2 Developing sustainable forest industries

This chapter describes current trends in the forest industry and shows how the industry is contributing to sustainable development. The analysis does not attempt to comprehensively measure the sustainability of the industry (although relevant statistics and other information are presented where available). Rather, the purpose of the analysis is to describe the factors affecting profitability and sustainability in the industry over the last 10–15 years and show how the industry is responding to the challenges they pose.

The analysis draws upon the recent work of FAO and others in outlook studies, policy analysis and forest resource assessment, but attempts to go beyond the measurement and forecasting of trends by combining and analysing these results within a strategic planning framework. It is hoped that this approach will present a new perspective on the trends and outlook for the sector that were originally presented in *State of the World's Forests 2009* to understand how sustainability might be improved.

The text is divided into two main sections. The first section describes some of the main external and internal forces affecting forest industry development. The second section outlines a number of different possible strategies to respond to these forces and current initiatives by governments and industry to improve sustainability in the sector. This is followed by a brief summary of the results and conclusions.

Driving forces affecting forest industries

The earliest references to the phrase 'sustainable industry' appeared at the start of the 1990s, in various articles about the activities of forestry companies (e.g. Renner, 1991). Although there is no commonly accepted definition of 'sustainable forest industry', papers such as this noted that sustainable industries should aim to make improvements in areas such as energy efficiency; lower waste production processes and resource conservation; the use of safe and environmentally compatible materials; safe working conditions; and human resource capacity. Economic sustainability must be a core part of these considerations because continual improvements

Table 36: Summary assessment of the main forces affecting forest industry development

	Positive forces	Negative forces
External forces	**Opportunities** • demographics in low and middle-income countries • economic growth • globalization • social trends	**Threats** • demographics in high-income countries • competing materials • competition for resources • changes in forest ownership, control and management
Internal forces	**Strengths** • environmental attributes of product • adaptability and management of raw material supply • potential for innovation	**Weaknesses** • existing industry structure • labour costs and working conditions • social and environmental performance and perceptions • maturity of existing product markets • end use issues (durability, regulations, etc.)

in productivity and profitability are fundamental requirements for the economic viability of the industry in the long-run.

Table 36 outlines the external and internal forces affecting the sector and categorizes them into potentially positive and negative influences. This is a very generalized assessment of the influences because they vary from country to country and between sectors of the industry. In addition, some forces (such as globalization) may be viewed as a positive force in some places, but as a threat in others. For the forest industry to continue contributing to sustainable development, the industry will need to consider the impact of the driving forces shown in Table 36, develop appropriate responses to overcome potentially negative impacts and take advantage of positive driving forces.

External driving forces

The main external forces affecting the forest industry are trends in economies, society and the environment. The two most fundamental forces are population demographics and economic growth. These have a major impact on forest product demand and may also influence industry development on the supply side through related changes such as increased globalization. Related to this, social trends also change with rising incomes, as people become less focused on meeting basic needs and demand a broader range of goods and services.

The other major driving force is changes in competing sectors as they also adapt and respond to the same trends. The competitive environment for forest products is constantly changing, often in unpredictable ways. Furthermore, linkages between the forest industry and the energy, chemicals and food sectors are becoming more evident, while policies that drive renewable energy, climate change mitigation and food security all influence the forest industry, both directly and indirectly.

Demographics and economic growth

As noted in *State of the World's Forests 2009* (FAO, 2009a), global population and the size of the global economy are expected to increase in the next few decades at similar rates to those seen in the past. Although global economic growth slowed in the recession of 2008–2009, this was more significant in developed countries. It is likely that most countries will return to a more normal growth trajectory in the coming years (see Box 1). Some of the main features of the long-term demographic and economic trends are outlined below.

The global population increased by 1.3 percent per annum from 5.3 billion in 1990 to 6.9 billion in 2010 and is projected to increase by 0.9 percent per annum to 8.2 billion in 2030. In the next two decades, the largest increases in population will occur in Africa (+235 million) and Asia and the Pacific (+255 million), which will increase their share of the global population (to 18 percent and 53 percent respectively). In contrast, Europe's population is expected to fall by 17 million over the period due to falling numbers in some significant countries.

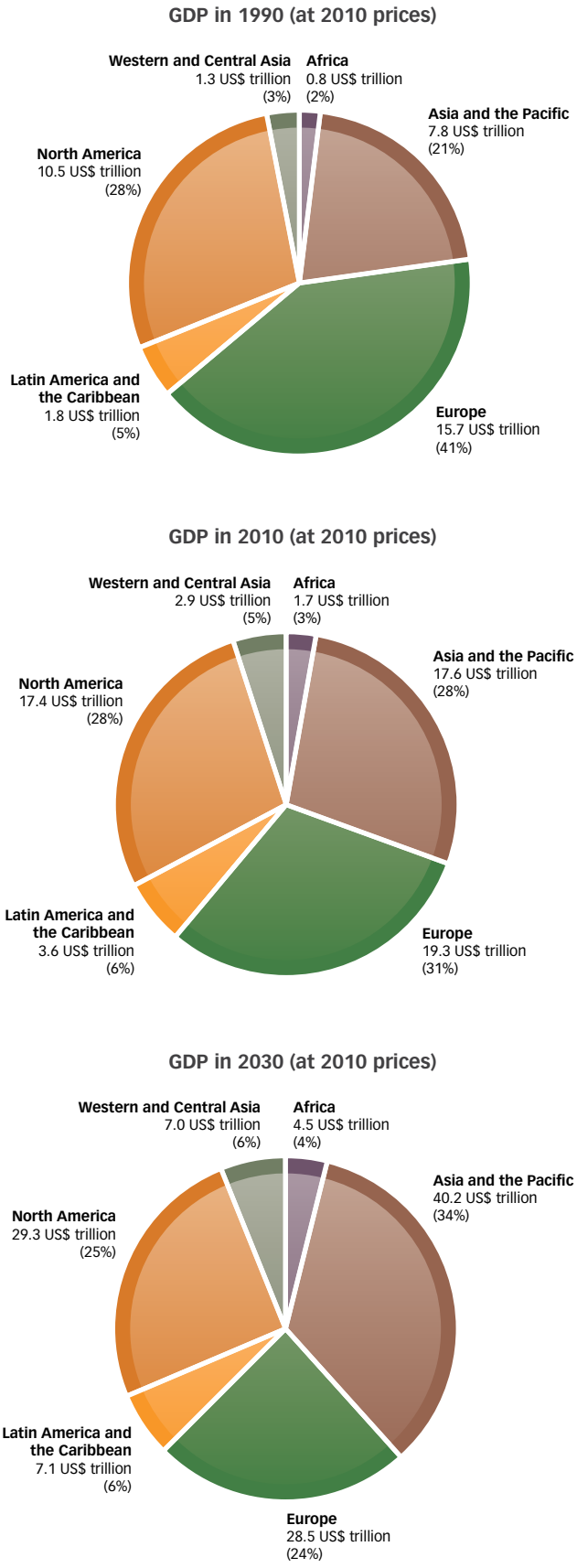
Box 1: Uncertainties in the economic recovery

Following the decline in global economic growth to 1.7 percent in 2008 and –2.1 percent in 2009, the World Bank has projected economic growth of 3.3 percent in 2010 and 2011 and 3.5 percent in 2012, bringing growth back in line with the long-term trend expected in the future. However, two factors continue to cause uncertainty about the strength of the recovery. The first is the speed at which fiscal policies are tightened to control public debt in the (mostly developed) countries that were most affected by the recession of 2008–2009. The second is the risk of a default or a requirement for major restructuring of government debt in one or more of the weaker European countries. Should these uncertainties persist, global economic growth could be somewhat lower due to weaknesses in credit markets and lower government spending (especially in Europe). As an alternative, lower forecast, the World Bank projects growth of 3.1 percent (in 2010), 2.9 percent (in 2011) and 3.2 percent in 2012.

