6.3.2 Food crops as key part of the system

Issues
- soil erosion/soil physical conditions
- soil nutrient stocks, especially for low-value, nutrient-rich products such as cassava, where it is not financially feasible to replace the nutrients exported with the farm products
- soil biodiversity and active soil organic matter fractions can fall below critical levels during intensification of land use for food crops
- weeds
- vertebrate pests are a key constraint for farmers in growing food crops as well as establishing tree crops; with increasing distance from the forest margin the main problems are caused by elephants, wild pigs and rats

Options
- easily established cover crops as source of organic matter
- rock-phosphate as key input on acid infertile soils
- rotational hedgerows as biological weed control
- live fences as pig deterrent
- new upland rice varieties which are well-suited as an intercrop during the establishment phase of agroforestry systems

Research needs
- evaluating effectiveness of 'weedy' fallow species such as *Chromolaena* and *Eupatorium*
- compatibility of 'improved' crop germplasm for early stages of tree-based systems
- developing methods for 'functional soil organic matter pools' as management tool
- establishing 'thresholds' for loss of soil biodiversity
- landscape diversity as element of vertebrate pest control
- economic analysis to assess feasibility of various options

6.3.3 Tree crops as the major part of the system

Issues
- income sources during tree establishment/length of establishment period
- weed-induced fire risks in period between food crops and closed tree canopy
- climatic risks, especially long dry seasons
- marketing risks and trade restrictions
- existing germplasm improvement programs biased towards monoculture plantations
- market failures in supply of higher-yielding planting material

Options
- selecting rapidly productive tree components, such as bamboo, fast growing timber, cinnamon, certain fruit trees
- credit schemes to bridge unproductive period; the existing nucleus-estate-plasma concept provides such credit, but also ties the smallholder to a single marketing outlet for future products; improved transport will increase options for physical access to production sites, e.g. for palm oil, and may help to un-couple credit supply and marketing. Smallholder credit for perennials has not met with much success,

- trade policy reform to reduce barriers faced by smallholders and by local traders
- policies and programmes to address market failures in supply of planting material

Research needs
- increased accessibility of rapidly producing tree crops
- options for reducing establishment costs/shortening establishment period
- options for extended cropping period
- design rules for selecting appropriate tree mixtures
- design rules for reducing *Imperata*-induced fire risk
- tests of compatibility of 'improved' tree germplasm in an appropriate systems context
- economic analysis to assess feasibility of technical options
- analysis of policy-induced distortions and of market failures

6.3.4 Livestock as major component

Issues
- year-round fodder supply,
- choice between: community level conflicts caused by free-roaming animals, land and input costs for fenced pastures or labour constraints to'cut-and-carry' systems
- use of livestock as source of draught power for plowing in crop-based systems and for transport
- others to be specified

Options
- fodder banks, fodder trees
- others to be specified

Research needs
- to be specified

6.3.5 Land tenure

Land tenure in the ASB benchmark areas can be obtained by four methods:

- via customary rights,
- by buying land,
- via 'transmigration' programs,
- via a 'free-for-all' in former logging concessions or along newly opened roads.

There are various restrictions on these types of land. Under certain customary rights, planting trees is not allowed on communal land, because it is the main avenue for establishing private (inheritable) land claims. Conflicts over land tenure established by buying land or via transmigration may arise from a lack of clarity in the customary rights, when one family member or village leader decides to sell, but others have valid claims as well.

The 'free-for-all' situation can cause serious conflicts with the Department of Forestry and concessionaires leading to (attempts at) eviction, or to a consolidation and acceptance of the status-quo. Usually, however, uncertainty remains for a long period and may affect land use decisions on both sides.

6.3.6 Alternatives to Agriculture

The most rigorous solution is obtained by those who look for 'Alternatives to Agriculture' rather than 'Alternatives to Slash and Burn'. Migration to urban and industrial areas is a major escape route from rural poverty, and may be a direct consequence of improved site accessibility (as the North Lampung case study in Tiuh Baru showed). Links with the rural areas may persist, however, as it is common for young people to spend time away from home ('Merantau'), but return at a later stage in the family cycle. Remittances from urban workers to rural family members also are an important link. Such links facilitate capital investment in agriculture (and other rural economic activities) and may also be compatible with the establishment of tree crops. Data of Elmhirst (1995), however, suggest that money earned was mainly invested outside agriculture, e.g., in sibling eduction (in- or outside the village). Migration choices at the household level still are poorly understood, at least in a quantitative and predictive sense, and are a priority for further research on forces driving deforestation.

6.4 Forces driving deforestation

6.4.1. What causes deforestation in Sumatra?

Some of the major forces that could drive deforestation are shown schematically in Figure 52, arrayed around an ellipse that depicts smallholders' production decisions. There are four clusters of phenomena in the figure:

- field-level phenomena
- "neighborhood effects" on natural resource management at the *community level*
- driving forces operating at the *benchmark level*
- environmental consequences of deforestation

The double-headed arrow connecting "on-site sustainability" with production decisions in farmers' fields indicates the interaction between smallholders' agricultural practices, on the one hand, and soil organic matter levels, below-ground biodiversity, and other *field-level phenomena* that were the topics of section 6.3. Most other *environmental consequences* depicted in Figure 52 (biodiversity loss, greenhouse gas emissions and sinks) will be taken up in section 6.5 on integration of biophysical, land use, and policy research. This section focuses on forces driving deforestation at the *community level* and the *benchmark level.* The latter includes watershed-level sustainability (soil and water conservation), sectoral policies, regional infrastructure investments, and macroeconomic policies.

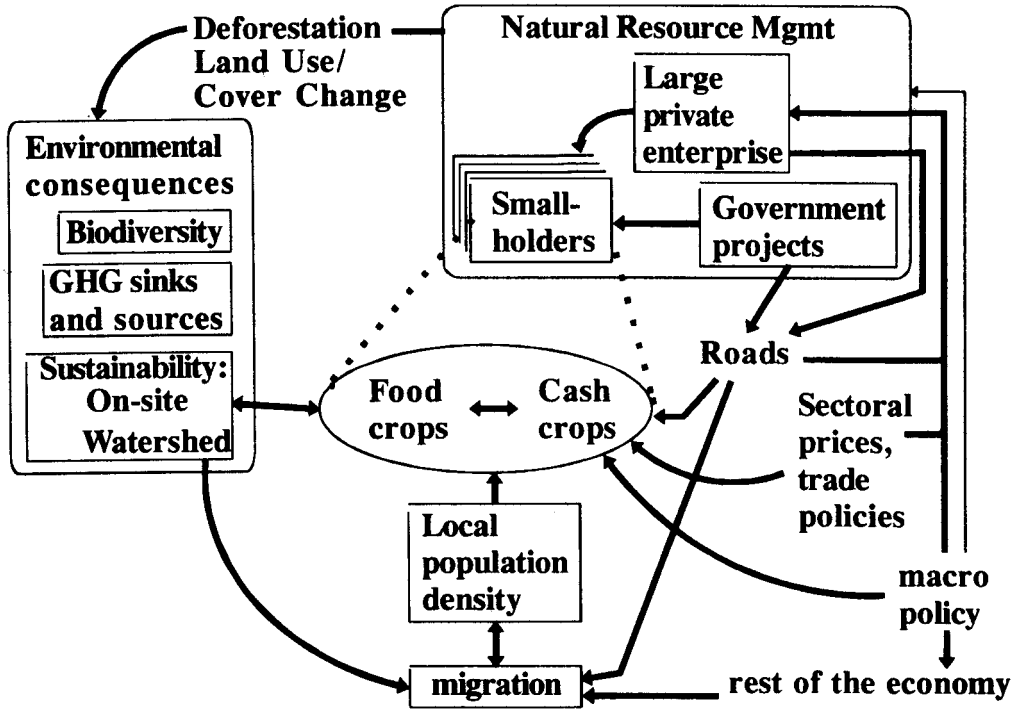

Figure 52. Driving forces of deforestation and other land use change, and some of their consequences

Smallholder production decisions are at the center of Figure 52 because of an implicit ASB hypothesis:

DEFORESTATION HYPOTHESIS 4. ROLE OF SMALLHOLDERS
Smallholders account for a significant share of deforestation in Sumatra.

