TRANSFER OF ENVIRONMENTALLY SOUND TECHNOLOGIES FROM DEVELOPED COUNTRIES TO DEVELOPING COUNTRIES

Background Document for the Ad Hoc Expert Group on Finance and Environmentally Sound Technologies

The Secretariat of the United Nations Forum on Forests

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ABBREVIATIONS AND ACRONYMS

%	percent
a	per annum
ADIE	

GFIS	Global Forest Information Service
GHG	Greenhouse Gas
GIS	Geographic Information System
GPS	Global Positioning System
GTZ	Deutsche Gesellschaft für Technische Zusammenarbeit
ha	hectare
IBRD	International Bank of Reconstruction and Development
ICETT	International Center for Environmental Technology Transfer (Japan)
ICONS	Integrated Conservation Networking System
ICPIC	International Cleaner Production Information Clearinghouse
ICRAF	International Center for Research in Agroforestry
ICT	Information and Communication Technologies
IETC	International Environmental Technology Center
IFAD	International Fund for Agricultural Development
IFF	Intergovernmental Forum on Forests
IIED	International Institute for Environment and Development
IMF	International Monetary Fund
IPCC	Intergovernmental Panel on Climate Change
IPE	Investment Promotion Entity
IPF	Intergovernmental Panel on Forests
IPGRI	International Plant Genetics Resource Institute
IPR	intellectual property rights
ISO	International Standards Organization
ITDG	Intermediate Technology Development Group
ITTO	International Tropical Timber Organization
IUCN	The World Conservation Union
IUFRO	International Union of Forest Research Organizations
LDC	Least Developed Countries
m^3	cubic meter
MEA	Multilateral Environmental Agreements
MNC	multinational corporation
MoF	Ministry of Forestry
NFP	National Forestry Program
NGO	Non-governmental Organization
ODA	overseas development assistance
ODI	Overseas Development Institute
OECD	Organization for Economic Cooperation and Development
OOF	Other Official Flows
OPIC	Overseas Private Investment Corporation
ORC	optical character recognition
PEFC	Pan-European Forest Certification
PID	

EXECUTIVE SUMMARY

This report has been prepared as a background document for the Ad Hoc Expert Group on Finance and Transfer of Environmentally Sound Technologies under the UNFF to support its deliberations at its meeting in Geneva in December 2003. It provides an overview of international processes and agreements relevant to environmentally sound technologies (ESTs) for sustainable forest management (SFM), including identification of barriers and potential technologies as well as recommendations on how to create enabling conditions for the successful and sustainable EST transfer. It also suggest approaches for improving EST transfer for SFM from developed countries to developing countries and identifies opportunities for cooperation among Collaborative Partnership on Forests (CPF) members, as well as relevant regional actors.

The study concludes that most international process for sustainable development and multilateral environmental agreements contain clauses with technology (EST) transfer. The most important multi-lateral environmental agreement with references to technology transfer in forestry is the United Nations Framework Convention on Climate Change (UNFCCC), which has direct implications for forest sector. Convention on Biological Diversity (CBD) and Convention to Combat Desertification (CCD) and various agreements of World Trade Organization also address technology transfer. IPF/IFF have prepared proposals for action related to transfer of EST in forestry sector, which are now being followed up by UNFF.

The framework adopted in this study emphasizes the need to view barriers to the successful transfer of EST using a demand-supply based systems approach. The analysis of barriers, including action aimed at improving the EST transfer should also make use of the division of barriers to those specific to EST in general, general barriers within forest sector, and general barriers outside forest sector. Regarding an enabling environment for EST transfer, most existing barriers are not specific to EST or the forest sector. Instead, they result from international agreements (e.g. WTO agreements) or the national policy or macroeconomic framework (e.g. import tariffs for technology) which are designed outside the forest sector. There can also be fundamental bottlenecks impeding EST adoption (e.g. lack of forest law enforcement capacity). The need to promote EST transfer is a contributing argument, but not

It is not possible to provide a "watertight" definition of EST because of four main reasons. First, while introduction of ESR may potentially improve environmental performance, there is no guarantee for this to happen because of misuse of technology or lack of enabling environment. Broadly speaking there are two types of technologies that are considered to qualify as EST: (i) those that prevent, limit, minimize, correct etc. environmental damage e.g. by reducing pollution; and (ii) those, which use resources more efficiently (combination of the two is also possible). While technologies in the first group can without greater difficulty be qualified as environmentally sound, the evaluation of technologies in the second group is more complex. The very same technology can be used sustainably or unsustainably. For instance, improved technology for processing non-wood forest products may create incentives to excessive use of the resource base. This is an important issue, since nearly all technologies are aimed at productivity increases, i.e. more efficient use of resources.

Second, geographic and temporal factors may also influence the assessment; what is environmentally sound in one country or region, may not be in another, and what is environmentally sound today may not be it tomorrow (IECT 2003). Some technologies may be environmentally sound now, but may be replaced in the future by other technologies with even better environmental performance. With the present wording, the technologies that qualify for EST must have an environmental impact, which is an improvement compared to "technologies for which they are substitutes". Since the source technology to be substituted in developing countries is often old, it is possible that technologies that are already considered obsolete in developed countries would technically qualify as EST, because they bring about an improvement compared to the current situation in the developing countries. However, such technology "dumping" would most likely provide only a temporary relief, and could be harmful in the long run.

Third, environmental effects are generated not only when using the technology, but also when manufacturing, maintaining and disposing of it. As an example, installing an improved waste water treatment at a pulp mill reduces pollution, which is a tangible and measurable environmental impact. However, in order to estimate the total impact it would be necessary to carry out a life-cycle analysis, where the environmental costs and benefits of manufacturing, transporting and disposal associated with the applied waste water technology would be accounted for. This, however, is a complex task and can seldom be applied to individual projects unless relevant information is available.

Fourth, , the direct technology impacts may also be diffuse and work into opposite directions. For example, technology enabling more efficient use of harvesting waste may relieve pressure on the remaining forest, but at the same time continual removal of large quantities of biomass may deplete soil nutrient levels in the harvested areas. Assessing the "net" environmental benefit is difficult, because there is no common yardstick to estimate the impacts working into opposite directions.

As suggested by the above discussion, the definition proposed in chapter 34 of Agenda 21 suffers from many problems. Still, it is the most comprehensive formulation available, and it is difficult to provide a definition that would eliminate the current shortcomings. This study adopts the Agenda 21 definition of EST and the IPCC definition of technology transfer, keeping the above-mentioned caveats in mind.

3. INTERNATIONAL PROCESSES AND AGREEMENTS RELEVANT TO EST TRANSFER

3.1 UNCED

Technology transfer has been recognized as a key "means of implementation" of international processes for sustainable development. It is solidly rooted in Agenda 21 of UNCED and considered indispensable for making progress in implementing its recommendations. Several meetings of the Commission on Sustainable Development (CSD) have adopted recommendations on technology transfer. The major multilateral environmental agreements all contain significant clauses dealing with technology transfer. The Special Session of the General Assembly for the 5-year-review of the Rio commitments in 1997 reiterated the importance of technology transfer. The Report of the Secretary-General for the preparatory process of the World Summit on Sustainable Development, Implementing Agenda 21, identifies technology transfer as one of the ten key areas in which progress is needed. The same report estimates that since the Rio summit the progress in addressing the constraints to transfer of environmentally sound technologies has not been very encouraging (UN 2002).

establishment of an ad-hoc expert group on finance and transfer of environmentally sound technologies (AHEG).

3.3 Multilateral Agreements

3.3.1 UNFCCC

The most important multi-lateral environmental agreement with references to technology transfer in forestry is the United Nations Framework Convention on Climate Change (UNFCCC). Under the Convention, Annex II Parties shall "take all practicable steps to promote, facilitate and finance, as appropriate, the transfer of, or access to, environmentally sound technologies and know-how to other Parties, particularly to developing countries to enable them to implement the provisions of the Convention" (Article 4.5). Pursuant to this commitment, the Parties have taken decisions to promote the development and transfer of environmentally sound technologies at each session of the Conference of Parties (COP). For instance, at COP 4 (Buenos Aires, November 1998) the parties decided to establish a "consultative process" on technology transfer. At COP 6, an Expert Group on Technology Transfer was established.

