

ASB Lecture Note 8

Evaluating land use systems from a socio-economic perspective

Marieke Kragten, Thomas P Tomich, Steve Vosti and Jim Gockowski

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Towards integrated natural resource management in forest margins of the humid tropics: local action and global concerns

Meine van Noordwijk, Sandy Williams and Bruno Verbist (Editors)

Humanity stands at a defining moment in history. We are confronted with a perpetuation of disparities between and within nations, a worsening of poverty, hunger, ill health and illiteracy, and the continuing deterioration of the ecosystems on which we depend for our well-being. However, integration of environment and development concerns and greater attention to them will lead to the fulfilment of basic needs, improved living standards for all, better protected and managed ecosystems and a safer, more prosperous future. No nation can achieve this on its own; but together we can - in a global partnership for sustainable development. (Preamble to the United Nations' Agenda21 on Sustainable Development; <http://www.un.org/esa/sustdev/agenda21chapter1.htm>).

Background to a series of lecture notes

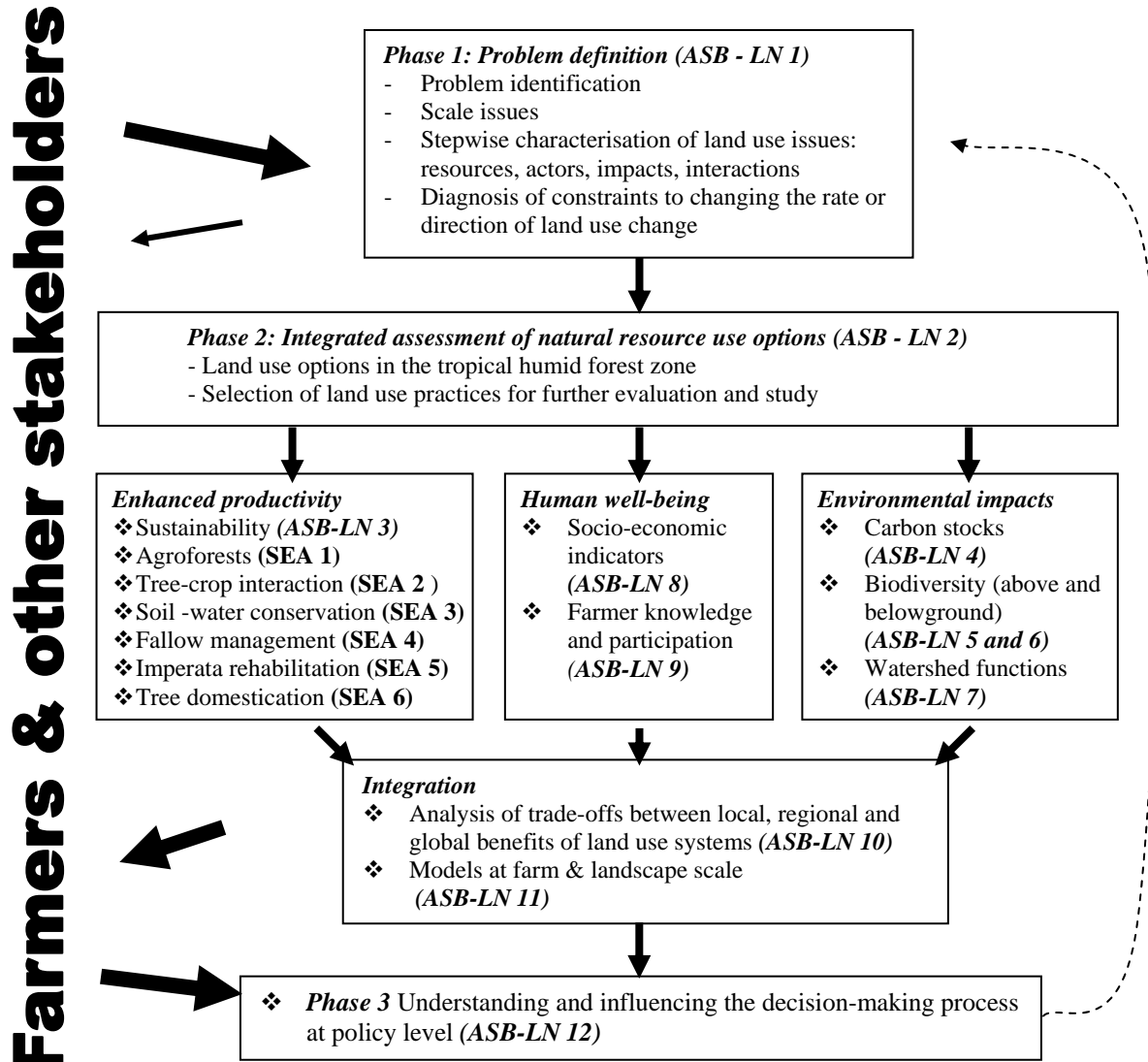
Much of the international debate on natural resource management in the humid tropics revolves around forests, deforestation or forest conversion, the consequences it has and the way the process of change can be managed. These issues involve many actors and aspects, and thus can benefit from many disciplinary perspectives. Yet, no single discipline can provide all the insights necessary to fully understand the problem as a first step towards finding solutions that can work in the real world. Professional and academic education is still largely based on disciplines – and a solid background in the intellectual capital accumulated in any of the disciplines is of great value. If one wants to make a real contribution to natural resource management issues, however, one should at least have some basic understanding of the contributions other disciplines can make as well. Increasingly, universities are recognising the need for the next generation of scientists and policymakers to be prepared for interdisciplinary approaches. Thus, this series of lecture notes on integrated natural resource management in the humid tropics was developed for use in university and professional training at graduate level.

The lecture notes were developed on the basis of the experiences of the Alternatives to Slash and Burn (ASB) consortium. This consortium was set up to gain a better understanding of the current land use decisions that lead to *rapid* conversion of tropical forests, shifting the forest margin, and of the *slow* process of rehabilitation and development of sustainable land use practices on lands deforested in the past. The consortium aims to relate local activities as they currently exist to the global concerns that they raise, and to explore ways by which these global concerns can be more effectively reflected in attempts to modify local activities that stabilise forest margins.

The Rio de Janeiro Environment Conference of 1992 identified deforestation, desertification, ozone depletion, atmospheric CO₂ emissions and biodiversity as the major global environmental issues of concern. In response to these concerns, the ASB consortium was formed as a system-wide initiative of the Consultative Group on International Agricultural Research (CGIAR), involving national and international research institutes. ASB's objectives are the development of improved land-use systems and policy recommendations capable of alleviating the pressures on forest resources that are associated with slash-and-burn agricultural techniques. Research has been mainly concentrated on the western Amazon (Brazil and Peru), the humid dipterocarp forests of

Sumatra in Indonesia, the drier dipterocarp forests of northern Thailand in mainland Southeast Asia, the formerly forested island of Mindanao (the Philippines) and the Atlantic Congolese forests of southern Cameroon.

The general structure of this series is



This latest series of ASB Lecture Notes (**ASB-LN 1 to 12**) enlarges the scope and embeds the earlier developed ICRAF-SEA lecture notes (**SEA 1-6**) in a larger framework. These lecture notes are already accessible on the website of ICRAF in Southeast Asia: <http://www.icraf.cgiar.org/sea>

In this series of lecture notes we want to help young researchers and students, via the lecturers and professors that facilitate their education and training, to grasp natural resource management issues as complex as that of land use change in the margins of tropical forests. We believe that the issues, approaches, concepts and methods of the ASB program will be relevant to a wider audience. We have tried to repackage our research results in the form of these lecture notes, including non-ASB material where we thought this might be relevant. The series of lecture notes can be used as a basis for a full course, but the various parts can also ‘stand alone’ in the context of more specialised courses.

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ASB-consortium members

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Lecture note 8

EVALUATING LAND-USE SYSTEMS FROM A SOCIO-ECONOMIC PERSPECTIVE

By Marieke Kragten, Thomas P. Tomich, Steve Vosti and Jim Gockowski

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I. Objectives

- To provide an introduction to the socio-economic issues involved in evaluating land-use systems
- To provide a conceptual framework for evaluating land-use systems from the perspective of small-scale farmers and policymakers
- To show how the conceptual framework may be applied in practice

II. Lecture

1. Introduction: why should we evaluate land-use systems from a socio-economic perspective?

Forests continue to fall, mainly for agricultural purposes, throughout the humid tropics. This forest conversion process has immediate and potentially large consequences for climate change and biodiversity loss. These issues are of key interest to one group of stakeholders in forest conversion debate - the international community. Some of the actors directly responsible for forest conversion, i.e. the small-scale farmers, fell trees to meet food and/or cash income needs. These are the issues of urgent interest to them and they constitute another very important group of stakeholders. National policymakers make up a third group of stakeholders in the debate on deforestation. They must consider the objectives of small-scale farmers and balance these against the international interest in the global public goods and services supplied by tropical rainforests and other policy objectives, and then decide on courses of action.

In lecture note 2 we discussed a conceptual framework that could be used to identify the land-use systems which have the best chance of attaining the multiple objectives of the different stakeholders in the debate. The framework allows us to quantify any trade-offs among these multiple objectives, using a matrix¹. In this lecture note we will focus on the methods that we can use to assess the various aspects of different land-use systems from a policymaker's and from a small-scale farmer's point of view.

The small-scale farmers are a very important group of stakeholders in the search for 'best bet'¹ land-use systems. Following the theory of "livelihood strategies" (see also Box 1) (Chambers and Leach, 1989; Scherr, 1995) small-scale farmers are "welfare (utility) maximisers" and base their decisions –including the decision about how to use the land – on the extent to which their potential alternatives fulfil their private household objectives. This means that even if various groups in the international community could successfully pressure national policymakers to impose a ban intended to silence chainsaws immediately in tropical forests, the consequences would be temporary; in the absence of alternatives more suitable to their objectives, small-scale farmers will continue to seek forest to clear to plant crops in order to secure their livelihood.

¹ Tomich *et al.* (1998b) define a best bet land-use system as 'a way to manage tropical rainforests or a forest-derived land-use that, when supported by necessary technological and institutional innovation and policy reform, somehow takes into consideration the local private and global public goods and services that tropical rainforests supply.'

Consequently, efforts to develop land-use systems and policy options to pursue global environmental objectives are useless without simultaneously considering objectives of small-scale farmers. In addition, weaknesses in markets and other institutions that influence the adoptability of land-use systems by small-scale farmers should be considered. Therefore, it is essential that the assessment of the adoptability of land-use alternatives should use a small-scale farmer's perspective. At the same time, the socio-economic concerns of policymakers should be taken into account.