Developing countries were less affected by the recession of 2008–2009 and are expected to continue to grow rapidly as a result of higher productivity growth and fewer difficulties in their government finances and banking sectors. The World Bank is projecting growth of over 6.0 percent over the three years (2010–2012) or 5.9 percent under the alternative low growth scenario, although it is noted that a sovereign debt crisis in Europe could weaken international capital flows to some developing regions where European banks are major operators (e.g. parts of Eastern Europe, Western Asia, Latin America and the Caribbean).

Source: World Bank, 2010.

Figure 26: Global economic growth is shifting to the east and the south



Sources: World Bank, 2010 and EIU, 2010.

The age-structure of populations will continue to change towards a higher proportion of older people in the total population and, in some cases, a decline in the workforce. This trend has already started to appear in some developed countries and will increase over the next 20 years. For example, in 2030, the size of the workforce in Japan, the Republic of Korea and most European countries will be less than it is today. Even in China, it is projected to peak in 2015 and then start to gradually fall. The main exceptions to this trend are Africa, South and Southeast Asia and Latin America, where the workforce is expected to continue to grow rapidly.

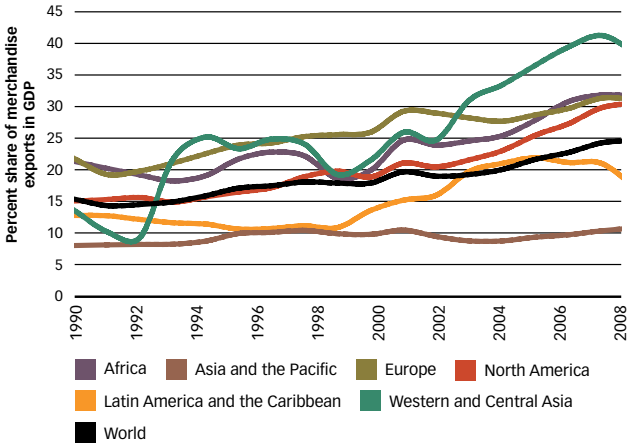
Global gross domestic product (GDP) increased in real terms by 2.5 percent per annum from about US$38 trillion in 1990 to US$63 trillion in 2010 (at 2010 prices and exchange rates). It is projected to grow by 3.2 percent per annum to US$117 trillion in 2030, with relatively higher growth rates projected for less developed regions. The result of this will be a continued shift in the regional shares of global GDP away from developed regions such as Europe and North America towards other regions such as Asia and the Pacific (Figure 26).

Globalization

The trends described above have contributed to increased globalization in recent years. For example, in some countries with large and rapidly growing populations, low labour costs have combined with other factors (such as investments in education, communications and infrastructure) to stimulate rapid growth in domestic markets and higher production for exports. Other countries have become more closely linked into the global economy for other reasons, such as domestic political and market reforms, international trade liberalization, and the expansion of regional trade agreements. The result of these changes has been a rapid expansion in international flows of capital, goods and services since 1990 (Figure 27), which is expected to continue in the future.

In addition to these supply-side impacts, globalization has also led to some homogenization of markets. For example, with the expansion of multinational corporations, many products and services are now delivered to consumers in a similar way across the world and consumers are now aware of trends, tastes and fashions in other parts of the world. These developments present opportunities to increase efficiency in the delivery of products and services across a much larger global marketplace, but they also enable firms to gain competitive advantage through local market knowledge, product differentiation and the development of local market niches.

Figure 27: Increasing globalization of the world economy



Source: UN, 2010.

Competing materials

The major end uses of forest products include media and communications materials, packaging, personal care products, construction (including home decoration) and furniture. In most of these markets, forest products compete with other goods and services and this competition has increased in recent years.

Demand for media and communications materials tends to increase when a significant proportion of the population earns incomes above subsistence levels (i.e. a middle-class develops). When this occurs, rising incomes result in more expenditure on leisure activities and the development of a service sector that relies very heavily on communication with customers. In these markets, speed, ease of use and cost are the major factors that affect competition between alternative forms of media. For many years, these markets relied heavily on newsprint, printing and writing paper to serve customers' needs, but advances in electronic media (i.e. increased availability and reduced costs) have resulted in strong competition in recent years. For example, paper books will continue to dominate this market for quite some time, but a gradual change is starting to occur as younger generations (who are more familiar with new technologies) shift the balance in demand towards electronic media, such as mobile phones and electronic books. More recently, the deregulation and, in particular, the expansion of internet connections (especially high-speed connections) have radically altered the way that companies and individuals communicate.

Packaging and personal care products (tissue paper and related products) account for the majority of other paper and paperboard consumption. Demand for these products increases rapidly once a certain level of economic development is reached. The demand for packaging materials is largely driven by growth in manufacturing, with cost, recyclability, weight, durability and ease of use being the main factors affecting their competitiveness. Plastic and, to a lesser extent, glass (in liquid packaging) and metal are the main materials competing with paper in these markets. Thus, energy and raw material costs are important factors affecting the cost competitiveness of the different materials. In most cases, paper products have maintained their share of this rapidly expanding market and, in some, have even improved it. This has largely been a result of investments in technology that have kept costs down and improved durability. In addition, the industry continues to innovate to produce packaging products that meet a wider range of customer needs, including product information or user instructions (Box 2).

In the markets for personal care products, paper products meet specific niches that are not so vulnerable to competition from other materials. Opportunities to increase revenue come from improvements in product quality and product innovations that meet new customer needs. In addition, sales of these products are not as strongly affected by business cycles and can remain profitable even during recessions, ensuring that this remains one of the most profitable sectors of the industry.

For solid wood products (i.e. sawnwood and wood-based panels) construction is the major end use in most countries and regions. The fundamental drivers of this market are population growth and economic growth, but expansion tends to slow (in relation to economic growth) at higher levels of income. Similar to packaging, construction meets basic functional needs, so cost, durability and ease of use are key factors determining the competitiveness of different materials.

The competitiveness of wood as a construction material varies quite a lot between countries and regions, partly for historical reasons. Countries with significant forest resources and forest processing industries tend to have a much longer history of wood use in construction and more familiarity with the potential of wood as a building material. In other countries, wood use for construction lags far behind its potential. For example, timber frame construction accounts for over 90 percent of house construction in

Box 2: Redeveloping paper markets through product differentiation and innovation

As noted by Wagberg (2007), many of the markets for paper products have suffered in recent years from fragmentation and increased competition from new media. For example, in Norway, the market for media has multiplied by a factor of 25 since 1980, but the different avenues for advertising have increased from five main segments in 1980 to over 40 today. In response to these developments, paper manufacturing and utilizing industries are using a number of different strategies to maintain demand for their products. Newspaper companies, for example, are switching from a focus on paid newspapers to a range of products that includes free smaller newspapers and internet services. At a broader level, paper companies are differentiating more between high-volume, low cost products (driven by technology developments) and more complex, high-value niche products (developed with greater understanding of customer needs and habits).