Whether or not this is the case is an empirical question that is being addressed as part of characterization activities that will continue in Phase 2. The answer is likely to depend on the type of forest. Figure 53 indicates the various types of forest land in Indonesia, including "village land" and "government forest land." There is a considerable zone of overlap (and conflict) between these two categories. The main classes of officially-designated government forest land are:

- conservation forest, national parks, and nature reserves
- (watershed) protection forest
- (limited) production forest
- conversion forest

It may be that smallholders account for much of the conversion at the margins of conservation and protection forests, where (at least formally) large-scale actors are not supposed to operate. In the case of production forest, conversion often occurs because of interaction between logging companies (that build roads) and the smallholders occupying this land as "spontaneous migrants."

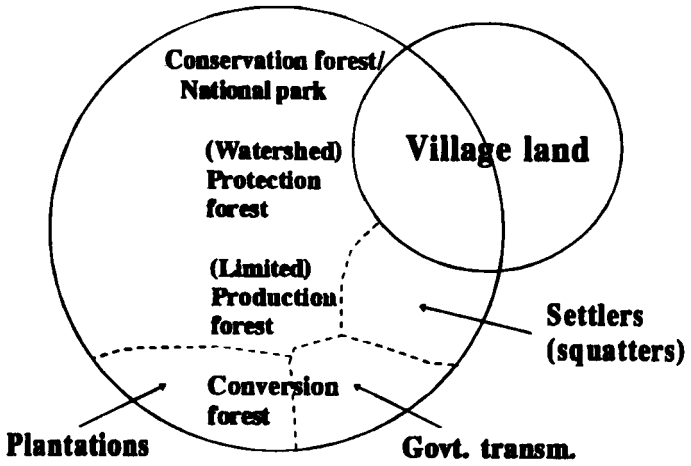

Figure 53. Forest categories in Indonesia; the overlap between the 'village' forests and the 'government' forests indicate a zone of debate and conflict

One important issue is how (or whether) one counts "conversion forest" as "deforestation." "Conversion forest" is state forest land that is officially-designated for conversion to other uses, usually involving agricultural production (such as transmigration projects and large-scale plantation agriculture). In terms of official policy, this land use change is viewed as an element of economic development strategy rather than (uncontrolled) "deforestation." Nevertheless, land use in these large projects often sacrifices much of the forests' environmental functions.

Table 32 shows that policy objectives (regarding the mix of forests' environmental and production functions) and policy problems differ significantly by forest policy domain. One task in the characterization activity for Phase 2 is to attempt to pull together the data on deforestation by forest class for the various actors involved in forest conversion in order to estimate, for example, the relative shares of officially-sanctioned forest conversion and conversion by smallholders to establish treecrops. To a large extent, the "conversion forest" policy problem rests with a global market failure: lack of mechanisms to compensate resource users (including national governments, companies, and smallholders) for supplying global externalities. No work is planned on this for ASB-Indonesia in Phase 2, but it is an issue that merits attention in Phase 3 planning at the global level.

6.4.2. What drives deforestation by smallholders?

If smallholders contribute significantly to deforestation--at least for some forest policy domains it--is important to know why if one wants to identify options for slowing forest conversion. The ASB Global hypotheses are that conversion of forest by smallholders is driven by (a) food production insecurity or (b) poverty. These hypotheses are stated below.

SMALLHOLDER DRIVING FORCE HYPOTHESIS 1A. FOOD INSECURITY

Deforestation caused by slash-and-burn is driven by food insecurity. Increased/prolonged food production will decrease deforestation.

SMALLHOLDER DRIVING FORCE HYPOTHESIS 1B. POVERTY

Deforestation caused by slash-and-burn is driven by rural poverty. Increased household income will decrease deforestation.

Three groups of smallholders have been studied in detail during Phase 1: local people, spontaneous migrants, and government-sponsored transmigrants. The general features of the livelihood strategies of these three groups are remarkably similar. Although foodcrops are produced after initial forest conversion, food production *per se* does not appear to be the primary objective. Hence, Hypothesis 1A does not seem to be the driving force. And while poverty clearly plays a role as a driving force, for reasons suggested above in section 6.1 and elaborated below in this section, it is clear that certain measures to raise income run the risk of increasing deforestation. Thus, hypothesis 1B is too simplistic and will be replaced later in this section with a number of hypotheses regarding "push" and "pull" factors affecting migration.

The twenty ASB-Indonesia researchers who participated in a two-day "driving forces" working group during the ASB planning workshop endorsed hypotheses 1C and 1D for research in the next phase. Each is derived from a fact that is obvious at all of the ASB sites in Sumatra: establishing treecrops is the primary objective of smallholders employing slash-and-burn.

SMALLHOLDER DRIVING FORCE HYPOTHESIS 1C. PROFITABLE TREECROPS
Deforestation caused by slash-and-burn by Sumatran smallholders is driven by profitable income-generating opportunities, specifically production of treecrops. These are an indirect means of attaining food security, but food production *per se* is not the driving force.

SMALLHOLDER DRIVING FORCE HYPOTHESIS 1D. PLANTING TREECROPS ESTABLISHES INFORMAL LAND CLAIMS. Deforestation caused by slash-and-burn by Sumatran smallholders is driven by their desire to establish claims over land. Planting treecrops such as rubber is a well-established mechanism for securing informal land tenure in Sumatra. Where communal forest land has to be cleared before it can be claimed by individual families, this tenure arrangement accelerates forest conversion.

Data from household and community-level characterization in Phase 1 support these two hypothesis, but it is not possible to discriminate between them with the survey data.

Table 32. Forest policy domains

Policy domain (forest class)	Policy objective regarding environmental functions	Policy objective regarding production functions	Policy problem	Represented by which ASB-Indonesia site?
Protection forest/ Conservation forest/ National park/ Nature reserve	Objective is 100%; less in practice.	Objective is few if any; perhaps limited to extraction of non-timber forest products (NTFPs).	Identifying incentive structures and/or regulations that minimize costs of monitoring and enforcement of forest boundaries.	Rantau Pandan
Production forest, including village forests	Partial	Partial	Identifying institutional mechanisms to create incentives for sustainable forest management.	Bungo Tebo; Rantau Pandan
Degraded production forest/imperata grassland; including village grasslands	Objective is to increase from a low level	Objective is to increase from a low level	Identifying institutional mechanisms to create incentives for reforestation.	North Lampung
"Conversion forest" and forest converted by smallholders	Virtually none. (Outcome depends on subsequent use.)	Conversion viewed as more profitable than forest production.	Identifying feasible compensation mechanism for value of global externalities.	Bungo Tebo; North Lampung

6.4.3. Forces operating on smallholders at the community level: "neighborhood effects."

As emphasized in section 6.2, smallholders are not the only actors converting forest nor are they the only group employing slash-and-burn in Sumatra. Forest concessionaires, industrial timber estates, treecrop plantations, and transmigration projects all have played a role too. Even if we retain the ASB focus on smallholder land use choices, it is impossible to ignore the potential for impact of the large-scale actors, whether public orprivate, on smallholders' opportunities and constraints. These *neighborhood effects* are depicted by the arrows running to the smallholder community from "government projects" (e.g., transmigration projects) and "large-scale private enterprises" (including forest concessions and treecrop estates) in the "natural resource management" cluster in Figure 52.

Appropriation of large tracts of land for projects effectively increases the local population density (since land that once was accessible now is closed to the local population or its use entails new risks for production and investment). Other implications depend on who the large-scale actors are in the smallholders "neighborhood." The following community-level hypotheses are organized by policy domain (see Table 32).

COMMUNITY-LEVEL HYPOTHESIS 1. MARGINS OF NATIONAL PARKS AND RESERVES: "Bufferzone Agroforestry" is not sufficient to protect national parks and nature reserves. Moreover, forest encroachment can be pulled by profitable agroforestry innovations (see migration hypothesis 3 below).

Productivity-increasing agricultural innovations that can be applied profitably within the forest margins will accelerate forest encroachment unless clear property rights can be established over forest lands. While clear property rights are necessary to establish incentives for natural resource management, they may not be sufficient to protect parks and nature reserves. Incentives structures and/or regulations that minimize costs of monitoring and enforcement of forest boundaries also are required for effective protection of this forest class.

