INDONESIAN FOREST SECTOR SUPPORT PROGRAMME (IFSSP)

FOREST FIRE PREVENTION AND CONTROL PROJECT (FFPCP)

Final Report
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SYLVO-PASTORAL POTENTIAL

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Summary

Foreword

The short term consultancy in livestock grazing has been realized by Dr. Bernard Toutain, pasture agronomist for tropical countries, scientist in CIRAD-EMVT, the livestock department of CIRAD, as a consultant of CIRAD-Forêt, Forestry department of CIRAD.

The Indonesia Forest Sector Support Programme, implemented by a European Union Consortium linking NRI (UK), BCEOM (France), CIRAD-Forêt (France) and SCOT-Conseil (France) has coordinated the mission with the Indonesian Ministry of Forestry. This mission has been organized by the head of the Forest Fire Prevention and Control Project.

This consultancy started the 13th of September 1997 by the arrival of the consultant in Indonesia for a duration of six weeks spent in Palembang and the South Sumatra province.

The consultant wants to sincerely thank all the persons who helped him during his stay in Indonesia to get the usefull information and make the life more fruitfull and plaisant. He is particularly grateful to M. Jean Jacques Maurer, manager of the project, Mr. Gustaaf Cosijn, and his counterpart Mr. Rusli, who particularly guided him in his work, Mr. Dalilan Abdullah, interpreter, the other specialists of the project for their support, all officers of administration or private compagnies who kindly received him and took time to discuss and give useful information.

He does not forget the head of villages and the farmers for their kind welcome everywhere.

Palembang, October 20, 1997

Introduction

Objectives of the consultancy

1 - Position of this consultancy in the existing programme

The overall aim of the **Indonesian Forest Section Support Programme** (IFSSP) is "*to give support, guidance and enhanced technical capability, specially at provincial level, for the rational and sustainable management of the country's forest resources*".

This programme is funded jointly by the European Union who provides grants and the Government of Indonesia who brings counterpart funds. It started in 1995 and is planned at this stage to be implemented until 31 March 1998. The Programme Coordination Unit is based in Jakarta.

The **Forest Fire Prevention and Control Project** (FFPCP) is one of the three projects conducted by the IFSSP (see annex 1). It is based in Palembang. Its objectives are :

- to obtain a clear understanding of the 1) **causes** and 2) **effects** of forest fire,
- to develop and demonstrate practical methods for 3) **prevention** and 4) **control** of forest fire.

The project organization includes the services of :
- a social forestry expert,
- a rural development expert,
- a fire management expert
- a remote sensing and geographic information systems (GIS) expert, using a NOAA reception station. This tool makes possible fire monitoring by satellite and early warning system for the southern Sumatera province and two eastern regions of Indonesia.

Short term consultants provide expertise and give proposals in :

- Bee keeping and honey production, because hives need unburnt vegetation to be managed.
- Mushroom production on cut vegetal material, helping farmers to slash and clean grass cover by a valuable production, avoiding by this way the cleaning by burning.
- Botany, collecting information on the traditional use of native plants to promote non-timber forest products, eventually by plantation of these species in the forest. Producing income through non-timber products, the natural forest is hoped to be more protected against fire by the surrounding population.

- Workshop on fight against fire using aircraft.
- Public awareness campaigns with support of posters, booklets, two cassettes of traditional music with relevant messages, a video cassette (24 min.).

2 - Short-term consultancy in tropical grazing

One of the options for reducing the fire hazard in forest areas is to diminish the layer of combustible organic matter in buffer zones around forests and in forest plantations by promoting grazing systems in these areas.This short term mission of consultant has the objectives to develop grazing schemes in the situations where they can help fire prevention in forests and in fire-prone plantations and make recommendations on sustainable livestock production by using grazing areas for plantation owners and rural livestock owners.

According to the terms of reference (see annex 1), the work plan proposed for this study is the following :

- The first chapter shortly presents the main forest areas and the types of forests and associated vegetations in the South Sumatra Province, as well as the tree plantations. The causes of fire described by the project and relevant for the study are selected and discussed.

- The second chapter deals with the actual situation of livestock in the South Sumatra Province and the perspectives of development. It describes the animal production systems, particularly those based on ruminants.

- The third chapter is a discussion about the possibility to develop sylvopastoral schemes in each kind of forest or plantation.

- The forth chapter gives recommendations for the constitution of grazing farm projects in ways presumably acceptable by the different types of producers. It proposes a plan for the training of the persons involved in such project.

The conclusion will summarize the report findings.

Chapter 1

Forest and forest fire in South Sumatra
The present situation

1 - Forest fire and smoke increasing

Indonesia is a country with equatorial climate, hot and wet, and the native vegetation is mostly rainforest. Traditionally agricultural systems in forested areas use shifting cultivation to open the forest and clean the land before sowing or planting. After a few years of crops as rice, maize, chile, beans, cassava, sweet potato, the soil fertility drops rapidly and the yield becomes very low. The field is abandoned and spontaneous vegetation grows again, developing slowly to a secondary forest. Years later, the same place can be burnt again for a new cycle of crops. The technique of "slash and burn" is called *ladang* in *Bahasa Indonesia* and the young secondary forest could be called "forest fallow".

Until recently this simple and cheap technique had a reasonable environmental impact and was more or less limited to the areas cultivated by traditional farmers. Since the eighties, and particularly 1984, forest- and bushfires increased so much that smoke began to cover large regions and to become an environmental problem. Several factors contributed to this upsetting change. The period is characterized by occurrence of particularly dry years as 1983, 1991, 1994, 1997 with dry season much longer than usual. Then, the low vegetation, grass and small shrubs, get very dry and combustible. The fire hazard becomes very high, much higher than the population commonly knows.

Other factors can explain that fire occurrence is increasing, specially in the South Sumatra province. The population density was 61 inhabitants per km2 in 1990, much less than in Jawa with 814 inhab./km2 and Bali with 500 (the average of Indonesia is 93). Large areas can be developed for farming and plantations. During twenty years, a "transmigration" programme helps farmers to migrate from the most populated areas to "transmigrations areas" and to settle in new villages with governmental incentives. Increasing the natural growth of the local population, the growth rate was 3.1 in the 80's (2.0 for Indonesia). The pressure of population on land and forests grew proportionally.

In the same time a strong impulse was given to forest exploitation and tree plantations (see map of forest concessions and forest plantations in South Sumatra). The commercial forest concessions or HPH (*Hak Pengusahaan Hutan*) are rent to private companies by the government

for a defined period to extract timber, but with the duty of replanting forest trees. The industrial forest plantations or HTI (*Hutan Tanaman Industri*) are let to companies by the government to establish commercial plantations as rubber or trees for pulp industry. They replace forest classified as convertible or degraded vegetation. This forestal activity changed the land cover on large areas and largely increased the actually cleared area before planting.

The total surface burned each year is variable, particularly in forest and related to the rainfall and the length of the dry season, as it is shown in table 1.

Table 1 - Total area burned for the registered fires (after FFPCP, 1997).

	1991	1992	1993	1994	1995
Climatic conditions	long dry season	normal	normal	long dry season	normal
Total area burnt (ha)	1 338	13 865	5 642	60 516	6 343

The year 1997 is much drier than usual. Forest and vegetation fires are mostly uncontrolled and they have become so abundant in Sumatra and Kalimantan that the smoke constituted a very large cloud, constantly present on a part of Sumatra, Kalimantan, and moved with the wind until Singapore and Malaysia. The visibility for airplanes and ships was sometimes very poor, and the level of air pollution raised in some cities was unbelievably high, causing respiratory troubles.

2 - Types of forest

Table 2 - Forest areas in South Sumatra province (source Department of Forestry, 1991) and proportion of the province area.

	Area in km^2	Percent of the total province area
- Natural forest reserve (& recreation forest)	7 750	7.4
- Protection forest	7 960	7.7
- Limited production forest	3 330	3.2
- Production forest non convertible	21 240	20.5
Total non convertible forests	**40 280**	**38.8**
Convertible forest	**11 860**	**11.4**
Total forests	52 140	50.3

In Indonesia, forests are classified according to an official land status. The areas covered by forest in the province are given in table 2. We recall that South Sumatra province (*Sumatera Selatan* or *Sumsel*) has a total area of 103 688 km2, representing 5.4 percent of the national area (473 481 km2). Areas for other use include fallow lands and scrublands with some content of woody plants. They can easily be burned, but are not in the field of this study.

- *Natural forests*

Obviously, natural forest reserves, protection forests and limited production forests are not areas adapted to feed livestock. In production forest, the logging activity is incompatible with animal husbandry. Reforestation and tree plantation could be damaged by animals. Rainforest contains very few palatable plant species. Even after logging, which opens the forest canopy and make possible the growth of pioneer plants, the flora is poor in species palatable by cattle. A small number of cattle and buffaloes live in forest areas ; they are raised in village and the surroundings, not really in forest.

- *Plantations*

Industrial plantations owned by big companies concern rubber (*Hevea brasiliensis),* oil palm (*Elaeis guineensis*) and trees grown for paper pulp (*Acacia mangium, Pseudoserianthes falcataria, Gmelina arborea*). Under rubber trees and oil palm, the ground cover is maintained quite clean : it is the result of the shade and sometimes herbicide treatments on the row of plantation. In young plantation, a cover crop controls the weeds. The fire hazard is low. In the contrary, the density of trees for pulp is high. Very few plants are able to grow under them but the soil is covered by an abundant litter. This structure of plantation makes them very susceptible to fire. The companies have organized their own warning organization and their fire brigades.

The small holders have also commercial plantations :
- rubber trees, mainly in the central region. The production collected by a full time farmer represents a sufficient income for his household. Often the native vegetation is allowed to regrow in the plantation. The rubber trees in production are included in the secondary forest. They are called jungle rubber.
- coffee trees (*Coffea canephora*) are planted in the mountain areas, often on deep slopes. Coffee is also a good commercial cultivation.
- candle nut trees (*Aleurites moluccana*) or *kamiri* are also planted in the mountains and often live in secondary forest.
- coconut trees are found in small plantations for the local consumption. The soil is covered by grass, very often heavily grazed.
- fruits trees are cultivated everywhere and the production is for the national market : durian, rambutan, mango, orange, banana, jackfruit, etc. The farmers usually associate three kind of spaces on three levels (tall trees, small trees and crops) in an integrated agroforestry system. In this system, the ruminants have several roles to play : they act as a cleaner in the cultivated areas, they are used for ploughing in the fields and for transport, they eat agricultural wastes, they produce manure, they are also a valuable capital.

3 - Causes of fire

The causes of forest and vegetation fires have been largely discussed in the frame of the FFPCP project, and the following comments refer to the findings already published or in way to be done.

- Direct causes

Land clearing, burning agricultural waste and shifting cultivation are the major actions explaining wild fire. Careless use of small burning or cigarette may spread out and cause big burning. Arson because of retaliation probably represents a significant cause of fire. The table 3 shows the list of official and non official causes mentioned by the project (FFPCP, report N° 10, 1997).

Table 3 - Usefulness of livestock according to direct causes of fire

CAUSE OF FIRE	HOW LIVESTOCK CAN HELP FIRE PREVENTION
Accidental	Only by reduction of combustible material by grazing and browsing
Burning to create grazing	Non commonly used. Rare in *Sumsel*
Burning of agricultural waste	Many byproducts of crops are valuable by feeding animals
Camping	no
Cigarette smoking	no
Hunting	no
Industrial accident	The same as accidental
Traditional land clearing (*ladang*)	No, or only on the long term by stabilizing cropping system : integration crop/livestock can improve soil fertility
Big scale land clearing (HTI)	no
Sonor [1]	no
Arson	We must treat the indirect causes

According to the FFPCP observations (1997), the high frequency of smoke emission comes from *ladang*, *sonor*, land clearing and burning agricultural waste, all practices accompanying agricultural production, tree plantation or exploitation of forest. Arson is also mentioned as an

[1] *Sonor* is the burning of grass to clean land before sowing rainfed rice in the swamp areas between Palembang and the west coast.

important cause, but rely with indirect causes. Livestock are not involved in these causes.

Burning to create grazing is not a traditional way in South Sumatra. All surveyed farmers during the mission explained that they never use fire to prepare pastures or to get grass regrowing. Except one, in Pendopo region (Muara Enim district), who owns 70 cattle and has established years ago 200 ha of pasture. He uses burning to maintain a savannah-type vegetation, to avoid bush encroachment and to produce regrowing of the native grass *Imperata cylindrica*.

We can easily explain why farmers do not burn vegetation for cattle feeding. The vegetation grazed by cattle include native grasses and leaves of bushes or trees found everywhere, in the fields after harvest, in the border of fields and roads, in fallow lands, in lowlands near the ponds where they can drink. In dry season, the best plants are found in wet places, remaining green, and are heavily grazed : they regrow without fire. In dry soils, the species of grasses are not a good fodder because too fibrous. Burning helps them to regrow, specially *Imperata cylindrica*, producing young palatable leaves in small quantity. But these very common grasses are not good enough for cattle to justify fires.

Burning of agricultural waste is an easy and cheap practice to clean the fields before a new vegetation cycle. The crop residues as dried leaves, old stems, straw and fruit envelopes hinder the futur soil preparation and have no value for farmer. Some of them have a forage value : hay of beans and peanuts after harvest, leaves of cassava. If they are properly conserved, they can readily be eaten by ruminants. Straws of maize and rice have low nutritive value but treatment with urea improves digestibility and nitrogen content.

Accidental fires are related to the presence of combustible material. Ruminants can help in controling the lowest vegetation biomass.

- Indirect causes

The indirect causes mentioned by FFPCP (1997) are presented and commented in the table 4.

Impact of livestock on land fertility is well know in the agricultural context. The strengthening of livestock and agriculture association is a response to the shortage of land. Cattle is used to prepare soil for cropping. Wider areas can be cultivated with the same manpower. Cattle can provide manure helping to fertilize soils. The best manure incorporates straw or rough material finally composted instead of burned. Part of the agricultural waste can be eaten or transformed by animals helping to recycling them. They also be mechanically incorporated to soil by ploughing with draught animals. Income earned with animal production can help the farmer to invest in chemical to fertilize soil and for crop treatments. More longer the soil conserve its fertility, less often the farmer burns forest to open new fields. This association concerns annual or short perennial crops, but not the plantations.

Table 4 - Usefulness of livestock according to indirect causes of fire

Indirect cause	Livestock expected impact on cause
Prolonged dry season	no
Land fertility	Association of livestock and cropping can considerably help to maintain soil in good condition of fertility
Price fluctuation of agricultural products	Livestock production, less sensitive to price fluctuations, can help farmer to stabilize his income
Logging activities	no
Lack of discipline, human negligence	no
Land dispute	only if animal production is felt as a compensation of lost privilege

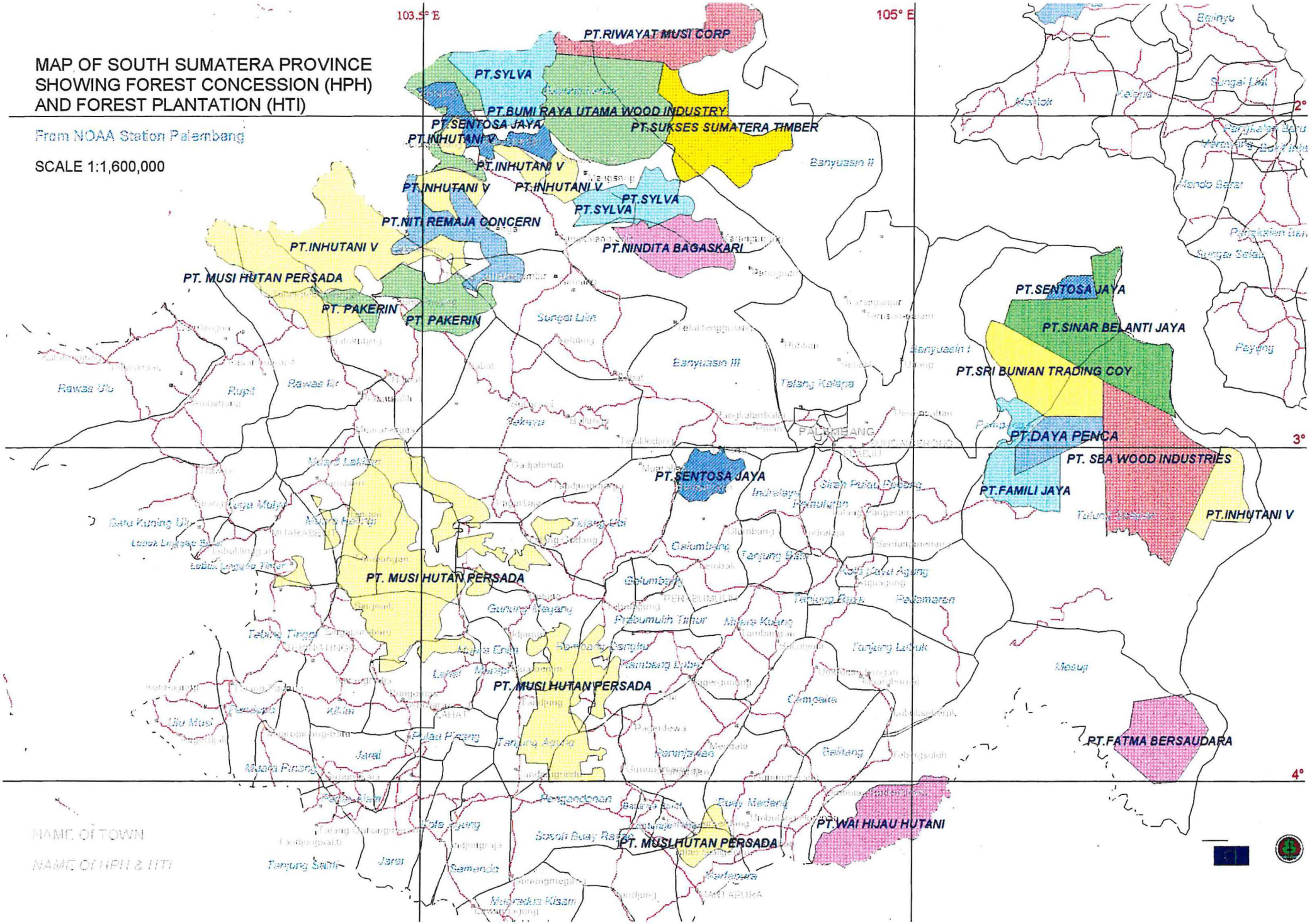
Fluctuation of market price mainly affects farmers specialized in agricultural products for export, as coffee or rubber. Animal production must be understood as a diversification activity, not time consuming, but needing a care every day. The meat market in Indonesia is stable and demand exceeds offer.