This lecture note starts with a discussion of the objectives of small-scale farmers and the socio-economic concerns of policymakers. What are these objectives and concerns and what are the criteria we can use to measure the extent to which land-use systems match these objectives and concerns? Subsequently, a conceptual framework will be presented for the evaluation of land-use systems in terms of these criteria. Quantitative and qualitative indicators will be identified in order to measure the extent to which these criteria are met. In the next section, the data needs and analytical methods capable of supplying an empirical base for this framework will be outlined. This will be illustrated by case studies from Cameroon and Indonesia. The lecture note concludes with a discussion of the main problems and challenges with regard to socio-economic issues within integrated natural resource management, for debate and for future research. In that section we will also consider the pros and cons of using this broad-based framework, which is useful for comparing land uses at a macro-regional level, as of course, this is just one approach that could be used to evaluate land use systems from a socio-economic perspective².

2. What are the objectives of small-scale farmers and the socio-economic concerns of policymakers?

If we want to find out whether a certain land-use system is adoptable by small-scale farmers we have to understand first how decisions are being made by the small-scale farming households. We should answer the question "why do farmers do what they do?". Therefore, we will start with an explanation of decision making processes at the household level, before discussing small-scale farmers' objectives. In the last part of this section the policymakers' concerns are set out.

2.1 Understanding decision making at the small-scale farming household level

Many of the small-scale farmers turning to environmentally unfriendly land-use systems appear to do so because they lack alternative livelihood options which suit their objectives better (Box 1). Therefore, to be able to define adoptability of a land-use system from a small-scale farmers' perspective we should understand their decision making process, i.e. what are the basic elements on which they base their decisions and what are the trade-offs between these elements from a small-scale farmer's perspective?

Two main elements influence the decision-making process, namely farmers' objectives and the possibilities and constraints that they face.

² For other situations where a socio-economic perspective is required, e.g. for assessing a site-specific project intervention, then other methods such as rapid rural appraisal (RRA), participatory rural appraisal (PRA) (see lecture note 9) or census- /survey-based valuation methods may be more appropriate, especially if it is important to consider diversity and heterogeneity within a region/system.

2.1.1 Objectives

According to the “**livelihood strategies theory**” (see Box 1) farming households pursue the following household **objectives** (see Figure 1):

- secure provision of food and essential subsistence goods
- cash for purchase of goods and services,
- savings (resources accumulated to meet future planned needs or emergencies) and,
- social security (i.e. secure future access to subsistence goods and productive resources).

Box 1. Livelihoods and livelihood strategies

A livelihood includes:

1. income, both in cash and in kind;
2. social institutions (family, kin, compound, village and so on)
3. gender relations; and
4. property rights

required to support and sustain a given standard of living. Social and kinship networks are important for facilitating and sustaining diverse sources of income. Social institutions are also critical for interpreting the constraints and options of individuals and families distinguished by gender, income, wealth, access and assets. For example, different access rights to land are often the key determinants of distinct livelihood strategies pursued by poor compared to better-off rural households. Likewise, local norms and values on appropriate behaviour of women can make big differences to the livelihood options available for women compared to men.

A livelihood also includes access to, and benefits derived from, social and public services provided by the state such as education, health services, roads, water supplies and so on (Ellis 1998).

Livelihood strategies are the ways in which households try to improve or sustain their livelihood.

2.1.2 Possibilities and constraints

We can group the possibilities and constraints that farmers face into two main categories: a) those at the household level (i.e. the resources that households have access to) and b) those that operate in the wider environment, beyond the household level.

a) Household level

Households will aim to achieve their multiple objectives by using **the resources to which they have access**. The extent to which households have access to these resources is called the household resource position (see Figure 1), i.e. the household access to and/or possession of human capital (including knowledge, skill, health and labour availability), natural resources (land, trees and livestock), physical capital (agricultural implements, household assets), and financial assets (earnings, credit, savings, remittances).

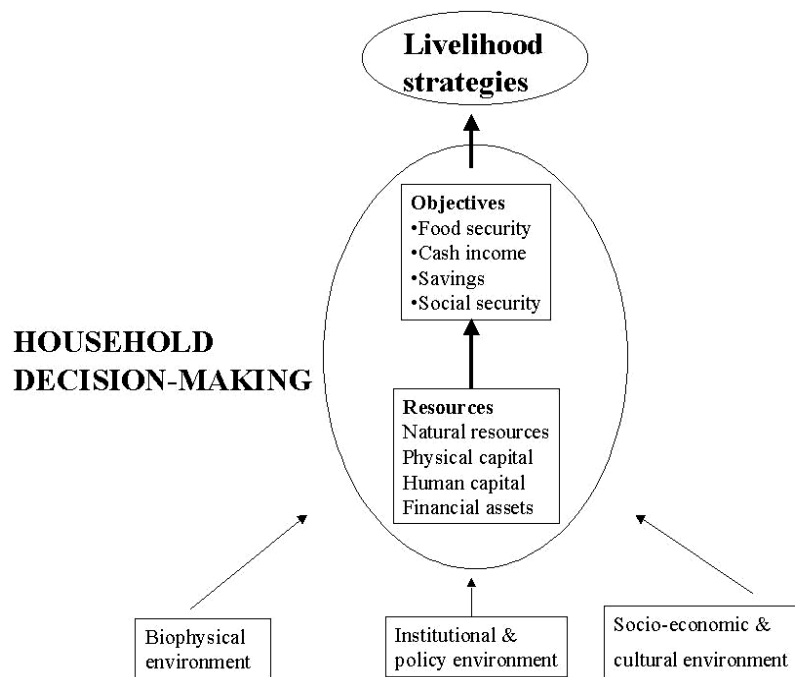


Figure 1. Factors conditioning the household decision making process.
Source: modified from S. Franzel (pers. comm.)

It is important to keep in mind that the resource position of households varies greatly even within a community or a village. Large differences in land ownership are common in Indonesia between households in one and the same village. But also the quantity and quality of labour available differs greatly per household, often depending on their life cycle. A family consisting of two adults and two children below six years old has much less labour available than a family consisting of two adults and two children above six years old. In the former family the mother is mainly busy with running the household and taking care of the children. In the latter the mother does not have to spend too much time any more on taking care of the children, leaving some time to work on the land. In terms of quality of labour, a household with one or more well-educated members has a better position than a household consisting of only non-educated persons.

The decision of a household to follow a particular livelihood strategy is the outcome of a fine-tuning of objectives to their possibilities and constraints. The resource position of a household is an important factor in the formulation of their objectives and consequently in the decision on the livelihood strategies to be chosen. In practice this means that *the decision making processes at the household level, including the decision on the adoption of a certain land-use system, varies between small-scale farmers depending on their resource position.* For example, farming households which are living just above the poverty line, i.e. which are just making ends meet, will reject a land-use system which requires substantial investments. These investments may not be a problem for households, which have a regular income that allows them to put/set aside a certain amount each month.

As stated above, **risk reduction** is an important objective in livelihood strategies of small-scale farmers and also affects decisions on land uses. Research has shown (Amacher, Hyde and Refiq, 1993; FAO, 1986) that households' attitudes toward risk and expectation of uncertain gains from adoption were among the most critical factors in adoption of land-use systems. An example of a risk, as perceived by a household, would be the adoption of unfamiliar species and/or systems. Furthermore, with multi-

year production cycles, cash flow is a problem and farmers carry the risk that there may be no harvest in the end, due to theft, tree damage, or tenure insecurity.

The degree to which households will try to reduce the amount of risk depends on their resource position. A household with substantial savings and/or relying on several sources of income will be more willing to take risks and, for example, adopt a new land-use system, than a household which does not have access to such sources and only relies on the income earned from their small plot of farmland.

b) The wider environment

The **environment** in which households are living also provides opportunities and constraints which influences their decision making process and their household objectives (Figure 1).

- For example, the amount of rainfall, an element of the **bio-physical environment** either prevents or makes possible the adoption of a land-use system requiring a high amount of rainfall (taking into account that there may be no irrigation possibilities).
- In terms of the **socio-economic environment** the availability of employment opportunities off farm can hamper the adoptability of a land-use system. If the earnings in the former are higher than the income to be obtained from practising the land-use system, the household will choose the off-farm job.
- The **socio-cultural environment** sets the norms and values that the households should obey. If they choose not to do so they will put their social security position at risk. For example, pig raising may be very profitable, but within a Muslim community this activity would not be accepted. The household would thus exclude itself from the community and its social security system.
- Finally, the **institutional and policy environment** includes among others the (mal) functioning of markets, formal and informal land and tree tenure institutions. For example, a lack of outlet channels and/or low prices for certain products will discourage farmers from adopting land-use systems involving those particular crops. Formal and informal land and tree tenure institutions, often operating at the community level, appear to be key determinants of incentives (and disincentives) for investment in productive assets and for sustainable resource management. For example, some land-use systems require land to lie fallow for several years. Farmers living in a community where once land is fallow it becomes community land, will hesitate such in adopting a system if land resources are relatively scarce. In these situations farmers prefer to plant trees in the fallow land to secure their ownership of the land.

*Consequently, any evaluation of land-use systems from a **small-scale farmer's** perspective should be made against the background of the household **objectives** as identified in the livelihood strategies theory, while at the same time taking into account their **opportunities and constraints**.*

Exercise

1. What are your personal/household objectives?
2. Try to describe your own livelihood and the livelihood strategies you use to sustain or improve your livelihood.
3. Which constraints and/or opportunities do you face in your environment, which influence your decision making about your objectives and livelihood strategies?

2.2 The small-scale farmers' concerns

Based on these objectives and opportunities and constraints, several criteria can be formulated which can be used in evaluation of land-use systems. It should be remembered that **these criteria should always be considered together and not in isolation**: a land-use system that fails to 'score' positively across all those criteria cannot be expected to be desirable or feasible for small-scale farmers:

- *Best bet land-use systems must be profitable*, and more profitable than alternative activities on-or off-farm. The time frame within which best bets would need to show a profit depends on the resource position of a household. Among small-scale farmers with few financial assets and little or no access to credit, this time frame could be quite short.
- *Best bet land-use systems must improve the food security situation of the farm household* (not always synonymous with improved prospects for future profitability), this is more important the closer the household lies to, or risks falling below, the threshold for minimum daily requirements.
- *The activities to be implemented in best bet land-use systems must be compatible with labour constraints at the farm level*; labour can be limited either by the quantity and quality of labour available at the farm household itself or by the rural labour market.
- *Best bet land-use systems must be socially and culturally acceptable* in the community in which the household lives. A land-use system that is not in accordance with local norms and/or values could put the social security situation of a household at risk.
- *The policy and institutional environment must be favourable for the potential best bet land-use system*. A non-favourable environment, such as a malfunctioning market, will hamper best-bet adoption even if the first four criteria are successfully met.