COMMUNITY-LEVEL HYPOTHESIS 2. COMMUNITY-BASED MANAGEMENT OF PRODUCTION FORESTS

Tenure conflicts between concession holders and local smallholders undermine natural resource management incentives for each group, resulting in degradation of forest resources. Under these circumstances, devolution of rights and responsibilities of production forest management (including logging) to local communities will improve natural resource management compared to the *status quo ante*. Management of production forests by local communities also can be a more effective means of monitoring and enforcing restrictions on forest encroachment by spontaneous migrants ("forest squatters").

COMMUNITY-LEVEL HYPOTHESIS 3. REHABILITATION OF DEGRADED PRODUCTION FORESTS (IMPERATA GRASSLANDS) BY SMALLHOLDERS

Property rights over all products, including timber, create incentives necessary for local people to do the hard work to re-establish trees on land that formally is classed as production forest but, in fact, is covered by extensive *imperata* grasslands. Clear rights of ownership of the trees they plant will create incentives for local people to cooperate in fire prevention and to take the lead in fire control. Without local cooperation and community involvement to control fire, sustainable rehabilitation of *imperata* grassland is extremely difficult.

COMMUNITY-LEVEL HYPOTHESIS 4. TRANSMIGRATION PROJECTS ("CONVERSION FORESTS") BEGET FOREST CONVERSION

Forest conversion is likely to be increased in the neighborhood of a transmigration project for two reasons. First, transmigration projects are a source of spontaneous migrants--either transmigrants themselves or relatives who follow them--who then convert forest. Second, cheap labor supplied by recent transmigrants combined with local people's superior access to forest land accelerates forest conversion for treecrop planting in areas adjacent to transmigration sites.

6.4.4. Forces operating at the benchmark level

Of the forces operating on deforestation and land use change at the benchmark level (Figure 52), priorities for ASB-Indonesia Phase 2 research may be grouped in three sets:

- migration pressure
- road construction
- sectoral price and trade policies

These sets of forces affect the profitability of forest conversion by smallholders, but the direction and magnitude of their impact on deforestation depends on interactions with other forces at the community and the benchmark level.

MIGRATION HYPOTHESIS 1. UNSUSTAINABLE AGRICULTURAL PRACTICES INCREASE MIGRATION PRESSURE IN THE FOREST MARGINS

Land use practices that create significant negative externalities at the watershed level (siltation, flooding, etc) and, thereby, significantly undermine land productivity, will contribute to migration. Under some circumstances, it can be true that "Alternative production techniques that maintain or enhance soil fertility and diminish weed invasion will prolong the productivity of recently cleared land, thereby reducing forest encroachment" (ASB Global Hypothesis on Food Security/Human Welfare). However, this is not always the case: compare migration hypotheses 2 and 3 below.

MIGRATION HYPOTHESIS 2. SUSTAINABLE PRODUCTIVITY INCREASES IN IRRIGATED LOWLANDS REDUCE MIGRATION PRESSURE IN THE FOREST MARGINS

Some productivity-increasing agricultural innovations (for example new rice varieties for irrigated lowlands) unambiguously reduce forest encroachment because they expand income-generating opportunities for the rural population but cannot be applied profitably in the forest margins.

MIGRATION HYPOTHESIS 3. UPLAND PRODUCTIVITY INCREASES (INCLUDING AGROFORESTRY INNOVATIONS) INCREASE MIGRATION PRESSURE IN FOREST MARGINS

Productivity-increasing agricultural innovations that can be applied profitably within the forest margins will accelerate forest encroachment unless clear property rights can be established over forest lands (see community-level hypotheses 1 and 2 above.)

MIGRATION HYPOTHESIS 4. GROWTH OF EMPLOYMENT OPPORTUNITIES IN OTHER SECTORS IS THE MOST IMPORTANT FORCE REDUCING MIGRATION PRESSURE IN THE FOREST MARGINS OF SUMATRA

Expansion of employment opportunities in manufacturing and services, *WHICH DEPENDS MAINLY ON SOUND MACROECONOMIC MANAGEMENT*, has greater potential to reduce forest encroachment by smallholders than sectoral policies in agriculture or forestry. (This result depends on the structure of the economy. Industry's share of GDP surpassed agriculture in 1992 and export-oriented manufacturing now is the engine of growth in the economy. The effect of growth in other sectors on migration pressure in the forest margins would be much less if (a) industrial growth were stagnant or (b) agriculture dominated national income and employment generation today as it did only 25 years ago.)

ROAD CONSTRUCTION HYPOTHESIS 1. SECONDARY ROADS. Other things equal, secondary roads built by logging companies, transmigration projects, and other large-scale actors contribute to forest conversion by making forest access easier for spontaneous migrants.

ROAD CONSTRUCTION HYPOTHESIS 2. MAIN ROADS. Patterns of land use change resulting from construction of a major road through a particular site depend on biophysical determinants of production potential (e.g., soil fertility), land tenure, access to markets, and migration pressure.

HYPOTHESIS ON SECTORAL PRICE AND TRADE POLICIES. Incentives created by sectoral price and trade policies have powerful influences on land use decisions and on environmental consequences (biodiversity loss, GHG emissions, erosion) of forest conversion. The case of rubberwood (see section 5.10 above) is a good example of links running from policies to land use, production, and marketing decisions at the household level and to biophysical outcomes.

6.5 Integrating biophysical, land use, and policy research at the benchmark level

Section 6.4 discussed the important task of analyzing the forces that link policy choices to land use change. But we also need a comprehensive set of biophysical measurements to understand the "who cares" question: are these effects big or little? When we know how big the differences are among the various land use systems (and we already have a good idea), we will have a basis for identifying the major opportunities to make a difference and, hence, to provide a more precise focus for priorities for policy research.

Except for biodiversity assessment, methodological foundations and research teams for all key biophysical indicators were established in Phase I. Planning is going on to identify the biophysical measurements that deserve priority for replication in Phase II and to clarify where additional work will focus. With CIFOR joining as an active partner in the ASB-Indonesia consortium for Phase 2, we now have the basis to begin biodiversity assessment.

All three of the ASB global hypotheses can be linked directly to land use changes and thereby adapted to conditions suited to the Sumatran benchmark sites.

BENCHMARK-LEVEL HYPOTHESES ON FOOD SECURITY/HUMAN WELFARE: Continuous, intensive foodcrop production is not agronomically sustainable in the forest margins of Sumatra while perennial-based systems (including agroforests) are sustainable and offer profitable alternatives for smallholders.

Soil organic matter (SOM) measurements are the key biophysical indicator for agronomic sustainability.

BENCHMARK-LEVEL HYPOTHESIS ON GLOBAL WARMING: Major land use systems in Sumatra differ significantly regarding greenhouse gas emissions and sink strength. Specifically, complex agroforests, industrial timber estates, and treecrop monoculture sequester more carbon than foodcrop-based systems, thereby reducing net greenhouse gas emissions as a result of deforestation at the forest margins in Sumatra.

Measurements of greenhouse gas emissions and sink strength and measurements of biomass (above- and below-ground) are the key biophysical indicators for global warming.

The source/sink relations for methane are more important for the global climate than the source/sink relationships for carbon dioxide.

Upland forest soils are a significant methane sink.

Burning vegetation, especially timber, produces large amounts of methane.

BENCHMARK-LEVEL HYPOTHESIS ON BIODIVERSITY CONSERVATION: Major land use systems in Sumatra also differ significantly regarding biodiversity. Specifically, complex agroforests preserve much greater biodiversity than other land use alternatives at the forest

margins (including industrial timber estates, treecrop monoculture, and foodcrop-based systems) thereby reducing biodiversity loss as a result of deforestation.

Much of the existing biodiversity can be maintained while productivity is increased through introduction of higher-yielding germplasm in complex agroforestry systems, such as rubber agroforests ('jungle rubber').

Work to develop indicators of the biodiversity of various groups (plants, soil microorganisms, etc.) will be developed in Phase 2.