The packaging sector is also developing new products to remain competitive by meeting existing and future customers' needs better. Paper packaging products are being designed with new functionality to improve logistics and storage capabilities, with features such as automatic tamper discovery, improved traceability, authentication and encryption, and chemical and temperature monitoring. Other advanced examples of 'smart paper' are also being developed, including the incorporation of Radio Frequency Identification technology into paper (to improve product tracking and logistics) as well as the integration of other electronic devices into paper to perform a variety of different functions (e.g. display devices and batteries).

Source: Wagberg, 2007; Moore, 2007.

North America, Australia and Nordic countries, but only about 45 percent in Japan and less than 10 percent in some West European countries (Palmer, 2000). Metal, plastic and concrete are the main competing materials, and energy and raw material costs become important factors in determining the selection of construction materials. On the whole, wood has remained competitive in construction markets, with the notable exception of external doors and windows, for which plastic (PVC) alternatives have taken market share because of their cost and durability advantages.

The other significant end use of solid wood products is furniture manufacturing. Unlike construction and packaging, furniture is mostly sold directly to the public, so personal disposable income is a major driver of demand. As with personal care products, rising incomes present opportunities to increase revenues and profitability through quality improvements, innovations and marketing of higher value products more generally.

Demand for wooden furniture is affected in part by its cost competitiveness in comparison with furniture manufactured from other materials (mostly plastic, metal, glass and aluminium, but also bamboo, rattan and other fibrous plants). Consumer tastes and product quality also play important roles in determining the demand for wooden furniture, particularly at higher levels of income. Across a broader part of the market, many furniture manufacturers also now produce or sell matching home décor and accessories. By doing this, manufacturers are no longer simply selling furniture to meet functional needs, but are encouraging redecoration or renovation of existing furniture. Often these additional items also have higher profit margins than the furniture itself, which increases the value-added and profitability of the business as a whole. Furniture manufacturers are adopting much more sophisticated marketing techniques than producers of other wood products to maintain competitiveness and profitability.

In general, wooden furniture has maintained a share of about 45 percent of the total furniture market and consumption has risen in line with increasing incomes. Globally, cost competitiveness has been maintained by relocating production to countries with lower labour costs while, at the same time, the industry has generally maintained its reputation for quality.

Social trends

Social trends are changes in public opinions, attitudes and lifestyles that occur when incomes rise. For example, as incomes increase, people move beyond trying to meet basic needs and start to seek new products and services that will improve their quality of life, according to their tastes and preferences. Other wealth related factors also affect consumption, such as increases in home ownership (including second homes), trends towards larger homes and greater leisure time, as well as changes in the amount of time spent at home.

As incomes increase, consumers' perceptions of products also move beyond consideration of their costs and functional attributes to include more intangible factors (e.g. quality, status and fashion) that meet different needs. People become more aware of environmental and social issues, leading to demands for more sustainable products and lifestyles. These trends affect the demand for forest products and may affect the industry in other ways, such as government attempts to improve environmental and social standards through incentives and regulation.

Some of these trends are also magnified by increased education levels and much better communication between consumers. For example, social networking sites and other internet sites enable consumers to become much more knowledgeable about companies and their products through online product reviews and discussion forums. These may also include information or discussions about the sustainability of different products.

Competition for resources

The driving forces described above mostly affect the demand for forest products. On the supply side, the main driving force affecting the forest industry is the increased competition for resources (land, labour and capital) that occurs when populations and economies expand. In particular, in the case of the forest industry, competition for land or, more specifically, competition for access to forest resources, is a major driving force that affects development. Competing demands for land are now sometimes referred to as the '5-Fs' - food; (animal) feed, forest (for conservation), fibre and fuel – and there is growing interest in how these demands will be met in the future (see, for example, OECD, 2009).

Although there is considerable scope to improve productivity, demand for land for food production continues to increase with population growth and this seems likely to continue for many years. More recently, with higher income levels in countries such as India and China, diets have started to change to include more meat and animal products. This has led to increased demand for animal feed, which is likely to reinforce the overall trend of increasing demand for agricultural land.

The rising demand for land to grow biofuel crops as a result of bioenergy policies is another emerging trend. Although the impacts of these policies remain uncertain and some policies are currently being revised, it seems likely that these developments will result in significant new demands for land and wood fibre that could stimulate forest conversion (Table 37).

These impacts are further complicated by the increased globalization of agriculture, so that higher demand in

Table 37: Potential expansion of biofuel crops onto other land uses by 2030 (in million hectares)

Region	Types of land likely to be used for expansion of biofuel crops						
	Mostly within agriculture		Degraded land	Possible forest conversion			Total
	Sugar beet and cereals	Oil crops	Jatropha, cassava, sorghum	Biomass energy crops	Sugar cane	Oil crops	
Net importers of biofuels							
North America	11.5	6.3		10			27.9
Europe	8.9	15.2		15			39.2
Asia and the Pacific	1.0	5.2	12.7		1.8	3.5	24.3
Net exporters of biofuels							
Latin America and Caribbean					4.3	8.0	12.3
Africa			1.4		1.3	2.8	5.5
World	21.5	26.8	14.2	25	7.4	14.2	109.1

Source: Cushion, Whiteman and Dieterle, 2010.

one part of the world leads to major (and unpredictable) changes in the demand for land in other regions. The potential impact of climate change also creates uncertainty, especially for water availability, which could affect demand for land or require changes in forest management.

Changes in forest ownership, control and management

Within the forestry sector, economic growth continues to increase the demand for wood while the social trends noted earlier are also leading to greater demands for forest conservation and changes in the way that forests are managed. These changes suggest that access to wood supply could become more complicated, with more fragmented forest ownership, more diverse forest management objectives and more forest areas excluded from wood production. Demand may have to be met by improving the management of forest resources and by relying more on other supply sources. For example, trees outside forests are already a major supply source in some densely populated Asian countries.

Internal forces

In addition to the forces described above, there are a number of other forces affecting industry development that can be more easily controlled by the industry or by others with an interest in the sector (e.g. governments). These forces appear throughout the production chain (i.e. from fibre supply to end product) and many are related to the way in which the industry operates. Other internal forces concern the industry's relationships with other stakeholders (including the general public), and these are more complicated and difficult to manage.

Industry structure and investment

In response to forces such as globalization, raw material supply and regional differences in economic growth, the structure of the forest industry is changing, but some features of the industry present challenges for future development.

In most countries, the forest sector is quite small especially in comparison with competing industries (e.g. cement) and others based on natural resources. The forest industry is also often fragmented and spread out across a country, for example where firms are located close to forests. The small size of the industry restricts the development of suppliers, subcontractors, service providers and other supporting infrastructure, and fragmentation makes it difficult to achieve economies of scale and other efficiency gains. Some countries have achieved economies of scale through industry consolidation (e.g. in pulp and paper and wood-based panel production), but sawmilling and, in particular, forest harvesting remain fragmented in many places.

The industry is also generally slow to adopt new technology. This is partly related to its small size and fragmentation: it is not viable for technology suppliers to serve countries where the market is fragmented or simply too small. Other factors play a part, too: market imperfections, a lack of knowledge or skills to operate and benefit from new technology, raw material supply insecurity, and the informal nature of the industry in some places all result in slower adoption. In some countries the forest industry continues to compete without much new technology by simply relying on good access to raw materials and using existing assets that are mostly depreciated.