Land dispute is probably one of the main root of many destructive fires in commercial plantations. The loss of access and use to the lands planted by the concessions seems to be one of the major claim or rural population around them. The increase of population, the arrival of transmigrants, but principally attribution of thousand of hectares to big companies have reduced the farmer's extractivist activities and additional incomes from the forest products. As written by FFPCP (1997), *"as long as land dispute issues are not solved, the risk of arson threatens these large plantation areas, especially during prolonged seasons"*. This year, high number and intensity of fires confirm this statement.

Like other agricultural activities of diversification, cattle raising can create a complementary activity and a new source of income, kind of compensation for all advantages lost with the free access to forest. Companies having received concessions in forest area are more or less engaged in actions of development in the villages concerned. Modern agricultural development schemes are proposed and mostly applied in the new villages of transmigrants. In traditional villages, social receptivity to change seems much lower. Nevertheless it is in these villages that the need of development in the highest.

4 - Transmigration programmes

In 1990, the population of the South Sumatra province reached 6 313 000 persons, representing 3,5 % of the Indonesian population, with an annual growth rate on the 20 last years of 3,3 %. The density was 61 inhabitant per km2, lower than the Indonesian average of 93 inhabitant per km2.


MAP OF SOUTH SUMATERA PROVINCE
SHOWING FOREST CONCESSION (HPH)
AND FOREST PLANTATION (HTI)
From NOAA Station Palembang
SCALE 1:1,600,000
103.5° E
105° E
2°
3°
4°
PT.RIWAYAT MUSI CORP
PT.SYLVA
PT.BUMI RAYA UTAMA WOOD INDUSTRY
PT.SUKSES SUMATERA TIMBER
PT.SENTOSA JAYA
PT.INHUTANI V
PT.NITI REMAJA CONCERN
PT.NINDITA BAGASKARI
PT. MUSI HUTAN PERSADA
PT. PAKERIN
PT.SINAR BELANTI JAYA
PT.SRI BUNIAN TRADING COY
PT.DAYA PENCA
PT. SBA WOOD INDUSTRIES
PT.FAMILI JAYA
PT.FATMA BERSAUDARA
PT.WAI HIJAU HUTANI
PALEMBANG
NAME OF TOWN
NAME OF HPH & HTI

One family was compound of about 5 persons. The province of South Sumatra is less populated than many other provinces.

Different funding sources have supported a important transmigration programme. Populations from the most populated areas of Indonesia migrate to less populated places, mainly Sumatra and Kalimantan. Population of the South Sumatra province increased the last two decades with the arrival of transmigrants. In the South Sumatra province, the main areas of transmigration are :

- a wide area in the lowlands and swamps of the northern and northeastern regions of Palembang, until the north of Sekayu,
- a wide area in the lowlands, south of Kayu Agung and east of Batujara,
- a long area of lowlands and hills along the montainous chain in the north of Lahat.

Some of these areas have an irrigation programme.

The programme helps the farmers at the first stage of settlement giving a support to get housing and land for cropping and gardening. In many cases, livestock is also given, mostly cattle used for draught and for market, and sometimes goats. Animals from other provinces were imported for this purpose. A farmer having received free a young cow must return to the head of village the first new born calf which is given to another family of settler. The calves born later are owned by the farmer. The provincial services of agriculture and livestock focuse their activity on these transmigration areas. Extension officers of these services work mainly with the transmigrants.

5 - Regional characteristics

- Climate

On the base of climate and rainfall, the province (islands excluded) can be roughly divided in 3 regions :

- the driest region receives about 1500 mm annually. It is located in the southeast (a large part of OKI district). Reference in the table 5 : Kayu Agung. The dry season has a duration of 5 months, from June to October.

- the largest region includes the central area and the northeast, receiving between 1500 and 2500 mm (large parts of Muba, Muara Enim and OKU districts, western and northern part of OKI). Reference : Prabumulih. The dry season can be almost so long as in the east.

- the highest region, up to 1000 meters in altitude, includes the western mountains receiving more than 3000 mm rainfall and the upland hills along the chain. It receives more than 2500 mm (large parts of Musi Rawas, and Lahat, western part of Muara Enim and OKU districts), except in some much drier valleys (Padang Tepung for example) . Reference : Muara Enim. The dry season is short (one or two months), except in very dry year.

Table 5 - Mensual and annual rainfall in 3 regions of South Sumatra (mm)

	Muara Enim	Prabumulih	Kayu Agung
January	530	150	190
February	260	260	180
March	250	220	290
April	260	200	170
May	250	90	180
June	160	80	30
July	80	50	0
August	170	90	100
September	200	50	40
October	300	70	30
November	280	20	190
December	580	400	90
Total	**3320**	**1680**	**1490**

- *Pilot areas for the project*

On account of the large size of the Province of South Sumatra, the mission was not able to conduct surveys on the full area. For this reason, the three pilot areas of the project (FFPCP, report No 10) representing the main important forest types were selected for field visits. The districts more concerned by forest fire are Lahat, Muara Enim, Musi Banyu Asin and OKI. The areas chosen by the project are the following :

- **Pilot area Ulumusi** in the district of Lahat (approx. 1000 km2). It is the most populated area of the province (100 inhab./km2), with the highest income per capita. Ulumusi subdistrict occupies part of the mountainous water catchment area of the Musi River. The major sources of income are from coffee, candle nut and rice. In this district, there is a clear competition between forestry and agriculture due to the pressure for land.

- **Pilot area Pendopo** in the district of Liot (approx. 4000 km2). A large part of this pilot area is occupied by the forest concession of *PT. Musi Hutan Persada (MHPP)* which belongs to the Barito Pacific Group. This concession area is mainly planted with *Acacia mangium*, the wood being thought to be processed for pulp. It includes transmigration settlements in Benakat and smallholder's rubber gardens. Other concessions are grown with oilpalm. Traditional villages are surrounding the plantations, getting income from fruit trees, rubber and rice. Reforestation areas including plantations are the most affected by fire, probably caused by land use conflicts.

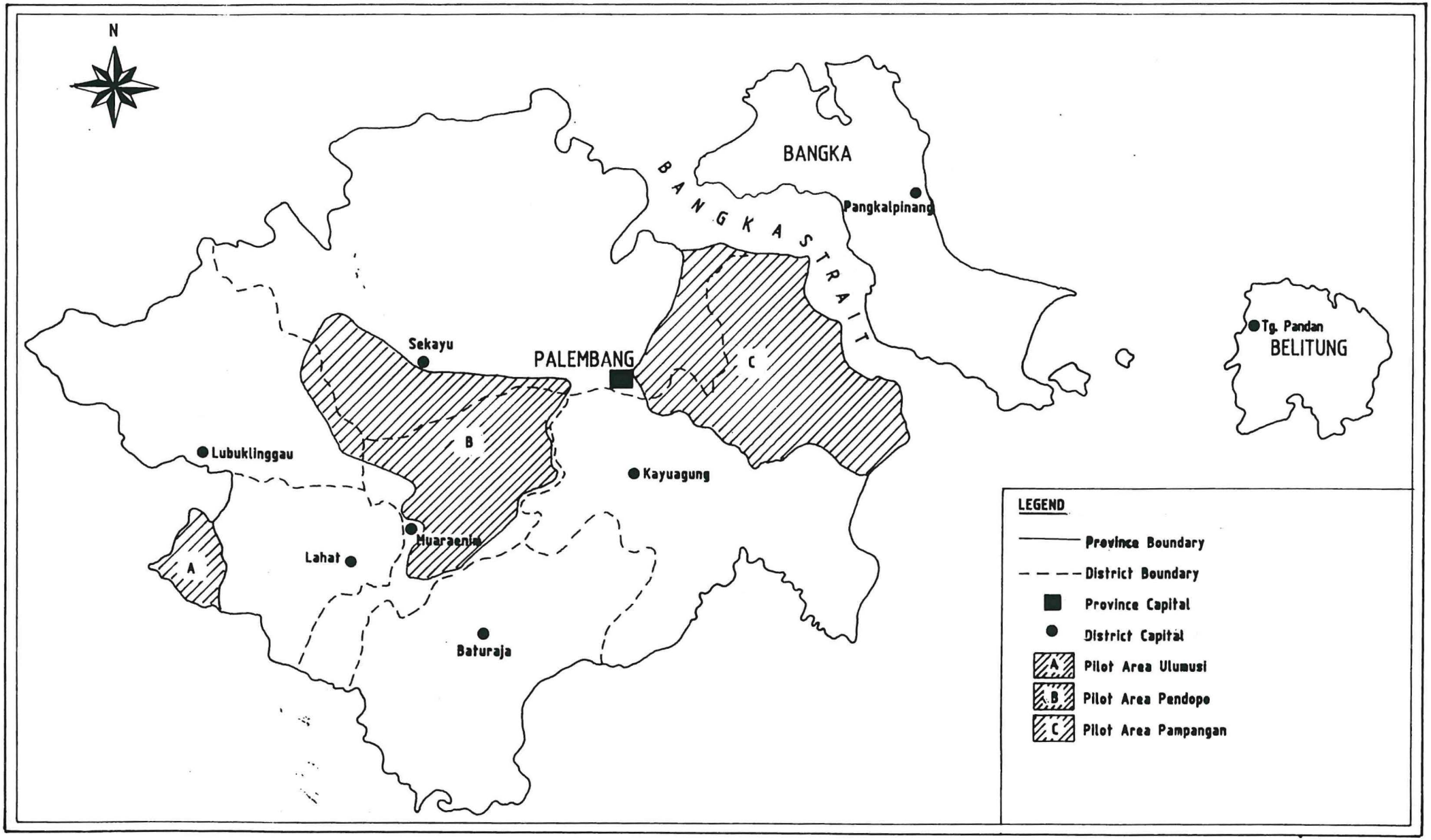
- **Pilot area Pampangan** in the districts of Muba/ Oki (approx. 13 000 km2). It consists mainly in peat swamp forest which is affected by forest fire, especially during prolonged dry seasons.

Surrounding planted or cultivated areas produce fruits, coconut and rubber. The swamp areas are covered by grasslands or swamp forests. The population is sparse and lives from fishing, from irrigated rice cultivating and watershed rice cropping in fields established after fires called *sonor*. Forest is used to timber extraction in HPH concessions (commercial forest concessions). In peat swamp forest, fires have a low occurrence but each one generally burn very large areas (average of 3000 ha per fire).

Detailed surveys have been carried out in selected villages by the rural development section of the project. In particular in these surveys, the respondent had to give the number of animals raised in his household.

PILOT AREA
PROVINCE SOUTH SUMATRA

SCALE 1 : 4,400,000



Chapter 2

Livestock in the province and perspectives of development

1 - Livestock population in Indonesia and in the province

By the analysis of the livestock population in the province and its evolution in comparison with the national data, we want to understand the recent situation and trends in the aim to highlight the potential of livestock development, particularly of the ruminants. The following sources were used to gather information :

- The statistics on livestock published by the national Directorate of animal husbandry (statistical book of livestock 1996).
- The last statistics (1994) published by the central Bureau of Statistics.
- The data on livestock collected by the project in the villages surveyed in the pilot zones.
- Oral information received in the provincial livestock service and the FFPCP project.
- Personal observations during the field trips.

- Statistics on livestock population

The following statistics are the official data for 1994. The table 6 compares the number of domestic animals and shows the proportion between the provincial and the national population.

In comparison with the human population of the province, the proportion of big ruminants (cattle and buffalo) is one for 11.3 inhabitant and the proportion of small ruminants is one for 10.2 inhabitant, very close to the national average.

The majority of ruminants is raised for meet. Cattle and buffalos are sometimes used as draught animals, specially for ploughing, but this activity is sometimes replaced by motoring.

We can underline the very low number of dairy cows. There is no dairy company in the province and the milk is imported in majority.The dairy cattle is mainly raised around the cities.

Table 6 - Livestock population (number of heads)

	Indonesia	**Sumatera Selantan**	**Percentage %**	**Provinces with higher population**
Dairy cow	334.000	154	0.05	Jawa Timur, Jawa Barat
Cattle	11.367.700	**446.400**	**3.9**	Jawa Timur, J. Barat, Sulawesi Selatan
Buffalo	3.104.400	**136.200**	**4.4**	Jawa Barat, Sulawesi Selatan
Horse	610.800	2.800	0.4	Sulawesi Selatan, Nusa Tenggara Barat
Goat	12.769.600	**545.000**	**4.3**	Jawa Tengah, Jawa Timur
Sheep	6.741.300	86.100	1.3	Jawa Barat
Pork	8.858.000	200.600	2.3	Sumatera Utara, Nusa Tenggara Timur, Bali

Source : Directorate general of animal husbandry

Statistics indicate also for the province 12.1 million of native chicken (5,0%), 1.5 million of ducks (5,5%), 806 000 layers (1,3 %), 853 000 broilers (0.1%).

- Livestock repartition in the province

The Sumatra Selatan province is divided in 10 districts called *Kapubaten* [1]. These districts are divided in subdistricts called *Kecamatan* [2] (a total of 101 in the province). Population of livestock in *Kapubaten* is shown in the table 7 and the density of ruminants in table 8 (source : survey report of the Livestock Service of the Province for 1995).

In the central region of the province, between Palembang, Muara Enim and Baturaja, as well as around cities (Palembang, Pangkalpinang), density of livestock is higher than in Eastern and Western part (districts of OKU, Banyu Asin, Muara Enim, and part of OKI). Cattle and goats are specially concerned. In the Western mountainous regions (Lahat, Musi Rawas), goats are common, al well as buffaloes. Density of ruminants is much lower in the eastern swampy areas (eastern OKI and Muba), cattle are dominant. We must underline the diversity of the livestock densities in the different subdistricts. For example many cattle live in Mesuji sub-district, southeast of Palembang, on the boundary of the province, related with dynamic transmigration villages. Only a small number of ruminants are raised in Bangka and Belitung.

[1] The head of the district is the *Bupati.*

[2] The head of the subdistrict is the *Camat.*

Table 7 - Livestock population in the districts of South Sumatra province (head) in 1995.

Kapubaten	Dairy cows	Cattle	Buffaloes	Goats	Sheep	Horses	Pigs
Palembang	14	3 379	101	6 337	1381	3	310
Musi Banyuasin	97	91 812	12 280	73 107	16 810	0	10 373
Musi Rawas	0	35 892	32 967	132 621	13 159	5	24 989
OKI	0	65 056	16 068	33 587	5686	9	1 385
OKU	0	167 993	32 487	103 936	22 047	2 319	110 796
Lahat	4	21 941	23 533	146 560	17 881	309	178
Muara Enim	0	59 508	9 518	51 805	6 416	108	472
Pangkalpinang	0	563	19	520	84	0	6 230
Bangka	0	679	550	389	975	0	47 037
Belitung	30	800	187	157	0	2	2 109
Total Sumsel	**145**	**447 623**	**127 710**	**548 659**	**84 439**	**2 755**	**203 879**

Table 8 - Density of ruminants in the districts of South Sumatra province

Kapubaten	Area (km2)	Human population (inhab/km2)	Cattle density (head/km2)	Goat density (head/km2)	Buffalo density (head/km2)
Palembang	401	1 095 925	8.4	15.8	0.2
Musi Banyuasin	25 526	1 025 476	3.6	2.9	0,5
Musi Rawas	21 513	559 396	1.7	6.1	1,5
OKI	21 619	887 688	3	1.5	0,7
OKU	10 408	1 044 538	16.1	10	3,1
Lahat	4 034	637 905	5.4	36.3	5,8
Muara Enim	9 575	653 529	6.2	5.4	1
Pangkalpinang	89	118 221	6.3	5.8	0,2
Bangka	11 557	526 753	0.05	0.03	0.05
Belitung	4 532	196 588	0.2	0.03	0.04
Total Sumsel	109 254	6 746 019	4,1	5	1,2

Goats are the most common ruminants, but cattle have the highest economic value. Buffaloes are present in all regions, except in the islands, and have the same population than cattle in the two montainous districts (Musi Rawas and Lahat). Sheep look to be less popular than goats and live in the south of the province and in the mountains. Dairy cows are only raised around Palembang (northern area) and in the island of Belitung. Their population is particularly low. Horses, used for transport, are not common and only live in the southwest of the province.