For each of the criteria - hereafter called **the small-scale farmers' concerns** - the resource position of the household will condition the 'weight' that household places on these issues as well as the relevant time frame. Therefore, although it was said that best bet land-use systems should be more profitable than other potential sources of income, farmers do not necessarily opt for the most profitable option. As they have multiple household objectives, a less profitable land-use system can be more suitable for a given household because of labour constraints and/or perceived risks and/or the access to other sources of income. For example, if the adult male in a household provides the household with an income from off-farm labour, a very profitable but high labour-input land-use system may not be the best option for this household. The adult female has to take care of all household tasks including taking care of the children, as well as taking care of the farm. In this case farming often becomes a sideline activity and a secondary source of income for the household. This means they do not want, and/or are not able to spend too much time on farming and do not aim to maximise the profitability of their farm³. On the other hand, a farming household with a plot of farmland just enough to cover their basic needs and with no access to other sources of income may not opt for the most profitable land-use system if it involves significant risks. A crop failure or a sudden decrease in market prices can be devastating for this type of household.

³ They do not quit their farming activities despite the attractive non-farm activity because they prefer to rely on several sources of income as part of a risk spreading strategy

Exercise

1. Try to evaluate several options you have or you can think of to gain an income, in terms of the criteria mentioned above.
 - Instead of food security you could evaluate an income earning opportunity in terms of the long term perspective it gives you, for example is it only a short term job or a long term job?
 - In terms of compatibility with labour constraints you could think of the impact this job would have on the time you can spend on your studies, or your leisure time.
 - With regard to the policy and institutional environment you can take into account, among others, the policy/attitude of your university/supervisors towards working students, for example are they flexible enough to let you study and work at the same time?

2.3 Socio-economic concerns of policymakers

Policymakers are caught in the middle of the various interest groups involved in the debate on tropical forest conservation. Ideally these policymakers would balance their primary public objectives with pressures they face from the international community and various domestic groups. Although their public objectives of course vary substantially between different countries, it is legitimate to hope that growth and equity could be important socio-economic concerns and objectives of policymakers in most of the countries dealing with deforestation problems.

- With regard to growth, the main criteria for policymakers would be the potential profitability of the land-use system or in other words, *does the country have a comparative advantage in this type of land-use system?* If so, expansion of this land-use system can contribute to economic growth.
- Depending on the (un/der)employment situation of the country, a major criteria for policymakers could be employment creation i.e. *"would expansion of this land-use system create employment opportunities, especially for unskilled rural workers?"* Or would it displace these workers, forcing more to migrate to cities?
- In terms of equity, the main question concerns *the adoptability of a land-use system for small-scale farmers*, making up the third criteria for policymakers

Finally, if the system scores positively on the three criteria discussed above, hereafter called the **policymakers' concerns**, the land-use system may have the potential to contribute to poverty alleviation.

3. Which indicators can we use?

The next step in the process of evaluating land-use systems is to identify indicators which can be used to measure the extent to which a certain land-use system matches the concerns discussed in the previous section. We will illustrate this step in the evaluation process with the framework used by the ASB research project⁴.

Although this framework does not take into account all of the concerns mentioned above – it does not take into account the social and cultural acceptability concern – it illustrates the evaluation process and some of the problems encountered in implementing it. The ASB framework consists of a general matrix (see Matrix 1) which

⁴ Alternatives to Slash and Burn project (ASB) is a system-wide initiative of the Consultative Group on International Agricultural Research (CGIAR) (for further information see lecture note 0, the background to the lecture note series).

covers the concerns of all the main stakeholders in the deforestation debate. In this lecture note we focus on the columns of the national policymakers and the small-scale farmers. The concerns of the other stakeholders of this matrix are discussed in the other lecture notes in the series on integrated natural resource management.

Matrix 1. Matrix for Evaluating Land-use systems as Potential Best Bet Alternative Systems to Slash-And-Burn at Forest Margins (General Matrix)

Land-use systems		Global Environmental Concerns			Agronomic Sustainability	National policy-makers' concerns		Small-scale farmers' concerns		
Description of System	Scale of Operation/Evaluation	Carbon Stocks	GHG Emissions	Biodiversity	Sustainability (at the plot level)	Social profitability	Employment*	Private profitability	Household Food Security	Institutional & Policy Issues

* The employment column for the policymakers at the same time forms the 'labour requirements' column for the small-scale farmers i.e. average labour input per hectare per year

The following sections present the indicators, which are selected for each of the small-scale farmers' concerns (except for the social and cultural concerns) and then the policymakers' concerns. Each of the indicators described below corresponds with a sub-column of the main column of the small-scale farmers' concerns and/or the policymakers' concerns column in the general matrix (Matrix 1).

3.1 Indicators for small-scale farmers' concerns

- **Best Bets must be profitable: Private profitability**, i.e. does it pay for small-scale farmers to invest in this land-use system compared with other options? The right measure of private profitability (see Box 2 for a definition of the underlined terms) is the expected Net Present Value (NPV) of revenues less costs of purchased inputs and of domestic factors of production, all valued at market prices. In addition, the time to reach positive cash flow (at a level sufficient to make a substantial contribution to sustaining a farm household), is critical, as is the existence of any subsequent period of negative cash flow.
- **Best Bets must be compatible with labour constraints at the farm level: Labour requirements**, (to be found in the policymakers' column, see the note in Matrix 1) i.e. is it feasible for the small-scale farming households to supply the necessary labour themselves or to hire workers? This is a measure of labour requirements (person-days per year) which will be averaged over the land-use cycle. This will be supplemented by a measure of cash flow to compensate for the opportunity cost of family labour or to meet hired labour needs should family labour be insufficient. The latter calculation also takes into account the periods of peak labour demand in the system itself (taking into consideration labour demand in other household activities). It is also necessary to measure division of labour by gender and age for agricultural activities where those distinctions matter.
- **Best bets must improve the food security situation of the farm household: Household food security**, i.e. even if the alternative land-use system is profitable and feasible given household labour constraints and labour market conditions, is it so risky (either in terms of variance in food yields or as a source of income to exchange for food) that adoption would endanger food security for the household? The appropriate food security indicator must incorporate both direct consumption of home-produced food as well as trade for food. This is especially important for land-use systems that do not involve food crops, but applies to food-producing systems as well.

Box 2. Definitions of economic terms (1)

Profitability: the difference between revenues and costs.

Net Present Value: the present day value of a potential project, whereby future costs and benefits are 'discounted' to present-day values in order to determine whether or not the project is worthwhile (Goodall, 1987).

$$NPV = \sum_{t=0}^n \frac{B_t - C_t}{(1+i)^t}$$

B_t = benefits (revenues), C_t = costs, including investments, t = each year of the project, i = the discount rate, n = the life of the project.

Discounting: the process of finding the present worth of a future amount. The present worth is determined by multiplying the future amount by the expression $1/(1+i)^n$ where i = the discount rate (interest rate) and n = the year (Gittinger, 1982).

Discount rate: the rate of interest that measures the opportunity cost of waiting to consume goods at a later time rather than consuming them today.

Factor of production: An input required to produce output (for example labour or land) (op. cit.).

Market price: A price at which a good or service is actually exchanged for another good or service (as an in-kind payment or for money) (op. cit.).

Cash flow: the amount of money generated from a production activity. It includes both expenditures (outflows) and revenues (in-flows). $B_t - C_t$ B_t = benefits (revenues), C_t = costs.

Opportunity costs: the benefit forgone by using a scarce resource for one purpose instead of for its next best alternative use. For example, suppose a farmer produces both rice and maize but applies all of the fertilizer to rice. If instead he transferred some of the fertilizer to his maize, he would reduce the value of his rice production somewhat, but he might gain a much higher value of increased maize production. The value of his rice production forgone would be the opportunity cost of the fertilizer used for maize production (op. cit.).

Social opportunity costs: the opportunity costs of goods and services estimated for an economy as a whole. In a reasonably competitive market, the price of an input reflects its opportunity cost and is equal to its social opportunity costs. However, due to policy distortions and market imperfections, opportunity cost may not reflect scarcity values. In this case social opportunity costs are used – often called shadow prices (see Box 4) – to estimate, for example, the potential profitability of a land-use system for a country.

- **The policy and institutional environment must be favourable for the potential best bets: Institutional and policy issues**, i.e. the level of institutional and organisational development as well as infrastructure and policies affect land, labour, capital and commodity markets and also the availability of information on production technology. This in turn affects the feasibility of adoption of a land-use system by small-scale farmers. In contrast to the other measures above, this criterion is concerned with qualitative information such as market dependence, market performance, and possible social system responses to market imperfections in the context of purchased inputs, marketed outputs, hired labour and formal credit for land-use systems. Apart from that, information is gathered on the

possible constraints to land use change posed by non-market information, regulatory issues, local environmental impact, property rights and equity issues.

3.2 Indicators for policymakers' concerns

With regard to the **policymakers' concerns** the following indicators have been selected to measure growth and employment generation:

- **Does the country have a comparative advantage in this type of land-use system? Social profitability**, i.e. profitability calculated at social prices, will be used to assess the impact of policy distortions on incentives for adoption and investment (Monke and Pearson, 1989) on the one hand. On the other, it provides an insight into the comparative advantage of a country for a given agricultural activity, as it presents the potential profitability of an activity. Social prices reflect scarcity values or *social opportunity costs* (see Box 2) and indicate the potential value added from a given land-use system if policy distortions and market imperfections were removed.

This impact on value added is directly linked to policymakers' growth objectives. Depending on the specific situation in a country, profitability will be measured in returns to land or returns to labour. With regard to the island of Sumatra (Indonesia) for example, local and national policymakers are increasingly making public policy decisions under conditions of land scarcity and labour abundance. In the case of Sumatra therefore, social profitability should be measured in returns to land. However, more commonly in the forest margins, labour is the scarce factor. In those cases social profitability should be calculated in terms of returns to labour.