Transfer of forest-related technology is promoted under the UNFCCC process. In terms of analysis, the most important contribution was the "IPCC Special Report on Methodological and Technological Issues in Technology Transfer" (2000) containing a special section on forestry. The potential of technology transfer to contribute to sustainable forest management in developed countries is constrained by the fact that the Clean Development Mechanism (CDM) - established to support actions in developing countries - restricts the eligible forestry activities to afforestation and reforestation.

3.3.2 CBD

The Parties to the Convention on Biological Diversity (CBD) have pledged to promote "technologies that are relevant to the conservation and sustainable use of biological diversity or make use of genetic resources and do not cause significant damage to the environment" (Article 16). To this end, the Convention has, *inter alia*, established a "clearing-

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3.3.4 Impact of MEAs

The developing countries have strongly emphasized the view that, by signing international agreements, such as the Kyoto Protocol, CBD, CCD, etc., the developed countries have committed to facilitate technology transfer by providing financial support to it. The developing countries' view is that the implementation of agreed obligations by themselves is dependent upon the effective implementation by developed countries of the financial co-operation and transfer of technology provisions. The developing countries are demanding that the developing countries will make ESTs available on concessional and preferential terms, and use their financial resources to purchase EST patents and licenses to transfer them to developing countries on non-commercial terms as part of development cooperation for sustainable development (Hoffman 1999).

The developed countries have been reticent to accept this view and have, instead, stressed that ESTs are mainly in the hands of the private sector and that commercial transactions should be the primary vehicle for EST dissemination. In the developed countries' view, the available funding should be spent above all on removing constraints to trade and developing an enabling environment in the recipient countries. The latter is seen as a precondition for successful transfer. In general, the impact of MEAs on EST transfer is weak, and Hoffman (1999) concludes that they have not affected or influenced the prevailing contractual terms and conditions for technology transfer in open markets. As far as their capacity to mobilize funding, the record is unclear. All the MEAs except UNFCCC, which is a market-based instrument, essentially rely on existing global funds such as the Global Environment Facility (GEF), but there is little evidence that MEAs would have triggered an increased flow of financing to transfer of EST.

3.3.5 WTO

The Agreements of World Trade Organization (WTO) include a number of provisions to facilitate technology transfer. Developed countries are encouraged to assist the developing (suc[illegible] upon the effective implem[illegible]

Tropical and subtropical dry forests are concentrated in Africa (containing 36% of the world total), South America (30%) and Asia (21%). The majority of tropical rain forests are located in South America (58%), but a large proportion (24%) is also found in Africa; most of the rest is in Asia (17%). Nearly all temperate and boreal forests are located in Europe, North and Central America and Asia (FAO 2000).

With respect to trends in forest condition, deforestation is perhaps one of the most telling indicators. It also one of the few indicators available for global comparisons. During 1990s, the net change in forest area was -9.4 million hectares per year, representing the difference between a deforestation rate of 14.6 million hectares per year of natural forests and an expansion of 5.2 million hectares per year of natural forests and forest plantations (Table 4.1). Most of the forest losses were in the tropics, where the net annual loss forests was 12.3 million ha. In non-tropical areas the forest area expanded annually about 2.9 million ha. The global rate of net change was slightly lower in the 1990s compared to the 1980s, due to a higher estimated rate of forest expansion in the 1990s (FAO 2000).

Table 4.1 Deforestation in Tropics and Non-tropics in 1990s

Domain	Deforestation	Increase in forest area	Net change in forest area
Tropics	-14.2	+1.9	-12.3
Non-tropics	-0.4	+3.3	+2.9
World	-14.6	+5.2	-9.4

Source: FAO 2000

The above difference is attributable to the fact that in relative terms, policy environments and forest management systems in non-tropics, especially in temperate and boreal forests, have been solid and systematic. Indicating this, in 2000 about 89% of forests in industrialized countries (mostly boreal and temperate forests) are being managed "according to a formal or informal management plan", and the situation has remained stable or improved over the last 20 years. The intensity of forest use in many countries is relatively high but usually well wii,.5 re f s0.75 red9T49 Tw (so85 Tc is/F0-69.75 -12.70.75 r) Tjden any c 5et,.5 re 3,415e sit

Conservation of biodiversity and other forest resources can also be made more effective using ESTs. One should also note that different forest types require different technologies.

transfer largely from the perspective of the factors limiting developing countries' access to technology in the developed countries. The framework adopted in this study emphasizes the need to view barriers to the successful transfer of EST using a demand-supply based systems approach. The analysis of barriers, including making recommendations to improve the EST transfer (Ch. 7) and setting priorities (Ch. 8) makes also use of the division of barriers to those specific to EST in general, general barriers within forest sector, and general barriers outside forest sector (Figure 6.1).

Many of the barriers to the EST transfer are assessed in connection with measures to improve the transfer of ESTs. In this chapter some specific barriers are reviewed in more detail.

Figure 6.1 Type of Barriers Hindering EST Transfer

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are few and far apart. Their programs are frequently dissociated from the actual needs of forest owners and managers. Coordination and cooperation amongst forest producers and forest industry are often non-existent or inadequate, driven by short-term market interests.

Large-scale industries may be able to bridge the gap owing to their larger resources and international contacts, but SMEs have limited access to technological information, and are
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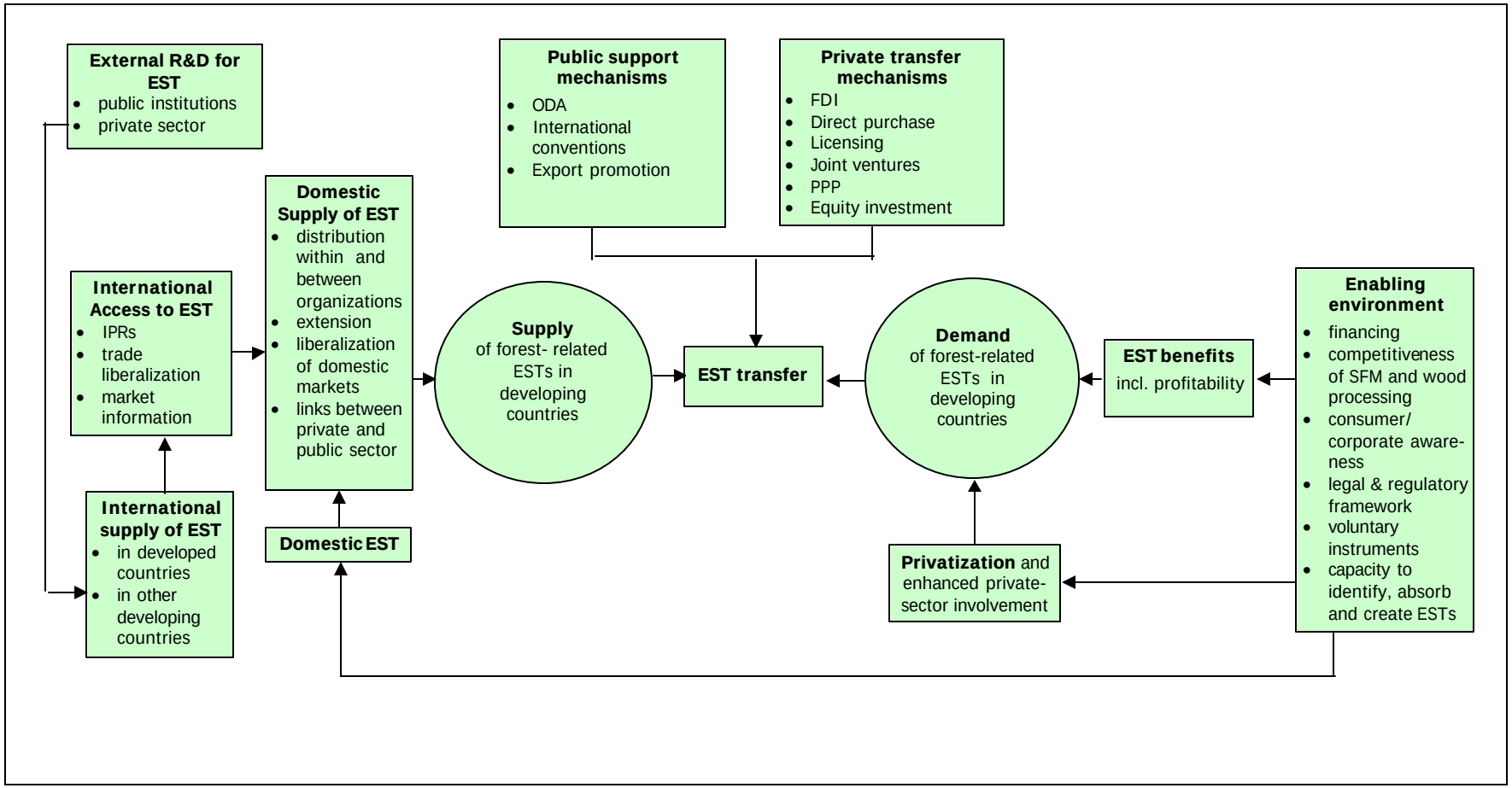
Figure 7.1 Supply and Demand of Environmentally Sound Technology



In forest industries, the private sector is the predominant actor for EST transfer. In contrast, forestry technology transfer is characterized by the non-commercial nature of the transfer of some technologies as well as low levels of involvement of commercial institutions. Currently technology transfer takes place largely from the government-controlled universities and research institutions to forest departments and farmers (IPCC 2000). Its impact in terms of enhanced productivity has been marginal and it is not geared towards EST transfer (cf. Ravindranath and Hall 1995 in IPCC 2000).