- Evolution and trends of livestock population

The table 9 shows the very high development of poultry at the village level, as well as pigs, and the decreasing of industrial production of layers and broilers. The number of cattle for meat increase rapidly, partly due to importation from other provinces, sign of a strong dynamic in South Sumatra. Sheep have not the favor of the farmers. The buffalo population is slowly decreasing.

The development of meat production is based in majority on native chicken and cattle.

Table 9 - Growth of domestic animal populations in Indonesia and South Sumatra province. Period 1991-1994 (in percent)

	Indonesia	**Sumatera Selatan**
Dairy cows	+9,0	-11
Beef cattle	+7,6	**+24,6**
Buffalos	-6,2	-1,1
Goats	**+11,2**	**+8,9**
Sheep	**+10,3**	-18,7
Horses	-12,1	+18,9
Pigs	**+16,4**	**+60,8**
Native chicken	+17,5	**+66,6**
Layers	+35,1	-32,0
Broilers	**+52,7**	-66,5
Ducks	+8,5	**+29,1**

Source : Directorate general of animal husbandry

2 - Main characteristics of domestic animals and pastures

- Cattle

Three different species of cattle are raised in South Sumatra province. Local cattle found in South Sumatra are the result of successive introductions of animals from different origins and the free crossing between them. Phenotypes are variable, showing more or less characters of one or other original breed. Herds are often heterogeneous. There is no traditional practise of selection, males are rarely castrated and reproduction is free. In the farms newly provided with cattle, the breed is Bali cattle.

Bali cattle (*Bos sondaicus*) are native from Java and Bali. It is an endemic species and the wild parents still live in some protected forests in Eastern Java. The development of this animal is promoted by the government. Farmers effectively like this breed for its nature easy to be domesticated, which makes it particularly adapted to live close to the house and to be used for ploughing. Its prolificacy is good, with a calf produced every 12 or 14 months. The carcass weight is 51-52 % of the liveweight (when it is only 44% in local breed). Bali cattle are imported from Java to provide animals to the transmigrants. Its colour is yellow for the female and dark brown for the male, with the lower half of the legs white. It is a small breed : 235 kg for females and 350 kg for males.

Zebu cattle (*Bos indicus*) are originated from India, but introductions in Indonesia are ancient. This kind of animal is well known in the region and very common. Its weight is higher than other cattle and for this reason it is used for drought, ploughing or pulling carts (310 kg for females and until 400 kg for males). Most of these zebus probably are Ongole breed. The colour is grey.

Bovine cattle (*Bos taurus*) are an ancient breed in South Sumatra. The size is small. Some local animals have already the characteristics of this breed. They crossed with the posterior introductions of zebu or Bali, and are progressively disappearing by genetic absorption.

The dairy cattle (*Bos taurus*) belong to the European Freesian Holstein breed. Animals are black and white. A small number of peri-urban smallholder farms still exist in the province, but their number is decreasing. A project from the government prepare the constitution of a dairy farm in Semendo, south of Muara Enim, with on site milk processing.

The Sembawa Animal Breeding and Forage Center has a regional mandate to improve the local cattle. The genetic program of the center is selection in a herd composed of local animals and then the genetic improvement by artificial insemination. The selected cows are mated by a local bull for the first partum, then, they are inseminated for the following calvings with Brangus breeds. The semen comes from Jawa. One or twice a year, the selected animals are sold as reproducers to the farmers at a price in relation with their quality.

- *Buffaloes*

Centuries ago, the buffalo was the most important livestock used for ploughing. Therefore in the last century the population was higher than the population of cows and, though having increased a lot, it is now one third of the cattle number. The present decrease is explained by a low birth rate, a slow growing up, a low resistance to heat, a decreased commercial benefit.
In Indonesia is distinguished the "mud buffalo", most common, from the "river buffalo", or dairy buffalo, localized in some villages.

- *Small ruminants*

Goats are very common in the villages. They probably belong to the Kacang breed. The weight is 25 kg for male and 20 kg for female. On the other hand, sheep are only found in some regions and their number is decreasing in the province. Farmers avoid to raise sheep and Bali cattle together, the former being rightly suspected to contaminate the later with *catarrhal malignant*

fever. The local breed wears short wool and the weight is 15-25 kg for male. Raising small ruminants is only done by farmers at family level : animals are kept close to the house in the night and graze freely all around in the day. There is no traditional genetic improvement.

- *Other animals*

Pigs are not common in the villages in this province where the Muslim religion is dominant.

Chickens are the most common animals raised in most families. Chickens are with fish the first animal products eaten in Indonesia. They are mainly local breed. Chickens are free in the house yard and find feed by themselves or just receive kitchen waste. The Sembawa Center has started an improvement programme on local chickens. Broilers and layers are raised in special farms with specific breeds.

Ducks are familiar in Indonesia and eggs are sold in the market. The number of ponds, rivers, canals, swamps and irrigated areas make duck raising easy. Some farmers have large herds and conduct them to paddy fields after harvest.

Fish are a popular food. Fishing is a very common activity. In the rivers and in ponds, some fish are fed in cages, principally gold fish and cat fish and the production is probably high. The fry is produced in special farms.

Birds like pigeons and other local species are shot in hunting parties and many are used as a meal.

- *Wild animals*

Native animals live in the forest. We can mention some of them : tiger of Sumatra, elephant of Sumatra, tapir, rusa deer, bear, pangolin, different monkey species, pythons... Guns are not allowed in Indonesia. Hunting is sometime practiced with traps and nets. Traditionally Indonesian people like to consume venison of deer very much but this animal becomes not common any longer. Bears and elephant sometimes cause damage in cropland, but wild pigs, very common everywhere, are worse. Hunting is organized to put them out of the field areas, but the meat is not eaten. Some of these animals are endangered due to the rapid destruction of their habitat. Very little profit seems to be taken from the wildlife. Fires not only damage and degrade their habitat but also cause terrible stress to these animals, wound them or kill them.

Some elephants are captured in the *Kapubaten* of Lahat to be domesticated. They are used to clear the forest. The companies in charge of these animals could face difficulties to feed them.

- *Pasture and forage plants*

The end of the dry season is not adapted to the botanical study of grasses and only a small number of species could be identified during the mission. Nevertheless, it is obvious that the main common spontaneous grasses growing in fallow lands, in roadside and in the non cultivated areas are not very palatable at this time. Good plants were only found in small wet areas. The

spontaneous vegetation is poor in good plants for ruminants. This characteristic is an important bottleneck to the development of cattle in the country. Sometimes plantations were established on grazing areas, reducing the pasture available for livestock. We can see cattle grazing on the roadside because of the lack of pasture. Animals also browse some tree or shrub species as Gliricidia, very commonly planted in the villages.

The development of the livestock production must be based on the plantation of adapted grasses for forage. Particularly under this climate, the forage trees can be helpful. In the center of animal breeding and forage of South-Sumatra in Sembawa, 40 km from Palembang, grasses, legumes and trees were tested. Animals are raised on the farm on beautiful improved pastures. The station produces seeds and cutting of the most relevant forage plants for the farmers (see annex).

3 - Livestock production system

3.1 - Animal production systems in pilot areas

The analysis of the survey realized by the surveyors in the selected villages of the three pilots areas give an idea of the place of cattle husbandry in the farming system.

- *In the Ulumusi area*, 402 households were questioned in 6 villages. The main productions for cash are coffee, candle nut, fruits, but poultry comes in good place in the production, as it is shown in table 10. The most common ruminants are the goats.

Table 10 - Animal population and number of households concerned in the Ulumusi area.

	Number of animals surveyed	Number of families concerned	Proportion of families	Number of animals per family	Maximum number of animals per family
Chicken	**2191**	232	**58 %**	9,4	100
Goats	**376**	102	**25 %**	3,7	20
Ducks	**741**	88	**22 %**	8,4	70
Sheep	49	10	2 %	4,9	18
Cattle	20	8	2 %	2,5	8

- *In the Pendopo area*, 233 households in 3 villages were questioned. The main productions are rubber, coconut, fruits and banana. For three families, 2 raise poultry, as table 11 shows :

Table 11 - Animal population and number of households concerned in the Pendopo area.

	Number of animals surveyed	Number of families concerned	Proportion of families	Number of animals per family	Maximum number of animals per family
Chicken	**1482**	146	**62 %**	10,0	**50**
Cattle	36	30	12 %	1,2	8
Goats	62	26	11 %	2,4	4
Ducks	132	25	10 %	5,3	16
Sheep	14	7	3 %	2	4

From the 3 surveyed areas, Pendopo is the place where the highest number of cattle is found.

- *In the Pampangan area*, the survey of 3 villages representing 195 households reveals that much less animals are raised in region.

Table 12 - Animal population and number of households concerned in the Pampangan area.

	Number of animals surveyed	Number of families concerned	Proportion of families	Number of animals per family	Maximum number of animals per family
Chicken	**990**	45	**23 %**	22	100
Cattle	**2250**	19	9,7 %	3,1 *	**1000**
Buffaloes	4	3	1,5 %	1,3	2
Goats	4	2	1 %	2	2
Ducks	1	1	0,5 %	1	1

* small farmer herds only

Only a quarter of the families have poultry. The number of cattle registered is particularly high because 3 large herds (500, 500 and 1000 heads) graze on the extensive native pastures of Simpang Tiga around the swampy area.

- *Conclusion of the survey* : in a general way, the livestock in the province is raised by farmers belonging 10 to 20 chicken, 5 ducks, 2 or 3 goats or 2 or 3 head of cattle, rarely 2 sheep.

3.2 - Techniques of animal husbandry

During the mission, several *Kepala desa* and cattle farmers were interviewed and many animals were seen in different conditions of husbandry. The ruminants in the visited regions were in reasonably good physical condition, when we know that the moment of the visit was a terribly dry season, may be the worse for years, and even many of them were fat. A lot of farmers care very well their animals, which look very happy and docile. Cattle and buffaloes usually have a ring through the nose, a bell attached to the neck and distinctive cuttings on the ear border. We passed men or women leading their cows with a rope to the plantation, or children with ten or fifteen animals, or cows attached in the side of a field with their calf, or a group of cattle coming back alone to the barn. Others pulled a cart or a sledge, carrying grains, wood for the kitchen or forage. Many goats browsed freely in the villages or in the surroundings. In the villages of South Sumatra, many houses and gardens are fenced, some with fences of wood or bamboo, other with living fences made of many stems of gliricidia or jatropha. These fences protect the garden from the animals or are used to keep animals in the night. It is not rare to see small stables under the traditional house built of wood on pillars. Male are rarely castrated, being sold when they are 3 years old. There is no selection, bulls and cows being raised together. Animals selected to be sold are attached near the house and fed with rich grasses and fattened during minimum six weeks, sometimes six months. Apparently, cattle have no special social function and only represents a source of income and a reserve of money convertible in cash if necessary.

After this field trip, three main systems to raise ruminants have been distinguished.

- Cattle attached or fed in barn.

The most common system to raise cattle is to keep it in a barn close to the house or attached by a rope in the pasture. Farmers care every day their animal, taking it with him when he goes to the plantation, and cutting forage for the evening. The cow attached in a field is changed of place 3 or 4 times in the day. On the way back to home, they stop near a pond and the animal drinks. In the night, animals stay in stable or in the house yard with an armful of green fresh cut grass. Some of these animals are trained and used for drought helping to prepare paddy fields. These farmers own between 1 and 5 animals.

- Animals grazing freely

This system is not rare in the central region of the province, it is less frequent in more populated and cultivated areas. Animals are not attached and find themselves the pasture. The farmers can have much more animals : we met one with 30, another with 70, one is reported to have more than 100. The barn where the herd stays each night is opened in the morning and the cattle freely walks around the whole day. They can be found in the fallows, in the bush, in the roadside, in the forest, in the plantations, near the pond or the river. They do not go far and come back in the evening. If the farmer fears of theft, a shepherd stays with them. For these farmers, cattle can be the principal or the unique revenue.

- *Cattle herding*

Several cattle owner having a small number of animals, mainly cows, trust them to a sherherd. Many owners are not farmers but live in cities and use cattle as a source of profit. The shepherd leads the herd to good places for grazing, watches them, care them and protects them to the thieves. The shepherd receives no payment but one calf every two calves is for him. He can watch until 30 animals.

- *Other systems*

A variety of ways to make money with exists but they are localized and less important. Only are mentioned some of them and have not been visited. Private dairy farms, farm for fattening animals, near the slaughtering house of Palembang, a group of women milking buffalo cows to make a kind of sweet.

Big herds of cattle with more than 500 heads have been reported in the OKI district, but they could not be found and visited during the mission. More information could be collected on these unusual extensive cattle farms.

4 - Animal health

For the ruminants, the province of South Sumatra is quite healthy. The most common diseases are the following :

- The *scabies* (?), a *skin disease* of goats and cattle is often mentioned. A treatment is possible.
- The most serious disease is the *Haemorrhagic septicaemia of cattle and buffaloes* (called septicaemia epizootica or SE in Indonesia). The vaccination is applied every year, sometimes every 6 months.
- The *Jembrana disease* is specific to Bali cattle. Originally endemic to Bali, it is present now in Java and Sumatra. This disease is not common in the province. All suspected focus is warned and the animals in the focus are vaccinated. The vaccine is recent and not yet very used. It has been created and produced by the Research Center of Bali in association with an Australian laboratory.
- The *catarrhal malignant fever* can attack the cattle. The sheep are suspected to infect the cattle and the farmers avoid to raise these two species together. It is probably one of the reasons for the decline of the sheep population in the region.

The diseases missing or well controlled are the foot-and-mouth disease (tests are negative), the trypanosomosis, the anthrax. In town, the veterinarian vaccinates dogs, cats and monkeys against the rabies.

Ticks are present, but in small quantities, and are not a problem. It is thought that they do not transmit parasites.

The livestock service is present in the sub-districts and certain villages have a small veterinary

center. The officers practice the vaccinations going in the villages and in the farms. They also are in charge of extension activities with groups of cattle farmers. Because of the wide dispersion of the animals owned by a big number of farmers, some villages are never visited. Vaccination, visits and treatment are free.

5 - Market and economic profit from cattle

- Livestock and meat market

At local level, the market for living animals is very favorable. Merchants come to villages, visit farmers to buy animals and transport them to cities where they are slaughtered. Prices seem to make farmers satisfied.

At national level, annual consumption of meat in Indonesia is about 9 kg per person. Indonesia is almost self sufficient in meat [3]. The objective of the government is to reach 10 kg per year representing an increase of the present production of 10%. An important part of this increase concerns chicken and poultry. Nevertheless the beef production is progressing : cattle population is increasing. Indonesia is not in situation to export cattle or meat, the objective is only to supply the local market. Except in Iryan Jaya where perhaps extensive cattle farming could be developed, the cattle production will probably remain in the hand of small farmers. Cattle have an additional value as animal power to cultivate rice : the challenge of the national agriculture is to be self sufficient in rice.

Sheep are not promoted in the villages because these animals can spread a disease to Bali cattle. Nevertheless, sheep or goats could be produced in big quantities for export to the Arabic countries. International market is very favorable for small ruminants in this part of the world.

Deer meat does not exist in Indonesia, or only by hunting. Meat produced in special deer farms could probably find very promising market in the big Indonesian cities. Other countries of Southeast Asia start a production in private deer farms. New Zealand, Australia and New Caledonia produce deer meat in very good conditions and export deep frozen antlers at velvet stage to China for medicinal products. New Caledonia exports living animals for reproduction and the farming technology in Southeast Asia. Dear meat could be prepared and frozen to be sent in Jakarta and big cities as a luxury product.

Only one third of the milk is produced in Indonesia. It is partly imported and mainly sold in powder. The national objective is to produce half the Indonesian need. Intensive farms are created and one is in preparation in South Sumatra (Muara Enim district). A certain number of small farms produce milk, particularly around the biggest cities of the province (only a few farms) but the population is not accustomed to consume fresh milk.

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[3] We have observed that the rural population usually does not eat meat, only in special occasions.

- Economic profit from cattle at farm level

Male cattle are sold when they are mostly 3 years old (until 5). The liveweight is often about 200 kg and range from 180 to 300 kg. The amount received by the farmer selling a bull is commonly comprised between 900 000 Rp [4] and 2 million Rp (often 1,2 million). The price per kg of the living animal is estimated about 5 000 Rp/kg, raising often 6 000 Rp/kg. Animals sold for feast and special events can get price 50% higher. Goats are sold when they are 3 years old, a male costs 150 000 Rp, a female 100 000 Rp. The retail price of beef meat are between 9 000 and 12 000 Rp/kg, until 15 000 Rp for the best meat. Price of carcass : about 8 000 Rp/kg.