- **Would expansion of this land-use system create employment opportunities, especially for the unskilled rural workers?** The total time-averaged **labour requirement** of a certain agricultural activity is (also) a good indicator that is related to the equity criteria set for policymakers' concerns in countries dealing with un(der)employment in rural areas. Note, however, that while labour-intensive alternatives should be attractive for policymakers who are concerned with job creation, these alternatives will only be attractive to households if they provide attractive returns to labour (as measured in the indicator of private profitability).
- **The overall adoptability for small-scale farmers** measured as described above should also be taken into account by policymakers.

4. How can we quantify and assess the indicators for small-scale farmers' and for policymakers' concerns?

To explain this step in the evaluation process we will continue along the lines of the ASB framework⁵ and discuss the quantification and assessment of the indicators identified in the section above.

It must be remembered that the evaluation process takes place at sites, which are each embedded within a broader socio-economic context. Therefore, there may be some essential elements that, described at each study site, give some important insights into this context, and which **will be relevant for the evaluation of all land-use systems considered**. A list of these essential elements (such as that below) and site-specific descriptions based on them should be attached to the general matrix, as these can be very important for the interpretation of the results of the evaluation.

⁵ For the identification of the different land-use systems within this framework see lecture note 2 in this series.

Recommended list:

- the socio-economic structure (different socio-economic groups to be identified);
- economic structure (importance of the various economic sectors, including the use of natural resources);
- demographic structure (population density, in/out migration etc.);
- land and tree tenure and access rules (formal and informal land and tree tenure arrangements, division of land ownership);
- tradition/history of economic activities;
- employment structure and labour force;
- relative accessibility of the site (including availability of public transport);
- socio-political context.

Furthermore, the quantification and assessment of the indicators requires a large amount of data and information for the specific site studied, such as land type, household labour composition and average production coefficients (here: the yield of a certain crop which can be produced on one hectare of land, given the use of certain quantities of certain inputs). In terms of socio-economic aspects one of the main issues concerns the need to decide upon an "archetypal household", i.e. a standard "representative" household in terms of labour composition, food needs, economic activities etc. Most of the measurements concerning profitability, labour requirements and food security are based on this "archetypal household". For more information on this and a general more in-depth account of the research protocol for the ASB matrix, see Vosti *et al.* (2000).

In Box 3 a brief overview of the most important characteristics of the case-study areas and of the land-use systems evaluated is presented. This only serves as an example of what kind of information is needed, as a complete description of the context of the two areas and the land-use systems is too extensive to present here.

Box 3. Case studies: Descriptions of broader socio-economic contexts and land-use systems evaluated

Sumatra, Indonesia

The evaluated land-use systems used as an example here are located in the peneplains and in the narrow piedmont zone of the Jambi Province of Sumatra.

Historically, the peneplains were sparsely inhabited, with human population concentrated along the riverbanks on relatively favourable sites. With the arrival of rubber trees a century ago, population spread in the peneplains. Major road construction projects have been completed over the past 20 years. Apart from that, the peneplains have been the focus of government-sponsored settlements schemes (called transmigration), large-scale logging, and various large-scale public and private land development projects since the 1970s.

With regard to the economy, forestry and the rubber processing industry contributed virtually all of the exports from Jambi province in 1993. In the rubber industry, smallholder rubber plays a crucial role. The total area of rubber cultivation in Jambi in 1993 was 502 642 ha, of which only 3 447 ha was planted with high-yielding varieties under intensive management, whilst the rest was 'jungle rubber' (the rubber agroforests). 64% of the land in Jambi is categorised as State Forest Land. However, 'forest status' often was declared long after local communities had already settled there. In practice, a large part of the forest land is used for rubber agroforests and other forms of agriculture.

After the completion of the Trans Sumatra Highway in the 1980s, Jambi has become a popular destination for migrants. The ASB survey in the study site indicates that over 80% of the spontaneous migrants came from Java and less than 20% came from other areas in Sumatra.

Box 3. (Continued)

Virtually every smallholder household interviewed in the ASB survey in Jambi is engaged in agriculture. Less than 10% of households of local farmers and spontaneous migrants engage in non-agricultural activities. This is in strong contrast to transmigrants. Although non-agricultural activities may not be the main occupation of transmigrants, 75% of these households reported non-agricultural work (in trading, services, and paid labour). The vast majority of household heads had not completed primary school.

Rubber agroforests are by far the most extensive smallholder land use in the peneplains of Sumatra. Two types of rubber agroforests were distinguished, the first being the indigenous system: forest clearing followed by upland rice and planting of unselected rubber seedlings, with natural regeneration of forest species. This is the dominant land-use system for small-scale farmers. The second type was distinguished as a possible best bet (for small-scale farmers): rubber agroforests planted with clones instead of seedlings (Tomich *et al.*, 1998a).

The Congo Basin, Cameroon

In the study area, located in southern Cameroon, extensive slash and burn agriculture is being used by smallholders. The most important food cropping system is the groundnut/cassava-based mixed food field, which largely guarantees household food security, and, in areas with market access, generates marketable surpluses. Women farmers manage this system, which is typically planted twice a year. The next most important system and also the largest source of household income from agriculture, are the cocoa agroforests. Men mainly manage these systems. The third most frequently encountered system (70% of the surveyed households) is the plantain banana field.

Fields in the study area are generally small and fragmented. The average number of annual crop fields per household is slightly more than 4. The mixed groundnut field which is the most predominant annual food field, has an average size of around 1,300 m². The mean annual land cover in productive agricultural land use (not including fallow fields) varies from 2.4 to 3.6 ha per household in different parts of the area. Roughly fifty percent of this area is accounted for by complex cocoa agroforests. Cocoa and robusta coffee revenues comprise the largest portion of household income.

The livestock sector is not well developed in the Congo Basin.

Large differences exist across the study area with regard to institutions and infrastructure. Both are much better developed in the parts where population densities are higher. For example, in the better-developed areas a fairly competitive marketing system for both outputs and inputs exists and farmers have easy access to purchased inputs. In the other areas farmers can spend more than a full day acquiring inputs.

One of the most rapid changes affecting the agricultural sector throughout the Congo Basin has been the tremendous growth in urban populations, providing a growing market for food commodities. The largest food commodity markets in terms of value are plantains, cassava and cocoyams. The rapid evolution in urban food demand is increasing income opportunities from food crops and encouraging the diversification process, especially in areas where market access and infrastructure area adequate.

Sectoral and macroeconomic policy reforms in Cameroon since the late 1980s have had important impacts on slash-and-burn agricultural systems. Most of these reforms occurred in the cocoa and coffee sectors. As a result, cocoa and coffee producers in Cameroon faced historically low producer prices and, in response, neglected their plantations and shifted resources into the production of plantain, cocoyams and horticultural production. This put significant additional pressure on the forest margins as new forest lands were cleared and brought into annual food crop production.

Here we will present the results of the evaluation of the two dominant slash-and-burn crop-fallow rotation systems in the Congo Basin region. The first type concerns the intercropped food field planted in a short fallow rotation. The main role of this crop system is to feed the household by marketing of food surpluses which are increasing in importance as market access improves. Surplus revenues tend to be controlled by women. The two dominant crops are groundnuts and cassava. The second land-use system presented here is the intercropped food field planted in a long fallow rotation. Melonseed, plantain, maize and cocoyam are planted into a 15 year fallow field. Although both male and female labour is used in this field system, the cash income from this field tends to be controlled by men.

For practical reasons, the Profitability, Employment/Labour Requirements, Food security, and Institutional and Policy Issues columns of the overall Small-scale farmers' concerns column and of the Policymakers' concerns column are each 'broken out' of the general matrix (see Matrix 1) into separate (sub)matrices, to be described below (sections 4 and 5). Section 6 explains the extent to which evaluations made in each of those sub-matrices can be 'summarised' in the general matrix. For a more in-depth account of research protocol for each indicator, see Vosti *et al.* (2000).

The description of the quantification and assessment will be illustrated by case-studies of the application of the framework in Indonesia and Cameroon.

4.1 The Profitability Matrix

Profitability can be measured as returns to land or returns to labour depending on the scarcity of either labour or land. If land is available in abundance and labour scarcity prevails, then the return to labour is the most appropriate measure for private profitability. The Profitability matrix contains sections with indicators for each (see Matrix 2).

Matrix 2. Profitability

Description of System	Returns to Land		Returns to Labour	Establishment Costs	
	Net Present Value – Private Prices	Net Present Value – Social Prices	Wage to set NPV to Zero	Net Present Value of Establishment Costs – Private Prices	Years to Positive Cash Flow
Sumatra, Indonesia	US \$ ha	US \$ ha	US \$ day	US \$ ha	Years
Rubber agroforest (seedlings)	1	30	1.67	544	10
Rubber agroforest (clones)	(40)* to 918	98 to 1510	1.63 to 2.88	1081 to 1193	6 to 7
Congo Basin, Cameroon	US \$ ha	US \$ ha	US \$ day	US \$ ha	Years
Intercropped annual food crop in a short fallow rotation	623	644	1.79	n.a.#	n.a.
Intercropped annual food crop in a long fallow rotation	283	288	1.70	n.a.	n.a.

* figures in brackets represent negative figures

n.a.: not applicable since this concerns annual systems. This criteria focuses on multi-year cash flow constraints (rather than on seasonal cash flow constraints) in order to assess whether the investments required by these systems are barriers to adoption by smallholders.

In this framework **Private Prices** are the prices that the small-scale farmers actually face, i.e. *farm gate prices* (see Box 4 for definition) or other prices relevant to farmer decisions can be used.

Social Prices are, in theory, the price to society, but in this analysis the international or world prices for traded goods (adjusted as necessary to reflect transport costs from the study area) are used as a proxy. In the case of non-traded goods, *shadow prices* and *border prices* can be used.

Returns to land

To estimate the returns to land the Net Present Value (NPV) of each system will be calculated both on the basis of Private Prices (small-scale farmers) and on the basis of Social Prices (policymakers). By comparing the differences between the NPVs calculated using private and social prices, policy (and other) distortions to markets can be identified, as well as the potential gains to particular types of policy interventions for promoting best bet land-use system adoption. For further discussion on the interpretation of differences between social and private NPVs, see Lecture note 12 on policy.

Box 4. Definitions of economic terms (2)

Farm gate price: the price a farmer receives for his products or pays for inputs at the boundary of the farm –that is, the price without any transport to a market or other marketing service (Gittinger, 1982).

Shadow price: used in economic analysis for a cost or a benefit in a project when the market price is felt to be a poor estimate of economic value due to market imperfections or policy distortions (op. cit.).

Border price: the unit price of a traded good at a country's border (op. cit.).

Imputed means a price or economic value determined by some computation rather than by using an observed market price (op. cit.).