7.2 Creating Demand for EST

The basic condition for successful EST transfer is that there is local demand for the

7.2.1 Competitiveness of Sustainable Forest Management and Wood Processing

EST transfer and related investment can take place in an environment where forest management and wood processing are economically feasible. Especially forest management suffers from low short-term profitability, which is a deterrent to investment. Coupled with the fact that ESTs often have a high initial capital cost, the basic framework for any technology transfer is challenging.

In addition, public policies often aggravate the problem. Agricultural subsidies applied in many countries increase the profitability of competing land uses and further reduce the interest to make investments in forestry. In energy production, the level of import duties on petroleum products (and related subsidies on the use of petroleum products) changes the relative cost of renewable and non-renewable energy technologies to the disadvantage of biofuels (STOA 2001). In some countries, forest policies are also contributing to low profitability of forest management. For instance, timber prices may be set administratively at a low level, or efficient functioning of timber markets is hindered by (state) monopolies or oligopolies. Lack of effective enforcement coupled with extensive illegal logging and trade also undermines the competitiveness of responsible producers. Removal of such distortions would favor EST transfer to forestry.

There are a number of R&D activities aimed at improving the productivity of forest management (increased tree growth, harvesting techniques, logging, waste reduction and efficiency in wood processing, etc.). However, these activities are mainly focusing on high-value forests subject to industrial forest management and harvesting. They represent only a limited portion of tropical forests, while a huge area of low-yielding forest (especially drylands) benefit only from very limited R&D inputs. For example, forest plantation productivity has increased spectacularly and average growth rates of 20-30 m^3/ha/yr are reached in operational activities. Still, with few exceptions, timber species grown on medium and long rotations have not benefited from these technological advances. They have limited appeal to commercial investors, who prioritize fast-growing species (Sayer *et al.* 1997).

Recommended action:

Finland, among many other developed counties, established an environmental permit system, which was crucial in reducing industrial pollution in the pulp and paper industries. The permit regulations speeded up the adoption of advanced techniques and created a market for environmentally friendlier solutions (Hildén *et al.* 2002). In developing countries, a study commissioned by UNIDO (2002) on EST adoption in the pulp and paper industries of selected

Recommended action:

- Introduce appropriate environmental regulations and strengthen the capacity to enforce them effectively
- Promote independent auditing and certification as voluntary measures to compliance with environmental regulations
- Where necessary, clarify property rights related to forest land and introduce effective and secure land tenure as a precondition for EST investment

7.2.3 Capacity Building

EST transfer is a highly complex undertaking requiring strong implementation capacity at all stages. Capacity building is a slow and multi-faceted process needing long-term commitments on the part of the various stakeholders. Many of the requirements are cumulative and involve tacit knowledge that can only be acquired through an incremental learning process (Barnett 1995 in IPCC 2000). Capacity building needs vary greatly from country to country, but in general terms the ultimate goal of capacity building should not be just applying a particular technological solution, but to build an autonomous capacity to acquire, adapt, and further develop technologies. This is a matter of enhancing the overall technological capabilities, rather than pursuing actions related to specific environmental technologies (Parikh 2000).

Training

EST transfer is a continuous and broad process extending far beyond the transfer of individual technologies. With respect to capacity development, the transfer should encompass (i) knowledge and competence necessary to operate and maintain the technologies transferred; and (ii) knowledge, competence and experience to simulate, create and lead technology change and development in the recipient country (TERI 2000). To enhance these capabilities improvements are needed both in training and research and development.

Successful transfer of ESTs requires the existence of basic technical skills among the recipients. The immediate need is for operational and maintenance skills, which both technology buyers and sellers usually focus on. Technology sellers often help with long-term training packages. Still, transferred technologies are often running much below their operational capacity suggesting that all shortcomings in the basic educational level cannot be overcome with short-term training. Enhancing skills related to specific technologies cannot fully address the fundamental problems, such as gaps in the basic education. As one response to bac8eb

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Another specific problem is lack of skills in Information and Communication Technologies (ICT), which in many cases are in close relationship with the capacity to use ESTs (cf. TERI 1997). These technologies are gaining an increasingly important role in forest management planning and monitoring, forest law enforcement, wood procurement, organizations and forest industries.

Foreign investment has the potential to serve as an effective vehicle for transferring capacity, but it does not automatically lead to it, and special measures are needed to ensure the development of local capacity. There are short-term incentives both for the technology

Recommended actions:

- Raise awareness among decision-makers on the capacity building methods related to EST transfer as well as the potential of new transfer mechanisms to overcome capacity constraints (e.g., build-operate-transfer)
- Strengthen environmental curricula in educational institutions for forestry and forest industries highlighting EST applications as well as management of environmental and social impacts and risks of forestry operations
- Facilitate the flow of information on ESTs to forest-related educational establishments by developing links to information networks, and by strengthening cooperation with enterprises and public institutions using ESTs

Research and Development

The main challenge regarding knowledge transfer is to create sufficient capacity for EST transfer and development of indigenous technology. This will ensure that the transfer process does not become a one-off event without having replicative and trickle-down effects on the

international research projects, and to adapt and transfer results of the research to the local level. Research on forests has not only suffered from a lack of resources; it has not been sufficiently interdisciplinary to provide an integrated view of forestry (FAO 1997 in IPCC 2000). Forestry research is often an undervalued and under resourced activity with limited external support. For instance, only 2% of the ODA in forestry is spent on research (OECD 2000). For comparison, in agriculture the allocation for research may have been as high as 10% (IPCC 2000).

Forestry research and technical training institutes in developing countries have traditionally been linked more to serve state forestry and public sector organizations rather than the private sector. Several countries are reducing public sector funding of research because of economic constraints. This is being partially offset by increasing private sector investment in R&D by large forest companies, but their focus tends to be on short-rotation industrial species and on processing technologies while little effort is spent on developing ESTs (Szaro *et al.* 1999). Expansion of multinational companies brings additional resources to developing countries, but their impact on local research capacity may be limited, because R&D activities are managed at corporate level. Few institutions, public or private, have used their capacity to develop ESTs for the poor forest-dependent people, disadvantaged groups, such as women, or on commercially less attractive forests. Research efforts to build on traditional forest-related knowledge have been negligible.

Because low-yielding forests often harbor significant environmental (e.g., biodiversity, watershed functions) or social values (e.g., fuelwood production), the public sector has a special responsibility to ensure that technological development benefits also these areas. Commercial development of ESTs suitable for these conditions is likely to remain limited in developed countries. Instead, companies in developing countries can find a niche market in this area, and therefore South-South EST transfer holds particular promise in this regard. As an example, an improved stove designed after a model developed in Thailand has become a mainstay on the commercial market in Kenya (IPCC 2000).

Escalating R&D costs have encouraged and enhanced collaboration among enterprises and governments to promote technological innovations. However, with the exception of the electronics industry (in few countries in Southeast Asia), this development has so far not extended to developing country firms to any significant extent (Hoffman 1999). In the forest sector, the situation is highly similar at least with respect to development of ESTs. However, the emergence of collaboration arrangements is highly desirable, and any initiatives in this regard should be strongly supported.