Other indirect profits from cattle could be taken into account, as the use of draught, the production of manure for gardening. In the opposite, we must consider a part of risk, either an accidental death or a theft, with the loss of capital and profit. In the actual situation of South Sumatra, raising cattle is a reasonably secure activity, less dependant of climatic variability than agricultural productions. Moreover, prices of animals are quite stable, not really influenced by import price of beef meat[5], independent of inflation, when the price of many agricultural products are dependent of international market.

Considering only one animal sold when it reaches 200 kg, a liveweight gain of 200 g/day is equivalent of a gain of 1000 Rp/day. It is estimated higher in many occasions and can commonly rich 1500 Rp/day. It is probably never lower than 800 Rp. The farmer has low monetary expenses : building of stable or fences, rope, bell, some tools for animal care and for forage harvest, sometimes medicines spontaneously bought in pharmacy, but vaccinations and veterinary interventions are free of charge. Investment of farmer is mainly his own time, making many things by himself, and the time of his family. The profit of farmer calculated in an annual base can be 360 000 Rp per animal or more. We can compare this profit with the minimum salary, which is about 1 500 000 Rp/year. For or five animals could give an equivalent income.

This calculation does not include the investment represented by cows husbandry, just for producing calves. A female commonly produces a first calf when she is three years old. Four other young are expected annually before the cow is sold. Females are kept to increase the herd or replace old cow, or are sold when they are two years old (price about 600 000 Rp).

This calculation also exclude the price of the land used for grass production. In case of using common land of the village, grazing is free, but if the grass is grown on private land, we must include the cost of the capital. One hectare of land can cost may be between 0,5 and 1,4 million Rp. An annual pay off could be evaluated from 25 000 to 50 000 Rp for fairly fertile soil, and 75 000 Rp in good soil.

If we consider that 3 hectares are needed to raise one head of cattle in moderately fertile soil or 1 hectare in fertile soil, the capital "land" used for one animal represents a equivalent of 1,5

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[4] At the date of writing report, the change rate is 3325 rupiah for 1 US$.

[5] Indonesia is self sufficient in beef meat.

million Rp. The annual income with this capital could be 360 000 - 75 000 = 285 000 Rp, or for one hectare 285 000 Rp for good agricultural land and less than 100 000 Rp in soil of low fertility. We can compare with income from agriculture : the average income from 1 ha of paddy field after deduction of production costs is about 1 million Rp. In comparison, an old coffee plantation produce 1 to 2 t of coffee for a value of 0,8 to 1,6 millions Rp (the very productive ones yield 3 t for 2,4 millions Rp). Cattle farming is only competitive if production costs are minimum and the charge of land very low or nil. Investments to create a farm needing pasture establishment, fences, equipment and animals can only come from another activity to secure a capital in a productive way. Indonesian farmer most commonly uses the money earned from cattle for domestic, familial or occasional expenses, or to get agricultural inputs, very rarely to increase his capital. Incomes from commercial or industrial activities apparently are not invested in cattle farming in Indonesia. Only some people living in cities own a few heads of cattle and find an agreement with a shepherd to care them.

- *General economy*

The gross domestic product (GDP) of Indonesia was 20 fold higher in 1991 than in 1971 (at constant price). This GDP per capita (including oil incomes) in 1991 was 1 253 000 rupiah (nearly 625 US$).

The GDP of agriculture was 10 fold higher on the same period. Contribution of agriculture to the GDP is proportionally constantly decreasing : 35.0 % in 1971 and 19,6 % in 1991. Nevertheless, the livestock participation to the product of agriculture is increasing : 11,5 % in 1991 against 7,6 % in 1971. At constant price, the livestock product was 177 billion rupiah in 1971 and 2 458 billion rupiah in 1991 (14 time more). Livestock product contributes for 2.3 % to the GDP (2.6 % in 1971). That could mean that the livestock development is near to follow the development of the global economic activity of the country. We can conclude that livestock is still a minor activity in Indonesia, but this activity is in development.

Chapter 3

Discussion on agropastoral schemes to reduce fire hazard

1 - Some general thoughts on interaction between forest fire and livestock

In many countries with warm humid or sub-humid climates, we commonly associate bush fires with livestock. Specially in the African or South-American savannahs, pastoralists and herders very commonly burn the dry vegetation to keep out dead leaves and rough material refused by ruminants, to control weeds and bush encroachment, to keep away some parasites or enemies of cattle and above all to stimulate grass regrow, producing a nutritious feed.

Environmental considerations have focused on this practice. In this case, impact of livestock on the ecosystem has been discussed. Many works have been carried out on bush fires to estimate the short term impacts (at seasonal scale) as well as the long term consequences after years and decades of repeated burning. Conclusions are complex : in somes case, some underline the positive effect by maintaining balance between grass cover and trees and conserving the savannah type vegetation with its biodiversity and its potential of production ; others explain the negative effect on the soil fertility and biology by eliminating organic matter, on the tree populations damaged by flames and on the global change by increasing the carbon dioxide rate in the atmosphere.

In drier environments, particularly in dry forests, which are very threatened in many countries of the world by human activities, the removal of part of the dry or combustible material in the first meter above the ground level helps avoid strong and damaging fires. Sometimes, ruminants are used to control the lowest vegetation in such forests. This situation is known in Mediterranean countries.

In tropical rainforests, logging and "slash and burn" practice have opened large areas of grassland or secondary forests. In dry theseason, degraded vegetation is susceptible to burning. Examples can be found in Amazonian basin. **Cattle farms developed in this area generally use sown permanent pastures which do not need fire as a management tool.** On the contrary, fire is considered as an accident destroying useful forage. Raising cattle to create income in the no-forest lands stimulates farmers to avoid uncontrolled burnings.

In Indonesia, and specially in South Sumatra, the length of the dry season, particularly in the driest years, is one of the indirect causes of huge forest fires. Beside this, cattle farming is not very developed. The present questions are : can the livestock development in this region help to prevent fires or mitigate their impact ? Taking into account the economic and social situation, which production systems must be promoted ?

2 - In the natural forest reserve and protection forest

If we refer to the number of fires and the area burnt according to the land status, the natural forest reserve and protection forest are much less concerned than the production forest : 10% of the total number of registered fires et 5% of the area burnt between 1991 and 1995. Many reasons can be given as the structure of vegetation and the fact that these forests are mostly remote from cultivated or populated areas.

Tropical rainforests are mostly naturally structured in 3 or 4 levels of vegetation. The highest includes the trunks and the canopy of the tallest trees, forming the roof of the forest. One or two lower levels are composed of trees living in the shadow of the canopy, generally high, thin, with not dense foliage. The herbaceous level is very scattered or inexistent. The soil is covered by a thick deposit of litter, dead leaves and branches commonly maintained more or less wet by the natural humidity of the air. This structure is not commonly threatened by accidental fire, or only if the litter becomes very dry. It is for example the case in the Ulu Musi pilot area where the protected forest do not burn or only rarely.

In the Pendopo area, a protected forest is located in the middle of plantation areas. The PT. Musi Hutan Persada developed a buffer zone to avoid illegal logging in the forest. They planted a belt at the border with several multipurpose trees or Acacia trees, cutting by this way the possibility to easily penetrate into the forest for destructive activities.

The peat swamp forests in the Pendopo region are very susceptible to fire. In the wet season, the region is a swamp and the soil is very wet and waterlogged. But in the dry season, the table water declines and the lowest plants as ferns or grasses suffer of draught. Fires, mainly accidental, are very difficult to extinguish because the peat is slowly consumed in the soil and spreads the fire.

Livestock cannot have influence on fire prevention in natural forest reserves or in protection forests. Prevention by cattle farming could only be applied on the margins.

3 - Limited production forest

When the forest begins to be cut or cleared, all the spots opened in the native forest are directly lighted by the sun, invaded by small plants and young trees and the litter can dry well. The native forest is not very susceptible to burning, but the degraded forest can become very combustible.

Fires ares lighted for shifting cultivation by farmers in order to open a piece of land for planting or cultivating. In Ulu Musi region, the forest is threatened by farmers wishing to appropriate land for planting coffee or kamiri. In the flat areas of the central region, the forest is cleared by farmers to plant rubber.

The sylvo-pastoralism can not be promoted in this type of forest. In montaneous regions, slopes are too strong for grazing. In flat areas or on hills where cattle could graze, coffee or rubber plantations give a sufficient income to a small family. To expect an equivalent profit with cattle, the farmer must raise 7 to 10 cattle grazing on 20 to 30 hectares of native pastures.

4 - Convertible forests, industrial tree crop plantations

Private or governmental companies are allowed to replace non productive forests largely covered by grass, bushes and low value timber by industrial tree plantations. The area can reach a hundred thousand hectares. We distinguish four different kinds of space in the industrial plantations (HTI) :

1) Production areas

Under rubber, the soil is generally cleared on the row of trees by spraying herbicide. Shade naturally reduces the weeds or stops them from growing ; only a few small grasses and sedges can cover the soil between rows (mostly the unpalatable *Ottochloa arnottiana*). Animals could find pasture only in the areas included in the plantation but not planted for any reason (unfertile places, waterlogged areas) or invaded by grass after the death of some trees. We have observed cows in rubber plantation readily eating dead rubber tree leaves (still green) lying on the ground. Planters avoid cattle in the plantation fearing damages to the bowls collecting latex. In Northern Sumatra, sheep have been tried to control the grass cover in plantations where rubber trees were decimated by a root disease. Fortunately it is not the case in South Sumatra where the climate is drier : sheep, as cattle, are not wished in the plantation.

Oil palm plantations are heavily shaded and the ground is bare. Association with livestock is practiced in some wet countries of Africa but this system is not relevant in Indonesia because the trees are shorter and stronger. Furthermore, the good yields obtained in Indonesia justify an intensive production system without cattle.

Acacia mangium plantations are densely planted (2 x 4 m apart). The shade is rapidly very dark. A few species of grasses were observed (some native *Panicum*) representing a very low biomass. The ground is covered by a thick mat of dead leaves. This litter can easily dry and be very combustible but livestock cannot remove it. It is not possible to feed cattle in these plantations.

Only the coconut plantations are covered by grass and are commonly used by grazing cattle and small ruminants. There are no industrial coconut plantations in South Sumatra, but only some small ones owned by farmers for local consumption.

2 - Areas newly planted

When the soil is cleared, it is prepared to be planted. The disturbed soil is directly lighted by the sun and many pioneer plants germinate, forming a cover of weeds. The grass "alang-alang" (*Imperata cylindrica*), which is almost unpalatable, is one of the common plants. When dry, this cover is highly flammable. A fire would kill the young trees and destroy the young plantation.

In rubber and oil palm plantations, the soil is maintained clean by herbicide or more often is sown with a cover crop which protects the soil against erosion and compete with the weeds. The cover crops are creeping legumes as *Pueraria phaseoloides, Calopogonium mucunoides, Calopogonium coeruleum, Centrosema pubescens*. In two or three years, the trees have reached a size big enough to shade the soil and eliminate the cover crop. Cattle are not allowed to graze in these areas : they could damage the young trees and browse the accessible leaves. In Malaysia, sheep have been used in plantations with pasture plants and fodder trees in intercropping. The main problem caused by animals is the compaction of soil by trampling.

In paper pulp tree plantations, weeds are allowed to grow. The species of trees as *Acacia mangium, Pseudoserianthes falcataria, Gmelina arborea* are fast growing. In one year, trees begin to shade the weeds and control them. The risk of fire is high the first year or the first two years.

We can imagine a grazing scheme to control weeds on the newly planted areas. A heavy grazing could reduce the biomass on the soil. The grass cover would be grazed by cattle or sheep (we must avoid goats because they are able to eat the leaves and the bark of the young trees). But we must take into account that the native vegetation is a very bad pasture and we can be very disappointed by the results. A better choice could be to sow a fast growing grass as Rhodes grass (*Chloris gayana*), a forage sorghum, and some legumes. The soil must be sufficiently prepared before receiving the seeds. This cover crop would be established for only one or two years.

The area planted by the biggest companies are enormous, about 20,000 hectares annually. On spontaneous vegetation, theoretically 4000 to 6000 head of cattle or 40,000 to 60,000 sheep would be needed to graze the totality of this area. On improved pasture, the cover could be grazed by 15,000 cattle or 150,000 sheep. In the last case, that means an annual production of marketable animals of 2000-2500 cattle, (40-50 heads each week) or 20 to 25,000 sheep. We must remember that 38,000 cattle were slaughtered 1993 in South Sumatra. The sheep could be proposed for export. This kind of activity should be very well studied, prepared and planned and forces the concerned company to create a special livestock branch, not only for the technical management but also for marketing. A quick economic assessment is given in the next table.

Quick assessment of grazing in a new established tree plantation

The calculation is done for a 100 hectare plot.

1) We suppose that cattle graze heavily the native plants growing after clearing and plantation.

Pasture has a very low quality : daily liveweight gain expected : 150 g/ head, carrying capacity : 3 heads/ ha. Annual gain : 1825 kg on the plot. Value : 5000 Rp/ kg. Annual revenue for a plot : about 9 millions Rp (the costs of production are not included).

2) We suppose that a fast growing pasture is established.

Expected production : daily liveweight gain : 350 g/ day/ha, or 12 775 kg /year on the plot.
Value : 63 millions Rp (costs of production not included).

Pasture establishment : seeds : 25 millions Rp, fertilizer : (to be calculated), soil preparation and sowing, waterpoint, fencing a barn : probably a total cost between 50 and 80 millions Rp including seeds.

A precise calculation must be made because the benefit is probably lower than the production cost. A pasture is commonly established for many years, but in the present case, for only one year, until the trees have grown enough to shade the soil.

This kind of project in the total area seems unrealistic. But it could be applied at a smaller scale, only in the most threatened areas. A minimum area must be used to justify equipment, shepherds' employment, training and marketing organization. The social impact of such activity would be very low.

3 - On firebreaks

In rubber and oil palm plantations, firebreaks are a narrow belt (6 to 10 m) at the border of each park, maintained with herbicide, just to stop creeping fire coming from outside. It does not need grazing.

In Acacia plantations, some wide firebreacks (30-40 m) divide the plantation blocks. The vegetation is a grass cover mixed with some young bushes and trees. The grass is *Imperata cylindrica*. We can imagine a good pasture maintained short by grazing. Establishment supposes ploughing, fertilizing, sowing a dense persistent mixture of grasses and legumes. The maintenance consists in an appropriate grazing and sometimes a mechanical or a manual intervention to control weeds and young trees. Herds of cattle or flocks of small ruminants would be led and watched by shepherds. Animals would probably find too much grass in the rainy season and not enough good fodder in the dry season, but with a clever management of the resources and may be the use of special pastures in complement for the dry season, reasonable results could be obtained. Zebu cattle would be preferred for their adaptation to seasonal bad feeding conditions. We could calculate the number of animals on the basis of 1 cattle head or 10 sheep for 750 m of firebreak. A herd of ten cattle would need 7,5 km of firebreack with improved

pasture. It is very long and needs several waterpoints and stables. Annual production would be 1,5 to 2 animals representing 1,8 to 2,4 millions Rp.

This solution faces difficulties : the distance to walk in the firebreack is too long. In the night, animals must be kept together in a barn or a stable to be protected against wild predators living in the forest and thieves. The shepherd must stay with them, far from the village.The production does not pay the shepherds and the pasture establishment.

4 - Surrounding agricultural areas and buffer zones

To improve the integration of the plantations in the rural areas, to increase exchanges with the villagers and to mitigate the atmosphere of dispute for the land, the plantation companies develop special programmes of social and agricultural development in the surrounding villages. For example, agroforestry is one of the social forestry programme of PT. Musi Hutan Persada. The objective is to increase the income of the farmers near the concession area by introducing intercropping farming system. The crops introduced are rice, maize, peanuts, soybean, chili, watermelon, banana, also pineapple in rubber tree plantations and sometimes king grass. The soil preparation and the cost of production are largely paid by the value of crops. This intercropping maintains clean the new plantation and reduce fire hazard. Such agroforestry system can be organized on a belt at border of the forest as a buffer zone.

In an agroforestry programme, cattle could have a positive effect, helping farmers to prepare the soil for cropping with animal draught and to transport tools and harvest between village and field. To improve the feed of these animals, pasture plants must be established for several years, presumably out of the plantation area. Some short perennial legumes can also be sown in the plantation [1]. We can choose a plantation system in successive rows of grasses, legumes and forage trees, in intercropping with other plants.

[1] For example, *Cajanus cajan* (leaves and pods eaten by ruminants, seeds edible by human), or *Codariocalyx gyroides*.

Chapter 4

Recommendations and proposals

1 - Conditions of feasibility

Before setting up project proposals in the context of this consultancy, several criteria must be fulfilled to get a reasonable feasibility. The following comments are considered of major importance. Successively are presented criteria concerning the objectives, the different participants, technical conditions, legal situation, social and economic profit.

1.1 - Objectives

Any project must take into consideration the general and regional development policy decided in the governmental departments concerned and conform to them. Even very innovative, a project must appear as an action complementary to the current activities. This condition is necessary to be accepted by authorities and to receive all the needed support for its realization. Concerned offices of official departments or companies must be able to incorporate the results in their annual activity.

Without any deep roots in an actual organization, a project in livestock development cannot succeed, and could even face difficulties.