Factor markets: markets for factors of production.

If the net present value of a land-use system is equal to zero, this implies that the system will yield a net cash flow just large enough to repay all the money invested in the land-use system and to cover opportunity costs of labour and capital. If the net present value is positive, it means the system can cover all its costs with some profit left over for the farming household (private prices). If negative, the system cannot cover its costs and should not be implemented by small-scale farmers. Clearly, the higher the net present value, the higher the profitability of the land-use system to small-scale farmers. In the case of social profitability, the higher the NPV of a land-use system, the higher the comparative advantage of the country in question for that particular type of land-use system.

Returns to labour

The wage rate that sets the Net Present Value (NPV) for an activity or system to zero is used to establish the returns to labour. This measure answers the question (for a given discount rate): what is the maximum wage level (paid to family labour and hired labour alike) at which this land-use system will be profitable? The outcomes of this measure could be compared with wages earned in off-farm work or wages paid to agricultural labourers, to assess whether the system will be attractive to family members compared to off-farm work or whether it would justify hiring labour.

The issues of human capital, or skills base, of household labour, *vis-à-vis* the systems' requirements, are taken up in the Institutional and Policy Issues matrices.

Establishment costs

The measure used for this aspect is “Net present value of all inputs used to establish a given system, including *imputed* value of family labour and family-owned implements, but excluding any imputed costs for family land and management.” Establishment, in this context is defined as the number of years to positive cash flow for a given land-use system.

The policy analysis matrix⁶ (PAM) technique can be used to estimate the profitability indicators discussed above. The PAM is a matrix of information about agricultural and natural resource policies and *factor market* imperfections that is created by comparing multi-year land-use systems budgets calculated at private and social prices (Monke and Pearson 1989 is the basic reference). The structure of the PAM is described and explained in Box 5. Case studies from Indonesia and Cameroon are presented in Box 6.

Box 5. The Policy Analysis Matrix (based on Monke and Pearson, 1989)

The PAM is a product of two accounting identities. One defines profitability as the difference between revenues and costs and the other measures the effect of divergences (distorting policies and market failures) as the difference between observed parameters that would exist if the divergences were removed.

Each PAM contains two cost columns, one for tradable inputs and the other for domestic factors. Intermediate inputs including fertilizer, pesticides, purchased seeds, electricity, and transportation are divided into tradable input and domestic factor components (for example land, labour and management). The appropriate measure of profitability is the Net Present Value (NPV) of revenues less costs of tradable inputs and of domestic factors. Profits are defined as the difference between total (or per unit) sales revenues and costs of production. This definition generates the first identity of the accounting matrix. In the PAM, profitability is measured horizontally, across the columns of the matrix, as demonstrated in the table below. The second identity of the accounting matrix concerns the differences between private and social valuations of revenues, costs, and profits. For each entry in the matrix –measured vertically – any divergence between the observed private (actual market) price and the estimated social (efficiency) price must be explained by the effects of policy or by the existence of market failures.

	Revenues	Costs		Profits
		Tradable inputs	Domestic factors	
Private prices	A	B	C	D ¹
Social prices	E	F	G	H ²
Effects of divergences and efficient policy	I ³	J ⁴	K ⁵	L ⁶

1 Private prices, D, equal A minus B minus C.

2 Social profits, H, Equal E minus F minus G.

3 Output transfers, I, equal A minus E.

4 Input transfers, J, equal B, minus F.

5 Factor transfers, K, equal C minus G.

6 Net transfers, L, equal D minus H; they also equal I minus J minus K.

⁶ This matrix is not part of the ASB general matrix but is a technique used to calculate some of the information needed to fill in the ASB one.

Box 5. (Continued)

Case study: Rubber Agroforest using **seedlings** as planting materials

	Revenues (US \$)	Cost (US \$)				Profits (US \$)
		Purchased inputs		Domestic factors		
		Tradable	Non tradable	Labor	Capital	
Private prices	856	192	69	582	12	1
Social prices	1199	254	87	816	11	30
Effect of divergences	(217)	(62)	(18)	(234)	1	29

This table shows that in terms of the rubber agroforestry system (using seedlings) there is a substantial difference between the private profits, i.e. the profits for the farmers and social profits, i.e. the potential profits. In this case the difference is mainly caused by the difference between the private and social interest rates used in the calculations, which were 15% and 20% respectively. The calculated figures in the 'profits' column are then used in the profitability matrix (Matrix 2).

4.2 The Labour Requirements Matrix (see Matrix 3)

In Matrix 3 two indicators are presented to measure the labour requirements of a land-use system. First is the total person-days required to establish a system, where 'establishment' refers to the period before positive cash flows begin. The second one measures the labour requirements in person-days for the operational phase (defined as the period after positive cash flow begins).

Establishment of the Land-use System

In this column the total amount of labour required to establish a system is measured, i.e. the total labour input in person-days in the initial phase of system establishment, expressed as an annual average per hectare (this period is the number of years to positive cash flow indicated above in the Profitability matrix). Gender issues and the requirement of specific types of labour for the activity can be mentioned using an asterisk in the cells.

Operation of the Land-use System

In this column the total labour input required for operating the system is measured as the total labour input required once the establishment stage is finished, expressed in person-days per hectare per year (averaged over the relevant period). Again, if gender issues arise or if a known reliance on hired or skilled labour exists, asterisks can be added to the cells. Both issues will also be taken up in the Institutional Issues matrices.

The purpose of the 'intensity' of labour requirements column is to highlight potential bottlenecks where the labour needs of new land-use systems (not yet widely adopted) overlap with other household activities. It should identify the activity and the season that might create these bottlenecks and which might prevent the system under evaluation fitting in with existing household activities.

The two indicators described above have to be used together to calculate the total labour requirements of a given land-use system, and this value is used in the employment column of national policymakers' concerns in the general matrix (Matrix 1).

Box 6. Case-studies: The profitability matrix

Sumatra, Indonesia (see Matrix 2)

Although a situation of local land abundance with household labour scarcity has historically prevailed, this fundamental relationship seems to be shifting in Sumatra. Nevertheless, it is still reasonable to believe that local land abundance and household labour scarcity continue in the forest margins, at least from the point of view of smallholder households in central Sumatra. Therefore, returns to labour valued at private prices was selected as the indicator of profitability for small-scale farmers, instead of returns to land.

At the same time, policymakers are increasingly making public policy decisions under conditions of land scarcity and labour abundance. Land scarcity certainly is a constraint that should be considered by policymakers in choices regarding development of large-scale estates versus small-scale farmers and there are other reasons to believe these development strategies are mutually exclusive (Tomich *et al.* 1995). Therefore, returns to land valued at social prices is used as the indicator for potential profitability from a policymakers' perspective.

The two contrasting rubber systems evaluated in Sumatra produce a wide range of results. First, it is encouraging that returns to labour at private prices for rubber agroforests planted with seedlings are virtually identical to the market wage. On the other hand, although these small-scale farmers are the lowest cost producers of natural rubber in the world (Barlow *et al.*, 1994), returns to land at social prices are not much above other land-use systems evaluated in Sumatra. The returns to labour and to land for rubber agroforests planted with clones are highest. However, the data on this land-use system must be treated with caution since they are based on projections from farmer-managed trials and have not been verified through broader experience by small-scale farmers.

The divergence in profitability at social prices and private prices are in this case mainly caused by the difference in private and social interest rates. Capital markets in Indonesia are full of imperfections and small-scale farmers often have no access to formal capital. Interest rates in informal capital markets are usually much higher than those of formal capital markets. Consequently, the social interest rate used in this example is substantially lower than the private interest rate.

Although the number of years to positive cash flow is substantial for both rubber systems, almost 3 million ha of rubber agroforests have been planted by small-scale farmers without any formal credit. Furthermore, the US \$ 544 required to establish these agroforests (with seedlings) has not been an impassable barrier for small-scale farmers. The estimates of establishment costs suggest that replacing seedlings with higher-yielding clones in rubber agroforests more than doubles investment costs to roughly US \$ 1081 - 1193 per ha. Since there is no long-term institutional credit for smallholders in Sumatra, whether these investment requirements are barriers to adoption depends in large part on the divisibility of the activity (i.e. is it possible to plant a bit at a time?).

The Congo Basin, Cameroon

In the relative land-surplus economies characteristic of much of the Congo Basin in Cameroon, adoption potential for small-scale farmers is most appropriately measured by the private returns to labour. The returns of the systems presented here are low. They actually lie below the official minimum wage per day of \$2.17 for unskilled manual labour. The returns to land at social prices are also very moderate, especially for the long fallow rotation system which had the lowest values of all 9 systems under evaluation in the Congo basin. The establishment costs for these annual systems on the other hand are zero, and positive cash flows can be obtained starting from the very first year.

Matrix 3. Labour Requirements

Description of System	Establishment Phase		Operation Phase	
	Total Labour (Person-days/ha/yr)	Intensity	Total Labour (Person-days/ha/yr)	Intensity
Sumatra, Indonesia				
Rubber agroforest (seedlings)	271	n.a.	157	n.a.
Rubber agroforest (clones)	444	n.a.	74	n.a.
Congo basin, Cameroon				
Intercropped annual food crop in a short fallow rotation	n.a.	n.a.	115	n.a.
Intercropped annual food crop in a long fallow rotation	n.a.	n.a.	44	n.a.

Box 7. Case-studies: the labour requirements matrix

Sumatra, Indonesia

In Sumatra, the system with the highest profitability (as shown in the previous section) – rubber agroforests with clones – has a very high labour requirement in the establishment phase. So, while the return to labour itself is not a problem here, problems in the labour market (that will be discussed later on), could impose a serious barrier to adoption. From the perspective of policymakers concerned with employment generation, the total time-averaged labour requirement is a good indicator that is related to equity criteria. The total labour requirement for the rubber agroforest planted with clones is higher than that of the seedling rubber system but also the highest of all the nine systems evaluated in Sumatra. Harvesting labour is the biggest component of total labour in the rubber systems.

The Congo Basin, Cameroon

In labour-scarce rural economies, or in rural economies where labour markets are institutionally underdeveloped (both issues pertinent to the Congo Basin region), labour ‘intensity’ is an important determinant of the extent to which a given system will be adopted. On the basis of the average annual number of days required for operations, the amount of labour needed does not seem to be a constraint for the two systems evaluated here. The figures are deceptive, however, because of the fallow period, especially in the case of the long fallow system. In fact, to bring a hectare of the long fallow food crop rotation system into production requires an estimated input of 731 person days of labour! A similar situation is seen regarding adoption of the short fallow food crop rotation system which requires an annual input of 690 person days, which, when averaged over the 6 years of the fallow-production cycle, lowers the figure to 115 days. This is still the highest annual labour intensity of any of the systems evaluated in Cameroon.