The ultimate goal is to fill in the cells of the following table. The potential number of cells is quite large, especially since we probably need at least two versions of the table, one for the peneplains and one for the piedmont zone. Proposal development for Phase 2 will require effort to set priorities for measurements across rows of the table. Since the two peneplains sites are similar biophysically, it may be possible to focus additional data collection on one of the two sites, at least for above-ground biomass and biodiversity. Phase 2 proposals on these topics (corresponding to the columns) will have to consider where the greatest payoff to additional measurements is most likely. And for some biophysical indicators, it may be necessary to look more closely at variation resulting from elevation, soils, climate, and other factors.

Table 33. Attributes of land cover units which are needed to evaluate the externalities of land use change

A. Major land use category	B. Extent in benchmark area (000 ha)	C. SOM (% C)	D. Carbon below-ground (kg C/ha)	E. Carbon above-ground (kg C/ha)	F. GHG emissions (CO_2, CH_4, N_2O) (kg/ha/yr)	G. Biodiversity, above- and below-ground (measured in area-based units)

The rows of this table are the major land use categories for the Sumatran benchmark sites (compare section 5.1). From the outset of Phase 2 it will be necessary to agree on precise descriptions of a common set of land use categories for biophysical monitoring. The categories have to be (a) comprehensive for major land use categories for the site and (b) consistent across the studies that produce data for the columns. Particular attention needs to be given to developing clear operational definitions for forests, agroforests, plantations, and other tree-based systems. Rubber agroforests - a category covering millions of ha in Sumatra - is a candidate for special attention. Among the outputs of the regional planning workshop were two partial tables of definitions, one for forest land use systems and cover types and the other for agroforestry and agricultural land use systems and cover types. These partial tables represent work in progress to reconcile the level of disaggregation in land use that is *desirable* with what is *feasible* given data constraints and current technology.

Fig. 54 indicates that the biophysical properties of the benchmark area, soil, vegetation and atmosphere are influenced by historical as well as current drivers of deforestation and

land use change. Government policies develop gradually with time and their may be a considerable time lag between policy development and its actual effects on the ground. For the ASB project, we are mainly concerned with the effects of the actual situation on the ground on three targets: 'increased human welfare', 'reduced greenhouse gas emissions' and 'biodiversity conservation'. Which policies can be developed now to reduce the conflicts and expand complementarities between these targets in the near future in the benchmark area?

Past policies continue to dictate the way in which local inhabitants use natural resources. For example, the development of agroforests and rubber plantations since the pre-war period both among smallholder and large private companies has been the backbone of the economy of almost the entire island of Sumatra. Therefore, at least until the 1970's, land use change in Sumatra was very much dominated by rubber plantations and rubber agroforests. The pattern of forest conversion followed the river system which was used as the main transportation pathway, both for the logs obtained in the primary step of deforestation and for the rubber which was obtained later. Today's driving forces of deforestation and conversion of natural forest may be to a large extent the product of central government policies, such as road development (leading to a very different system of access), the transmigration program, forest concessions and industrial timber plantations, and estate crop development which are extensive in some of the benchmark areas. These policies were developed to address government priorities. If we now conclude that they have undesirable side-effects as well, (how) can these be changed without unduly compromising the original objectives? And can such change be implemented soon enough to make a difference?

Reward systems do not yet exist for those who develop without destroying the environment, but also for those who improve the environment. On the contrary, land clearing using fire, for example, has been extensively and commonly practiced by virtually all actors (public and private, large and small) contributing to forest conversion. Slash-and-burn methods are attractive for all these actors because fire is the cheapest, most effective means to clear land.

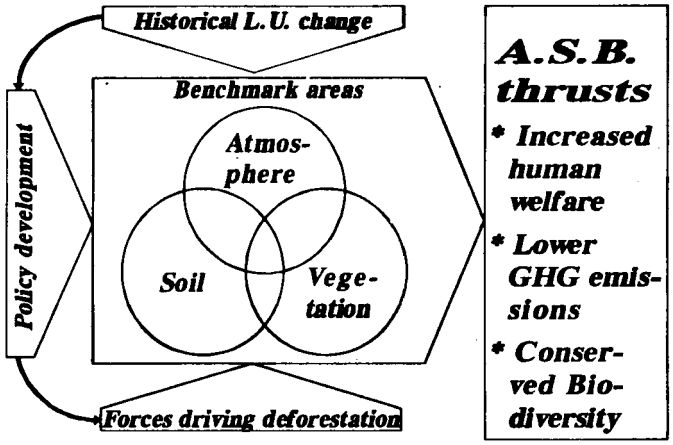

Figure 54. Past and current policies affect biophysical aspects of the benchmark areas and thus have an (indirect) effect on the three ASB thrusts.

Figure 55 gives a more detailed biophysical account of the relations between 'vegetation' (natural or man-made) and the main production factors (water, nutrients and soil). Long term sustainability of the production system depends on the management of the water balance, the nutrient balance and soil organic matter (carbon) balance. In each case, there is a trade-off between short term gains and long term sustainability. A quick profit can be obtained by stimulating the breakdown of soil organic matter and benefitting from the nutrients thus mineralized, by not replacing the nutrients removed from the system in harvested products, and by not investing in soil and water conservation measures to protect areas downstream. How can (government) policies influence decisions made on the ground, and tip the balance in the direction of sustainability rather than quick profits? An obvious first requirement is long term security of land tenure. Emphasis on long term tree crops (rubber, cassiavera, fruit trees) rather than annual food crops probably helps as well.

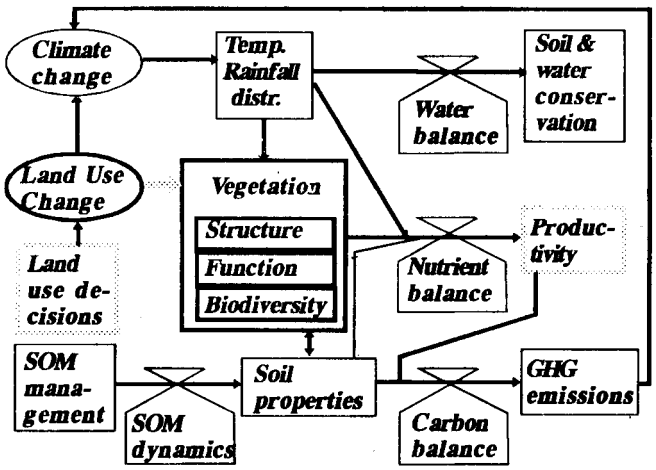

Figure 55. Integrated approach to study slash-and burn process in order to find alternatives

In most cases governments will have to accept the *status quo* of the current distribution of people. The policy challenge is to identify methods that are economically and institutionally feasible and sociallyt acceptable to give them incentives to increase the sustainability of their land use and prevent further encroachment of remaining natural resources. Costs of moving people out of their current areas are high, both from an economical, a social and a political perspective. The 'local transmigrants' of the N. Lampung benchmark area were moved in such a way out of a 'protection forest' area, and now have to make a living in an area with much poorer soils than where they previously settled by their own choice. It is understandable that many of them have moved or are still considering that option. The overall balance in terms of forest protection may well have been negative, if all aspects are considered.

6.6 Research priorities for Phase 2 and Phase 3

During the regional planning workshop, members of the ASB-Indonesia team rose to the challenge to develop proposals for Phase 2 that (a) can have a clear impact on the three main ASB objectives (poverty alleviation, reduction of greenhouse gas emissions, and conservation of biodiversity) or that address broader forces driving deforestation and (b) are 'researchable.' Table 34 summarizes the proposals made, under the 4 major headings, agreed at the global level:

1. Characterization and Diagnosis
2. Food security and human welfare
3. Global warming
4. Biodiversity conservation

A number of gaps still exist and further cooperation with partners outside the current ASB consortium will be welcome to help fill these gaps.