In many countries it is also difficult for the forest industry to raise capital. For example, in many tropical countries, firms rely heavily on internal funds (e.g. retained profits) and unconventional sources of finance due to their small size and the difficulty for investors to assess risks (Canby, 2006). In many temperate countries, forest industry investments are relatively unattractive because of the lack of scale and the perception that the industry is a low-risk, low-return industry.[10] Other financing issues include the long-term nature of investments, the highly cyclical markets for products such as pulp and paper, and risks associated with fibre supply and regulation. The result is that many technologies exist that could improve profitability and sustainability, but many firms do not have the incentives or funding to invest in these technologies.

Labour costs and working conditions

In almost all countries, there is a trend towards mechanization, but much of the industry is still quite labour intensive, especially in harvesting and small-scale processing. In addition, the public have a very poor

[10] One exception is the Russian Federation, where there is considerable potential for large-scale investment in the sector. Unfortunately, this has not yet materialized due to the perceptions of high investment risk in the country and the more attractive investment opportunities currently available in other natural resource industries.

perception of employment in the forest industry, with many believing that most jobs involve repetitive, low skill tasks with little chance for innovation and career progression. The one contrasting view is that some parts of the industry (e.g. furniture and papermaking) offer opportunities for creativity and innovation in design and marketing (EC, 2002).

With rising labour costs, ageing populations and higher expectations from employment, this situation makes it increasingly difficult to hire and retain workers in the industry (see Box 3). It also increases the need for mechanization (putting further strains on the industry's ability to raise capital) and encourages relocation towards countries where working conditions and labour costs are lower (with further consequences for the sustainability and public perceptions of the industry).

Social and environmental performance

The increased interest in social and environmental issues (noted previously) presents a unique challenge to the forest industry, because of its reliance on forests for much of its raw material supply. Forest harvesting is very different from other industries, in that it occurs over relatively large areas and has an impact on large numbers of people. Not only is this impact relatively large, but it involves a broad and complex set of environmental and social issues that are often difficult to mitigate. It is also complicated by the diversity of views held about these issues and the failure (in many cases) to resolve the different and often conflicting interests of stakeholders.

These factors have had a number of impacts on the forest industry. First, they have placed new demands on forest harvesting operations, requiring forest managers to

Box 3: Trends in employment

Trends in employment indicate that mechanization in the sector is increasing. For example, the value-added per employee in forestry increased by almost 50 percent from 1990 to 2006 (see Figure A) and much of this increase can be attributed to the mechanization of harvesting in the sector. In the wood industry (sawnwood and wood-based panels), labour productivity has also increased by around one-third since 1990. The paper industry is already capital intensive, which is reflected in the much higher level of value-added per employee (roughly twice the level of the other two parts of the forestry sector).

However, there are still significant differences in the levels of mechanization between countries (see Figure B). As might be expected, Europe and North America generally have the highest levels of labour productivity in the sector (particularly in processing). With ageing populations in both developed and many developing countries it is likely that further investments in mechanization will be required in the future.

For example, there are already automated plants in the furniture and flooring industries, where industrial robots are used in the same way as in the car industry. Many modern paper machines can also be operated from outside the mill premises and some machinery manufacturers provide this service, which increases their earnings and reduces the labour requirement in the mill.

Source: Lebedys, 2008.

Figure A: Value added per employee in US$ (at 2010 prices and exchange rates)

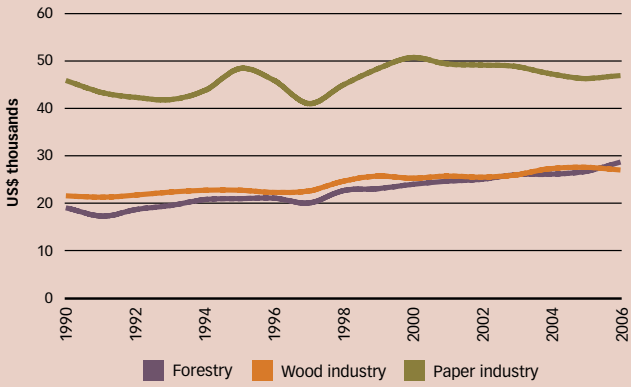
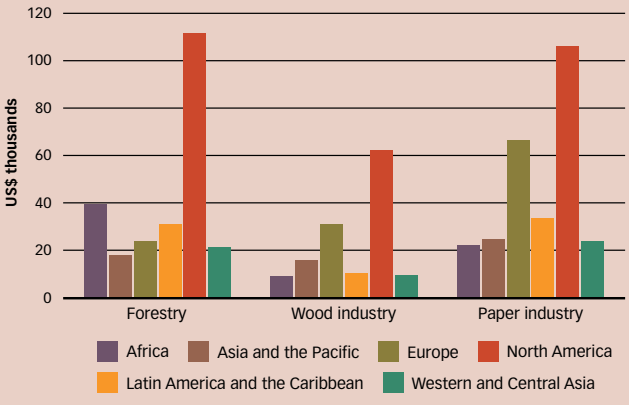


Figure B: Value-added per employee in 2006, by subsector and region (at 2010 prices and exchange rates)



consider more social and environmental aspects of their activities. To some extent, this has increased production costs and may have reduced supply where companies have – either voluntarily or because of regulation – set aside forest areas for conservation and restoration (see Box 4). However, these measures are not always costly and a good deal of ignorance remains about how some improvements in harvesting can be profitable, as well as supportive of other forest benefits. Thus, it is important to improve communication about the forest industry's contributions to sustainable development, educate the public about forest industry operations, and promote the benefits of using wood as a renewable resource that contributes to sustainable forest management.

A second impact is the generally poor perception of wood products that has developed over many years in some countries. In response to consumer demand, some parts of the forest industry do meet high environmental and social performance standards, but other parts of the industry have seen less need to respond to these issues. As a result of this uneven performance, the industry as a whole has not yet managed to overcome these negative perceptions.

Since 2002 leading forest stakeholder organizations from the NGO community, companies, resource owners and managers, intergovernmental organizations, universities and labour have used The Forests Dialogue (http://environment.yale.edu/tfd/) platform and process to address pressing forestry issues with the aim of building consensus and agreement across social and environmental fracture lines. Multi-stakeholder dialogues have focused on certification, forest biodiversity, the role of intensively managed forests, illegal logging and corruption. Current dialogue streams are on forests and climate (REDD+), investing in locally controlled forestry and "free, prior and informed" consent of indigenous peoples and local communities.

Maturity of existing product markets

In addition to factors affecting the industry, forest products themselves have a number of characteristics that affect developments in the sector. One of these characteristics is the concentration of demand in a few end uses, some of which are mature markets. For example, as noted previously, construction, printing and publishing grow rapidly in the early stages of economic development, but growth slows when countries reach a high level of development and these markets mature. Currently, the largest markets for these products (i.e. in developed countries) are already mature and growing relatively slowly. Although demand in developing economies is growing rapidly, it is also likely to diminish in these countries when their markets mature.