4.3 The Household Food Security Matrix (see Matrix 4)

The evaluation of land uses from a socio-economic perspective would not be complete without considering the issue of household food security. It is necessary to use a number of indicators, as, for example, using only food nutrient content measures (as presented in the first main column of Matrix 4), can be seriously misleading. This is because food security derives from the ability to obtain food, including purchases, and not just the capacity to grow it. An unsustainable, low-productivity shifting cultivation system that is suffering decreasing yields because of nutrient depletion and increasing variability in yields because of pest problems may be a riskier basis for securing household food supply than a rubber plot that reliably produces a steady stream of

output that can be readily marketed in exchange for rice (in the case of Indonesia) that trades at a stabilised price.

Therefore, our matrix also includes a column which indicates the way in which the land-use system provides for the food needs of the household and a column which presents the food security indicator based on Sen's (1982) concept of risk of food entitlement failure (see below for an explanation).

Nutritional Value of Food Produced by the Land-use System

In this framework, the amount of food produced by a particular system is measured in terms of its nutritional value, measured in calories, protein contents, and indicators of the presence of key micro-nutrients (where 'key' can be determined by site-specific shortfalls of micro nutrients).

Food Entitlement via Own Production or Exchange

This column presents the way in which the land-use system provides for the food needs of the household. The label 'Own prod'n' (Own Production) means that the system enables food production on-farm; 'Exchange' means that the system only provides additional income for food purchases and 'Own prod'n & exchange' means that both are applicable. Wages mean that additional income is earned through off-farm employment.

Risk of Food Entitlement Failure

As explained above, in order to accommodate land use alternatives that do not involve food crops, the food security indicator used in this framework is based on Sen's (1982) concept of risk of food entitlement failure, which encompasses trade-based and production-based entitlements to food as well as security of property rights over productive assets (inheritance and transfer entitlements).

Matrix 4. Household Food Security

Description of System	Nutritional Value of Food Produced by the System			Food Entitlement via: Own Production, Exchange, or Wages		Risk of Food Entitlement Failure		
	Calories: avg. kcal /ha/yr	Protein: Avg. kg /ha/yr	Micro-nutrients	Establishment	Operation	Production Risk	Non-food	Terms of Trade Risk
Sumatra, Indonesia								
Rubber agroforest (seedlings & clones)	118	2.2	?	Own prod'n	Exchange	n.a.	0.13*	0.26
Congo basin, Cameroon								
Intercropped annual food crop in a short fallow rotation	3,803 (x 000)	54.8	yes	--	Own prod'n & exchange	?	?	?
Intercropped annual food crop in a long fallow rotation	780 (x 000)	10.9	yes	--	Own prod'n & exchange	?	?	?

* coefficient of variation of annual rubber yields per hectare, over 14 years

Moreover, one of the key dimensions of this analysis is the 'path' of food entitlement – is it derived from consumption of one's own food production, exchange of one's own

production for food, or working for wages to buy food? These ‘paths’ determine the measure of risk of entitlement failure. If the path is production of one’s own food, one simple indicator of production risk is the coefficient of variation of yields⁷. A simple indicator of terms of trade risk⁸ is the coefficient of variation of the ratio of revenue (price of output times yield) to the price of the staple food (Matrix 4). This can be viewed as the coefficient of variation of purchasing power in terms of rice in Indonesia for example. Finally, if the path is wage labour, risk of entitlement failure is a function of the employer’s financial situation, which is only partly related to production or terms of trade risk.

Box 8. Case-studies: The household food security matrix

Sumatra, Indonesia

The risks involved in the rubber agroforest systems are relatively high, especially the terms of trade risk. However, the high profitability of the rubber agroforests compared to the other systems under evaluation in Sumatra is probably the reason why the rubber agroforest systems have displaced other systems (i.e. upland rice) over the years.

The Congo Basin, Cameroon

In many areas of the Congo Basin, rural food markets either don’t exist or, if they exist, are often periodic and access is limited. As a consequence, most households rely on their own production for the vast bulk of their food intake. Under such conditions, the contribution of a system to household food subsistence goals becomes important. In essence, the mixed food crop field in short fallow rotation is the household granary and is the type of field most frequently found in the area studied. Subsistence objectives are predominant, and commercial objectives are secondary. The same is largely true of the annual food crop in long fallow rotation, although in some areas these fields are planted by farmers with primarily commercial objectives in mind. When calculating the food entitlements during the productive stage for these systems, again the assumption of zero production during the fallow period reduces the per hectare figures significantly. Nonetheless, the calorific and protein output of the short fallow rotation systems was the highest of all systems evaluated in Cameroon.

5. Assessing institutional and policy issues with regard to adoptability by small-scale farmers

5.1 General approach

The objective of these institutional matrices (Matrices 5 and 6) is to identify potential institutional bottlenecks and to address equity issues associated with systems linked to land-use systems. In addition, several columns of the ‘Institutional Capacity Vis-à-vis System-Specific Institutional Needs - A Checklist for Other Institutional Issues’ (Matrix 6), focus on the potential for social co-operation in response to one or more of the institutional problems raised in these matrices.

In the cells examining each institutional issue in detail a low/medium/high approach is employed to signal if, and to what degree, an institutional bottleneck or equity problem is likely to exist and the extent to which the system can respond. This matrix uses a

⁷ The coefficient of variation is the standard deviation of a series of values divided by the mean of the series. It is a relative measure that expresses variation as a proportion of the average level (e.g. the value 0.13 for rubber production in Matrix 4).

⁸ The Terms of Trade Risk concerns the relationship between prices of products sold and the prices of products purchased by the small-scale farmers. The terms of trade deteriorate if the prices of products sold decrease relative to the prices of products purchased.

‘traffic light approach’ as follows: ⊕ indicates no problem is anticipated or that the issue is not relevant for a particular land-use system; ♦ indicates that some problems may exist; and • indicates that a severe bottleneck or equity problem is likely to exist.

An aggregate assessment row is located beneath each land-use system row, and its purpose (also using a 'traffic light' approach) is to signal the extent to which one or more of the possible institutional bottlenecks, equity, or other problems is likely to limit the adoption and spread of a particular land-use system.

5.2 The Institutional Capacity *Vis-à-Vis* System-Specific Institutional Needs (see Matrix 5)

Markets

This matrix assesses market dependence, market performance, and possible social system responses to market imperfections in the context of purchased inputs, marketed outputs, hired labour, and formal credit.

Matrix 5. Institutional Capacity *Vis-à-vis* System-Specific Institutional Needs: a Checklist for Markets

Land Use	Input Supply Markets	Output Markets	Labour Markets	Capital Markets
SUMATRA, INDONESIA				
Rubber agroforest (seedlings)	⊕	⊕	⊕	⊕
Rubber agroforest (clones)	•	⊕	⊕	⊕
Congo basin, Cameroon				
Intercropped annual food crop in a short fallow rotation	⊕	⊕	♦	⊕
Intercropped annual food crop in a long fallow rotation	⊕	♦	♦	⊕

blank = n.a, ⊕ = no constraint, ♦ = possible constraint, • = constraint

Input Supply Markets

With regard to the input supply markets the objectives are to assess the extent to which:

- purchased inputs are important components in land-use systems,
- input markets perform the basic functions required to make adoption of the system feasible, and
- social systems can compensate for input market imperfections.

For example, if they exist, can/will farmers' co-operatives take on the challenge of providing the necessary inputs for new land-use systems?

Product Output Markets

In terms of product output markets, the objectives are to assess the extent to which:

- output markets are required for land-use systems,
- these markets perform the basic functions required for technology adoption, and
- social systems compensate for output market imperfections.

For example, if they exist can /will farmers' co-operatives take on the challenge of marketing the outputs from new land-use systems?

Labour Markets

Concerning labour markets, the objectives are to assess the extent to which:

- unskilled and skilled labour is required for land-use systems
- markets for these categories of hired labour perform the basic functions required for technology adoption, and
- social systems compensate for labour market imperfections (markets for skilled and unskilled labour are handled separately in the matrix).

For example, are there labour-sharing arrangements among households that compensate for the absence of hired labour markets or imperfections in these? Special attention needs to be paid to seasonal failures in labour markets. Hired labour markets are often really tight during planting and/or harvesting seasons. If they exist, can labour-sharing arrangements among households fulfill the labour requirements of these households during the peak seasons?

Box 9. Case-studies: The Institutional Capacity Vis-à-vis System Specific Institutional Needs Matrix

Sumatra, Indonesia

In the case of Sumatra, planting material supply markets are the greatest barrier to adoption of the more profitable clonal rubber agroforest systems. Farmers have little access to improved rubber planting material. They have been largely ignored by the government's supply and advisory service while the private nursery industry has only begun to develop. Apart from that, for public and private sources alike, there are serious problems of reliability regarding quality of planting material, which is difficult to assess until several years after planting. In terms of output markets, local markets for natural rubber have functioned for a century or more. Although there are some imperfections affecting quality – viz., difficulty of assessing dry rubber content – these markets transmit world price changes to the farmgate rapidly and marketing margins reflect transport and other costs. Natural rubber markets have been subject to few distortions from national policy, but at times the international buffer stock has depressed prices.

Instead of hiring permanent skilled workers, small-scale farmers may be more likely to develop certain technical skills themselves. Therefore, the analysis of labour markets focuses on unskilled labour only. So, the barrier for the small-scale farmers is the acquisition of technical information (see next matrix) rather than the market for skilled labour. With regard to unskilled labour, labour markets appear to work reasonably well. Capital market problems are second only to planting material supply as a barrier to adoption resulting from market imperfections.

There is no long-term institutional credit available in rural Sumatra. Household savings, which financed investments in existing smallholder rubber agroforestry systems are often underestimated. In rural Indonesia, farmers are able to receive considerable credit from informal sources (relatives, moneylenders). However, current economic hardships – especially high food prices - may be straining these resources. Capital market imperfections (lack of credit and interest rates well above the social prices of capital) may constrain small-scale farmers' use of relatively high-priced clonal rubber planting material.