Nevertheless, the project must have an independent direction, as well as an administrative and technical staff so far that part of the founding is provided by international or foreign organization.

1.2 - Coordination

As any project in the narrow area of the mission might particularly concern animal production but with expected impacts on forestry (as well as presumably in farmers' income), the various participants in addition to the farmers would belong to different services or separate companies. For example the Livestock Service and the Forestry Service have very few common fields of interest. The main other concerned departments seem to be the Forestry and Soil Conservation Service, the Transmigration Service and the Service of Agriculture. In addition, we must consider the HTI and HPH, as well as probably development projects as IFAD. Without any specific

organization connecting two or several offices on a particular objective, there is no reason for them to work together.

According to the areas where projects will be expected to be realized, the concerned organizations will be identified. It will be necessary to create a convenient system of coordination if none is yet in place. At the elaboration stage, this system will play an important role to consult the partners and elaborate a realistic project receiving a common agreement. Later, at the implementation stage, it would be the central place to decide actions of common interest and check the obtained results, like a monitoring committee could do it. This coordination group has to be placed at a relevant level, probably the district or the province.

1.3 - Technical conditions

At least in livestock production, any proposed project must be based on the current experience of farmers and the awareness of the technical service officers. We can only do proposals for progressive changes of the production systems in use. It is surely wrong, particularly for a project crossing forest interests and livestock production, to propose schemes too innovative or technologies far from the existing context. The most promising orientations in progress must be studied and taken into account : for example the agricultural development based on the integration of several complementary productions as tree plantation and intercropping with annual or shortly perennial plants, or the cattle development based on the small holders and the transmigrants.

1.4 - Legal situation

Cattle production supposes an access to large areas. We can keep in mind two useful benchmarks. In a cattle farm with an semi-intensive production of forage (rainfed improved pastures and cultivated grasses), the area necessary to feed an animal during one year is between 0.5 and 1 hectare. In traditional extensive system, the area to feed one adult head of cattle on native pasture and fallow lands is between 2 or 3 hectares, sometimes more in bad conditions. A cattle farmer who wants to develop his herd must have access to the needed areas.

Access rights differ according to the situation : sometimes the farmer owns his land, sometimes the pasture is a common land owned for example by the village and its access is free, sometimes the government or a company is the owner but identified farmers are allowed for a time to take for their own certain productions as fruit, or annual crop, or grass. During the elaboration phase of a project the access rights to land must be considered. Improving pasture or planting grass is only possible if the production is protected for a private use.

Many farmers are self-willed members of cattle farmer associations with a legal status. These associations are encouraged by the government and can be found in many villages. Some of them are very active. Groups of farmers can organize themselves to raise in common a cattle herd, or

manage the pasture, or process the products [1]. As all partnership based on human relations, the actual cases functioning are diverse. Projects must be addressed to these groups.

1.5 - Access to animal capital

Cattle farming needs not only sufficient areas of land but also the living capital. The constitution of this capital can take years. To promote cattle, the development projects as IFAD and the government help transmigrants by giving them cows imported from Java. The farmers must give back the first calf born of these cows to the project which distribute it to other farmers. This scheme is an example of action with technical and social effect which could be developed.

If we imagine a project with the need of a large number of animals, we can only get them by importating them from other regions of Indonesia. For social equity, it is impossible to help a small number of farmers acquire many heads of cattle. Reimbursement of this capital would be too long and too hazardous. The projects cannot promote private farms able to get a herd large enough to give an income sufficient for a household, if they still exist.

1.6 - Economic and social benefits

To be accepted and supported by all participants, each of them must find an economic benefit. As seen in chapter 2, a farmer raising cattle can normally expect a good income of his activity, in a way reasonably secure.

Foresters or plantation holders must also find advantage in the projects. The logical impact expected is a lower fire hazard. All preventive action can be considered as beneficial. Fires indeed are considerable losses of capital. Nevertheless it seems difficult to establish for the projects direct indicators of efficiency. Benefits for foresters and plantation holders cannot be quantified. For these organizations, the projects must be understood as complementary activities of their main objectives in the aim to improve social welfare of the surrounding populations. They join in the efforts for better integration of the forests and plantations in the rural society.

The projects can set up pilot areas where the proposals are implemented and tested, to be shown as examples. If the proposed technologies are well accepted and then replicated, we will be able to conclude that they are a success.

2 - Project proposals

The environmental, social and economic conditions are very good to propose livestock development schemes and some realistic projects could be elaborated to improve animal

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[1] For example, cattle farmers of Pampangan are organized to make for market a preserved food with buffalo milk and sugar, the *gula puan*.

production in the no-forest area. But **the following proposals are restricted to the interactions between forest fire and domestic animals**, either directly by removing biomass or indirectly by mitigating possible social causes of fire, in the aim to help prevention of fire through animal production.

1 - **It is not relevant to introduce livestock in forest or plantation area** for technical or economic reasons. Furthermore it could create specific issues on land tenure.

2 - One of the ways to help prevention activities against forest fire seems to be the strengthening of **economic and social development in the rural areas close or surrounding the forest areas.** A national effort must be done not only in transmigration areas but also in traditional villages.

3 - **Animal production is one of the main components of the rural development** in the province. Draught animals participate in agricultural intensification and extension of paddy field areas. Animal production for meat gives the farmer an additional income, a constant use of the familiar manpower and constitute a capital easily changed into cash when needed.

4 - Economic and social development could be focused in these specific areas by different official services as Agriculture Service, Livestock Service, Forestry and Soil Conservation Service, Transmigration Service, also social services as Health Service and Education Service. We suggest **a specific coordination group of rural actions accompanying fire prevention activities** (for example as an annex to any fire prevention group which could be organized) to be created, under a strong coordination of the Governor and the *Bupati*. But planification with the choice of the development areas and the strategy of development must be decided at the national level and executed under the responsibility of the Governor with a council of representatives of the mentioned services and other organizations as BAPPEDA.

5 - **Cattle production is in direct relationship with the forage availability**. When the native pasture resources are too limited in quantity as well as in quality, forage must be produced at the farm level by planting convenient perennial grasses, perennial legumes and forage trees. The number of species and varieties available in forage centers (like Sembawa, see annex) is already useful but could be improved to cover a bigger variety of environments used by farmers. For example, King grass (*Pennisetum purpureum*) is largely promoted but can only succeed in deep soil well drained and always with some content of water. Grass and legume species adapted to drier environment and less fertile soil, but easy to cut for feeding animals could be tried in the frame of a research activity. Foreign or international research centers as CSIRO in Australia, CIAT in Colombia, CIRAD in Europe can provide **germplasms for trials**. An important place must be given to the forage trees because many are well adapted to the wet tropics, and trees remain green longer than grasses in dry season (see annex). Forage plantations can be included in specific areas along the fields or under tree crops in an integrated agroforestry system. The Three Scheme Level (*Tiga strata)* with a first plant level on the ground (grasses), a second with shrubs and the third with forage trees is particularly convenient to the "cut and carry" feeding system.

6 - The development of animal production needs a strong support of the livestock service in the target areas, not only in forage development but also in animal health and genetic. In particular,

the livestock extension service has a very important role to play, being the main contact between administration and producers, either to introduce new technologies or receive useful informations and questions. The present activity organizing regular meetings of the field extension officers with groups of farmers looks very convenient and could eventually be extended if necessary or stimulated : regular training on new improved technologies, financial incentives. Extension service is the most efficient contact with the farmers and the farmer organizations.

7 - **Applied research** is an investment necessary to promote development. The researchers elaborate new technical schemes or improved technologies to be proposed to producers. But the link between research and farmers is the responsibility of the technical services, particularly the extension service. An efficient communication must work not only top-down but also bottom-up research and extension service.

7 - Production by farmers of perennial plants as trees and forage, as well as intensification, can only be developed in **a clear land tenure system**. The present system must be revised and adapted to the new situations. The land tenure is a key to the rural development.

Conclusion

The FFPCP has shown in other reports that large areas of forest are burned to clean lands for agricultural purposes or before tree plantation, either by small holders or big companies. In many other occasions, the cause of fire is not clearly known, with a large part of negligence and in some cases arson because of retaliation. But the fire hazard considerably increases during the day with a high fire risk. Considering the causes, livestock raising can principally be of some use by improving soil fertility : better agricultural practices including the crop livestock association (better ploughing, incorporation of organic matter in soil, use of manure) could reduce the frequency of the shifting cultivation at farm level.

Livestock production is growing in Indonesia and South Sumatra, particularly concerning chickens and cattle. Cattle development is based on the Bali breed, the integration of cattle in agriculture and the feeding by the "cut and carry" system, more than direct grazing. A 10% growth of the cattle population could probably be easily accepted by the meat market. Most of the natural pastures are not good in quality. The first step to improve cattle farming is the production of forage and a better utilization of the agricultural byproducts.

Livestock raising in an extensive way, with big herds and only grazing is not common and not specially supported by official services. The use of cattle to remove combustible grass or bushes has been taken in consideration, but the areas under forest land status can not be used to develop grazing activities, either for technical or for economic reasons. Furthermore, a livestock development in these areas could create land tenure issues, as well as increasing fire hazard.

Livestock development, and specially cattle, must be associated with agricultural development. Special areas of development and support could be chosen in places close to the forests and the HTI or HPH, not only with transmigrants but also in traditional villages. The aim is to mitigate the fire hazard on the border and give an impulse to the social and economic development in this rural area. This development would be based on an agroforestry system, including multipurpose trees, forage trees, fodder plants to "cut and carry" and crops. The first and most important step to begin a project is to convene the relevant services and other organizations at the district level, in order to decide on a common objective and create a continuing working group in charge of the elaboration of the concrete terms of the project. An integrated project could be realized in a pilot area with participation of several services involved in forest, agriculture and livestock, with a strong coordination at the province level. It would be an example in case of success for further development projects.

References

J.M. Bergès, L. Msellati, 1989. Elevage à viande et génétique. Monographie de l'Indonésie. Maisons-Alfort (France), CIRAD-IEMVT, 40 p.

Sri Dadi Wiryosuhanto, 1997. Buku statistik peternakan, 1996 (Statistical book of livestock). Direktorat Jenderal Peternakan, Djakarta.165 p.

G. Cosijn, 1997. In depth study of the direct and indirect causes of forest fires in pilots areas. Rural development section. Project report N° 10. Palembang, FFPCP, 31 p, ann.

J. Ramon, Alamsah A. Ateng, 1996. Forest fire occurrence and causes in South Sumatra. Project report N° 13. FFPCP, Palembang

Sugito Ma, 1995. Statistik Indonesia 1994.(Statistical Yearbook of Indonesia). Biro Pusat Statistik, Djakarta.

Pembagian administrasi pemerintahan propinsi Sumatera Selatan, 1/600 000, ed. IPS Indo Prima Sarana.

Wartomo Hardjosubroto, Jovita Maria Astuti, Buku pintar peternakan, Jakarta, Grasindo, 1993, 178 p.

Anonymous, 1980. Firewood crops. Shrubs and trees species for energy production. Washington, National Academy of Sciences, 237 p.

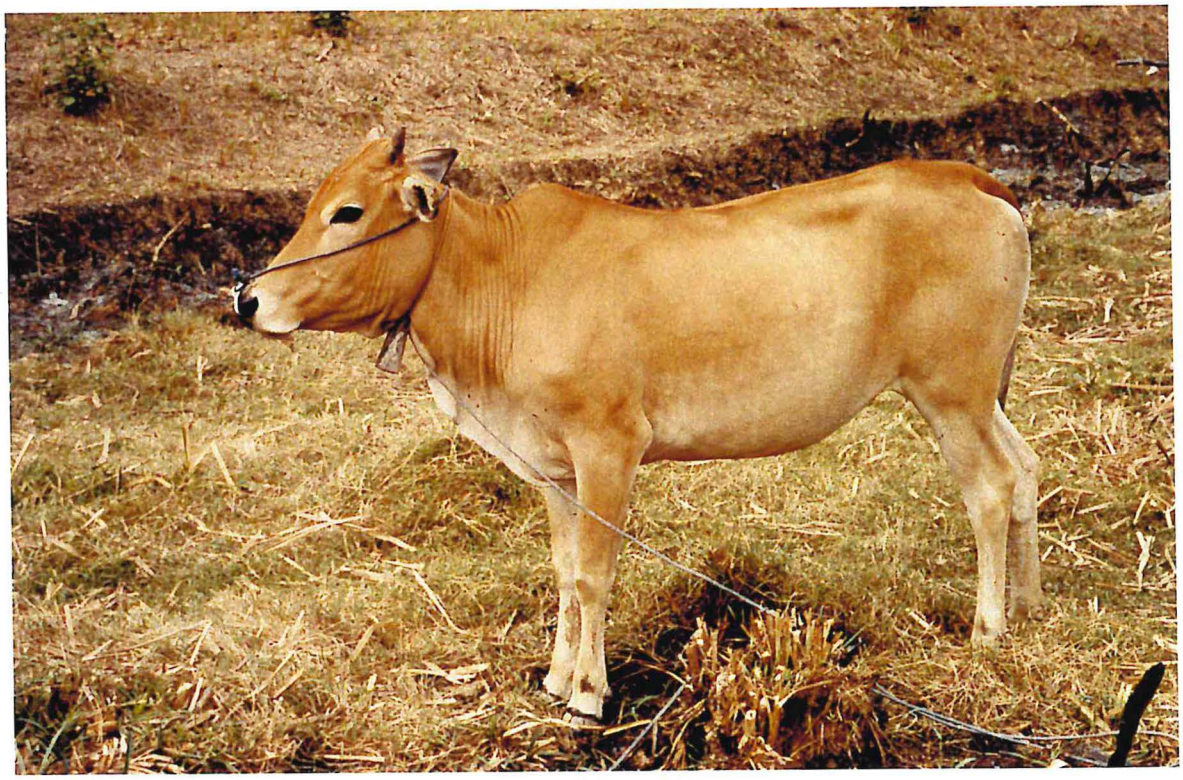
The buffalo population is decreasing in South Sumatra.
This animal is ready to be sold at the market

Some improved grass species for establishing perenial pastures are well known, but they are rarely used.
(*Paspalum* trial in Sembawa Livestock Center)

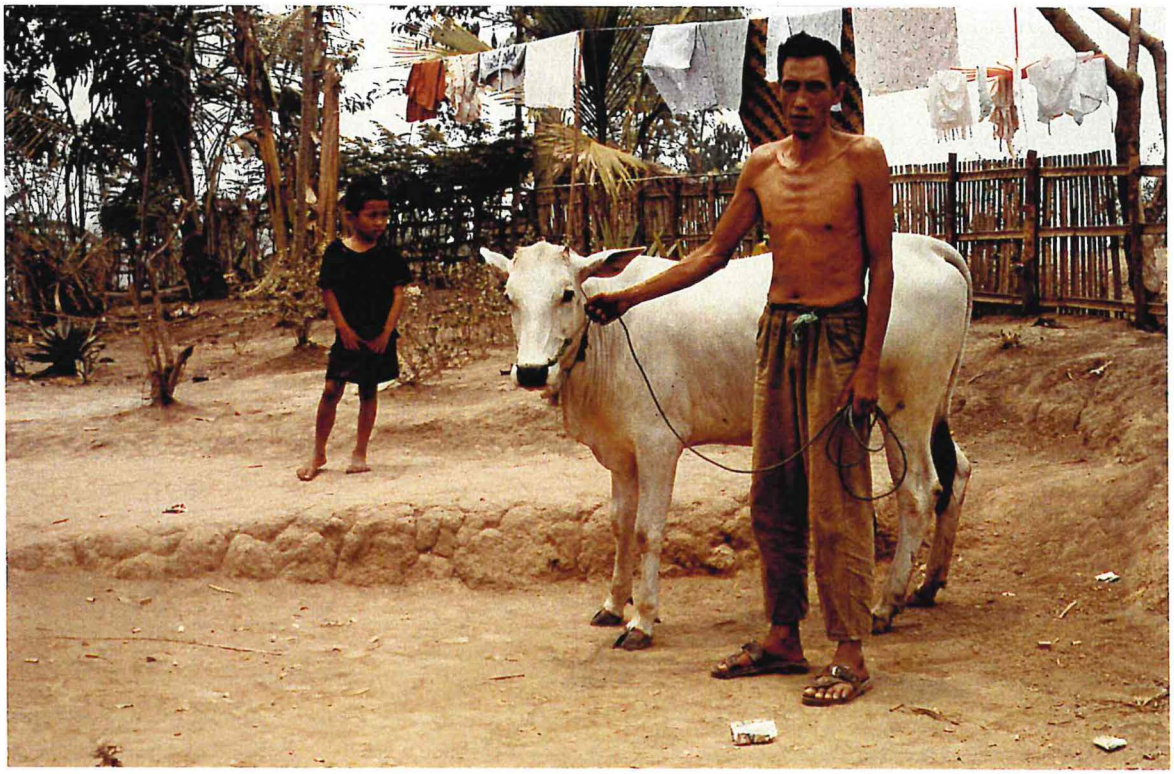
A firebreak in an *Acacia mangium* plantation.
The natural grass cover is hardly palatable for cattle

A little number of cattle can gather some forage in a rubber plantation, but such a vegetation is not really a pasture.