Related to this, it is quite difficult for the sector to advance through product innovation in mature markets. For example, there have been many innovations in markets for solid wood products, but they have often substituted one wood product for another rather than

Box 4: Case study – Sustainable Forest Mosaics Initiative

In late 2007, the Sustainable Production and Biodiversity Conservation in Forest Mosaics Initiative (or Sustainable Forest Mosaics Initiative) was launched by Kimberly-Clark, Conservation International, and the Instituto BioAtlântica to work toward the creation of sustainable landscape mosaics. Joined shortly afterwards by The Nature Conservancy and forestry companies Suzano Papel e Celulose, Veracel Celulose, Aracruz Celulose and Votorantim Celulose e Papel (now jointly Fibria), initiative partners recognized the potential to transform the pulp and paper industry by promoting an industry-wide movement towards practices that are both environmentally beneficial and economically sound.

Objectives and results to date

The Sustainable Forest Mosaics Initiative has set out an ambitious set of objectives against which to measure progress and impact. Among the results expected from a fully-implemented initiative at the end of the five-year period are:

- 250 000 ha of natural ecosystems on forest company land in Northeast Brazil under more effective and scientifically-sound protection, and restoration to enhance the Central Atlantic Forest Corridor (CAFC);
- 4 000 ha owned by companies in Northeast Brazil formally protected as new private reserves, and more than 13 000 ha of forest company private reserves using management effectiveness tools in the CAFC;
- an additional 400 000 ha of natural ecosystems in the Atlantic Forest owned by forestry companies or their suppliers under protection or restoration;
- 200 000 ha of biodiversity priority areas in forestry landscapes worldwide identified for conservation;
- 20 percent of new global forest plantations/managed forests of participating companies set aside for conservation.

expanding the total market for wood products. Some notable examples of this include:

- the replacement of sawnwood and plywood used in construction by other types of wood-based panels and engineered wood products;
- the replacement of sawnwood produced from natural and semi-natural forests in the north by finger-jointed sawnwood manufactured from plantation wood grown in the southern hemisphere;
- the increasing competition between laminate flooring made from medium and high density fibreboard (MDF, HDF) and traditional solid wood flooring;
- the competition between laminated veneer lumber (LVL) and glue-laminated beams.

Where markets are mature, radical and disruptive technologies and innovations are usually required to boost growth in the sector above the more normal (relatively slow) growth trends. Product innovations in the forest industry in recent years have tended to be more incremental with relatively modest impacts on growth, although recent developments in bioenergy and biomaterials may present some opportunities for a radical reorientation of the sector.

The maturity of many forest product markets means that it is difficult to increase product value, value-added and profitability through product innovation, especially when many wood products meet basic functional needs and the products are relatively simple. This suggests that the industry should try to look beyond traditional end uses and explore the potential for expanding into new markets that may present new opportunities for growth.

Other end use issues

Forest products are natural materials that can vary in quality and reliability, which means that they may have less durability and higher lifetime 'costs of ownership' than competing non-wood alternatives. These factors are particularly important in some end uses of solid wood products (e.g. construction), where reliability and durability are crucial factors in the purchasing decision.

Related to this, the complexity of building codes, environmental regulations and other measures can make it difficult for forest products to enter new market segments. Not only are such codes complicated, but they often vary from country to country, making it more difficult to develop export markets. In addition, in some countries forest products are excluded from some end uses simply because they are not recognized at all in such regulations.

The forest industry continues to invest significant resources in product development, testing and awareness-raising to address these issues, but perceptions and practical barriers remain that limit the expansion of forest products into new end uses. Product development is not always sufficient to overcome such problems, as the costs of addressing systemic and regulatory bottlenecks may outweigh the benefits of product improvements.

Environmental attributes of forest products

In contrast to the problems noted above, wood products – as natural materials – have environmental attributes that may be preferred over other competing materials. Forest products are renewable materials that can be relatively easily recycled. Furthermore, most solid wood products are produced with relatively little use of energy (see Box 5). This results in a low 'carbon footprint' from their production and use, which is further enhanced by the fact that carbon is stored in wood products. Pulp and paper production is more energy intensive, but is coming under increased pressure to reduce its energy intensity and carbon emissions by adopting better technology (see Box 6).

Improvements in communications with consumers, architects and material specifiers have been achieved in the area of timber certification, and tools such as environmental scorecards in retail outlets have been effective in attracting consumers' attention. Lessons can be learned from these efforts for communicating other environmental benefits of wood products (such as their lower energy intensity and emissions of greenhouse gases during manufacturing), but improved information (with rigorous scientific proof) will be required to convince professional buyers.

Adaptability and management of the raw material supply

Most forest products are manufactured from a relatively small number of inputs. By far the most important input is the fibre itself, followed by energy and then a variety of chemical inputs (glues, preservatives, fillers, etc., depending on the product). While this simplicity may limit the scope for product innovation, it does benefit the sector in other ways.

First, the overwhelming importance of fibre as a raw material means that the sector has become adept at using fibre from a wide variety of sources, such as wood from trees outside forests, recycled paper, wood residues, recovered wood products and non-wood fibres

Box 5: Energy intensity in the forest industry

Energy intensity can be measured in a number of ways, such as the amount of energy used to produce a given weight or volume of a product, or the amount used to produce one dollar of value-added.

Table A shows how much energy is used to produce one cubic metre (m^3) of sawnwood and wood-based panels and one metric tonne (MT) of paper and paperboard. For sawnwood and panels, energy use is about 2 400 megajoules (MJ) per m^3, with some considerable variation between the different regions. It is also increasing in some major regions such as Europe and North America. This can be explained by the shift in production towards reconstituted panels, because the amount of energy used to produce a given amount of particleboard and fibreboard is higher than that used to make sawnwood. Taking this into account, the energy used to make each type of product has probably not increased at all and may have decreased.

For paper and paperboard, energy use is about 19 300 MJ per MT, with less variation between the regions. Much more information is available about energy use in this industry, so these figures are more representative of the sector as a whole. The figures also show that energy intensity has declined slightly in recent years at the global level and in most regions.

The energy intensity per unit of value-added is shown below. The energy intensity of sawnwood and panel production is slightly higher than in the economy as a whole. However, the service sector (included in the latter) has a very low energy intensity and,

Table A: Energy use by product volume or weight, 2002 to 2007

Region	Sawnwood and wood-based panels				Paper and paperboard			
	Data availability		Energy use		Data availability		Energy use	
	2007 (%)	2002–2007 (%)	MJ/m^3 in 2007	Annual change 2002–2007 (%)	2007 (%)	2002–2007 (%)	MJ/MT in 2007	Annual change 2002–2007 (%)
Africa	0	25	n.a.	4.1	0	79	n.a.	0
Asia and the Pacific	67	67	1 686	-6.7	87	97	14 299	-0.9
Europe	75	79	1 806	3.4	90	90	16 831	0.1
Latin America and Caribbean	1	6	3 120	-2.1	88	95	24 752	-1.4
North America	63	98	4 167	5.1	97	100	25 091	-1.1
Western and Central Asia	0	88	n.a.	5.8	37	45	18 832	12.3
World	61	74	2 443	1.4	90	95	19 304	-0.7

Note: Data availability is shown as the total production of countries with information about energy use divided by the total production (of all countries) in each region. Statistics for partial energy use (e.g. electricity only) are not included in the figures for 2007, but are included in the calculations of trends (annual change), so data availability is higher for the latter.