The Congo Basin, Cameroon

Labour is a critical factor in both the long and short fallow food crop rotation system. As labour markets do not function efficiently this could be a important constraint for this system. Output markets could be a constraint for the long fallow food crop rotation system. The large increase in the supply of plantain in the market relative to the demand for the product led to significant decrease of the market price. Furthermore, a potential change in the tastes of urban populations as incomes rise may lead to a switch from plantain to other starch products, such as rice and wheat flour, but this is a factor which is difficult to predict.

Capital Markets

In terms of capital markets, the objectives are to assess the extent to which:

- borrowed money is required for land-use systems,
- capital markets perform the basic functions required for technology adoption, and
- social systems compensate for capital market imperfections.

For example, are there local money lenders and/or farmers' co-operatives that can substitute for private or public banking systems in providing credit?

5.3 Other Institutional Issues (see Matrix 6)

This matrix examines the possible constraints to land use change posed by non-market information, regulatory issues, local environmental impacts, and property rights. The final two sets of columns address possible equity biases inherent in land uses, and the need for, and likely availability of, social co-operation in the context of adoptability of particular land-use systems.

Non-Market Information

In terms of non-market information the objectives are to assess the extent to which:

- non-market information (for example technical information) is required for land-use systems,
- this information is currently available to farm households, and
- social systems can fill non-market information gaps.

Regulatory Issues

With regard to regulatory issues, the objectives are to assess the extent to which:

- information on and the ability to deal with regulatory issues is required for adoption of land-use systems,
- this information/ability is currently available to farm households,
- social systems can respond to assist farmers in becoming aware of and dealing with regulatory issues.

Matrix 6. Institutional capacity vis-à-vis system-specific institutional needs: a checklist for other institutional issues

Land Use	Non-Market Information	Regulatory Issues	Local Environmental Impact	Property Rights	Equity Biases	Social Cooperation
Sumatra, Indonesia						
Rubber agroforest (seedlings)	⊕	⊕	⊕	•	◆	◆
Rubber agroforest (clones)	•	⊕	⊕	•	◆	◆
Congo basin, Cameroon						
Intercropped annual food crop in a short fallow rotation	⊕	⊕	◆	⊕	⊕	⊕
Intercropped annual food crop in a long fallow rotation	⊕	⊕	⊕	⊕	◆	⊕

blank = n.a., ⊕ = no constraint, ◆ = possible constraint, • = constraint

Local Environmental Impacts Beyond the Operational Holding

Here the objective is to assess the extent to which local environmental impacts beyond the operational holding (that is, local environmental externalities) affect the adoption of particular land-use systems. For example, will the actions of non-adopting neighbours affect a farmer's decision to adopt a particular land-use system? Or as a more specific example, what would the effect of annual pasture burning by one's neighbours be on the likelihood of adopting a coffee production system?

Property Rights

The objectives with regard to property rights are to assess the extent to which the ability to own, use, derive income from, sell, and/or bequeath real property or the improvements made to real property influence the adoption of a given land-use system. Property rights can apply to land, water, trees (all factors of production), and the products derived from these.

Equity Biases

In terms of equity biases the objective is to assess the potential impact of a given land-use system on the concentration of land and wealth, and on gender roles currently in place. The impact on land concentration and wealth is assessed regarding the extent to which a particular system will lead to the concentration of land and/or other forms of wealth in rural areas due to economies of scale in some aspect(s) of production, including harvesting. The organisational/ institutional checks to land/wealth concentration need to be absent or at least unlikely to function well. For example, if technological change leads to an increase in the optimal scale of operation and land rental/leasing markets do not function properly, then land concentration might be expected.

The impact on gender roles is assessed regarding the extent to which a particular land-use system modifies existing gender-specific production activities and/or the gender-specific distribution of the returns to those activities.

Social Co-operation

Finally, the objectives with regard to social co-operation are to assess the extent to which social co-operation is required for the adoption of a particular land-use system, the extent to which existing types and amounts of social co-operation might meet these needs, and the potential for social change to meet these needs.

6. Bringing it all together: from the sub-matrices to the General Matrix

Finally, the following information from the (sub-)matrices discussed in sections 4 and 5 will be placed in the general matrix (see Matrix 7);

- Profitability: two sub-columns can be presented under the profitability column
 1. Returns to land at social prices, providing an estimate of the international comparative advantage
 2. Returns to labour or land, depending on the most scarce factor, providing an indicator of attractiveness for adoption.
- Employment/Labour requirements: total labour requirements over the evaluation period will be reported. Asterisks or footnotes should be included in case of competition with other household activities.

Box 10. Case-studies: The Other Institutional Issues Matrix

Sumatra, Indonesia

In Indonesia, information acquired from research (e.g. new technologies) comes primarily from the government, and existing research facilities are inadequate to meet the research needs presented by diverse production conditions. This bottleneck in technical information is a concern for the rubber land-use systems using clones but not for the rubber agroforests using seedlings where indigenous knowledge is well developed.

Property rights are a highly-charged political issue for both rubber systems (actually for nearly all systems evaluated in Sumatra). In most cases, the tenure status of land at the forest margins (and the products derived from those lands) needs to be clarified between the government and local communities.

The Congo Basin, Cameroon

With regard to the long fallow food crop rotation system in the Congo Basin, one possible constraint faced concerns an equity issue, i.e. the intra-household distribution of returns. In contrast to the short fallow food crop rotation system where women manage the mixed groundnut fields, the cash income earned in the long fallow system tends to be controlled by men. Therefore, there is a significant risk that women might not receive an equitable share if an expansion of the long fallow food crop rotation system were to occur.

The short fallow food crop rotation system on the other hand faces a possible constraint in terms of deteriorating local environmental conditions (e.g. soil fertility).

- Household food security: Food acquisition routes (own production and/or exchange and/or wage) - will be reported, both for the establishment and the operational phase of each land-use system. In case of 'own production', footnotes can be used to report the calorific value of the food component.
- Each of the institutional and policy matrices will be summarised with upper and/or lower case letters presenting the constraints (see Matrix 7). Upper case letters suggest major problems; lower case letters imply substantial problems; the absence of a letter indicates that no problem is known to exist.

Matrix 7 provides an example of the socio-economic concerns part of the general best bet matrix for the land-use systems described in the case studies.

The matrix shows that in the case of Sumatra, the clonal rubber agroforest system is the most profitable system. Still, the seedling system seems to be the most attractive system for the small-scale farmers. The profitability lies at the level of the market wage, the establishment costs are lower than those of the clonal system and it faces less institutional constraints than the other system.

The preference for any one of the two types of systems, however, probably varies significantly between different socio-economic groups of farming households. Assuming that the institutional constraints could be put right and that labour is not a constraint, a household, which can fulfill its basic needs through other sources of income might be interested in maximizing the income from their rubber agroforest. These households could opt for the clonal system, as their basic needs are secured and they could use their rubber agroforest as a way to increase their income.

On the other hand, a household, which already earns a relatively high income from other sources may not be interested in the clonal system because of its high labour requirements, although the initial investment might not be a major constraint for them. They may consider the activities from which they already earn a high income as more

important than their rubber agroforest. Therefore, they would not want to put too much effort into investing in a new system. Finally, for households with few resources who just make ends meet, the clonal system will be not be a realistic option. Even if they could obtain a loan for the initial investments they probably would consider it too risky. This type of household would opt for the seedling system.

Matrix 7. The socio-economic concerns of the general matrix

Land use	National policymakers' concerns		Small-scale farmers' concerns			
Description	Potential profitability	Employment (=labour requirements small- scale farmers)	Profitability	Household food security	Institutional & policy issues	
	Returns to land at social prices	Time- averaged labour input (days/ha/yr)	Returns to labour at private prices	Food entitlement via:	Market imperfections (1)	Other institutional problems (2)
Sumatra/ Indonesia	US \$ ha/yr		US \$ day			
Rubber agroforest (seedlings)	30	111	1.67	Exchange		P, b, c
Rubber agroforest (clonal planting)	98 to 1510	150	1.63 to 2.88	Exchange	I, k	N, P, b, c
The Congo Basin/ Cameroon	US \$ ha/yr		US \$ day			
Intercrop food field short fallow	644	115	623	Own production	l	e
Intercrop food field long fallow	288	44	283	Own production	o, l	b

I,i = input markets, O,o = output markets, L,I = labour markets, K,k = capital markets, N,n = non-market information, R,r = regulatory issues, E,e = local environmental impacts, P,p = property rights, B,b = equity bias (concentration of wealth or intra-household issues)), S,s = social co-operation

7. Issues for discussion and future research

As the framework presented above is still relatively new, several practical and theoretical issues need to be studied further, the most important of which will be discussed briefly below.

First of all, some problems exist related to the **filling in of the cells** of the sub-matrices.

- These concern, among others, measurement errors, i.e. with regard to measuring key inputs and outputs of systems, and setting thresholds. For example, setting the threshold for 'poverty' for a household for the food security matrix is an important issue to be dealt with.
- Time scale issues are important to consider when filling in the cells. Problems can arise in choosing appropriate discount rates, and when assets and household composition change over time, for example. In addition, biophysical measurements over time in terms of impact on productivity of systems, and measurement of risk in new systems are also time-related problems.

Secondly, **several factors have to be held constant** within the best-bet matrices and for evaluation of particular rows of the matrices.

- One of the most important ones is the need to decide the characteristics of an archetypal household for which the necessary calculations would be performed; these characteristics include elements such as household gender and age

composition, access to infrastructure, resource ‘base’ (financial and human capital, as well as natural capital). Depending on the socio-economic structure of a certain region or community, this could be a major complicating factor. For example, in the case of a skewed socio-economic structure, asset positions of households may vary greatly. Therefore, in that case, measurements based on an archetypal household do not represent the actual situation of the small-scale farming households. In such a case it seems better to distinguish between different socio-economic groups and to measure the various indicators for each group.

- The location of a research site in relation to cities, markets and alternative employment opportunities is a very important conditioning factor in the decision making process of small-scale farming households in terms of economic activities. First of all, it influences their access to alternative employment opportunities. Secondly, it affects the opportunity costs of labour. Thirdly, it influences the (farmgate) price for agricultural commodities. Therefore, considering the factor of the relative location as a constant factor significantly restricts the extrapolation potential of the results of this framework.
- The need to compare systems across rows necessitates a focus for a given matrix on a particular land type, i.e. soil type/quality, on which all systems would be evaluated. For each site, this means strategically choosing one among several land types for the evaluation.
- Parameters are needed to characterise systems for evaluation in one or more matrices. These could include technical coefficients (for example production coefficients), market prices, social prices, discount rates and institutional contexts. Sensitivity analysis can be carried out on discount rates, price changes and some key technical coefficients to measure the impact of changes in these. The results can be added to the matrices.