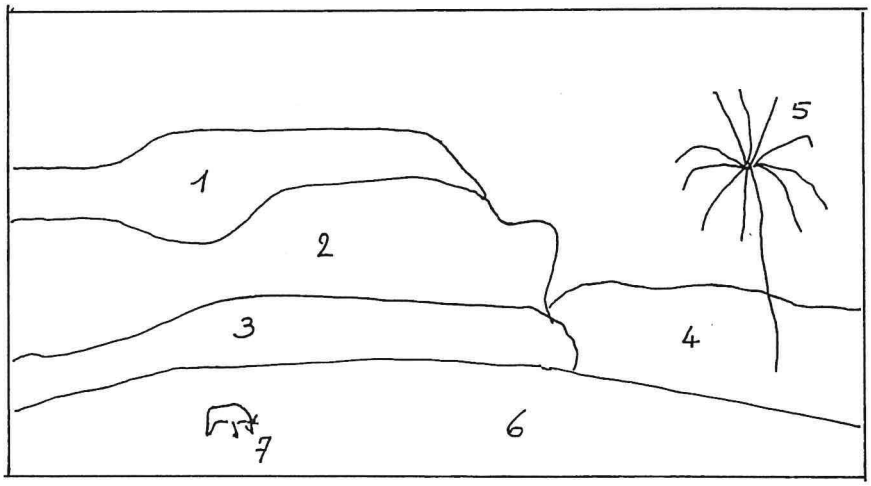
Cattle in south Sumatra combine three genetic origins :
Bali breed (Bos sondaicus): Zebu (Bos indicus) and bovine bali breed (Bos sondaicus)
Bali breed (Bos sondaicus) : Zebu (Bos indicus) and bovine (Bos taurus)



Cattle in South Sumatra.
We notice the small size of the local breed.



Agricultural landscape in the central plain of South Sumatra combining tree plantations, fruit trees, annual cropping and livestock.



1- Plantation of pines
2- Fruit trees (durian)
3- Young rubber plantation
4- Banana
5- Coconut palm
6- Fallow after paddy field
7- Cattle grazing

ANNEXES

TERM OF REFERENCE

SHORT-TERM CONSULTANCY IN TROPICAL GRAZING (National or International)

Background

The European Union financed Forest Fire Prevention and Control Project (FFPCP) is undertaking studies in three pilot areas of South Sumatra Province representing three types of economically important forest. The studies are investigating the causes of forest fire and seeking possible ways of reducing fire risk and fire use. One of the options for reducing the fire hazard in forests is to diminish the layer of combustible organic matter in forest plantations by promoting grazing systems in forest plantation areas.

This consultancy aims to develop such grazing schemes in forest areas which should either be managed on a sustainable basis by the management of the forest area or by the rural population living in the close vicinity.

Under the supervision of the Project Leader and his national counterpart the expert will be responsible for making a feasibility study of livestock grazing schemes in tropical forest plantations.

BACKGROUND AND EXPERIENCE
- University Degree in Agriculture with majors in livestock, livestock nutrition and grazing systems
- A minimum of 10 years experience in developing countries in the humid tropics (preferably Indonesia, Sumatra) as well as in low rainfall areas
- Experience with livestock fattening schemes and rotational grazing systems
- Experience with grazing areas in forest plantations
- Experience in livestock management, diseases (ticks, internal parasites) and feeding
- Be able to speak the Indonesian language

RESPONSIBILITIES
- Survey the livestock situation in the rural areas and the forestry plantations of South Sumatra
- Study the feasibility of introducing grazing schemes in forest plantations with the aim to reduce the amount of litter under plantation trees
- Transfer of knowledge to local counterparts
- Make recommendations on sustainable livestock production by using grazing areas in forest plantations for plantation owners and/or for rural livestock owners
- Produce a final report at the end of the working period including the results of the survey and options for practical grazing schemes in forest plantations including an economical assessment

Duration 1,5 month

CALENDAR OF MISSION

Friday, September 12, 1997, departure from Montpellier, 16h50, AF 8345, and from Paris, AF 256.
Saturday 13, arrival at Jakarta, 16h20.
Monday 15, **Jakarta**, Introduction to Coordination Programme Unit of IFSSP
Flight to Palembang BO 606, arrival 16h30.
Tuesday 16, **Palembang**, introduction to the FFPCP director and team.
Presentation of the FFPCP project objectives and main results by Gustaaf Cosijn.
Wednesday 17, introduction to the head of the provincial forestry department *(Kakanwil)*.
Analysis of data collected by the rural development expert.
Thursday 18, visit to the animal production service and collection of data. Analysis of these data.
Friday 19, interview with two members of the provincial forestry department. Planning of the field trips. Analysis of statistical data on livestock.
Saturday 20 and Sunday 21, writing the chapter on livestock.
Monday 22, meeting at PT. Musi Hutan Persada, Palembang, preparation to visit Pendopo plantations. Collecting environmental data of the province and revising available maps.
Tuesday 23, **field trip** (until Tuesday 30). **Pendopo**, visit to PT. Musi Hutan Persada's *Acacia mangium* plantations. Village Sungai Ibul.
Wednesday 24, Pendopo, Unit VII. Village Talang Bandung. Unit VIII, village Jambumente, village Simpang Solar. Unit IX, village SP6 and SP5.
Thursday 25, Pendopo, Musi Hutan Persada, Unit VI, village SP1. Journey to Muara Enim. Administrative procedures in Muara Enim.
Friday 26, **Muara Enim**, meeting with the Sospol, journey to Pagar Alam.
Saturday 27, **Ulu Musi,** meeting with Camat. Village Padang Tepung, village Batu Lintang, village Muara Kalangan, village Lubuk Puding Lama.
Sunday 28, **Nanjungan**, meeting in the Kantor Camat. Village Air Mayan and Nanjungan, village Karanggede.
Monday 29, Muara Enim, visit to the Kantor Kapubaten to meet with the Sospol, the head of the Forestry service and the head of the Livestock service. Visit to Camat of Gunung Megang, Village Gunung Megang.
Tuesday 30, **Pendopo**, Talang Ubi, visit to Camat. Village Karta Dewa. Pendopo, visit to the Livestock Officer. Journey to Palembang.
Wednesday 1st October, **Palembang**, oral report of the field trip. Preparing next field visits. Collecting detailed statistical data in the Livestock service.
Thursday 2, field trip to **Kayu Agung**, meetig with the Camat of Pampangan. Visit of the show of Kayu Agung.
Friday 3, Palembang, meeting at London Sumatra Indonesia. Visit of the satellite NOAA reception station. Writing report.
Saturday 4 and Sunday 5, analysing data recorded during field trip and writing the report.

Monday 6, **Sembawa**, visit of the livestock research station, talk on intercropping in the rubber research station. Discussion on the report in EU office in Palembang.
Tuesday 7, Palembang, writing report.
Wednesday 8, Palembang, talk in the Livestock service and in the forestry service. Preparation of next day field trip. Writing report.
Thursday 9, **Kayu Agung**, successive talks in the livestock service, the forestry and soil conservation service, the forestry service, all at district level.
Friday 10, Palembang, writing report.
Saturday 11 and Sunday 12, writing the report.
Monday 13, Tuesday 14, Wednesday 15, Thursday 16, writing the report.
Friday 17, presentation of a partial first draft.
Saturday 18, Sunday 19, writing the report.
Monday 20, writing the report. Talk with Musi Hutan Persada on the conclusions.
Tuesday 21, writing the report. Talk with PT. Daya Penca.
Wednesday 22, final discussion in FFPCP and delivery of draft report.
Thursday 23, Journey to Jakarta.
Friday 24, **Jakarta**, presentation of conclusions to IFSSP. Meeting in French Embassy. Meeting with the CIRAD representative.
Saturday 25, flight to Paris.
Sunday 26 October, arrival to Montpellier

Relevant persons met during the mission

In Montpellier :
Mireille Chiaverini, CIRAD-Forêt
Jean Guy Bertault, CIRAD-Forêt, chef du Programme Forêt naturelle
Yves Laumonier, IFSSP/ FIMP (basé à Djakarta), project leader

In Djakarta :
J.R.David Wall, IFSSP/EU Co-director
Gérard Martheleur, IFSSP, Programme administrator
John Hansen, IFSSP/ IFRCP, Project leader

In Palembang :
- FFPCP :
Jean Jacques Maurer, FFPCP, project leader
Gustaaf Cosijn, FFPCP, rural development expert,
I.R. Rusli, FFPCP, assistant of the rural development expert,
Johan Ramon, FFPCP, social forestry expert,
Marc Nicolas, FFPCP, forest fire management expert,
Ivan Anderson, FFPCP, remote sensing and GIS expert,
Jean Marie Bompart, consultant, botany and ethnobotany
Abdullah Dalilan, interpreter

- Provincial Forestry Service :
The Director (*Kakanwil)* Mr. Surachmanto (*vérifier)*
Ibu Kusmarini, Secretary of the Kakanwil
Ibu Sudarjati Firmaningsi, socio-economy
Pak Sardjito, mapping
Ir. Denny Kustiawan, reforestation and reclamation

- Provincial Livestock service :
The Director, Drs. Rydhwan Saleh, *(Kepala Dinas Peternakan)*
Ir. M. Kaharyanto, head of the animal production division
Drh. Nasir Somad, head of the livestock statistics division
Drh. Sri Rezeki, head of the animal health division

- PT. Musi Hutan Persada :
Hardjono Arisman, Deputy General Manager
Dr. Kenneth Gales, Advisor, research and development
Erwin Donovan, Agroforestry section, research and development

- PT. PP London Sumatra Indonesia :
Peter Bayliss, Development Officer

-PT. Daya Penca :
Mr. Asli Husin

In the Kapubaten (District) of Musi Banyu Asin

- Sembawa Research Station :
Ing. Ilyas Semendaway, head of the animal breeding and forage center
Dr. Ir. Gede Wibawa, agronomist farming systems, Rubber research institute

In the Kabupaten (District) of Muara Enim
Mr. A. Gani, director of Sospol (*Kepala Kantor Bina Sosial Politik*)
The Head of the Livestock service
The Head of the Forestry service

- Sub-district de Gunung Megang :
Pak Thobarih, Head of the Sub-district (*Camat*)

- Sub-district of Talang Ubi :
Pak Jabba Akim, Head of the Sub-district (*Camat*)
Sahya Udin, *Kepala Desa* of Karta Dewa
Ibu Ida Martini, Livestock Service Officer, Pendopo
Haji Ibrahim, farmer in Karta Dewa

- Musi Hutan Persada plantations :
Mr. Willem Gunding, head of the Bloc
Pak Prayitno, staff in Unit VIII, agroforestry specialist
Pak Toni, staff in Unit VII, agroforestry specialist
Sigit Herdyianto, Head of Unit VI
The *Kepala desa* of HTI Transmigrasi : Sukamto Bondan in SP6, Kosma Wanto in SP5, Pak Banhung in Idu Baru, SP1 and farmers
The *Kepala desa* of the villages : Udjang Kowi in Sungay Ibul, Pak Haryono in Talang Bandung and farmers
Farmers in villages Jambumente and Simpang Solar

In the Kabupaten (District) of Lahat

- Sub-district of Ulu Musi :
Mr. Suparman, Head of the sub-district (*Camat*)
Gatmir Arivin, *Kepala desa* of Muara Kalangan and farmers
Pak Saetan, *Kepala desa* of Lubuk Puding Lama
Sayyidina Ali, *Kepala desa* of Batu Lintang

- Sub-district of Manjunan :
Suto Suprihono, Division of Social Development in the *Kantor Camat*
Mr. Ading, farmer in Air Mayam
Syamtul Baru, *Kepala desa* of Nanjungan

Habi Bullah, *Kepala desa* of Karanggede

In the Kabupaten (District) of OKI

- In the livestock service :
Mr. Supandi, administrative director
Ing. Ir. Abdul Muthalib, coordinator of extension service

- In the forestry and soil conservation service :
Ing. A. Latief Solihin, head
Ing. Mohammad Najib

- In the forestry service :
Mr. Satyo Yawono, head

- Of the sub-district of Pampangan :
Mr. Bayumi Anwar, *Camat* of Pampangan

Barchart of activities for Mr. B. Toutain for the period of 15 September - 05 October 1997

ACTIVITY	M 15	T 16	W 17	T 18	F 19	S 20	S 21	M 22	T 23	W 24	T 25	F 26	S 27	S 28	M 29	T 30	W 01	T 02	F 03	S 04	S 05
Arrival and introduction to FFPCP	■	■																			
Study project documents, discussions		■	■	■	■																
Visit HTI PT Musi Hutan Persada								■													
Visit HTI PT Musi Hutan Persada								■													
Visit PT Inhutani V																		■			
Visit HPH PT Family Jaya																		■			
Visit Dinas Peternakan			■																		
Field visit to lowland Pilot Area Pendopo									■	■	■	■									
Field visit to upland Pilot Area Ulumusi													■	■	■	■					
Reporting						■	■										■		■	■	■
Co-ordination meeting with RDE					■												■				

Barchart of activities for Mr. B. Toutain for the period of 06 October - 31 October 1997

ACTIVITY	M 06	T 07	W 08	T 09	F 10	S 11	S 12	M 13	T 14	W 15	T 16	F 17	S 18	S 19	M 20	T 21	W 22	T 23	F 24	S 25
Field trip to Pilot Area Pampangan			■	■	■															
Visit to Sumbawa Research Station					■															
Visit Dinas Peternakan															■					
Visit BAPPEDA	■																			
Co-ordination meeting with RDE												■						■		
Reporting	■	■				■	■	■	■	■	■	■	■	■	■	■	■	■		
Final meeting and handing in of report																			■	

Visit to BPT-HTM Sembawa
Animal breeding and forage center of South Sumatra

The Center has a mandate given by the Ministry of Agriculture in Jakarta and its area of influence is the four southern provinces of Sumatra. The station covers 278 hectares. Its mandate includes :

- Selection and improvement of the local cattle.
- Selection and improvement of the local chicken.
- Produce and multiply forage plants for improment of pasture and ruminant feeding.

1) The local cattle have various origins and are the result of uncontrolled crossing between three main genetic breeds : Bali cattle (*Bos javanicus*), zebu cattle or Ongole (*Bos indicus*), bovine cattle (*Bos taurus*). The common animals in the villages often express more intensively the characters of one of this strain, but differ from the pure breed for other criteria caused by the free crossing. A local cow has a common liveweight of 170 kg, generally less than 200 kg. A local bull can weight 300 kg. A new born local calf is 14 kg (meanwhile a new born Brangus reach 25 kg), and has 75 kg livewheight when it is 7 months aged.

The genetic program of the center include the selection of the best animals of a herd composed of local animals and then the genetic improvement by artificial insemination. Selection is done on young animals born in the Center. These animals are weighted at birth, then 7 months, 12 months and 24 months later. Only the best fifty percent of the animals are selected for reproduction. The selected cows are mated by a local bull for the first partum, then, they are inseminated for the following calvings with Brangus breeds. The semen comes from Jawa. The Center also plan to embryo tranfer.

The selected animals are sold as reproducers to the farmers one or twice a year at a price in relation with their quality.

2) The local chicken selection is at starting stage. Objective is to raise 3500 animals in four hen houses. Nowadays, they are 2000 from the chick to the adults hens and cocks. Vaccinations include Newcastle disease, CRD and coccidiosis.

3) The pasture and pasture plants are developed on 70 hectares, plus a greenhouse and fields for trials. Several species are grown on the station :

- Grasses : *Panicum maximum*, *Paspalum plicatulum*, *Brachiaria decumbens* Signal, *Brachiaria humidicola*, *Pennisetum purpureum* "King grass", *Tripsacum laxum* (called *Euchlaena mexicana*).

- Legumes : *Leucaena leucocephala* (tree for the giant strain, small tree for the Cunninham variety), *Sesbania grandiflora* (small tree), *Stylosanthes guianensis* CIAT EM 05-3 (perennial herb), *Gliricidia sepium* (small tree), *Macroptilium atropurpureum* Siratro (twinning perennial herb), *Desmanthus virgatus* (tall perennial herb), *Flemingia congesta* (tall perennial herb).

Others species and varieties are in trial : *Brachiaria dictyoneura* and *Brachiaria brizantha* for perennial pastures, *Paspalum atratum* (idem), *Centrosema pubescens* (twinning legume), *Vetiveria zizanioides* (only to protect soil from erosion).

The best producers grasses are *Panicum maximum* and *Paspalum plicatulum*, particularly for cut and carry, *Brachiaria decumbens* associated with *Leucaena leucocephala* for grazing.

Comments have been made for other plants : *Sesbania sp.* not resistant to draught, King Grass only for soils with sufficient water, "Euchlaena" same comment, *Brachiaria humidicola* production lower than Signal, *Flemingia congesta* not readilly eaten, *Gliricidia* leaves not as palatable than *Leucaena* leaves. *Setaria anceps* has been abandonned, for its high level of oxalate.

One of the objectives was the production of seeds and cuttings for farmers. They did produce seeds formerly[1], but in this moment there is no demand. Therefore, they stopped the production. Nevertheless, they multiply in glasshouse plants of legume trees.The broadcasting of feeding techniques and the distribution of seeds and cuttings of pasture plants are under the responsability of the Livestock Service. Progress in feeding cattle and promotion of pastures need an intensive programme of training among the farmers. The extention service of the Livestock Service is lacking of awareness in this matter and is to weak to establish a normal link between the Center and the farmers.