As the first step, the capacity of the public forest research institutions to participate in R&D must be strengthened. Apart from providing training and increased resources, one of the most promising avenues is sub-regional and regional networks of research in

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Recommended actions:

- Expand funding to public forest research; and where feasible, provide support to development of public-private partnerships
- Provide support for training and research programs focusing on adaptation of ESTs to recipients' contexts; pay special attention to identifying opportunities to support South-South collaboration; shift focus gradually to efforts to creating new ESTs
- Provide support to research programs targeted at identifying, refining and extending indigenous ESTs that can be used to incorporate and preserve traditional forest-related knowledge
- Where necessary, redesign training and research programs to focus on development of SFM-related technology, including ESTs suitable for the poor, disadvantaged groups such as women, and commercially less attractive forests, as well as ESTs based on traditional forest-related knowledge
- Provide support to strengthening the cooperative networks of research institutions in developing and developed countries and among those in developing countries; particular attention should be paid to enhancing the developing countries capacity to take advantage of the existing and emerging opportunities

7.2.4 Information Management and Monitoring

Because of its public good characteristics, the technology infrastructure required to generate new knowledge and information may lack direct economic value to one firm, and thus individual firms rarely serve adequate incentives to build technology infrastructure on their own. This points to an important role for governments to create the necessary information assessment and monitoring capacity. Also, there is a need to support private sector actors and mong may D /F0 11.24ieing counu(.056 201ae is a need to 5toy (owTc -0.1icseizgtheningavail suitging opportuna iowTizvelopnsul existing omicnformarelyicuntriesfor tics,Inhartiv.,Ins tosphancing Tw ( ) Tj 330 0 .4580.0038

some instances, they may also help commercialization of local technologies (e.g. CESTT in China). In the forest sector, such intermediaries are not well developed which led to the conceptual development of the Investment Promotion Entity which, however, could not take off due to lack of public sector support (Salmi *et al.* 2001).

Intermediaries are typically specialized private consultants, public sector or public/private institutions or non-governmental organizations. All types exist, but in slightly different environments and serving different needs. For instance, in the pulp and paper sector, companies in open, market-based economies, (e.g. in Brazil and India) rely to a large degree on private consultants. In socialist economies (e.g. in China and Vietnam), there is often a heavy reliance on public sector institutions. Experience in India suggests that to enable a proactive role for the intermediary, it would be necessary to combine the information service with a financing facility. Adoption of technology by SMEs hinges often on the availability of financing, and to ensure smooth implementation of plans to transfer ESTs, easy access to financing plays a key role (TERI 1997).

The international information networks and clearinghouses that provide advice and training are often necessary to support country-level intermediaries. A number of bodies already exist that can be relevant to the forest sector ,including

- FAO Forestry Program
- UNFCCC Technology subprogram
- UNEP/DTIE International Environmental Technology Center (IETC),
- UNEP International Cleaner Production Information Clearinghouse (ICPIC)
- UNIDO Cleaner Production (CP) Program
- International Center for E nvironmental Technology Transfer (ICETT) (Japan)
- The APEC Virtual Center for Environmentally Sound Technology Exchange (APEC-VC)
- The Asian and the Pacific Center for Transfer of Technology (APCTT)
- The Center for Environmentally Sound Technology Transfer (CESTT) (China)
- SANet supported by GEF and UNEP (see Box 7.1)

Box 7.1 Sustainable Alternatives Network (SANet)

The Sustainable Alternatives Network (SANet) is a partnership between the United Nations [redacted] C
World Federation of Engineering Organizations (WFEO), the International Federation of Consulting Engineers (FIDIC), j 88.5D BT 10 0 TD Tc (3011 Tw (The Center for En37.25 0 TD 0.1875 Tc1F 11.25 rea.ito375 eld Fe

The key problem does not appear to be the distribution of information at the international level, but having the capacity at the country level to use the available EST-related information in a systematic manner and being able reach out to those who are unable to access it. Training of local intermediaries is a key activity.

Another possibility is to subsidize the services of the private sector consultants to make them more accessible to SMEs. There is some experience on this, but such arrangements tend to produce lower quality services than a pure market-based mechanism. The consultancy sector could also become a significant driver for EST transfer (cf. TERI 1997). A potential weakness is that the cost of using international consultants is usually prohibitive for a public subsidy system. In many countries it would be difficult to find a sufficiently large body of domestic consultants to ensure adequate quality of service and competition between the service providers.

Recommended actions:

- Where appropriate and feasible, provide support to the development of private consultancy capacity to implement intermediary functions in EST transfer in the forest sector
- Enhance the capacity of public intermediaries relevant to EST transfer in the forest sector by providing them with training and financial assistance; if possible, provide them with access to a financing facility; explore the possibility of introducing output-related incentives for staff in public intermediaries
- Strengthen the capacity of the NGOs with respect to facilitation of EST transfer, and fully tap their capacity to contribute to the efforts carried out by the public sector
- Develop the interface between international information networks and clearinghouses and country-level intermediaries to ensure that the existing information flow is in full use

7.2.5 Consumer and Corporate Awareness

High awareness of environmental issues among consumers is a major driver for EST use in developed countries. In developing countries consumer awareness is often low, and it influences mainly those companies that export their products to environmentally sensitive markets. For instance, in Brazil the pulp and paper industries' environmental performance was found to be linked to pressure from customers demanding ISO 14001, forest certification and environmental labeling. This situation particularly characterized exporting companies selling environmentally friendly products (chlorine free paper) in niche primarily in Europe. In addition, pressure on firm image is important especially for multinational companies, which do not want to be seen as impacting negatively on the environment (e.g. Chudnovsky & Lopez 1999).

As regards natural forest management, buyers and consumers in importing countries have concerns related to legality and sustainability of tropical timber products. These concerns have led to the emergence of forest certification systems and independent auditing of legal compliance. Developing countries have perceived these demands as yet another hurdle to theri market access, which should be discussed in the context of non-tariff barriers to trade. Unilateral measures to restrict tropical timber use for these reasons are another area of concern. It appears that these requirements (legality and sustainability) are gradually

becoming baseline requirements in public procurement driving the demand of ESTs in logging as well as management and information systems.

In general, corporate awareness is on the rise and it is not obviously limited to concerns about the world's forests. For instance, the World Business Council for Sustainable Development (WBCSD) representing major industry groups has announced plans to promote development and expansion of new markets for innovative climate-friendly technologies, in particular, by providing a mechanism for companies in developing countries to acquire new ESTs (IETC undated).

The overall impact of consumer awareness on the forest sector in the developing countries is, however, quite limited and largely confined to key exporting countries. Only a minor portion of roundwood or processed timber traded in developing countries goes to environmentally sensitive markets, and the certified forest area in developing countries is still modest (see Ch. 4). Increasing globalization in the forest product markets will create increasing incentives for firms in developing countries to adopt SFM innovations, leading to derived demand for EST. The certification process itself often involves transfer of soft ESTs and helps change practices by diagnosing forest operations and identifying gaps for improvement to achieve SFM. The learning process that is achieved through certification is especially effective in transferring technologies to small and medium enterprises (Vertinsky & Vertinsky 1998).

The pressure to improve corporate environmental performance is real, and the companies need tools to demonstrate that they act responsibly and in an environmentally sustainable manner. Establishment of environmental management systems as one of the tools toward SFM is desirable because their adoption entails an indirect, but significant incentive for EST transfer. Independent verification of performance and related communication, including on-product labeling, can provide market advantage for creating demand for EST.

Recommended action:

- Support the establishment of relevant and appropriate environmental management systems in private enterprises in developing countries
- Promote voluntary certification of sustainable forest management

7.2.6 Voluntary Instruments

The importance of, and the need for, technical standards and codes of conduct have been well recognized by the technical community. Were standards and codes absent, transaction costs would increase because each buyer must ascertain the quality and functionality of potential technologies individually. Technology risks can increase because of the uncertain quality of technologies (IPCC 2000).

The existence of quality and environmental standards is an essential element in the dissemination of ESTs. The objective of EST transfer is to provide an environmental benefit, and, in order to verify this benefit, it has to be measured. Standards provide a common framework, which makes it possible to measure and demonstrate the positive impact of ESTs (STOA 2001).

The International Standards Organization (ISO) has prepared a number of standards related to several sectors of economic activity. Two series of standards have special importance for ESTs: (i) ISO 14000 series, which relates specifically to the environment; and (ii) ISO 9000 series, which relates quality management systems for products and services. These ISO standards do not describe particular measurements of quality or environmental impacts (for instance emissions standards). Rather, they are management system-oriented, and aim to secure adequate documentation permitting ex-post verification on the appropriateness of management actions. Further, the implementation of the 14000 series is considered to be complex and its application is presently limited rather exclusively to very large firms. Therefore, there is ongoing work within the ISO to create a "subset" of the 14000 standard applicable to smaller companies (STOA 2001).