Table 34. ASB-Indonesia Ongoing Activities and Proposals for Phase 2 Research

ASB Global category/Title	Scale[1]	Status	Leader(s)	Site(s)
1. Characterization & diagnosis				
Testing basic hypotheses using household questionnaire data	H/C	Ongoing	ICRAF	RP, BT, LU
Farmer participation/setting up local ASB liaison committees	C	Proposal	FNCRDC UGM CRIFC/. UniLa	RP, BT, LU
Developing models of driving forces of land use change	B	Ongoing	ICRAF	RP, BT, LU
History of land use change*	B	Ongoing	ICRAF(w/UC Davis, ANU)	Jambi
Public investment policy: the role of large projects	C/B	Proposal	CASER	BT, LU
Public investment policy: road construction*	B	Ongoing	World Bank ICRAF	Jambi
Price and trade policies: rubber-wood; other topics to be identified	B+	Ongoing	ICRAF	Sumatra
Regional migration	B+	**Gap**	??	Java/ Sumatra
Impacts of macroeconomic policies	B+	**Gap**	??	Sumatra/ national
Bibliography of slash-and-burn agriculture*	B+	Proposal/ ongoing	IPB - CIIFAD	National
2. Food security/human welfare				
Integrated soil fertility management	F/H	Ongoing; new proposal	CRIFC, UniBraw, IRRI, ICRAF	BT-Sitiung LU
Increasing rice yields during establishment of agroforests	F/H	Ongoing; new proposal	CRIFC, IRRI, ICRAF, Sembawa	RP, BT

Agroforestry techniques for rehabilitation of degraded lands	F/H	Ongoing; new proposal	ICRAF, CRIFC	LU
Soil and water conservation at the watershed level	F/H/ C/B	**Gap?**	FNCRDC? CSAR? (CIIFAD?) (IBSRAM?)	RP, BT (Batang Hari watershed)
Migration case study	H	Proposal	CASER, TRANS	LU
3. Global warming				
Timber and fruit-based agroforestry systems	F/H	Proposal	FRDC, UGM, ICRAF	RP, BT
Rubber agroforestry*	F/H	Ongoing; new proposal	ICRAF; Sembawa	RP, BT
Vegetation change, biomass measurements	F/B	Ongoing; new proposal	BIOTROP	RP, BT, LU
GHG emissions/soil organic matter fractions	F/B	Ongoing; new proposal	IPB, UniBraw TSBF	RP, BT, LU
Production forest management: community forestry	H/C/ B	Proposal	UGM	BT
Imperata grassland rehabilitation policy options	C/B+	Ongoing	ICRAF	nation-wide
4. Biodiversity conservation				
Biodiversity assessment -- below-ground	F/B	Proposal	UniBraw; CRIFC, TSBF	RP, BT, LU
Biodiversity assessment -- above-ground	F/B	New	CIFOR	RP, BT
Protected forest/National park buffer zone management*	H/C/ B	Ongoing	ICRAF, IFPRI	RP

* co-financed. 1. Scale indicators: F = Field, H = Household, C = Community, B = Benchmark area, B+ = *idem*+national; RP = Rantau Pandan, BT = Bungo Tebo, LU = North Lampung

References ASB-Indonesia - The reader is referred to the following reports for a more detailed account of the research. Via this list we would like to acknowledge all contributions made to this summary report, much of which was borrowed from these sources.

Alternatives to Slash-and-Burn Indonesia. Annual report 1994. ASB-Indonesia Report Number 3. Bogor. 1995.

Elmhirst, R.J., 1995. Population Stabilization on Lampung's Forest Margins: The Role of Women's Environmental Knowledge. Final Report to LIPI.

Cairns, M., 1994. Stabilization of upland agroecosystems as a strategy for protection of national park buffer zones: a case study of the coevolution of Minangkabau farming systems and the Kerinci Seblat National Park. Masters thesis, York University, Ontario, Canada.

Garrity, D.P. and A. Khan (eds.), 1994. Alternatives to Slash and Burn, a global initiative. Summary report of a research methodology workshop, 25 February to 8 March 1993 Bogor, West Java and Sitiung, West Sumatra. ICRAF, Nairobi. 73 pp.

Garrity, D.P., C.K. Lai, C. Neely and I. Basri, 1993. Sustainable Land Use Systems and Agroforestry Research for the Humid Tropics of Asia. Summary report of an international training course, 26 April to 15 May 1993. ICRAF-S.E. Asia report 93-1 APAN Report No. 9. Bogor. 125 pp.

Gintings, A.N. et al. (CFNRD Team), 1995a. Agroforestry Characterization in Pakuan Ratu and Tulang Bawang Tengah Sub District, North Lampung Province in Paper presented at Regional Workshop on Alternatives to Slash and Burn, Bogor 6-9 June 1995.

Gintings, A.N. et al. (CFNRD-Agroforestry Team), 1995b. Characterization of Rantau Pandan, Muara Tebo, Jambi: Basic Information for Combating Deforestation Caused by Slash and Burn Agriculture in Paper presented at Regional Workshop on Alternatives to Slash and Burn, Bogor 6-9 June 1995.

Gintings, A.N. et al. (CFNRD-Agroforestry Team), 1995c. Agroforestry Characterization in Pelepat Sub District Bungo Tebo, Jambi Province in Paper presented at Regional Workshop on Alternatives to Slash and Burn, Bogor 6-9 June 1995.

Hadi, P.U et al., 1995. Socio-economic Characteristics of Slash-and-Burn Agriculture at the Community Level in Three Ecological Zones of Sumatra, Indonesia in Paper presented at Regional Workshop on Alternatives to Slash and Burn, Bogor 6-9 June 1995.

Hairiah, K., 1995. Greenhouse Gas Emissions and Carbon Balance in Slash and Burn Practices (II) in Paper presented at Regional Workshop on Alternatives to Slash and Burn, Bogor 6-9 June 1995.

Husein Sawit, M., F. Sulaiman, S. Mardianto and Suyanto, 1995. Metodologi Participatory Rural Appraisal (PRA), dalam Alternatif Sistem Tabas-Bakar. ('PRA methodology in the context of alternatives to slash and burn') ASB-Indonesia report no. 2.

ICRAF, 1995. Site selection for alternatives to slash-and-burn in Indonesia: report of a site-selection exercise in Kalimantan and Sumatra, 18-27 August 1992. ICRAF, Nairobi. 31 pp.

Murniati, M. Otsuka and M. Cairns, 1995. Highlights of the 1994 Characterization of the Air Dingin - Muara Labuh Area: farm and national park interaction. "So where to now?" in Paper presented at Regional Workshop on Alternatives to Slash and Burn, Bogor 6-9 June 1995.

Murdiyarso, D., K. Hairiah and M. van Noordwijk, 1994. Modelling and measuring soil organic matter dynamics and greenhouse gas emissions after forest conversion, report of a workshop/training course 8-15 August 1994 Bogor/Muara Tebo, Indonesia. ASB-Indonesia report no. 1.

Murdiyarso, D. and Husin, Y. (IPB Team), 1995. Greenhouse Gas Emissions and Carbon Balance in Slash and Burn Practices (I) in Paper presented at Regional Workshop on Alternatives to Slash and Burn, Bogor 6-9 June 1995.

Penot, E., 1995. Improving the Productivity of Smallholder Rubber Agroforestry Systems: Sustainable Alternatives in Paper presented at Regional Workshop on Alternatives to Slash and Burn, Bogor 6-9 June 1995.

Rachman, A. et al. (CSAR Team), 1995. Characterization of Biophysical Parameters for Determining Alternatives of Slash And Burn Practices in Paper presented at Regional Workshop on Alternatives to Slash and Burn, Bogor 6-9 June 1995.

Rosalina-Wasrin, U. et al., 1995. Vegetation Characterization and Monitoring: Its Contribution to Alternatives to Slash and Burn Practices in Paper presented at Regional Workshop on Alternatives to Slash and Burn, Bogor 6-9 June 1995.

Sabarnuddin, Sambas et al. (UGM Team), 1995. Characterization of Slash and Burn Agriculture in Bungo Tebo (A Case Study of Silvagama Area) in Paper presented at Regional Workshop on Alternatives to Slash and Burn, Bogor 6-9 June 1995.

Saleh, H.H. (Transmigration Department Team), 1995. Study of Sustainable Land Use Development Patterns in Paper presented at Regional Workshop on Alternatives to Slash and Burn, Bogor 6-9 June 1995.