A third type of problem is related to **system evaluations within sites**.

- An important (over-)simplification that we find when using the analytical framework discussed in this paper is that of cross-row comparisons. This assumes that we are comparing mutually exclusive activities/systems, and that farmers will choose one system or another, but not both (at the same time or over time). This situation often does not hold in reality, and some assessment of the potential for combinations of systems involving best bet and/or other technologies needs to be made.
- Apart from that, households often rely on multiple sources of income – often a combination of on- and off-farm sources. The interaction between these multiple (potential) sources of income have to be taken into account in assessing the adoption potential of a land-use system just like the multiple objectives which households aim to fulfil.

The implications of the compromises described above can be summarised as the analytical framework being a **“hypothetical plot level approach”**. This means that the results do not represent the farming household level. Consequently, the findings can not be applied to the farming household level. Apart from that, because of the many factors being held constant, the analytical framework presented in this paper should either be used for a **hypothetical case or in a specific site where conditions with regard to the factors described above are similar**, i.e. the results can not be extrapolated to areas where different conditions prevail.

Therefore, future research on methodology development should, among other things, focus on establishing a household decision-making framework for land-use evaluation purposes. This conceptual framework should include the different (potential) sources of

income that households have (or have access to) and their multiple objectives. Furthermore, different socio-economic strata should be distinguished based on the asset position of the household, as the objectives of households differ according to their asset position. Apart from that, the different asset position influences their (access to) potential sources of income.

Finally, an overriding caution regarding technological change connected with the outcomes of the framework presented above, must be faced:

The fact that a land-use system is financially profitable is a necessary condition for adoption of best bets by small-scale farmers, BUT it is not sufficient by itself as a means to slow deforestation.

Indeed, because best bet alternatives are profitable, they can have the opposite effect - actually accelerating deforestation, either by attracting new migrants to the forest margins (the 'pull' factor) or by promoting increased forest conversion by current inhabitants (this issue is considered in a landscape context below). In practice, a promising way to handle these kinds of uncertainties would be to re-apply the evaluation under different scenarios. For a description of such an approach applied to agroforestry systems for the western Brazilian Amazon, see Oliveira and Vosti, 1997.

8. And finally... revisiting the 'segregate-integrate' landscape debate

The 'segregate-integrate' debate was introduced in lecture note 1: to attain the twin goals of productivity (food, timber, other products/raw materials etc.) and maintenance of environmental services (watershed functions, C stocks, biodiversity, etc.) what is the best spatial arrangement of land uses in the landscape? Would a fully segregated landscape, where natural undisturbed forests are kept separate from lands where intensive high-input agriculture is practised, be most efficient at achieving the two goals (Figure 2)? Or would a fully integrated landscape, composed entirely of a mosaic of crops, trees and small forest patches be best?

We can now summarise the consequences of segregated or integrated land-use options in terms of profitability (Table 1). In a fully segregated landscape (protected forest and highly intensive agriculture), agriculture is, of course, the most profitable option per unit area of land. Thus, any forest patches left within the matrix of a more 'integrated' landscape would probably be under great pressure of conversion. From a socio-economic perspective, more integrated landscapes may not be as potentially profitable, but risks are spread, and this may be very important to the livelihood strategies of some households.

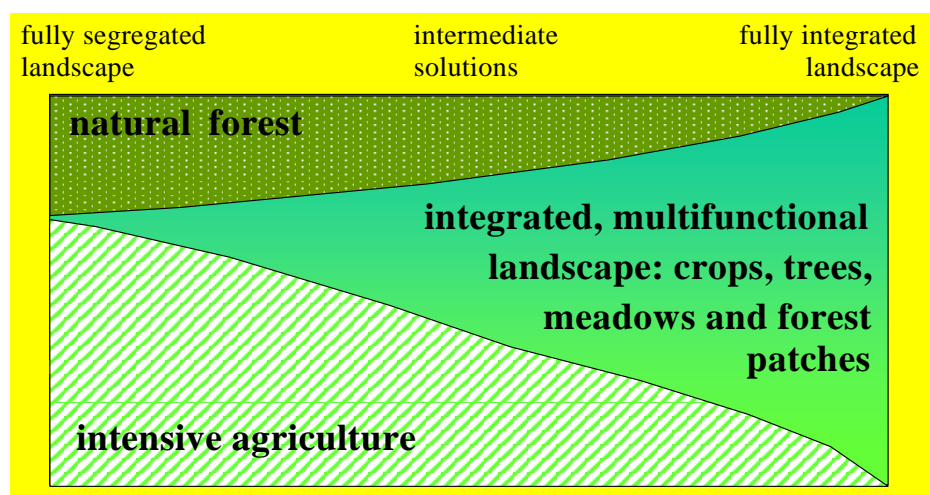


Figure 2. Segregated and integrated landscapes.

Table 1. Summarising profitability conclusions for segregated or integrated landscapes (see Figure 2).

Segregated - Agriculture	Segregated - Natural forest	Intermediate solutions	Integrated - Agroforestry mosaic
Potentially high	Low direct returns, option and <i>ex situ</i> use values	Potentially OK – but profitability difference between the Agriculture and Forest parts encourages forest conversion	Multi-functionality can lead to high overall value and hedging of risk

III. Reading Materials

Textbooks

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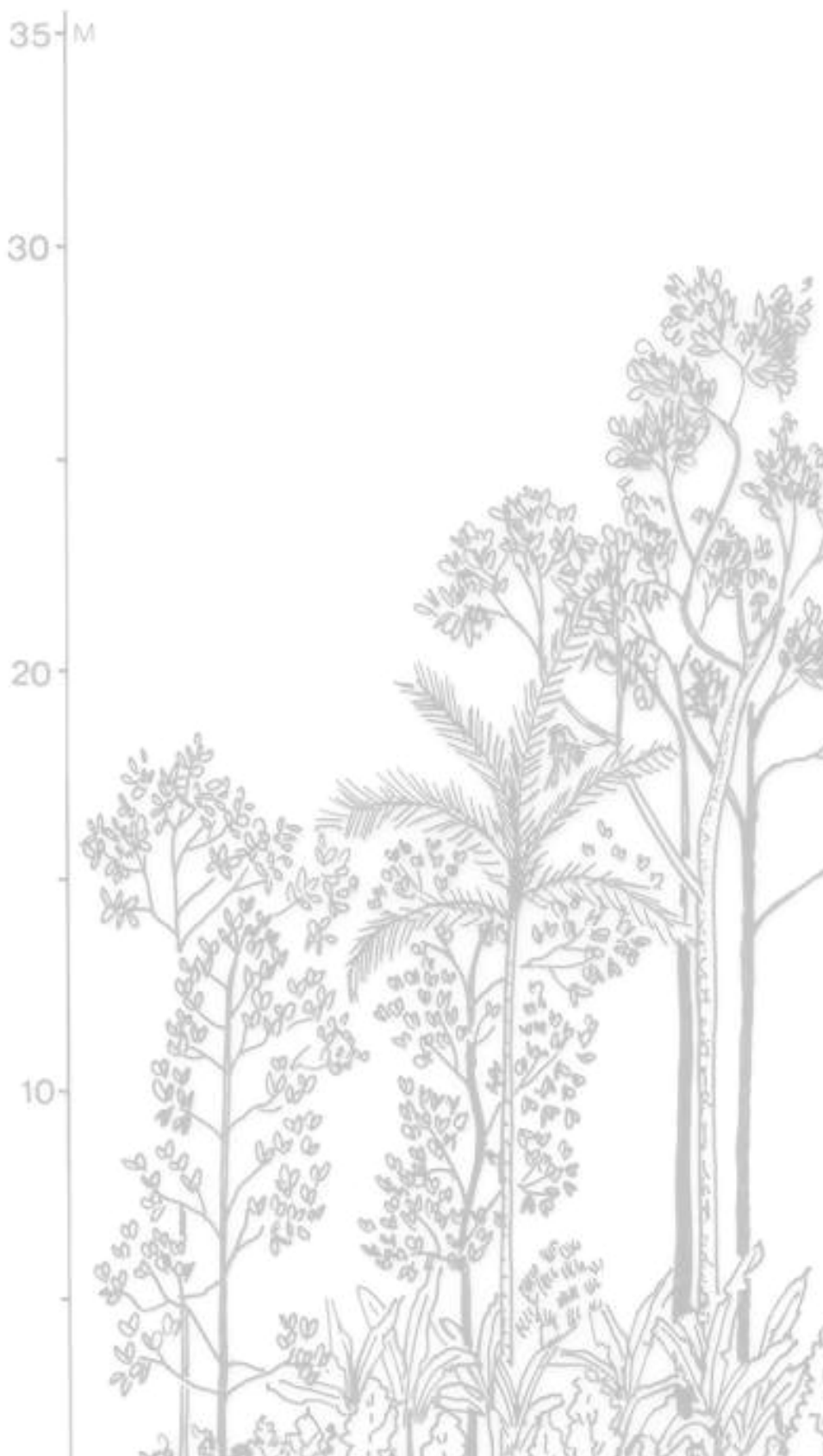
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Contents of this series of lecture notes

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by: Meine van Noordwijk, Pendo Maro Susswein, Cheryl Palm, Anne-Marie Izac and Thomas P Tomich
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by: Meine van Noordwijk, Pendo Maro Susswein, Thomas P Tomich, Chimere Diaw and Steve Vosti
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by: Meine van Noordwijk, Kurniatun Hairiah and Stephan Weise
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by: Kurniatun Hairiah, SM Sitompul, Meine van Noordwijk and Cheryl Palm
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by: Kurniatun Hairiah, SM Sitompul, Meine van Noordwijk and Cheryl Palm
- 5.** Biodiversity: issues relevant to integrated natural resource management in the humid tropics
by: Sandy E Williams, Andy Gillison and Meine van Noordwijk
- 6A.** Effects of land use change on belowground biodiversity
by: Kurniatun Hairiah, Sandy E Williams, David Bignell, Mike Swift and Meine van Noordwijk
- 6B.** Standard methods for assessment of soil biodiversity and land use practice
by: Mike Swift and David Bignell (Editors)
- 7.** Forest watershed functions and tropical land use change
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- 8.** Evaluating land use systems from a socio-economic perspective
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- 9.** Recognising local knowledge and giving farmers a voice in the policy development debate
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- 10.** Analysis of trade-offs between local, regional and global benefits of land use
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- 11A.** Simulation models that help us to understand local action and its consequences for global concerns in a forest margin landscape
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