In the forest sector, ISO 14000 series has been applied in forest industries as well as in forest management organizations (particularly state forests) in developed countries. A recently developed conceptual framework, Criteria and Indicators (C&I) for Sustainable Forest Management, constitute an additional tool, but one that is specific to measuring the sustainability of forest management. While the existing C&I sets differ somewhat in their national application, they commonly include indicators for all key elements of SFM (CICI 2003). The C&I, which are applicable at the Forest Management Unit (FMU) level can be used for assessment of EST and its impacts. C&Is have a comprehensive scope which renders them somewhat cumbersome in assessing the impact of individual EST, but a sub-set of full C&I may be used to overcome this problem. On the other hand, the benefit of a comprehensive framework is that it enables a systematic assessment, and draws attention not only to direct impacts but also to indirect ones, which may easily be overlooked (e.g. social effects). Development of appropriate monitoring systems is an integral part of C&I development.

Both ISO standards and the C&I for SFM list indicators but they do not define performance requirements. Such requirements are set in forest certification standards such as those of the Forest Stewardship Council (FSC) and the Pan-European Forest Certification (PEFC). As noted earlier, these standards have proven controversial because the developing countries have expressed concerns that they may constitute barriers to trade (see Ch. 7.2.5). This issue can be overcome if forest management standards are developed nationally within relevant regional or international C&I framework for SFM. As some type of environmental (and social) standards are necessary to enable measurement of the impact of ESTs, forest industries and forest managers, such as timber companies, state forest enterprises, communities and forest owners should be supported in adopting such standards.

It is also necessary to develop technology performance benchmarks to enable assessment of the impact individual technologies. This is particularly relevant for ESTs in forest industries. For instance, the findings of a study on waste reduction in industrial sectors in Asia, including pulp and paper, showed that the benefits of cleaner production were difficult to measure (cited in Llanto 2000). The availability of benchmark information would be a significant advantage for efforts to market ESTs as it would dissipate much of the uncertainty surrounding EST investments. Risk aversion has been found to be a major barrier to adoption of ESTs in forest industries (Thiruchelvam *et al.* 2003).

Recommended action:

- Develop national C&I sets for SFM within relevant regional/international frameworks and adjust existing ones to make them suitable for assessing the impact of ESTs; develop appropriate monitoring systems
- Provide technical assistance to enterprises embarking on certification of industrial activities or SFM
- Develop technology performance benchmarks for ESTs used in the forest sector, especially in forest industries and wood harvesting

7.3 Supply of EST

The supply of ESTs to developing countries filters through barriers that are found both at the international and national level. To enhance the supply the international community and the national decision-makers need to take action. Most hindrances are market-related and dependent on international or macro-economic policies. Few impediments are specific to the forest sector, but in some cases effective action can be taken within the sector. This applies in particular to domestic barriers. The following discussion deals with factors affecting the international availability of ESTs, and as well as domestic barriers.

7.3.1 Internationally Supplied ESTs

Currently, the bulk of internationally available ESTs come from developed countries. The supply is concentrated in few countries, and even in few enterprises in the case of pulp and paper engineering technology. Supply from developing countries is slowly emerging along with improved technological skills in the few countries displaying rapid economic development and sectoral growth. Most of this supply goes to domestic market, but part of it is exported (e.g. genetically improved species from Mexico and Brazil, logging and wood-working machinery and equipment form Brazil and China, etc.) (cf. IPCC 2000). South-South transfer of ESTs is likely to become increasingly important because of similarities in ecological and socio-economic conditions. It holds, therefore, a great promise and provides support to the emerging initiatives may yield high returns.

The research on ESTs in the developed countries is geared towards servicing the market in developed countries. Governments in the North encourage R&D investment by a variety of means, including: (i) direct spending (e.g. funding government programs and R&D contracts); (ii) provision of scientific and technological assistance at less than market prices; (iii) tax credits; (iv) direct subsidies to R&D establishment; (v) support of infrastructure development; and (vi) public training programs (Vertinsky & Vertinsky 1998).

These programs could be modified to encourage EST development, specifically targeted at developing countries. Such programs could involve cooperation between private companies, universities and research institutions in developed and developing countries. Fostering the emergence of capacity to carry out autonomous R&D in developing countries would have to be an important part of these programs.

These activities would require additional financing, because they would probably not fit within the "ordinary" mandate of R&D institutions in developing countries. The most logical

7.3.2 International Access to ESTs

Trade liberalization is a major trend in the international markets. Reduction of tariffs on

- Ensure that WTO regulations on IPRs enable appropriate benefit sharing (e.g. when forest-related resources from developing countries are used as a basis for IPR-protected innovations in biotechnology)

Box 7.2 Intellectual Property Rights with Respect to Traditional Medicines; Case Study in Zimbabwe

In 1995, the University of Zimbabwe, in partnership with the Swiss University of Lausanne, undertook a study of Zimbabwe's medicinal and poisonous plants. The two academic institutions signed an agreement that any commercial success resulting from the project would be shared. Samples of many different plants could be supplied to the project, including the bark of the *Swartzia* tree used by traditional healers.

The research scientists at the University of Lausanne discovered that *Swartzia* bark contains one of the world's most powerful anti-fungal agents. Used as a medicine, it can cure yeast and microbial infections. It was anticipated that *Swartzia* bark would have a potential for huge commercial success.

However, a legal wrangle between the universities ensued. According to the scientists from the University of Zimbabwe, the University of Lausanne took out a sole patent on the substance, and sold the license for further development and manufacture to a US drugs company. The Lausanne University maintains that the University of Zimbabwe was fully informed of the deal which allowed for 0.75% of net sales to go to each university in the event of a commercial success. The University of Zimbabwe claims that the Swiss university broke the agreement by registering the patent alone and not jointly. They settled their differences by re-filing for a joint patent but the research into commercializing *Swartzia* bark compounds was eventually halted due to toxicity problems (TVE 2003).

It has been pointed out that the traditional healers were not part of this agreement. However, in an another case their rights have been recognized. The University of Lausanne has reportedly patented an anti-malarial derived from a plant indigenous to Southern Africa. The plant was submitted by the healers to the University of Zimbabwe, which later passed this to Lausanne. To give due credit to the healers, the Zimbabwe National Traditional Healers Association has been given the right to share any future profits from this drug (TIFAC 2001).

7.3.3 Domestic Supply of ESTs

The issues related to diffusion of ESTs within developing countries have drawn much less attention than barriers to EST transfer at the international level. However, domestic impediments are often a serious handicap, and reduce the effectiveness of EST transfer.

In part, the same barriers impeding international transfer of EST constrain domestic diffusion. These include weaknesses in macroeconomic framework, high initial cost of EST investments, lack of information, etc. One barrier that often is specific to domestic markets in the developing countries is the poor functioning of the market mechanism. The markets are often small in size and the number of players is limited. Combined with lack of appropriate regulation, this situation easily leads to emergence of monopolistic or oligopolistic structures, which can be a serious hindrance to the supply of ESTs.

There is a tendency for individual companies to restrict the spread of ESTs rather than to promote it. This because the companies usually acquire EST to gain competitive edge and are unwilling to share their experience with others. Thus, while FDI is an effective mechanism for bringing EST to developing countries, it may have a limited impact in terms of distributing the ESTs within the country. In particular, the demonstration effect from successful use of

ESTs may not be achieved. Still, any EST transfer will eventually lead to information "trickling-down" down to other players in the sector through staff turnover, collaboration and sub-contracting arrangements with local partners, etc. Promotion of joint ventures and any form of public-private partnerships could enhance this effect.

Distribution within large organizations is often hampered owing to limited staff and other resources to use and maintain the EST. Training and resource needs may have been underestimated, and qualified staff and sufficient resources are often available only in one location, usually the central office in a major city. With limited geographic distribution, the opportunities offered by EST cannot be fully taken advantage of. The problem affects both private companies and government institutions, but it is more severe for the latter, because they often receive initial funding from external sources, and once financial resources are exhausted, the organization's own resources are inadequate to maintain the operation. For instance, in the forest sector computer-based applications are often installed only in the forestry administrations' headquarters and not in district offices. Besides lack of resources in the organization, hardware and maintenance services for hardware are often unavailable in remote locations. This seriously hampers one of the main strengths of computer systems, which is to enable organization-

not focus only on increasing the funding volumes, but also on how the existing flows can be made to work in support of sustainability objectives. There is not an automatic connection

Box 7.3 French Global Environmental Facility as an Instrument for EST Transfer

The French Global Environment Facility (FGEF) was set up in 1994 to encourage efforts to protect the global environment in developing countries and countries in transition. It is France's bilateral complement to the multilateral Global Environment Facility (GEF). It provides resources in the form of grants to investment projects with a beneficial impact in terms of the global environment. These resources are intended to cover the incremental costs arising out of measures taken to protect the global environment. The FGEF was launched with resources of 440 million francs for the period 1994-1998. It was renewed in 1999 for a further four years.