Suyanto, 1995. Policy Perspective on Development of Rubberwood in Indonesia in Paper presented at Regional Workshop on Alternatives to Slash and Burn, Bogor 6-9 June 1995.

Taryoto et al., 1995. Policy Analysis of Slash and Burn Practices: The Case of Three Agro-ecological Zones in Sumatra in Paper presented at Regional Workshop on Alternatives to Slash and Burn, Bogor 6-9 June 1995.

Tomich, T.P., 1995. Highlights of the workshopp and Seminar on Agroforestry Innovations for *Imperata* Grassland Rehabilitation. Report to the Indonesian Minister of Forestry. ICRAF, Bogor.

Van Noordwijk, M., Woomer P., Cerri C., Bernoux, M. and Nugroho, K. Soil carbon in the humid forest zone. *submitted* to Geoderma.

Van Noordwijk, M., Van Schaik, C.P., de Foresta, H. and Tomich, T.P., 1996? Segregate or integrate nature and agriculture for biodiversity conservation? *in prep.*

Zaini, Z. and Basa, I., 1995. Characterization of Production and Land Use Systems at Sitiung Benchmark Area, Indonesia in Paper presented at Regional Workshop on Alternatives to Slash and Burn, Bogor 6-9 June 1995.

Zaini, Z. and Suhartatik, E., 1995. Slash-and-Burn Effects on C,N, and P Balance in Sitiung ASB Benchmark Area in Paper presented at Regional Workshop on Alternatives to Slash and Burn, Bogor 6-9 June 1995.

Non-ASB references used in the text:

Anonymous, n.d. Profil Pemanfaatan Kayu Karet Dalam Rangka Pengembangan Eksport Barang Jadi Kayu Olahan.

Arsjad, A. and R. Dereinda, 1988. Pendayagunaan Kayu Karet Untuk Mengembangkan Industri Hilir dan Penerimaan Devisa Negara. Balai Penelitian Perkebunan Sungei Putih.

Barlow, C., 1978. The Natural Rubber Industry: Its Development, Technology, and Economy in Malaysia. New York: Oxford University Press.

Barlow, C., S.K. Jayasuriya, and C.S. Tan, 1994. The World Rubber Industry. London: Routledge.

Barlow, C., J. Quizon, and Suyanto, 1993. Towards a Planting Materials Policy for Indonesian Rubber Smallholdings: Lessons from Past Projects. Agriculture Group Working Paper No. 14. Jakarta: Center for Policy and Implementation Studies.

Boserup, E., 1965. The Conditions of Agricultural Growth: The Economics of Agrarian Change Under Population Pressure. Chicago: Aldine.

BPS Jambi, 1993. Jambi Dalam Angka. Kerjasama Bappeda dan Kantor Statistik Tingkat I Jambi.

BPS Lampung, 1993. Lampung Dalam Angka. Kerjasama Bappeda dan Kantor Statistik Tingkat I Lampung.

Burhan G., W. Gunawan and Y. Noya., 1990. Geologi Lembar Menggala, Sumatera, Puslitbang Geologi. Departemen Pertambangan dan Energi.

Burkill, I.H., 1935. A Dictionary of the Economic Products of the Malaya Peninsula. London, Crown Agents for the Colonies Millbank.

CPIS (Center for Policy and Implementation Studies), 1993. Local Levies on Rubberwood in West Kalimantan. Jakarta. Internal report.

De Foresta, H., 1992. Complex agroforestry systems and conservation of biological diversity: for a larger use of traditional agroforestry trees as timber in Indonesia, a link between environmental conservation and economic development. Golden Jubilee issue. *Malaysian Nature Journal.* Proceedings of the International conference on the conservation of tropical biodiversity.

Deharveng, L., 1992. Field report for the soil mesofauna studies.

Deharveng, L. and Y.R. Suhardjono, 1994. The Isotomiella Bagnall, 1939 (Collembola: Isotomidae) of Sumatra (Indonesia). Tropical Zoology: in press.

Dove, M., 1993. Smallholder rubber and swidden agriculture in Borneo: a sustainable adaptation to the ecology and economy of the tropical forest. Economic Botany 47: 136-147.

Dunn, F. L., 1975. Rain-forest collectors and traders: a study of resource utilization in modern and ancient Malaya. Kuala Lumpur.

Dupain, D., 1994. Une region traditionnellement agroforestière en mutation: le Pesisir (A traditional agroforestry area in mutation: Pesisir). CNEARC, Montpellier, France.

Eswaran H., et al., 1993. Organic carbon in soils of the world. Soil Sci. Soc. Am. J. 57: 192-194.

FAO/MacKinnon, J., 1982. *National Conservation Plan for Indonesia, Vol. II. Sumatra.* FAO, Bogor. (10.2.16).

Hardon, H.J., 1936. Factoren, die het organische stof-en het stikstof-gehalte van tropische gronden beheerschen (Factors controlling the organic matter and the nitrogen content of tropical soils). Landbouw XI (12): 517-540.

Forspa, 1993. Role of Rubber wood in Forestry: Malaysia Experience. Food and Agriculture Organization of The United Nations. Bangkok.

Forum Pengkajian Perkaretan, 1994. Konsepsi Pembangunan Jangka Panjang Perkaretan Indonesia (1994-2019).

Gafoer S.T.C. Amin, dan R. Pardede, 1994. Geologi Lembar Baturaja, Sumatera. Pusat Penelitian dan Pengembangan Geologi.

Gouyon, A. et al. ???, 1990. Penggunaan Bahan Tanam Karet di Tingkat Petani Dan Respon Penawaran Dari Pengusaha Pembibitan (Kasus di Kab. Musi Banyuasin, Sumatra Selatan). Prosiding Konferensi Nasional Karet. Palembang.

Gouyon, A., H. de Foresta and P. Levang, 1993. Does 'jungle rubber' deserve its name? An analysis of rubber agroforestry systems in southeast Sumatra. Agroforestry Systems 22: 181-206.

Hayami, Y. and V.W. Ruttan, 1985. Agricultural Development: An International Perspective. Baltimore, MD: Johns Hopkins University Press.

Hassink J, 1994. Active organic matter fractions and microbial biomass as predictors of N mineralization. in: J.J. Neeteson and J. Hassink (eds.) Nitrogen mineralization in agricultural soils. Proc. Symp. Haren (NL), 19-20 April 1993. AB-DLO, Haren, pp 1-15.

Hassink, J., 1995. Density fractions of soil macroorganic matter and microbial biomass as predictors of c and n mineralization. Soil Biol. and Biochem. 27: 1099-1108.

Hendratno, S., 1990. Batas-Batas Kelayakan Finansial Usaha Perkebunan Karet Rakyat Di Sumatra Selatan. Lateks.

ITC, 1993. International Trade Centre UNCTAD/GATT. Rubberwood: A Study on World Development Potential.

Laumonier, Y. and U.R. Djailany-Syafii, 1989. An evaluation of SPOT satellite data for forestry in Sumatra. Biotropia 3: 1-24.

Laumonier, Y. The vegetation of Sumatra. *In press*.

Malingreau, J.P. and R. Christiani, 1981. A land cover/ land use classification for Indonesia. First revision. Indonesian J. of Geog. 11(41): 13-47.

Mary, F. and G. Michon, 1987. When agroforests drive back natural forests: a socioeconomic analysis of a rice/agroforest system in South Sumatra. Agroforestry Systems 5:27-55.

Meijboom, F.W., J. Hassink and M. van Noordwijk, 1995. Density fractionation of soil macroorganic matter using silica suspensions. Soil Biol. Biochem. 27: 1109-1111

Michon, G., 1985. De l'homme de la forêt au paysan de l'arbre: agroforesteries indonésiennes (From forest people to forest farmers: Indonesian agroforesters). Ph.D. dissertation, U.S.T.L., Montpellier, France.

Michon, G. and J. M. Bompard, 1987. The Damar gardens (Shorea javanica) in Sumatra. Proceedings of the third round-table conference on Dipterocarps. Samarinda, UNESCO. 3-17.

Michon, G. and H. de Foresta, 1992. Complex agroforestry systems and conservation of biological diversity 1/ Agroforestry in Indonesia, a link between two worlds. In: In Harmony with Nature. An International Conference on the Conservation of Tropical Biodiversity, Kuala Lumpur, Malaysia, The Malayan Nature Journal. Golden Jubilee issue.