Box 6: Benchmarking CO_2 emissions in the European pulp and paper industry

The European Commission and member states are currently in the process of defining carbon dioxide (CO_2) emission trading benchmarks for industrial sectors in Europe, including the pulp and paper sector. These benchmarks will provide the basis for allocating emission rights among the pulp and paper mills in Europe after 2012. Benchmarks will be based on performance levels of the best 10 percent of mills, with different benchmarks for different product groups. If a mill emits more than the benchmark value they will have to buy additional credits from the market or at government auctions. The Confederation of European Paper Industries (CEPI) is involved as a key stakeholder in the process.

compared with many other manufacturing activities, sawnwood and panel production has a relatively low energy intensity. In contrast, pulp and paper production has a high energy intensity and the sector is one of the five most energy intensive industries when measured in this way.

Table B also shows that energy intensity is increasing slightly, due to the increasing energy use in sawnwood and panel production and declining value-added (per MT of production) in the pulp and paper sector. In the case of pulp and paper, this is partly a result of the business cycle (where value-added has been declining in recent years). For example, a longer time series on energy use and value-added is available for Europe and this shows that, since 1990, energy intensity has increased by about one percent per year rather than the 6.1 percent seen between 2002 and 2006.

The use of renewable energy is a further important factor in the evaluation of energy intensity in the sector. Only partial information exists, but statistics show, for example, that renewable energy accounts for almost 40 percent of the energy used in sawnwood and panel production in much of Europe. For pulp and paper production, renewable energy accounts for about 30 percent of consumption in Europe and Japan, 45 percent in North America and over 60 percent in South America. Most of this energy is produced from waste wood, so the use of fossil fuels in the sector is much lower than suggested by the tables.

Comparisons with other materials usually take into account a wider range of energy inputs in the production and use of products using life cycle analyses (LCA). Consequently, LCA studies vary considerably in terms of their methodologies and results (see, for example, Hammond and Jones, 2008 and Alcorn, 2003). In general, they show that, for a given weight, sawnwood and panel products tend to have similar or slightly higher energy intensities than bricks, cement, concrete and plaster, while the energy intensities of metals are 3–5 times higher and plastics up to 10 times higher than wood. However, comparisons in use also have to take into account the different amounts of materials needed for any specific purpose to lower energy use overall.

Sources: data derived from EIA, 2010; EUROSTAT, 2010; FAO, 2010b; and IEA, 2010.

Table B: Energy use by US$ of value-added, 2002 to 2006

Region	Energy intensity (MJ per US$ of value-added)				
	Sawnwood and panels		Pulp and paper		Whole economy
	MJ per US$ in 2006	Annual change 2002–2006 (%)	MJ per US$ in 2006	Annual change 2002–2006 (%)	MJ per US$ in 2006
Africa	n.a.	1.9	n.a.	4.7	14.6
Asia and the Pacific	17.8	-6.0	39.1	-2.5	14.2
Europe	8.8	3.2	36.3	6.1	8.6
Latin America and Caribbean	12.3	-5.5	52.9	5.8	11.8
North America	15.2	5.5	46.7	-0.7	8.4
Western and Central Asia	n.a.	1.8	19.7	9.2	20.6
World	13.4	1.9	41.6	1.0	10.7

(see Box 7). Furthermore, to deal with the diffuse and fragmented supply sources in many countries, some companies have developed considerable expertise in transport and logistics and have become excellent managers of their fibre supply chains.

Second, waste products from one production process can often be used in other processes or other parts of the industry either as fibre inputs or for energy. Complex wood fibre supply chains and linkages have already developed in many countries with well developed forest industries and these are gradually being expanded to accommodate growing demands for bioenergy. The industry is also continuing to examine ways in which more wood fibre can be extracted from the forest resource base through, for example, the use of forest harvesting residues and the use of forest resources previously considered to be uneconomic.

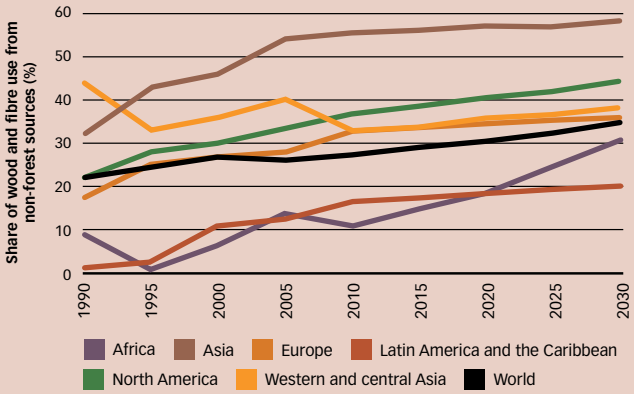
Box 7: Extending the resource through the use of recycled and recovered fibres

The fibre used to manufacture sawnwood, panels and paper comes from a wide – and increasing – variety of sources. In 2005, the fibre required to produce these products was equal to 2.6 billion m^3 of roundwood, yet industrial roundwood production only amounted to 1.7 billion m^3. The remaining fibre requirement (equal to 900 million m^3 or about 35 percent of the total) was met through the use of recovered paper (550 million m^3), non-wood fibre sources, and unrecorded sources such as wood residues from sawnwood and plywood manufacturing and recovered (waste) wood products.

Figure A shows the trend in the use of these other fibre sources from 1990 to 2005 and projections to 2030 from FAO's global outlook study (FAO, 2009a). It shows that the importance of these other sources has increased from 21 percent of fibre requirements in 1990 to 37 percent in 2010 and is projected to increase to almost 45 percent in 2030. Recovered paper is the most important of these other sources, but increased collection of waste wood products (demolition waste, used furniture, etc.) is also increasing rapidly.

As the problem of waste disposal increases in many countries, the ability of the forest industry to recycle waste fibre into new forest products will help the industry to meet its growing fibre requirements as well as reduce the environmental impact of growing consumer demands.

Figure A: Trends in use of recycled, recovered and non-wood fibre sources, 1990 to 2030



Sources: data derived from FAO, 2009a and 2010b.

Recently, the World Business Council for Sustainable Development's Vision 2050 project – looking at the future role of global business in achieving a sustainable, carbon and natural resource constrained world – has articulated a forest 'pathway' based on significantly improving the bio-capacity of intensively managed forests to supply expanding fibre needs for wood, paper and bio-energy products, and the regeneration and conservation of natural forest systems for their ecosystem services, starting with carbon market incentives and payments.[11]

Potential for innovation

Despite some of the challenges described earlier, the forest industry has shown that it is capable of innovation. This is demonstrated by the advances the industry has made in harvesting and logistics, processing technologies and the steady progress in extracting more product from each unit of fibre input. There have also been a number of successful product innovations in engineered wood products and paper products. The increased attention given to patents and licensing

Table 38: Possible strategic responses to driving forces affecting the forest industry

	Strengths (S)	Weaknesses (W)
Opportunities (O)	**S-O Strategies** • green building and green packaging initiatives • bioenergy and biomaterials development	**W-O Strategies** • industry restructuring for investment and expansion • industry clusters and partnerships • measures to strengthen fibre supply
Threats (T)	**S-T Strategies** • product and process innovation • diversification of fibre sources • life cycle analyses (LCA) • collaboration to secure fibre supplies	**W-T Strategies** • industry restructuring for cost savings • product focus and product differentiation • development of technical standards and information • mechanization of operations and human resource development

Note: The strengths, weaknesses, opportunities and threats shown in Table 38 are those identified in Table 36 on page 30 (i.e. strengths – environmental attributes, adaptability and management of raw material supply, innovation; weaknesses – industry structure, labour costs and working conditions, social and environmental performance, maturity of existing product markets, end use issues; opportunities – demographics (low and middle-income countries), globalization and economic growth, social trends; threats – demographics (high-income countries), competing materials, competition for resources, changes in forest ownership). Each strategy identified in Table 38 responds to a different combination of strengths, weaknesses, opportunities and threats, as discussed in the text.