In 2000, FGEF had a portfolio of forestry projects worth EUR 6.5 million with an average contribution of 10% of total project cost. There are two broad areas of support: (i) biodiversity conservation and (ii) forest management with participation of local population. Regarding EST investments FGEF is interesting in the sense that it provides funding, *inter alia,* to physical investments, training, inventories and monitoring. Also, forest management planning is considered a key activity, the basis of sustainable forest management.

The FGEF contributes to the financing of sustainable forest management plans in Morocco, Mali, Gabon, and Chile. The approach is focused on biodiversity and carbon sequestration , and emphasizes local involvement in the planning process. New projects with a similar approach are being planned in Congo, Cameroon, and Georgia. There are also two projects aiming to enhance the use of wood energy by transforming coal-fired boilers into boilers using fuelwood (Russia), and by improving the energy effectiveness of Turkish steam baths (Morocco).

Source: FGEF 2003

Owing to limited private sector involvement, most cooperation has taken place between governmental organizations in developing and developed countries, and between government forestry organizations in developing countries and bilateral and multilateral organizations in developed countries. Privatization programs, increased use of concession contracts, etc. have already started to increase the role of the private sector and may represent an untapped opportunity to use ODA support for promoting EST transfer in the forest sector. EST criteria could be incorporated in various stages of these delivery processes, but the governments are generally unfamiliar with such procedures.

As a special use of ODA, the developing countries have demanded that developed countries purchase patents and licenses on commercial terms for transfer to developing countries on non-commercial terms for sustainable development. These countries have also suggested that special fiscal and other incentives should be created to encourage the transfer of privately owned ESTs from developed coun

Regarding the enabling environment, there may be minimum preconditions that have to be fulfilled for the EST transfer to be successful, but it does not mean that the environment has to

controlled, preferably only to "kick-start" EST markets (cf. CSD 1996). It is also difficult to target such measures on single sectors such as forestry. Targeting could be possible, were the provision coupled with an advisory component.

Recommended action:

- Explore the possibility to include EST-related conditions on loans given to SMEs or to apply fiscal or financial incentives to EST investments
- Promote the involvement of financial specialists with special knowledge on forest-related ESTs in advisory bodies for SMEs and financing institutions responsible for delivery of financing to SMEs

7.4.3 Micro and Mini Finance

A few ESTs in the forest sector, such as improved charcoal kilns and stoves, are targeting individual producers or consumers in developing countries. The conventional financing instruments are usually inaccessible to them and the small size of investments makes them also uninteresting to commercial banks. However, there are successful micro-financing initiatives that are available to poor people such as the Grameen Bank, and purchase of simple, low-cost ESTs would fall within their scope. The development of these schemes would probably be conducive to increased uptake of ESTs as long as transaction costs related to promotion of EST transfer are not excessive. Efforts to promote small-scale ESTs in the forest sector should concentrate on product development.

Recommended action:

- Collaborate with existing micro-credit schemes to raise awareness on the benefits of adoption of forest-related ESTs.

7.4.4 Public-private Partnerships

Public-private partnerships can be an effective, complementary way of financing the transfer of ESTs. The aim of these partnerships is to facilitate cooperation between private and public sectors which often involves a public intermediary covering part of the transaction costs. A publicly funded framework for cooperation can also catalyze partnerships in forestry investments. Public funding support can encourage investment in ESTs which may not be competitive from business standpoint, but which should be subsidized for public interest reasons. In the short term, the aim of public-private partnerships is to mobilize private capital and harness market forces for EST transfer (IETC, undated).

Investment funds

Examples of public-private partnerships that could be relevant to the forest sector include publicly sponsored investment funds that focus on ESTs or at least identify them as a priority investment area. Sector-specific funds can be established only with difficulty, since the amount of financing to make them economically viable is substantial. For instance, the idea of

Intermediaries

8. SETTING PRIORITIES

8.1 Technology Assessment at National Level

any costs (e.g. R&D) incurred to reduce the acquisition cost would be taken into consideration when estimating the cost-effectiveness of public measures.

Formulating a policy for EST transfer should be a broad effort involving all relevant stakeholders. A participatory process is necessary to reduce the bias caused by subjective assessments, business or political interests involved in EST transfer. The most suitable framework for formulating an EST-related policy would be within comprehensive sector strategies, such as national forest programs (NFPs), the key features of which are broad-based participation and fostering consensus among parties. A national set of C&I for SFM as a reference point would provide a sound basis for decision-making. Integrating EST promotion as a comprehensive sector policy also provides a firm foundation for the international funding agencies to target their EST-related activities.

Forestry organizations should also attempt to influence prioritization made at higher political levels, which may bring additional resources to the sector. As an example, Indonesia and China have included forestry among the priority sectors for EST promotion (TERI 2000).

8.2 Global Agenda

The selection of priority technologies for R&D is highly dependent on the local context, and especially in forestry there is great variation between locations. At the national level the local forest and socio-economic conditions are the natural starting point for decisions to promote EST transfer. The priorities set by the international community will have an impact on the broader regional and global levels, and this should to some extent be reflected in their agendas. Admittedly, defining regional or global priorities is at best highly subjective so the following viewpoints should be regarded only as ingredients to the discussion.

The international community and the private sector should work in concert to complement each other's activities. The private sector will be guided by the market mechanism, which implies that activities that are not viable from a business perspective will be paid less attention to. There are nevertheless activities that are not commercially viable but merit support on environmental and social grounds, and the international community - having essentially the character of public sector – should attempt to fill these gaps.

Increasing the number of commercially used tree species. Deforestation is one of the main forest-related environmental problems in forestry and technologies that help in arresting should be considered priority. In humid tropical forests the main opportunity is to increase the number of commercially utilized species. Currently, only a minor portion of available timber is harvested, but if a higher portion could be used, the pressure to open up new areas for harvesting would be reduced. This is a key activity since the main conduit for deforestation is not direct conversion of forest into agricultural land; instead, conversion usually takes place only after the forest area has been made accessible through logging. Developing processing capacity for lesser-used species is therefore one of the priority areas for EST development. As long as there is room to expand harvesting areas, the private sector alone may have little incentive to develop such technologies.

Enhancing the competitiveness of sustainable forest management. In many forest areas the difference between financial returns from agriculture and forestry is often so large that marginal improvement in the profitability of forestry will not have an impact in terms of

of existing ESTs. One of the key measures is to support the development of intermediaries to facilitate transactions between the EST providers and users. The long-term objective, however, should be to develop capacity for creation of new technology. In countries, which have moved along this path and already possess more developed capacities for R&D, the international community should focus on fostering the development of public-private partnerships as a means to mobilize resources.

9. RECOMMENDATIONS

The most important measures that would facilitate EST transfer but are not specific to it include the following:

Outside the forest sector

(i) Adjusting export credits to incorporate conditions favoring EST transfer
(ii) Stabilizing the macroeconomic framework; strengthening legal institutions
(iii) Creating enabling conditions to attract FDI; promoting joint ventures with EST
(iv) Removing import tariffs and other trade barriers related to EST (hardware, software, services)
(v) Contributing to development of appropriate regulations for IPRs
(vi) Enhancing SMEs' access to investment financing with priority on EST
(vii) Exploring the opportunities to introduce fiscal and financial incentives for private enterprises to adopt EST
(viii) Establishing micro-credit schemes linked with EST available to communities
(ix) Removing monopolies, oligopolies and other market imperfections restricting the domestic supply of EST

In the forest sector

(i) Improving the legal and regulatory framework for environmental management to internalize externalities
(ii) Making forest environmental law and enforcement effective
(i) Establishing secure land tenure and resolving conflicts over land rights
(ii) Eliminating policies reducing the relative competitiveness of forestry as a land use
(iii) Increasing consumer and corporate awareness on SFM
(iv) Promoting adoption of environmental and social standards by public and private entities
(v) Improving education and training on environmental management and social issues in forest management

However, there are a few actions that can be taken rather independently from other considerations and targeting especially at EST transfer in the forest sector. The most important ones among them are:

(ix) *Strengthening of R&D capacities.* This would contribute directly to facilitating EST transfer. Lack of capacity to assess, select, and adapt ESTs is one of the major impediments to successful transfer. Investment in R&D also represents a possibility to reduce the cost of ESTs and enhance their competitiveness, which in all circumstances is conducive to increasing transfer and adoption. Special attention should be paid to

encouraging the development of EST with social and environmental benefits that cannot be captured through the market mechanisms.

