,276 | 12.8 | 67,533 | 1.7 | 8,969 | 0.133 |
| 5 | 8,124 | 18.7 | 151,919 | 1.6 | 12,998 | 0.086 |
| Total | 25,367 | | 494,226 | | 40,357 | 0.082 |

Note: The number of the watersheds in this table correspond to the number in Table 6-7.

## 6.4 Survey on Existing Erosion Control Works

The existing erosion control works in the Project Area consist of check dams, revetment works, wire gabion works and terracing, etc. A check dam is an earth dam designed to encourage sedimentation for soil conservation purposes and the standard measurements are a catchment area of 100 -- 250 ha, a maximum dam height of 8 m and a maximum crest length of 100 m with a reservoir area of 1 - 4 ha. Check dams are constructed to prevent damage to conservation subjects in the lower reaches by means of facilitating the sedimentation process of soil discharged in the upper reaches and to improve the groundwater conditions at critical land and the microclimatic conditions. The construction of check dams is also expected to have such benefits as a reduced risk of flooding in the lower reaches, promotion of extension programmes, improved supply of water, promotion of fishery, improved irrigation and the enhancement of recreation prospects. Check dams are usually constructed at sites where other soil conservation measures are found to be inadequate in the face of greatly undulating topography characterised by a slope gradient range of 15 – 35% which causes much erosion. The existing check dams in the Project Area were constructed in 16 places in the period between 1980 and 1996 (see Attached Appendix F-3).

In addition to check dams, gabion works are used as small check dams in Indonesia to prevent sediment discharge at gullies. The standard height and catchment area of this type of torrent works are 1 – 4 m and 30 ha respectively. Gabion works are used at sites with gently undulating topography (gradient of 15 – 35%) where other soil conservation measures are found to be inadequate. Another measure to prevent soil erosion at gullies is the use of gully

plugs (which use gabion works), the height of which is lower than that of a small check dam. There are no small check dams or gully plugs in the Project Area.

Revetment works usually consist of gabions having a width of 1.5 m, a length of 3 m and a height of 0.5 m. The wire used in constructing the gabions has a diameter of 4 mm in general. Hardly any revetment works exist in the Project Area except for that at the dam site under the Musi Hydroelectric Power Project along the main stream of Musi River near Desa Ujan Mas Atas.

Terracing is introduced at dry crops field with a gradient of 3 -- 50% to gather surface water in order to facilitate its ground infiltration and also to guide the surface flow to prevent any damage to the ground surface by the surface flow. There are various types of terracing, i.e. Teras Datar, Teras Kridit, Teras Gulud, Teras Bangku, Teras Kebun and Teras Individu. Teras Gulud and Teras Bangku are observed in the Project Area.

## 6.5 Natural Disasters

Propinsi Bengkulu has experienced four earthquakes, ranging from 6 to 7.6 on the Richter Scale, in 1938, 1941, 1971 and 1979. The most recent large earthquake which caused damage in the Project Area occurred on 15th December, 1979. This earthquake was 6 on the Richter Scale and damaged some 3,100 houses, etc. in Kec. Curup and Kec. Kepahiang, killing four people and seriously injuring another 14. It also caused a huge landslide near the summit of Bt. Daun (see Attached Appendix F-4).

In response to the interview survey, local people mentioned the inundation of paddy fields at the time of flooding. However, no official damage record was found by the survey conducted by the Cabang Dinas Sosial Tingkat II Rejang Lebong.