The pastures of the Center, mainly in *Brachiaria decumbens*, *Panicum maximum*, *Brachiaria humidicola*, *Centrosema pubenscens*, *Macroptilium atropurpureum* and also other species are grown for feeding cattle raised for selection, partly in a "cut and carry" system (three parts of grass and two parts of legume), partly for direct grazing. Pasture receive fertilizer (mainly urea, superphophate triple, potassium chlorid) after use (grazing or cutting).

In Indonesia, they are 9 livestock centers :

1- BPT-HMT Indrapuri - Aceh - local cattle
2 - BPT-HMT Siborono Borone Sinur - North Sumatra - buffaloes and sheeps
3 - BPT-HMT Padang Mangatas - West Sumatra - Simenthal pure breed
4 - BPT-HMT Sembawa - South Sumatra - local cattle, local chicken
5 - BPT-HMT Cipelang Bogor - West Jawa - embryo tranfer
6 - BPT-HMT Baturaden - Central Jawa, dairy cattle
7 - BPT-HMT Pelaihari - South Kalimantan - Bali cattle, ducks, sheeps
8 - BPT-HMT Serading - West Nusa Tenggara - Bali cattle
9 - BPT-HMT Lili - East Nusa Tenggara - Ongole Cattle

The system proposed to improve the forage production at farm level is an agroforestry system including grasses and legume trees, able to produce leaves eaten by cattle and wood for fuel (charcoal) or for housing. The scheme proposed is called "three levels scheme" (*tiga stata*) including :

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[1] Seeds of *Panicum maximum, Paspalum plicatulum* and *Brachiaria decumbens*, cuttings of King Grass and "Euchlaena".

- first level : grasses on the ground, with a reasonnable high,
- second level : bush or small tree, mostly a legume,
- third evel : multipurpose trees.

Production of forage is used by the method of "cut and carry", to feed animals in stable, commonly practised in Indonesia.This area integrating grasses and trees can be grown around fields for annual crops.

This scheme has been establish in several stations as an example for farmers, but it has not been proposed to the farmers by extension service and it is not applyed in this moment.

The Indonesian Livestock : An introduction

(Translated after Buku Pintar Peternakan, 1993)

The Balinese Cow.

The Balinese cow derived from ox (Bibos ox) that had been domesticated centuries ago. In Indonesia, this wild animal can only be found in Blauran protected forest (East Java) and Ujung Kulon protected forest (West Java), an in some zoos.

The Balinese cow has several synonyms such as Bos javanicus, Bos ox , and Bos sondaicus. The latest name is issued in Common. Systematically, the Balinese cow is included in Bovidae family, Genus Bos, and sub-genus Bibovine. The Sub-genus are Bos gaurus, Bos frontalis and Bos sondaicus.

In the nineteenth century, the Balinese cows began to be distributed to Lombok and Timor by the local kings. In the earlier twentieth century, the Balinese cows were already exported to the Province of South Sulawesi. Since 1962, the Balinese cows have been distributed to several districts in Indonesia, except Java Island, Madura, and Sumba.

There are approximately 2,7 million Balinese cows in 1989 and the most population is in the Province of South Sulawesi (1,2 million).

Australia, Malaysia, Thailand, and Philippine are among the countries to which the Balinese cows are distributed. It is recognized from the blood type Hb x found in the countries.
The hair color of the young Balinese cows is brick red and this color changes into black when the male ones grow up.

The particular characteristics of the Balinese cows are as follows:

a. White color in the back of thigh (butlock), in upper lips and in leg from tarsus and carpus to the upper part of toenail.
b. Black color in the tip of the tail.
c. White color in the inside part of the air.
d. Black stripes in the upper part of the back.

The Balinese cows are quite reproductive and their reproduction rate is high. The Balinese cows, however, are very sensitive to the diseases such as Jembrana disease, bali ziekte and catarrhal malignent fever, cmf). The Balinese cows must not be mingled with sheeps to avoid catarrhal malignant fever (cmf). Disease from them (the sheeps)

The Madurese Cow

The Madurese cows are those derived from the result of the crossing process between the ox and Bos indicus that have been imported to Indonesia centuries ago. Therefore, the prototype of the Madurese cows is in between the ox body and Zebu cow.

The Madurese cows are usually used for Karapan Sapi (cow racing). This racing is very popular in Madura. The improvement of the Madurese cow quality is ever tried by crossing with the male Santa Gertrudis. The result of the crossing is then called Madrali which has a big body and

better growth. But, the local people dislike this new kind of cows because they cannot be used for the cow racing.

The hair color of the male and female Madurese cows is brick-red with little body and short leg. The male ones have good humps, little and half-curved horns, and its tips points to the front.

Sumba Ongole Cow (SO) and Hybrid Ongole Cow (PO)

Ongole cow is derived from Madras, India. This kind of cows early came to Sumba in 1906 for the aim to be bred. Respectively in 1915, 1919, and 1929 they were distributed to out of Sumba.

In Java, the government carried out the Programme of Ongolisasi (Ongolization) in which the local cattles(Javanese cows) should be crossed with Ongole cattle. The result of the crossing was then called Hybrid Ongole Cow.
The population of this new cows is growing rapidly.

The characteristics of Sumba Ongole Cows are: whitish color, head, neck, and knee are dark color, the feather surrounding eyes, eyelish, snout, nail, and the hair of the tail are black, short horn, big body, short neck, and middle size hump exactly on skapula.

The characteristics of Hybrid Ongole Cow are: blackish-gray color, shorthorn, big body, a little short head, dome-shaped forehead, big hump points to the neck, wattlelike skinfold below the belly and neck.

Buffalo

The buffalo is categorised into Bovinae sub-family, genus of Bubalus. Bubalus arnee is only species that can be domesticated. Some species of thc wild buffalo that can still be found are:

1. Anoa (Buballus deppressicornis, the wild buffalo that can still be found in Minahasa, Gorontalo, Tolitoli, and Bontain. This kind of buffalo has a small body.
2. Mindoro buffalo (Buballus mindorensis) in Philippines. It has a small body.
3. Buballus caffer, a strong and will kind of buffalo found in East and Western Africa, Transuaal and Congo. The characteristics are: long hair, short and pointed horn . 1,5 - 1,8 height.
4. Red buffalo (Bos pumilus) a red and small buffalo. They live in West Africa, Chad, Niger, Congo, and South Maroco: 1,2 - 1,5 height.

The domesticated buffalo (Bubalus arnee) is supposed to come from India. There is no clear information about how this kind of buffalo is bred.

Centuries ago, the buffalo was the most important livestock used for ploughing. Therefore, the population of this animal was higher than the population of cow in the last century. In 1841, the population of buffalo and cow in Java was respectively 1.475.000 and 476.000. In the end of 1923, the population was 2.146.437 and 2.647.878. In 1989, the population of buffalo in Indonesia is 3.244.000 and 10.094.000 cows.

The decreased population of buffalo in Indonesia is caused by some factors such as low birth rate, slow growing up, low durability in hot season (heat), decreased commercial benefit.

The buffalo in Indonesia is derived into two : mud buffalo and river buffalo (dairy buffalo). The population of mud buffalo is higher than those dairy one.

If compared with cow, buffalo has bigger bone, stronger leg and nail, without wattlelike skinfold. When they are young, they have thick stiff and long hair. Its horn is flat, wide, and half-circled. In Bali we can find many albinoids (albino that has black color).

Cajanus cajan

Botanic Name *Cajanus cajan* (L.) Millsp.

Synonym *Cajanus indicus* Spreng.

Common Names Pigeon pea, congo pea, red gram, gandul

Family Leguminosae (Papilionoideae)

Main Attributes Pigeon pea, a food crop with tall woody stalks, has seldom been considered a producer of firewood. Nevertheless, it offers the promise of a crop that within 3–9 months produces both food and fuel for family use. Its cultivation is already well known. In India, about 2.3 million ha are devoted to growing this crop. The stalks are an important by-product for the rural home because they make excellent firewood for the family's daily needs. Information gathered from the farmers indicates that the value of the stalks is roughly equivalent to that of the grain.

The plant is adapted to lands normally unsuited for other crops because of infertility, aridity, or topography. It is one of the best nitrogen-fixing legumes and costs little to produce. In 1979 it was selected as one of the most promising "new" crops for the United States.*

Description The pigeon pea is a woody shrub that can grow as tall as 3.6 m. There are many diverse types that vary in shape (for example, tall, open, and upright, or dwarf, compact, and bushy), growth period, and in the color, shape, and size of pods and seeds. Many cultivars have been selected or bred for high seed yield, but there has been no consideration of their relative qualities for use as firewood. The plant's nitrogen-fixing capacity is reportedly excellent.

Distribution The pigeon pea's origin is not well known, but the plant is probably native to northeastern Africa. It was cultivated in ancient Egypt and has been used widely in Africa and Southeast Asia since prehistoric times. It reached the Americas and Pacific in colonial times. Today, India is responsible for over 90 percent of the world's production, but the crop is also popular in the West Indies and throughout the tropics at a longitude between 30°N and 30°S.

*Theisen, Knox, and Mann. 1978.

Use as Firewood The spindly stalks are extensively used as fuel for cooking in Indian villages. In the past the stalks were employed for making charcoal used in the production of gunpowder. Generally, the thick main stem is used for firewood and the thin straight branches are used for thatch and basket making. The plant is also used for firewood in Chirazulu District, Malawi, an area with a particularly severe shortage of fuelwood.†

Yield On average, 2 t of woody stalks are obtained per ha per growing season.‡ The plants mature and produce seeds in 100–300 days, depending on cultivar, location, and time of sowing, but they are perennials and can be cultivated as such. When cut off at ground level, the plants do not resprout, but regrowth is satisfactory if the plants are cut at heights above 0.15 m. The crop is planted very densely with at least 30,000 plants per ha.

Other Uses

- Food. The pigeon pea is, of course, normally grown as a pulse crop. The dry seeds contain about 22 percent protein and are an important protein food in many tropical areas. Also, the green seeds and the immature pods are often eaten as fresh vegetables.
- Forage. The pods, husks, and foliage can be used for feeding animals. The plant has also been cultivated for feeding silkworms and the lac insects from which shellac is obtained.
- Amenity planting. The pigeon pea very rapidly produces dense ground cover that protects soil from erosion. It is sometimes planted in double rows as a windbreak and makes a hedge that also provides food and fuel.

Environmental Requirements

A range of cultivars is available that adapt the pigeon pea to many different environments. Only tall-growing types should be planted for fuelwood. The following details are based on experience growing the pigeon pea as a food crop.

- Temperature. The crop is cultivated in areas with average temperatures as high as 35°C, but the most favorable growing temperatures

†Information supplied by J. E. M. Arnold. See Research Contacts.

‡Information supplied by D. Sharma. See Research Contacts.

Tall pigeon pea varieties in experiments at the International Crops Research Institute for the Semi-Arid Tropics, Hyderabad, India. (D. Sharma) See also pictures pages 8 and 13.

seem to be between 18° and 29°C. It is killed by frost.

- Altitude. Various cultivars of pigeon pea are grown from sea level to high altitude (up to 3,000 m in Venezuela, for example). The plant does not thrive in seashore areas subject to salt spray.
- Rainfall. Average annual rainfall between 600 and 1,000 mm is most suitable. However, the pigeon pea can be grown in humid areas (even over 2,500 mm annual rainfall) and is renowned for its drought tolerance. Indeed, it has been selected as one of the most promising food crops for the semiarid tropics. It gives economic yields of seeds in areas where rainfall averages about 400 mm annually.
- Soil. Although it cannot withstand waterlogging, the pigeon pea can be grown in a wide range of soils. Its deep taproot and extensive lateral root system allow it to tolerate low fertility and low moisture. (The upright types, which are probably best for firewood, have the deepest roots.) It thrives in light sandy soils, but grows best in neutral deep loams. Some cultivars tolerate problem soils with excess salt, soluble aluminum, or manganese. Inoculation is not needed to get good nodulation in most sites.

Establishment The crop is established from seed sown directly in the field. It can be intermixed among other crops.

- Seed treatment. None needed. Fresh seed germinates well (85-95 percent). In humid regions the seed may lose viability after 4 months.
- Ability to compete with weeds. Requires weeding during the first 4-8 weeks.

Pests and Diseases Many troublesome insect pests and diseases (wilt and rust, particularly) are known to attack the succulent foliage. Local extension services should have details.

Limitations Pigeon pea seeds can bear fungi and must be treated with fungicide before shipment.

The plants initially grow slowly, although a small amount of nitrogen fertilizer boosts early growth. The crop cannot be produced in shaded sites.

When cultivated commercially as a pulse crop, the pigeon pea is grown as an annual or biennial because productivity declines after the first year. When grown for forage or green manure it is usually maintained no more than 5 years. The plant will die in about 10-12 years.

Calliandra calothyrsus

Botanic Name *Calliandra calothyrsus* Meissn.*

Synonym *Calliandra confusa* Sprague Riley

Common name Calliandra

Family Leguminosae (Mimosoideae)

Main Attributes This small bush is unusually promising as a firewood source because of its excellent coppicing ability and very quick growth. In Indonesia it has been cut for fuel after only a year's growth and harvested annually for the next 15-20 years. Even when harvested on such short rotations, it produces a sizable yield of branch wood that makes good household fuel.

Description *Calliandra calothyrsus* is a leguminous shrub that rarely reaches more than 10 m tall, with a maximum diameter of 20 cm.

Distribution The plant is native to Central America, but seeds were introduced from Guatemala to Indonesia in 1936. Calliandra proved so successful as a plantation crop that in 1950 the Indonesian State Forest Enterprise (Perum Perhutani) began planting it on a large scale, so that by early 1979 about 30,000 ha in Central, East, and West Java were under cultivation.

Use as Firewood In many parts of Java, *Calliandra calothyrsus* has become a favorite fuelwood. (In one instance, an experimental plantation of 0.5 ha was established in 1963; by 1975, over 250 ha of firewood plantations had been independently established on nearby privately owned farms and home lots.) The wood has a specific gravity of 0.51-0.78, its calorific value is 4,500-4,750 kcal per kg, and its ash content is 1.8 percent. It is used for cooking as well as in small industries; for example, those making lime, tiles, or bricks.

Yield Trial plots in Indonesia showed initial growth of 2.5-3.5 m in only 6-9 months. After 1 year's growth, calliandra can be cut at about 50 cm above the ground, reportedly yielding about 5-20 m^3 per ha. Afterwards, yearly cuttings are possible, producing between 35 and 65 m^3 of small-sized fuelwood per ha.

Other Uses

- Erosion control. The species grows very quickly, its dense foliage provides ground cover, and its extensive and deep root system binds soil, thereby making *Calliandra calothyrsus* particularly suitable for erosion control on slopes and for rejuvenating degraded soils. Extensive use is planned for stream-bank protection in Java.
- Soil improvement. By its nitrogen fixation and litter production, calliandra improves soil quality and productivity. Because of this, farmers in East Java sometimes rotate agricultural crops with calliandra plantations.
- Fodder. Livestock relish the leaves and the plant is a good fodder crop. In Indonesia, annual yields of 7-10 t of dry fodder (22 percent crude protein) per ha have been recorded. It has been grown together with elephant grass for fodder in large areas previously unable to support any crop.
- Ornamental. The bush is an exciting ornamental, producing beautiful red "powderpuff" flowers. It forms attractive hedges.
- Firebreaks. It is planted in strips on Indonesian state forest lands to protect the forest against fire (as well as illegal woodcutting).
- Bee forage. Honey produced by bees that forage on calliandra flowers has bittersweet flavor.

Environmental Requirements

- Temperature. Unknown.
- Altitude. On Java, the plant grows at altitudes between 150 and 1,500 m.
- Rainfall. The plant grows where rainfall is over 1,000 mm per year, though it can withstand drought periods lasting several months.
- Soil. It can grow on many different soils, including infertile ones, and even grows on heavily compacted clay-type soils with poor aeration.

Establishment Plantations are easily established by direct seeding or by seedlings. Seeds or seedlings are usually planted at the beginning of the wet season. Seedlings are transplanted from the nurseries at about 4-6 months at spacings of 2 m x 2 m or 1 m x 1 m.

- Seed treatment. Seeds are treated with hot water and then soaked in cold water for 24 hours.
- Ability to compete with weeds. Because it grows so rapidly and densely, calliandra suppresses competing plants very quickly.

Pests and Diseases Unreported.

Limitations There is little information on performance of this species on different sites. The plant is so hardy and reproduces so easily that it may become a weed of sorts and may be difficult to keep in check.

*A recent study by Wiersum and Breteler has shown the type specimens of *C. confusa* (the name most commonly used in Central America) and *C. calothyrsus* (the oldest name) are identical. In the NAS report *Tropical Legumes: Resources for the Future*, the name was misspelled *C. callothyrsus*.

Gliricidia sepium

Botanic Name *Gliricidia sepium* (Jacq.) Steud.

Synonym *Gliricidia maculata* (H.B.K.) Steud.