(x) *Establishment of intermediaries to facilitate EST transfer*. Lack of information is a major impediment to EST transfer, especially among SMEs and communities. Past experience suggests that enterprises require information for highly specific needs, and that it is best delivered by locally-based intermediaries with access to a financing facility. Support could be provided to private sector consultants, research institutions, technology centers, public extension services, farmers' associations and NGOs to provide these services through contracting and project funding.

(xi) *Technology partnership programs*. These can be fostered in conditions where government institutions and science and technology centers are sufficiently strong to form a balanced and mutually beneficial partnership with private enterprises (e.g. research institutions with private enterprises in product development, and with forest industries and farmers in tree growing). While these partnerships should eventually develop and operate independently, public sector support is often necessary to establish the basic framework for collaboration.

(xii) *Applying environmental criteria in privatization processes, concession management contracts, public procurement etc.* The ongoing process whereby the private sector is assuming a larger role in forest sector activities provides several opportunities to enhance the adoption of EST. Incorporation of environmental criteria in agreements made between the public and private sectors provides substantial incentives to increase EST transfer.

(xiii) *Educating decision-makers about ESTs.* Decision-makers in the forest sector are not fully aware of the opportunities provided by EST transfer or of the demands its places on the capacity of the public sector to support it. Increased awareness would increase the support to EST transfer.

(xiv) *Providing technical and financial support to transfer of specific ESTs.* The main vehicle for supporting EST transfer in the forest sector will be projects integrating EST as one of the tools to promote SFM, which requires increased attention to identifying all relevant opportunities to enhance EST transfer. Additional, activities that directly support EST transfer (see above) should receive adequate technical and financial support. Direct financial support (e.g. subsidies) to transfer of specific ESTs may be considered in individual cases where the enabling environment is adequate to secure a successful transfer. These opportunities are likely to arise especially in forest industries and plantation development.

(xv) *EST assessments*. To define a public policy for EST promotion and relevant support strategies for effective transfer requires a broad analysis of issues – often in qualitative terms - and value judgements. To reduce the possible bias due to subjective views on business and political interests, it is advisable that such processes are carried out in a participatory and transparent manner involving all relevant stakeholders.

(xvi) *Integration of EST into national policies.* Policies for EST transfer should be formulated as part of comprehensive sector strategies such as national forest programs (npfs) enabling broad-based participation and balancing of conflicting objectives. The commitments emanating from relevant MEAs serve as an overall framework for policy formulation, and as a justification for the international community to provide support to its implementation.

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Although it varies somewhat with the local situation, RIL in tropical forests generally requires the following (Dykstra 2001):

- pre-harvest inventory and mapping of individual crop trees;
- pre-harvest planning of roads, skid trails and landings to provide access to the harvest area and to the individual trees scheduled for harvest, while minimizing soil disturbance and protecting streams and waterways with appropriate crossings;
- pre-harvest vine-cutting in areas where heavy vines connect tree crowns;
-

1.2 Environmental Effects

When properly applied, RIL can have dramatic results. A recent review of 266 studies and articles on RIL and conventional logging in tropical forests revealed the following environmental benefits from RIL (Killmann *et al.* 2001):

- On average, RIL results in 41% less damage to residual stands when compared with conventional logging systems.
- The area covered by skid trails in RIL operations is almost 50% less than in con

2. REMOTE SENSING AND GIS

2.1 Technology and Its Use in Tropical Countries

The use of remote sensing and GIS has expanded in tandem with the development of computer and satellite technology, and the forest sector has been quick to take advantage of the new opportunities. Remote sensing (using areal photos, satellite imagery, laser, video) is routinely used in forest resource assessments, and GIS applications in forestry serve both strategic and operational purposes. The various applications are numerous and diverse; the following list provides selected examples of technologies in use: (e.g. GIS applications 2003).

Remote sensing

Mapping and monitoring of changes of

- Forest (stand) characteristics (volume, biomass, carbon sequestration, species composition, growth, vegetation site, basal area etc.)
- Potential threats to forest (deforestation, forest degradation, desertification, fragmentation, spread of invasive species)
- Forest damage (fire, pest and disease infestation, wind damage, pollution)
- Wildlife resources
- Grazing pressure, and shifting cultivation, end clearing for agriculture
- Logging impact
- Extent of road network
- Extent and location of illegal logging

GIS applications (often in combination with remote sensing)

- Land use and ecological landscape planning
- Forest management planning (strategic and operational)
- Planning of protected area management
- Planning of timber harvesting schedules and timber transport
- Planning of fire response and predicting fire behavior
- Planning of forest access and road design (including scenic roads)
- Planning of biodiversity conservation strategies and ecosystem management (e.g. identification of areas suitable for habitat protection and wildlife corridors, ecological landscape planning)
- Planning of wilderness areas (e.g. development of recreational trails)
- Estimating recreation value and tourism potential
- Predicting evapotranspiration and runoff
- Supporting the resolution of forestry/wildlife conflicts.

Tropical countries use remote sensing widely for forest resource assessment. GIS has principally been used for research and only to a limited extent to formally support policy formulation, the planning process or management decisions (Apan 2000). In contrast, in developed countries GIS applications are routinely used as an operational decision-making aid suggesting that the potential for transfer of GIS technology to developing countries is substantial.

2.2 Environmental Effects

3. BIOENERGY

3.1 Technology

Biomass contributes significantly to the world's energy supply, accounting for about 9-13% of the total. It is particularly important in the developing countries, where it represents on average one third or fifth of the total energy consumption. The dominating use of wood is fuelwood for cooking, space heating and hot water. In contrast, in the industrialized countries biomass-based energy production accounts for only 3% of the total consumption (Turkenburg *et al.* 2000).

"Modern" bioenergy conversion technologies classified by production type include (Turkenburg *et al.* 2000)

(1) Heat production

   (a) Improved stoves for cooking and heating (in developing countries)
   (b) Domestic biomass-fired heating systems (in Nordic countries, Austria, Germany)

(2) Heat and electricity production

   (a) Combustion
   (b) Combined heat and power (CHP) (e.g. in sawmill factories)
   (c) Standalone
   (d) Co-combustion (e.g. natural gas and coal with biomass)
   (e) Gasification
   (f) Tj 19.54w (Hea(-)(.)tion (Turke) ,kd1d power (CHP) (e.g. in sawmill fa,(0 TD 0.0487 Tc 0 T5gl Tc 0.1875

Scenarios investigating the potential of all renewable energy sources indicate that they could contribute 20-50% of energy supplies in the second half of the 21st century (Turkenburg *et al.* 2000).

3.2 Environmental Effects

Bioenergy production has a number of positive environmental effects. However, unless proper safeguards are applied, some negative impacts may also emerge. The main considerations include (Turkenberg *et al.* 2000; Sims 2002):

- Biomass energy can be considered carbon neutral as released Co_2 was first sequestered for the atmosphere by trees.
- Increased availability of plantation wood for energy production, more efficient conversion of fuelwood and charcoal and increased use of waste wood may relieve pressure to harvest natural forests. On the other hand, without appropriate precautions increased demand for wood-based fuels could encourage deforestation.
- Replacing traditional uses of biomass with "modern" technologies could reduce indoor and outdoor air pollution and reduce health risks.
- Fuelwood plantations could reduce erosion, if they replace annual crops or are established on degraded or bare land.
- The impact of large plantations with fast growing species on water supply is unclear, but in some instances groundwater resources could be reduced.
- Use of pesticides can have negative effects, but experience with wood crops (e.g. poplar, eucaluptys) indicate that strict environmental standards can be met.
- Biomass plantations display low biodiversity as they support a much narrower range of biological species than natural forest. However, if plantations are established on degraded lands or on marginal agricultural lands, the restored lands are likely to support a more diverse ecology.
- Continual removal of large quantities of biomass may deplete soil nutrient levels; on the other hand, energy farming with short rotation forestry requires less fertilizer than conventional agriculture.
- Large plantations may significantly change land use, crops and landscape evoking resistance from the local population
- The environmental impact of bioenergy production vis-à-vis other energy sources cannot be accurately determined unless full life-cycle is taken into account

From a social viewpoint, it is worth noting that biomass power generation is far more labor-intensive than conventional power generation.