Michon, G. and H. de Foresta, 1994. Forest resource management and biodiversity conservation: the Indonesian agroforest model. IUCN/ Madrid workshop "Biological Diversity Conservation Outside Protected Areas: Overview of Traditional Agroecosystems", Madrid.

Murdiyarso, D. and U. R. Wasrin, 1995. Estimating land use change and carbon release from tropical forest conversion using remote sensing techniques. Global Ecol. and Biogeogr. Letter. *In press.*

Oldeman, L.R. et al., 1979. An agroclimatic map of Sumatra. Contr. Centr. Res. Inst. Agric. 52. Bogor.

Oldeman, L.R., 1975. An agro-climatic map of Java. C. R. J. Agr. Bogor.

Peluso, N.L., 1992. The ironwood problem: (Mis) management and development of an extractive rainforest product." Conservation Biology 6: 210-219.

Penot, E., 1995. Improving the Productivity of Smallholder Rubber Agroforestry Systems: Sustainable Alternatives. Summary and main features of the project presented at the Regional Workshop on Alternatives to Slash-and-Burn, Bogor, 6-9 June 1995.

Rappard, F.W., 1937. De damar van Bengkoelen ('The damar of Bengkulu'). Tectona D1(30): 897-915.

Richards, J.F. and Flint, E.P., 1993. Historic land use and carbon estimates for South and Southeast Asia, 1880 - 1980. Carbon dioxide information analysis center, Oak Ridge National Laboratory, Environmental Sciences Division Publication No. 4174.

Rosidi, H.M.D., S. Tjokrosaputro, dan B. Pendowo, 1976. Peta Geologi Lembar Painan dan Bagian Timurlaut Lembar Muarasiberut, Sumatra. Direktorat Geologi.

Rutgers, A.A.L., 1925. De toekomst van de bevolkings rubber in nederlands Indie [The future of smallholder rubber in Dutch Indies] Ind. mercuur 48 p.833.

Schmidt, F. H. and J. H. A. Ferguson, 1941. Rainfall type based on wet and dry period ratios for Indonesia with W. N. Guinea. Verh.42. Kementrian Perhubungan RI. Jakarta.

Simandjuntak, T.O. Surono, and T.C. Amir, 1991. Geologi Lembar Muarabungo, Sumatera.

Sanchez, 1995. Science in Agroforestry. Agroforestry systems 30: 5-55.

Scholz, 1983. The natural regions of Sumatra and their agricultural production pattern, a regional analysis.

Sibuea, T.T.H. and D. Herdimansyah, 1993. The variety of mammal species in the agroforest areas of Krui (Lampung), Muara Bungo (Jambi), and Maninjau (West Sumatra). HIMBIO (UNPAD), Bandung, Indonesia.

Siebert, S.F., 1989. The dilemna of dwindling resource: rattan in Kerinci, Sumatra. Principes: 32(2): 79-97.

Stoutjesdijk, J.A.J.H., 1935. *Eupatorium pallescens* D. C. op Sumatra's Westkust (*Eupatorium pallescens* D. C. on the west coast of Sumatra) in Tectona. Vol. 28. 919-926.

Sumana et al., 1991. Pendapatan Dan Motivasi Petani Dalam Penjualan Kayu Karet Tebangan. Jakarta.

Suyanto and J.B. Quizon, 1994. Fertilizer Policy in Indonesia: An Historical Account. CPIS.

Thiollay, J.M., 1995. Are traditional agroforests an alternative for the conservation of rainforest bird diversity? Three case studies in Sumatra. Conservation Biology.

Thornthwaite, C.W. and J.R. Mather, 1957. Instructions and Tables for Computing Potential Evapotranspiration and The Water Balance. Publ. in Climatology vol. X No. 3. Centerton, New Jersey. pp. 185-311.

Torquebiau, E., 1984. Man-made Dipterocarp forest in Sumatra. Agroforestry Systems 2(2): 103-128.

Tomich, T., 1991. Smallholder Rubber Development in Indonesia. In: D. Perkins and M. Roemer (eds.) Reforming Economic Systems in Developing Countries. Cambridge, Massachusetts: Harvard University Press.

Van Gelder, 1950. A. Bevolkings rubber culture [Smallholder Rubber] p. 427-475 in C. J. van Hall and Van de Koppel (eds)'s Gravenhage, De Landbouw in de Indische Archipel. Van Hoeve.

Van Steenis, C.G.G.J., 1935. Maleische vegetatieschetsen. Tijd. Kon. Ned. Aard. Gen. 52: 25-67, 171-203, 363-390.

Appendix 1. List of Personnel Involved in ASB Project Indonesia, 1994-1995

National Steering Committee	
1. Faisal Kasryno, PhD	Director General of AARD, Chairman
2. Toga Silitonga, PhD	Director General of AFRD, Vice Chairman
3. A.M.Fagi, PhD	Director of CRIFC, Secretary of S.C. and Chairman of Technical Working Group (TWG).
4. Harun Alrasyid, Ir., MS.	Director of Center for Forest and Nature Conservation Research and Development, Secretary of S.C. and TWG.
5. Djoko Budianto, PhD	Director of Research Program, AARD
6. Farid Bahar, PhD	Director of Cent. Res. Inst. for Horticultural Crops, AARD
7. Syarifuddin Karama, PhD	Director of Cent. for Soil and Agroclimatic Research, CSAR
8. Effendi Pasandaran, PhD	Director of Cent. for AgroSocioEconomic Research, CASER
9. Chairil Anwar Rasahan, PhD	Director of Planning Bureau, Ministry of Agriculture
10. Rofiq Ahmad, Ir., MS.	Director, Center for Research and Development, Ministry of Transmigration and Forest Squatters Resettlement
11. Wibowo, SE.	Director of Planning Bureau, Ministry of Transmigration and Forest Squatters Resettlement
12. Harsono, Ir.	Director of Planning Bureau, Ministry of Forestry
13. Soerjadi Tjokrosoewoto	Director of Natural Resource Management for Resettlement, Ministry of Home Affairs
14. Hendro Prastowo, Ir.	Chairman Deputy of Association of Junior Businessmen
Technical Working Group	
15. Sunendar K., PhD	Head of Research Program, CRIFC; Secretary
16. Soetjipto Partohardjono, PhD	Farming Systems Specialist, CRIFC
17. Soleh Sukmana, PhD	Soil Conservationist, CSAR Coordinator of Biophysical Characterization
18. M. Husein Sawit, PhD	Economist, CASER, Coordinator for Policy Characterization
19. A. Ngaloken Gintings, PhD	Forest and Nature Conservation Research and Development, Site Coordinator for Rantau Pandan
20. Zulkifli Zaini, PhD	Plant Nutrient Specialist, CRIFC Coordinator for Sitiung Site
21. Rahayu Supriadi, Ir., MSc.	Center for Forest Product Research and Development
22. Widarjanto, Ir.	Center of Research and Development, Ministry of Transmigration and Forest Squatters Resettlement
23. Budiman Notoatmodjo, PhD	Center for Research Program, AARD
24. M. Kenda, Drs.	Directorate for Natural Resource Development and Resettlement, Ministry of Home Affairs
25. C.P. Mamaril, PhD	IRRI Bogor Representative
26. Dennis P. Garrity, PhD	ICRAF, Southeast Asian Regional Research Programme
27. D. Murdiyarso, PhD	Bogor Agriculture University (IPB)
28. Herman Supriadi, Ir., MS.	Farming Systems Specialist, CRIFC Secretary of ASB Project
29. Tri Nugroho, Ir.	NGO-representative (LATIN).