[11] http://www.wbcsd.org/Plugins/DocSearch/details.asp?DocTypeId=25&ObjectId=MzczOTc

to protect intellectual property and increase revenue provides an indication of the importance of innovation in the forest industry.

Strategic choices for the future of the forest industry

The driving forces described above will affect developments in the forest industry for many years to come. They will directly influence markets for both raw materials and forest products, and are also likely to affect government policies and regulation of the sector.

As part of their long-term planning, industries and governments need strategies to respond to these forces. Table 38 lists some of the different strategies that the forest industry has already developed – often in collaboration with governments, end users and other stakeholders – to strengthen the long-term profitability and sustainability of the forest industry in the future. Some of these strategies focus on increasing the profitability and competitive advantage of individual firms (e.g. industry restructuring and mechanization), so it is appropriate that they have mainly been implemented by individual firms. However, where there are benefits for the industry as a whole or benefits from a more co-ordinated approach, strategies may be developed and implemented at the sectoral level, usually with a lead from industry or government.

Traditional government support for industrial development declined in the 1980s and 1990s in many countries with changes in the political landscape, privatization of nationalized industries and an emphasis on deregulation of economies. This free-market approach to economic development prevailed for many years, but there has recently been a reversal in some countries and some parts of the economy. This reversal can be explained by a number of factors, such as the impact of globalization on industrial competitiveness and growing interest in the development of a more sustainable 'green economy'. More recently, the recession of 2008–2009 has caused a number of countries to re-examine their economic policies and to support stronger, more sustainable economic growth in the future.

In line with these trends, support for the development of forest industries has increased over the last few years in almost all developed countries. For example, the European Union (EU) examined the competitiveness of the European forestry sector in 2007 (IIASA, 2007) as part of the EU Forest Action Plan and currently provides support through initiatives such as the Forest Technology Platform. A number of Canadian provinces have recently examined the competitiveness of their forest industries and, at the federal level, Canada has recently launched a major initiative to support innovation in the sector (the 'Transformative Technologies Program'). Other recent initiatives to examine industry competitiveness and support industry development can be found in Australia (DAFF, 2009) and New Zealand (MAF, 2009). Many countries have also started to provide considerable support for the development of biofuels and bioenergy, which is partly directed towards the forestry sector.

Most of these initiatives have some similar features, including analyses of competitiveness, strengths and weaknesses in the sector; measures to increase supply and lower the costs of fibre; support for research, development and innovation; and development of new products (especially biofuels and new wood-based products and materials). Although they differ in scale and emphasis, they indicate that many governments believe the forest industry has a viable future, especially as part of the emerging 'green economy'. Some of these initiatives are relatively new (e.g. bioenergy developments) or have suddenly grown in recent years (e.g. wood promotion activities) and greater demands for sustainability are part of the reason for this. A review of some of these initiatives, below, shows how the industry is responding to the driving forces described above.

Wood promotion initiatives

The promotion of forest products (e.g. through advertising and communication) is a core function of the forest industry; individual companies and industry associations have been promoting their products for many years. However, over the last decade these activities have expanded considerably and have become much broader than simply advertising and marketing of products. Significant, well-organized and co-ordinated wood promotion initiatives currently operate in Australia, New Zealand, North America and most western European countries. Industry associations in a number of emerging economies (e.g. Brazil, Ghana and Malaysia) are intensifying their wood promotion initiatives.

In most cases, these initiatives are industry-led and have developed as specific projects initiated by forest industry associations (or groups of associations). Government agencies may be involved (especially where state forests are used for wood production) or, in some

cases, provide funding or technical assistance. Most initiatives focus on domestic markets, but a number of regional or multi-country wood promotion initiatives have also started (e.g. Pro:Holz in Austria has been very active in collaborating to establish wood promotion initiatives in other countries).

Public demands for sustainability have been a driving force behind these new initiatives, so many of them have gone far beyond the traditional promotional activities of trade fairs, product literature and business directories. In particular, they show how forest products can contribute to more sustainable lifestyles and, based on this, try to develop a stronger wood-using culture. Initiatives have developed a wide range of information materials and resources, including:

- case studies on the design and sustainability aspects of wood product use;
- literature about the technical properties of wood products;
- information about environmental aspects of wood product manufacturing;
- tools and models to assess the environmental impacts of wood use;
- discussion forums and mechanisms to provide technical advice;
- seminars and training in wood use;
- competitions in design and sustainable use of wood;
- directories of suppliers and other service providers and experts.

Most of these wood promotion initiatives have three common features: linkages to green building initiatives; development and provision of information about technical standards; and examples of life cycle analysis of wood products or wood product use.

Green building initiatives

Most of the countries with well-developed wood promotion initiatives also have green building initiatives. Some of these are industry-led, but many are governed by boards or committees that include other stakeholders with an interest in sustainable construction. In a few places (e.g. United States of America) there are a number of green building initiatives that may compete or collaborate with each other.

Green building initiatives exist to promote sustainable construction rather than one material over another or the construction industry more generally. They tend to focus on the development and implementation of tools, models and methodologies for assessing the sustainability of buildings and often administer certification or rating schemes for companies that want to demonstrate their environmental performance. Green building initiatives are largely voluntary, although some aspects of green building (e.g. standards for energy efficiency) may be included in building regulations.

To assess the sustainability of buildings, the efficiency of resource use (e.g. energy, water and other natural resources) is examined throughout a building's life cycle from location to design, construction, operation, maintenance, renovation and demolition. It also takes into account waste, pollution and environmental degradation associated with a building project, as well as aspects of building use such as indoor air quality and employee health and safety.

Wood is just one of a range of materials used in building construction, and the environmental impact of manufacturing forest products compares favourably with many other materials. Thus, the emphasis on green building within wood promotion initiatives is a useful strategy that builds upon the strength of the environmental attributes of forest products. However, many green building systems are still in the early stages of development and a number of problems remain for promoting wood within such systems.

For instance, most schemes do not adequately consider LCA in material specification, which puts wood at a disadvantage compared with other materials because wood generally scores favourably (UN, forthcoming). Furthermore, scoring systems often give a relatively low weighting to material selection (where wood performs well) compared with other factors such as energy efficiency and sourcing of local materials. Some systems such as the Leadership in Energy and Environmental Design (LEED) in the United States of America and the Green Building Council in Australia have chosen to recognize only forest product certification by the Forest Stewardship Council, effectively barring other certified wood products from their systems (UN, forthcoming).

Green packaging

At present, wood promotion initiatives focus mostly on green building, but interest in green packaging is also increasing. This has been largely driven by retailers and consumer goods companies, which are much closer to consumers and more directly affected by the growing public interest in environmental issues. As with the green

Box 8: Sustainable packaging: an opportunity for the paper industry

The European Directive 94/62/EC on Packaging and Packaging Waste, adopted in 1994, was one of the earliest attempts to increase the sustainability of packaging. This focused on minimizing the use of packaging and the hazardous materials it contained, and on encouraging the reuse and recycling of packaging materials. Most other countries outside the EU have not so far followed a regulatory approach towards increased sustainability in the packaging sector. However, sustainable packaging initiatives have been developed by a number of industry groups, non-governmental and government agencies, and large individual companies.