Common Names Madre de cacao, mother of cocoa, mata-raton, kakauati (Philippines), Mexican lilac, madera negra

Family Leguminosae (Papilionoideae)

Main Attributes This fast-growing tree is good for cultivation in populated areas; for example, in villages, farms, backyards, and along fence lines, paddy bunds, and the edges of roads and paths. It produces good fuelwood. It fixes nitrogen efficiently and grows well in, and enriches, poor soils. During dry (or cold) seasons it drops its heavy mantle of leaves and so conserves precious groundwater.

Description *Gliricidia sepium* is a small, thornless tree that grows up to 10 m high. It has an open crown and an often contorted trunk that is 30 cm or less in diameter. It is one of the most common and best-known trees of Mexico, Central America, and northern South America.

Distribution *Gliricidia sepium* has been introduced to the West Indies, where it is becoming naturalized. It has also been introduced to Africa and Asia and has become naturalized in the Philippines. It has been planted in southern Florida and in South America as far south as Brazil.

Use as Firewood Wherever *Gliricidia sepium* grows, its hard, heavy wood is used for fuel. Although not tall, the tree produces much branch wood and coppices easily. Its calorific value is 4,900 kcal per kg.

Yield Unreported.

Other Uses

- Timber. The wood finishes smoothly and is suitable for furniture, small articles, agricultural implements, and tool handles. Highly resistant to termites and decay, it is also used for posts and heavy construction.
- Living fence. *Gliricidia sepium* is easily propagated by cuttings, provided there is ample soil moisture. Even large branches will sprout roots and grow when they are stuck in the ground. A row of these makes a very effective living fence or windbreak that will last for many years without maintenance. Trimming these "fences" every month or 2 during the rainy season assures large amounts of foliage for green manure or ruminant feed.
- Ornamental. The tree produces dense masses of attractive white or pink flowers.
- Shade and green manure. The tree's long, leafy branches make it ideal as a shade tree. It is widely used to shade cacao, coffee, vanilla, and tea. The foliage is rich in nitrogen and the falling leaves enrich the soil beneath the trees. The foliage can also be cut and used to fertilize nearby crops.
- Fodder. The leaves contain over 20 percent crude protein and are nutritious for cattle. (They are, however, toxic to most other animals, including horses.)
- Honey. The flowers are a good source of forage for bees.

Environmental Requirements

- Temperature. 22°-30°C.
- Altitude. It is found growing on the plains and foothills of Central America extending up to about 1,600 m elevation, mainly below 500 m.
- Rainfall. 1,500-2,300 mm per year and more.
- Soil. It does well in moist or dry soil, even with heavy concentrations of limestone.

Establishment The plant is propagated easily by seed; however, the natural regeneration of large cuttings (often nearly 2 m long) is a simple method of getting large specimens quickly.

- Seed treatment. Soak in hot water, cool off during the night, sow the next morning.
- Ability to compete with weeds. Unreported.

Pests and Diseases The tree is losing popularity in Puerto Rico because the foliage is often attacked by aphids that secrete a sweet honeydew that attracts ants and causes the leaves to fall.

Limitations The roots, bark, and seeds are poisonous. The leaves may also be toxic to humans, although they are eaten in some parts of the tropics. Perhaps cooking inactivates the toxin.

Leucaena leucocephala

Botanic Name *Leucaena leucocephala* (Lam.) de Wit

Synonym *Leucaena glauca* Benth.

Common Names Leucaena, ipil-ipil (Philippines), lamtora (Indonesia), guaje, yaje, uaxin (Latin America), leadtree

Family Leguminosae (Mimosoideae)

Main Attributes Of all tropical legumes, leucaena probably offers the widest assortment of uses. Through its many varieties, leucaena can produce nutritious forage, firewood, timber, and rich organic fertilizer. Its diverse uses include revegetating tropical hillslopes and providing windbreaks, firebreaks, shade, and ornamentation. Individual leucaena trees have yielded extraordinary amounts of wood—indeed, among the highest annual total yields ever recorded.

Description Depending on variety, leucaena is either a tall, slender tree that may grow up to 20 m, or a rounded, many-branched shrub less than 5 m high. It has feathery leaves, bunches of long, brown pods—often almost translucent—and small, white "powderpuff" flowers.

Distribution Leucaena originated in the midlands of southern Mexico and was introduced to the Pacific islands, the Philippines, Indonesia, Papua New Guinea, Malaysia, and East and West Africa, so that now it is truly pantropical.

Use as Firewood Leucaena wood makes excellent firewood and charcoal. It has long been used for these purposes in the Philippines. New varieties are so productive that they are already being planted to provide fuel for electric generators, factories, and agricultural-processing facilities. The wood has uncommonly high density and calorific value for a fast-growing tree, and because the stumps readily coppice, the plant could become a renewable fuel resource in areas suited to its agronomic requirements. The calorific value is 4,200–4,600 kcal per kg.

Yield In the Philippines, dense leucaena plantations have yielded higher annual quantities of wood than any species yet measured. Annual leucaena increments have been measured from 24 to over 100 m^3 per ha. Average annual increments, however, are expected to be between 30 and 40 m^3 per ha.

It grows poorly in acidic soils, and much of the tropics has acidic latosolic soils high in alumina and often deficient in molybdenum and zinc.

Establishment Seed viability is high and the seeds can be successfully planted by hand or machine. Seedlings are slow starters. Leucaena can be reproduced by cuttings or grafts, but only with difficulty.

- Seed treatment. Eighty percent germination within 8 days can be achieved by treating the seeds with hot water (80°C) for 2–3 minutes. Further increases can be obtained by then soaking the seed for 2–3 days.

Other Uses

- Forage. Cattle feeding on leucaena foliage in Queensland, Australia, have shown some of the highest weight gains ever measured in the tropics. Suited mainly to cattle, water buffalo, and goats, leucaena forage is highly palatable, digestible, and nutritious. Both beef and dairy cattle thrive on it and can live on leucaena alone until mimosine-related toxicity occurs. This can be delayed or eliminated entirely by supplementing the diet with other forages. The plant's drought tolerance and hardiness make it a promising candidate for increasing meat and milk supplies throughout the dry tropics.
- Wood. The newly discovered arboreal leucaena varieties grow rapidly, yielding wood of useful size for lumber and timber. Leucaena wood has the potential to become a major source for pulp and paper, roundwood, and construction materials.
- Soil improvement. Leucaena is a nitrogen-fixing legume that helps to enrich soil and aid neighboring plants. Its foliage rivals manure in nitrogen content, and natural leaf-drop returns this to the soil beneath the shrubs. Its aggressive root system also breaks up impervious subsoil layers, improving moisture penetration and decreasing surface runoff.
- Reforestation. Its ability to thrive on steep slopes, in marginal soils, and in areas with extended dry seasons makes it a prime candidate for restoring forest cover to watersheds, slopes, and grasslands that have been denuded through wood cutting or fire.

Environmental Requirements

- Temperature. Leucaena is restricted to the tropics and subtropics; frost kills it.
- Altitude. This is a species for lowland areas mainly below 500 m. The plant continues growing at high elevations; but without its lowland vigor.
- Rainfall. The species grows best where annual rainfall is 600–1,700 mm. However, it is the dominant vegetation covering Honolulu's Diamond Head, where annual rainfall amounts to only 250 mm.
- Soil. Leucaena's root system allows it to tolerate a wide array of soil conditions. It is found in soils varying from rock to heavy clay to coral. Unaided, leucaena grows well only in neutral or alkaline (especially limestone) soils.
- Ability to compete with weeds. To establish leucaena, weeds must be controlled. Once rapid growth begins, the leucaena plants form a canopy of foliage that shades out weeds.

Pests and Diseases It is highly resistant to pests and diseases. Common pests are seed weevils, twig borers, and termites.

Limitations Leucaena's reputation has suffered in some areas because of a rugged, persistent variety that has become a weed. Also, its foliage contains mimosine, toxic to ruminants if consumed in excessive amounts.

Pithecellobium dulce

Botanic Name *Pithecellobium dulce* (Roxb.) Benth. (Genus sometimes spelled *Pithecolobium dulce*)

Synonyms *Mimosa dulcis* Roxb.

Common Names Manila tamarind, Madras thorn, quamachil, guamuchil, kamachile, blackbead, bread-and-cheese tree, opiuma (Hawaii)

Family Leguminosae (Mimosoideae)

Main Attributes The Manila tamarind is fast growing, endures drought, and withstands heavy cutting. It survives both heat and shade and is able to grow on poor soils and denuded lands in dry climates and on seacoasts even with its roots in brackish or salt water. It is a widely appreciated, easily established, multipurpose plant that produces useful fuelwood.

Description A large, nearly evergreen tree that grows up to 20 m or more in height, the Manila tamarind has a broad crown (to 30 m across) and a short bole (to 1 m thick). At the base of each leaf is normally found a pair of short, sharp spines, though some specimens are spineless.

Distribution It is native to a vast region that extends from the Pacific slopes of Mexico and southern California through all of Central America to Colombia and Venezuela. It has been widely planted and naturalized in many tropical regions, particularly in the warmer and drier regions of the Philippines and India. It has been introduced to the Sudan, Tanzania, and other dry areas of tropical Africa, largely the coastal regions. Further, it has been commonly planted and runs wild in southern Florida, Cuba, Jamaica, Hawaii, Puerto Rico, and St. Croix.

Use as Firewood The reddish-brown wood is usually hard, heavy, and strong, though it is also brittle and rather difficult to cut. It is used in India, Africa, and Central and South America as a fuel, but it smokes considerably and is not the best quality firewood. Calorific value, 5,200–5,600 kcal per kg. In parts of India it is planted and harvested as fuel for brick kilns. The tree coppices vigorously.

Yield In favorable soils and climates, the Manila tamarind may reach a height of 10 m in 5 or 6 years.

Establishment Manila tamarind is readily propagated by cuttings or seed. It fruits at an early age. Seed may be stored for about 6 months (though it must then be protected from insects).

- Seed treatment. None necessary. Germination takes only 1 or 2 days.
- Ability to compete with weeds. Readily outgrows competition.

Pests and Diseases Normally pest damage is insignificant, but the tree can become affected by leaf spot diseases and a number of defoliating and boring insect pests. It is a favorite host of the thornbug.

Other Uses

- Wood. The wood is durable, finishes smoothly, and is used in several countries for general construction purposes and for posts.
- Shade, hedges, and ornamental use. This attractive species makes a good highway tree. With regular trimming it makes dense, almost impenetrable, thorny hedges that keep out livestock and form useful shelterbelts.
- Food. The pods are harvested in Mexico, Cuba, and Thailand and are customarily sold on roadside stands. They contain a thick, sweetish, but also acidic pulp that is usually white, but sometimes red. It is eaten raw or made into a drink similar to lemonade.
- Forage. The pods are devoured by livestock of all kinds; the leaves are browsed by horses, cattle, goats, and sheep; and hedge clippings are often gathered for animal feed. The plants withstand heavy browsing.
- Seeds. The seeds contain a greenish oil (20 percent), which, after refining and bleaching, can be used for food or in making soap. The presscake residue is rich in protein (30 percent) and may be used as stockfeed.
- Miscellaneous. An extract from the bark is used in the Philippines for tanning; it produces a light-colored leather. The flowers are visited by bees and yield good-quality honey. The wounded bark exudes a mucilaginous gum somewhat like gum arabic.

Environmental Requirements

- Temperature. Warm subtropical and tropical, though it can withstand both shade and heat.
- Altitude. Up to 1,800 m in Mexico and 1,500 m in Burundi.
- Rainfall. This species is suitable for most dry regions. It is drought resistant and in low rainfall areas develops an extensive root system. In Burundi it grows well at 800 m elevation where annual rainfall fluctuates between 450 and 600 mm, spread evenly year-round. In southern Florida rainfall averages 1,650 mm or more.
- Soil. Manila tamarind has great adaptability and grows on most soil types, including clay, oolitic limestone, and rather barren sands. It can also be found in wet sands that have a brackish water table.

Limitations Once introduced, it may hold an area firmly. In Tamil Nadu, India, repeated attempts to replace this plant with other species have failed. It is classed as a pest in Hawaii because it infests pastures and shades out more-desirable forage plants.

Because the trees are often top heavy and shallow rooted, in heavy windstorms branches may break off or the whole tree may topple.

Both the thorniness and an irritant sap that causes severe eye irritation in tanners and long-lasting welts on skin are limitations that have caused the tree to be abandoned as a street tree in southern Florida. Any injury to roots gives rise to suckers that are exceedingly thorny.

Sesbania grandiflora

Botanic Name *Sesbania grandiflora* (L.) Pers.

Synonym *Agati grandiflora* (L.) Desv

Common Names Agati, bacule, katurai (Philippines), August flower (Guyana), West Indian pea tree, turi (Malaysia, Java), gallito, chogache (India)

Family Leguminosae (Papilionoideae)

Main Attributes This small tree produces firewood, forage, pulp and paper, food, and green manure and appears to hold promise for reforesting eroded and grassy wastelands throughout the tropics. It combines well with agriculture (agroforestry) in areas where trees are not normally grown and becomes an important fuelwood source. After the plant is harvested, shoots sprout with such vigor that they seem irrepressible. The tree's outstanding quality is its rapid growth rate, particularly during its first 3 or 4 years.

Description *Sesbania grandiflora* grows to a height of 10 m, with a trunk diameter of about 30 cm. The bole is straight and cylindrical, the wood white and soft. The bark is light grey, deeply furrowed, and corklike in texture.

Distribution Native to many Asian countries, for instance, India, Malaysia, Indonesia, and the Philippines, *Sesbania grandiflora* is commonly found growing on the dikes between rice paddies, along roadsides, and in backyard vegetable gardens. It has been widely distributed in southern Florida and the West Indies as well as from southern Mexico through most countries of Central America down to South America. It has also been cultivated in Mauritius. A closely related species, *S. formosa*, is native to northern Australia.

Uses

Firewood *Sesbania grandiflora* has long been used as firewood in Southeast Asia and has been planted in several areas in Indonesia to provide fuel and other products in "turinisasi" projects (after turi, the indigenous name). However, the wood is white, soft, and has a rather low specific gravity of about 0.42, which is poor for fuelwood.

Growth In India, plantation-grown trees have reached 8 m in as little as 3 years (with average diameter not less than 10 cm). Moreover, *Sesbania grandiflora* can be planted very densely (up to 3,000 stems per ha). Wood yields of 20-25 m^3 per ha per year are commonly achieved in plantations in Indonesia. Even when planted only along the edges of agricultural fields, as in Java, yields of 3 m^3 of stacked firewood per ha from 2-year rotation periods have been recorded.

Other Uses

- Utility plantings. In Manila, the tree is often planted for beautification along roadsides, fence lines, and other boundaries. The large, handsome flowers and long pods make it a striking ornamental. With its open, spreading crown of feathery leaves, *Sesbania grandiflora* gives light shade. It also makes useful windbreaks and is often grown as a living fence.
- Food. The young leaves, tender pods, and giant flowers of *Sesbania grandiflora* are favorite Asian vegetables. They are used in curries and soups or sometimes fried, lightly steamed, or boiled. The leaves contain over 36 percent crude protein (dry weight), and with their high mineral and vitamin content, they make a nutritious, spinach-like vegetable.
- Forage. Cattle relish the feathery leaves and long pods (up to 60 cm). In parts of Java where cattle breeding is important, the tree is frequently planted as a source of forage, continually topped to keep it within the animal's reach.
- Green manure. Foliage of *Sesbania grandiflora* makes excellent green manure; in Indonesia, trees planted along dikes are often used to fertilize nearby crops. They are considered an excellent support and nurse crop for betel and pepper vines.
- Reforestation. In Taiwan, *Sesbania grandiflora* has proved useful for reforesting eroded hill regions.
- Gum and tannin. When cut, the bark of the tree exudes a clear gum that has been used as a gum arabic substitute in foods and adhesives. The bark also yields a tanning agent.
- Pulp and paper. In East Java, the tree is extensively used as a pulp source. The wood's fiber length (1.1 mm, about average for hardwoods used for paper) and chemical composition are suitable for pulping.

Environmental Requirements

- Temperature. The tree is frost sensitive and is adapted only to tropical conditions.
- Altitude. Grows up to 800 m above sea level.
- Rainfall. *Sesbania grandiflora* grows best where annual rainfall exceeds 1,000 mm and there are only a few months of dry season. It is widely grown in areas where there is extensive irrigation or flooding, such as in Asian rice paddies. On the other hand, the species grows abundantly on the semiarid Timor Islands of Indonesia.
- Soil. *Sesbania grandiflora* is able to grow in a wide range of soils, even poor ones, including black, poorly structured clay. Its extraordinary nodulation undoubtedly helps restore fertility to these soils. On Timor, the species is commonly found on abandoned swidden land. This, coupled with its rapid growth, suggests that its soil improvement qualities—though unmeasured—may be exceptional.

Establishment The species propagates easily by cuttings or seedlings. It requires little maintenance and can readily be planted on a large scale by direct seeding and even by aerial sowing.

- Seed treatment. None.
- Ability to compete with weeds. Unreported.

Pests and Diseases *Sesbania grandiflora* is very susceptible to nematodes. In northern Australia, plantations have also been damaged by birds (cockatoos) and grasshoppers.

Limitations There is no information available on general silviculture of this plant; thus, those who may wish to grow it face considerable uncertainty.