Research Personnel and Resource Persons

30. Djuber Pasaribu, Ir., MSc.	Agronomist, CRIFC; Project Leader
31. Made Oka Adnyana, PhD	Agroeconomist, CRIFC; Coordinator for Land Use and Socioeconomic Characterization
32. M.Sambas Sabarnurdin,MSc,PhD	Forest Silviculturist, Gajah Mada University, Site Coordinator for Bungo Tebo
33. Aman Djauhari, Ir., MS.	Agroeconomist, CRIFC
34. Imtias Basa, Ir.	Farming Systems Specialist, CRIFC
35. Endang Suhartatik, Ir., MS.	Crop Physiologist, CRIFC
36. Zainal Lamid, PhD	Weed Specialist, CRIFC
37. Askin, Ir.	Agronomist, CRIFC
38. Nasrul Husen, Ir.	Agronomist, CRIFC
39. Buharman, Ir., MS.	Agroeconomist, CRIFC
40. Tita Permata, Ir., Dra.	Sociologist, CRIFC
41. Teddy Sutriadi, Ir.	Soil Fertility Specialist, CRIFC
42. Subagjo, PhD	Soil Classification Specialist, CSAR
43. Achmad Rachman, Ir., MSc.	Soil Conservation Specialist, CSAR
44. Untung Sutrisno	Soil Classification Specialist, CSAR
45. Harijogjo	Soil Classification Specialist, CSAR
46. Lukman Hakim, Ir., MS.	Climatologist, CSAR
47. Prajogo Utomo Hadi SE, M.Ec.	Agroeconomist, CASER
48. Andin H. Taryoto, PhD	Agroeconomist, CASER
49. Fauzia Sulaiman, PhD	Sociologist, CASER
50. Nizwar Syafaat, Ir., MS.	Agroeconomist, CASER
51. Mat Syukur, Ir.	Agroeconomist, CASER
52. Harry Saleh, Ir., MSc.	Community and Regional Specialist, Ministry of Transmigration and Forest Squatters Resettlement
53. P.M. Amin, Drs.	Geomorphologist, *idem*
54. Agus DS, PhD.	Remote Sensing Specialist, *idem*
55. Baslian K. Yoza, Ir.	Soil Scientist, *idem*
56. Saraswati S., Ir., MA.	Socio Economist, *idem*
57. Sigit Suwarno, Ir.	Geodet, *idem*
58. Prayitno, Drs.	Geomorphologist, *idem*
59. Rudoro Susanto, Drs.	Sociologist, *idem*
60. Teti Herawati, Ir.	.. *idem*
61. Eti Diana, Ir.	Environmental Specialist, *idem*
62. Yahya Abdul Husin, PhD	Environmental and Natural Resource Management Specialist, IPB
63. Kurniatun Hairiah, PhD	Root ecologist, Univ. Brawijaya
64. Suryo Hardiwinoto, PhD	Silviculture and Forest Ecology, UGM
65. Heru Iswantoro, Ir., MSc.	Sociologist/Rural Development, UGM
66. Sambas Sabarnurdin	Forester, UGM
67. Muhajir Utomo, PhD, MSc.	Soil Management , Lampung University
68. Sutopo Nugroho, PhD	Soil Biologist, Lampung University
69. Efnizon	"Bina Kelola" NGO, Padang
70. Kukuh Setiawan, Ir., MSc.	"Kawal" NGO, Lampung, ASB Researcher
71. Upik Rosalina, PhD	Forest Ecologist & Remote Sensing Specialist, Biotrop
72. Nining Puspaningsih, Dra.	Vegetation and Cartography Specialist, Biotrop.
73. Agus Eka Putra, PhD	Forest Ecologist, Biotrop

74. Selvandra Kawulur, Dra.	Computer Scientist, Biotrop
75. Iwan Setiawan, Ir.	Laboratory Technician, Biotrop
76. Boen Purnomo, PhD	Agroeconomist, FPRDC
77. Sri Suherti, Ir., MSc.	Social Forester, FNCRDC
78. Chairil Anwar, Ir., MSc.	Forest Ecologist, FNCRDC
79. Sumarhani	Agroforester, FNCRDC
80. Soegito, Ir.	Horticulturist, Solok, West Sumatra
81. Budi Supriyanto	Horticulturist, Solok, West Sumatra
82. M.E. Siregar, PhD	Animal Science Specialist, Bogor
83. Gede Wibawa, PhD	Agronomist, Rubber Research Institute Sembawa
84. Hisar Sihombing, PhD	Soil Scientist, Rubber Research Institute Sembawa
85. Retno Winahyu, Ir. MS.	Agroforestry Systems Improvement Specialist, ICRAF.
86. Pratiknyo Purnomosidhi, Ir.MS.	Soil Ecologist, ICRAF
87. Suyanto, Ir., MS.	Agricultural Economist, ICRAF
88. Thomas P. Tomich, PhD	Natural Resource Economist, ICRAF
89. Meine van Noordwijk, PhD	Soil Ecologist, ICRAF
90. Hubert de Foresta, PhD	Forest Ecologist, ORSTOM/ICRAF
91. Genevieve Michon, PhD	Agroecologist, ORSTOM/ICRAF
92. Eric Penot, MSc.	Rubber agronomist, CIRAD/ICRAF
93. Neil Byron, PhD	Director, Policy and Social Sciences Division, CIFOR
94. Andrew N. Gillison, PhD	Principle Scientist, CIFOR

Appendix 2. List of institutions participating in research planning and implementation of ASB Indonesia

Government Institutions:
- Agency for Agricultural Research and Development (AARD)
- Central Research Institute for Food Crops (CRIFC), Bogor
- Center for Agro-Socioeconomic Research (CASER), Bogor
- Center for Soil and Agroclimate Research (CSAR), Bogor
- Central Research Institute for Animal Husbandry, Bogor
- Central Research Institute for Holticultura Crops
- Sembawa Research Institute for Rubber, Palembang
- Agency for Forestry Research and Development (AFRD)
- Forest and Nature Conservation Research and Development, (FNCRD), Bogor
- Forest Product Research and Development (FPRD), Bogor
- Planning Bureau, Ministry of Agriculture
- Planning Bureau, Ministry of Forestry
- Planing Bureau, Ministry of Transmigration and Forest Squatter Resettlement
- Center for Research and Development,Ministry of Transmigration and Forest Squatter Resettlement
- National Land Agency
- Directorate General for Regional Development, Ministry of Home Affairs

Universities :
- Faculty of Agriculture, Bogor Agricultural University, Bogor
- Faculty of Forestry, University of Gajah Mada,Yogyakarta
- Faculty of Agriculture, University of Brawijaya, Malang
- Faculty of Agriculture, University of Lampung, Bandar Lampung
- Faculty of Agriculture, University of Andalas, Padang
- Faculty of Agriculture, University of Lambung Mangkurat, Banjarmasin

Non Government Organizations:
- "Bina Kelola", Padang
- "LATIN", Bogor
- "Kawal", Lampung
- Rubber Processors' Association, (GAPKINDO), Jakarta
- Forestry Concession Holders Organitation (APHI), Jakarta

S.E. Asia Regional Institutions
- SEAMEO BIOTROP, Southeast Asian Regional Center for Tropical Biology, Bogor

International institutions:
- International Centre for Research in Agroforestry (ICRAF), Southeast Asian Regional Research Programme, Bogor
- International Rice Research Institute (IRRI), Indonesia Representative, Bogor
- Center for International Forestry Research (CIFOR), Bogor
- ORSTOM
- CIRAD

Reports of ASB-Indonesia:

Murdiyarso, D., K. Hairiah and M. van Noordwijk, 1994. Modelling and measuring soil organic matter dynamics and greenhouse gas emissions after forest conversion, report of a workshop/training course 8-15 August 1994 Bogor/Muara Tebo, Indonesia. ASB-Indonesia report no.1.

Husen Sawit, M., F. Sulaiman, S. Mardianto and Suyanto, 1995. Metodologi Participatory Rural Appraisal (PRA), dalam Alternatif Sistem Tabas-Bakar. ('PRA methodology in the context of alternatives to slash and burn') ASB-Indonesia report no. 2.

Alternatives to Slash-and-Burn Indonesia. Annual report 1994. ASB-Indonesia Report Number 3. Bogor. 1995.

Van Noordwijk, M, T.P. Tomich, R. Winahyu, D. Murdiyarso, Suyanto, S. Partoharjono and A.M. Fagi, 1995. Alternatives to Slash-and-Burn in Indonesia, Summary report of Phase 1. ASB-Indonesia report no. 4.


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