3.3 Barriers

There are several barriers, either real or perceived, that can obstruct implementation of modern biomass energy applications. These barriers may be technical, financial, economic, institutional or a combination of them. The financial, economic and technical barriers are generally influenced by the following factors (FAO 1998, Sims 2002):

- Biomass energy projects suffer from not having a level playing field in competition with conventional energy sources (i.e. tax policies, power-purchase agreements, etc. often favor conventional energy projects).
- Bioenergy production requiring large land areas may not be able to compete with alternative land uses in densely populated areas, where the demand for land is high.
- Biomass-based energy projects may have competition for their fuel source from higher-value applications such as the furniture industry, especially in the case of wood.
- Available biomass energy technologies do not offer sufficiently high returns or they may not be sufficiently mature to represent an acceptable risk to private-sector investors.

Besides these, there are also institutional constraints, which vary from country to country and over time, depending on prevailing conditions. These can be summarized as follows (cf. FAO 1998):

- Current energy policies are often biased against renewable energy sources; energy prices do not reflect external social costs such as the effects of air pollution or GHG emissions.
- Taxes and subsidies often encourage fossil fuels, favoring operating costs over long-term investment.
- Cooperation between developers/researchers, manufacturers and potential users is not well coordinated.
- Technology transfer of mass products, e.g. improved stoves, is often too focused on fuel efficiency and direct cost; however, acceptance is strongly influenced by indirect costs and social factors, such as simplicity of operation and maintenance, availability of materials, cultural preferences and patterns, and the mechanisms to promote the new stoves.
- Market creation is often difficult; biomass producers may not be willing to plant energy crops unless they are assured of a market for their output. At the same time, the power utilities may not be willing to build bioenergy power facilities unless they have assurances that fuel will be available.
- Widespread implementation of afforestation programs is often constrained by economic and social factors.

4. PULP AND PAPER PRODUCTION

4.1 Technology

The pulp and paper industry has been under substantial regulatory, social and market pressures to improve its environmental performance since the 1970s. These pressures were felt especially in the developing world where the industry responded by introducing new and improved technology. The environmental technologies adopted by the pulp and paper 4.

Unfortunately, very few of these technologies were adopted in developing countries. In mid-1990s, less than one quarter of the world's pulp and paper-making capacity (in Asia excluding Japan, Russia, Eastern Europe and all of Latin America) is responsible for about 75% of TSS (total suspended solids) emissions, and 49% and 38% of COD (chemical oxygen demand) and AOX (absorbable organo-halogens), respectively (IIED 1996).

At the same time technological development has made rapid progress in developed countries swifting focus from traditional control and treatment technologies to pollution prevention at source. Some of the most recently adopted pollution prevention techniques applied at pulp and paper facilities in the United States include (EPA 2002):

- *Extended delignification*, *oxygen delignification* and use of *anthraquinone catalysis* to reduce the need for bleaching chemicals
- *Ozone delignification* (ozone bleaching) to eliminate the need for chlorine in the bleaching process.
- *Improved black liquor spill control and prevention*

4.3 Barriers

Environmental investments in pulp and paper sector typically require substantial capital inputs. Many of the barriers are therefore related to the weakness of the financing sector in general. Foreign direct investment (FDI), which is a major vehicle for technolo

Additionally, biotechnology could be used to develop specific tree qualities that provide desired environmental services. For example, modified trees could survive and provide environmental services in conditions previously unsuitable for them. Arid and degraded lands or those in cold climates could benefit from erosion control and watershed services provided by trees. Biotechnology could be used to enhance capacity of trees for phytoremediation, i.e.

SELECTED EXAMPLES OF EST TRANSFER PROJECTS

Annex 2

Type of Project/Country	Supported by	Objectives	Lessons learned
Rationalization of the Production Process in Pulp and Paper Production in Zhejinang Province (China)	National Cleaner Production Center 1997	Achieve Cleaner Production by process modification and good housekeeping	Opportunities for Cleaner Production are often low or no cost and the main barrier to their implementation is lack of information. High-cost options can be implemented if they are economically viable. In the mill in question the pay-back periods ranged from six months to one year (ICPIC 1997).
Soil and Water Conservation and Agroforestry Program (Lesotho)	IFAD 1989-Pem		

FOREST-RELATED RESEARCH AND INFORMATION NETWORKS

L'Association pour le Développement de l'Information Environnementale (ADIE) has a mission to support various public, private and collective entities involved in the management of natural resources in Central Africa. Together with other partners ADIE has developed FORAC - the Central African Forest Watch (Observatoire des forêts d'Afrique Centrale).

The Association for Temperate Agroforestry (AFTA) is a private, nonprofit organization formed in 1991. The mission of AFTA is to promote the wider adoption of agroforestry by landowners in temperate regions of North America. Agroforestry practices combine trees and shrubs with crops and/or livestock to increase and diversify farm and forest production while conserving natural resources.

Asia Pacific Association of Forestry Research Institutions (APAFRI). is an association of forestry research institutes in the region. FORSPA assisted in setting up this association to strengthen regional research networking and collaboration. At the moment APAFRI has over 55 member institutions, including NGO's and private institutions

Asia Pacific Forest Rehabilitation Network (APFReN) has been established by FORSPA in collaboration with the Forest Research Institute Malaysia. The objective of the network is to facilitate the sharing of information, experience, expertise and technology, as well as to support human resource development and to facilitate collaborative research in rehabilitation of logged– over forests

The European Tropical Forest Research Network (ETFRN) is a forum for communication between European organizations, researchers, EU institutions and others concerned with (sub-)tropical forest research.

FACT Net was an international network of community groups, development workers, tree breeders, researchers, students, and farmers. FACT Net closed in 1999 after operating for almost 20 years as a successful international network. Winrock International's Forestry and Natural Resource Management Program maintains a web site as an on-line resource

Forestry and Society Network is a Chinese community forestry network funded by the Ford Foundation and executed by Chinese Academy of Forestry.

The Forestry Research Support Program for Asia and the Pacific (FORSPA) is a regional project funded by the Netherlands government and executed by the Food and Agriculture Organization of the United Nations (FAO). Its main objective is to build capacity in national forestry research systems.

Forest to Customer (FORAC) is a research consortium involving partners from the forest product industry, the high tech sector, and both public and private organizations dedicated to research and development. The consortium is concentrated on the management of value creation networks and maximizing the potential of Web-based resources.

Global Forest Information Service (GFIS) is an information network under development with the support of IUFRO-SPDC.

The Integrated Conservation Networking System (ICONS) is an information management system designed to meet the needs of non-government, rural and indigenous organizations and individuals working in developing countries.

Network on Ethnoforestry is a peer group of concerned foresters, scientists, international agencies, and NGOs working for documentation, dissemination and integration of indigenous knowledge on forest management with formal forestry, in various cultures and indigenous peoples across the globe.

Pulp and Paper Net is designed to be an information and communication resource for the pulp and paper industry.

La Red Forestal Amazónica (Amazonian Forestry Network) is a virtual entity consisting of various public, private and community organizations promoting exchange of information and experiences in SFM in the Amazon Region)

The Regional Community Forestry Training Center for Asia and the Pacific (RECOFTC) offers a range of consulting and advisory services to community forestry project, programs and organizations throughout the region.

The Rural Development Forestry Network (RDFN) is a component of the outreach program of the Forest Policy and Environment Group (FPEG) of the Overseas Development Institute (ODI)

TEAKNET's objective is to strengthen interaction among all those concerned with conservation and sustainable management of teak-bearing forests and plantations through sharing of information and promoting collaborative efforts to deal with common problems.

Tree Nutrition Research South Pacific is collaborative research project 'Nutrition of Tropical Hardwood Plantation Species in the South Pacific' involving the Departments of Forestry in Fiji and Samoa and funded by FORSPA

WARSI (Conservation Information Forum) is an organizational network established in January 1992, with membership made up of twelve NGOs from four provinces in Sumatra (South Sumatra, West Sumatra, Bengkulu and Jambi), whose focus is biodiversity conservation and community development.