The objectives of many of these initiatives are similar to the EC Directive: to reduce the total amount of packaging used and increase the reuse and/or recycling of packaging materials, increase the content of recycled materials and reduce the use of hazardous materials. Some go even further and examine other aspects, such as greenhouse gas emissions from packaging production, the use of resources (water, energy, land, etc.) in packaging production, and transport distances along the supply chain.

Many of these initiatives are voluntary, but some are backed by major companies which expect their suppliers to improve performance in packaging sustainability (e.g. the Wal-Mart Packaging Scorecard). These initiatives offer various tools to help companies assess and minimize their environmental impact, including scorecards for assessing overall impacts, design guidelines, LCA tools and other design tools (Five Winds International, 2008).

Although reducing packaging is a major objective of many of these initiatives, they can also encourage changes in the types of packaging materials used. For example, as a result of the Wal-Mart Packaging Scorecard, paper cartons have replaced metal cans for some products in ASDA supermarkets in the United Kingdom. Further research and development in the paper industry on issues such as tamper-proof mechanisms and temperature monitoring ('smart paper') could enable more paper products to replace less environmentally-friendly packaging materials and contribute to these efforts.

building initiatives described previously, sustainable or green packaging initiatives (Box 8) are likely to present opportunities for the forest industry to contribute to more sustainable lifestyles.

Technical standards and information

Many wood promotion initiatives include activities to explain and provide information about technical aspects of wood use (especially in construction) to businesses and professionals, as well as to the general public. This complements the promotion of wood in green building and aims to overcome one of the weaknesses of wood promotion, which is the lack of information about the properties of wood products, or the perception that they are less reliable than products made of other materials.

In addition to raising awareness, wood promotion activities in many countries also include active participation in the development of technical standards and codes. Although such standards are, quite rightly, administered by public agencies, contributions and expertise provided by the forest industry are often useful for their development and revision, especially when the industry develops new products. In some cases, these consultations occur at an international level, as in the case of the Canada–US–Japan Building Experts Committee.

Life cycle analysis

Most wood promotion initiatives also include case studies, tools and models to calculate and demonstrate the environmental impacts of substituting wood for other materials. With the high public interest in climate change, many of these focus on the effects of product substitution on energy use and carbon emissions, but some go further and examine a broader range of environmental impacts such as those evaluated in green building initiatives (as noted above). This strategy complements efforts to promote wood in green building, by addressing the threat of competing materials and quantifying the environmental benefits of using forest products.

Collaborative business practices

The development of more collaborative business practices in many sectors and industries is an increasing trend in recent years. For many years firms in many industries have collaborated closely along the production chain with suppliers and end users to improve product quality and develop new markets, but new approaches to collaboration aim to address some of the specific weaknesses in the forest industry.

Collaboration to secure fibre supplies

Greater collaboration offers a response to the threats of increased competition for fibre supplies, changes in forest ownership, control and management, and the fragmented

nature of forest ownership in many countries. This takes the form of both collaboration among forest owners, and between owners and the industry to secure fibre supplies and encourage wood production from forest areas that would previously have been considered uneconomic or unsuitable for harvesting. Such collaborative strategies build on the strengths of the forest industry to organize and manage fibre supplies and (in some cases) transfer some of these skills to small private forest owners.

Collaboration between forest owners (in cooperatives and associations) has occurred for many years in some countries (e.g. in parts of Europe and North America), but has expanded in recent years to become an important force in wood supply. For example, private forest owners' organizations in 23 European countries are members of the Confederation of European Forest Owners (CEPF). A recent survey of 11 of these countries indicated that members of the national organizations accounted for 11 percent of all private forest owners, 42 percent of the area of private forests and 22 percent of total roundwood production (CEPF, 2008). There is also evidence of the expansion of forest owners' organizations in other countries such as Mexico and the United States of America.

The expansion of cooperatives and forest owners' organizations has occurred for a number of reasons. With the transfer of state forests to private owners in Eastern Europe in the 1990s, a number of forest owners' organizations emerged to assist the new private forest owners with forest management and harvesting (e.g. in the three Baltic States, Czech Republic, Hungary and Slovakia). In some places, opportunities for forest certification have been a motivation for better organization of forest owners (e.g. see Ota (2007) for a description of recent activities in Japan). Other examples of improved collaboration include the use of internet tools to manage forests and market forest products such as the 'myForest' service in the United Kingdom (see Box 9).

Box 9: The use of internet technology to develop wood supply from small forest owners

For many years, roundwood supply from the private sector in the United Kingdom has been well below its potential because of the large number of small forest owners and the very variable (or unknown) quality of wood resources in many of these forests. Recent developments in renewable energy policy and incentives have substantially increased the demand for wood with lower quality requirements to meet the needs of the energy sector. In response to this, a number of organizations have been examining ways of increasing wood supply. One example is the 'myForest' service developed by the Sylva Foundation.

The service provides a web-based map that allows wood users to link up with local wood producers. Forest owners can identify their forest on the map and store inventory information for each forest compartment. This is complemented by a forest management module that can be used to prepare forest management plans in the format required by the Forestry Commission in grant and licence applications.

The third module is a national map where forest owners and other forestry businesses can advertise their products and services and display where wood is available or required (see Figure A). Other features include a forum for discussion about forestry issues and links to other resources of interest to forest owners and managers.

During the 18 months it took to develop the service (which was launched in April 2010), 100 businesses and 50 forest owners registered to use the service. The Sylva Foundation is currently actively promoting this free service to other potential users.

Source: Sylva Foundation, 2010.

Figure A: Businesses registered with 'myForest', June 2010

The development of outgrower schemes is another form of collaboration to secure fibre supplies. In this format, the forest industry supports tree planting by private forest owners in order to increase wood supply and develop local capacity for plantation establishment and management. Outgrower schemes appeared in the 1990s and now exist in at least 13 developing countries (Brazil, Colombia, Ghana, India, Indonesia, Papua New Guinea, Philippines, Solomon Islands, South Africa, Thailand, Vanuatu, Viet Nam and Zimbabwe) as well as some developed countries (e.g. Australia, New Zealand and Portugal).

Forestry outgrower schemes vary tremendously in size and the scope of their activities, as well as the distribution of costs and benefits between the forest owners and industry. With the growing interest in such schemes, organizations such as FAO and the Center for International Forestry Research (CIFOR) have analysed the strengths and weaknesses of different types of partnerships and developed guidelines to enable them to continue contributing to sustainable development of the sector in the future (FAO, 2002).

Industry clusters and partnerships

Industry clusters occur where firms and other related institutions (e.g. research facilities) are closely located or strongly linked together in other ways. Sometimes these clusters develop spontaneously as a result of the accumulation of technical expertise over a long time (e.g. some of the furniture industry clusters in Italy) or they may occur based on the location of resources (e.g. forest industry clusters in areas with significant forest resources). More recently, a number of countries have stimulated the formation of industry clusters through public policies and carefully located investments in research and technology.

Industry clusters usually include core businesses within the industry, plus a number of suppliers, end users, related service industries and, sometimes, training, research and development facilities. Clusters can potentially increase the competitive advantage of firms within the cluster by increasing productivity, stimulating innovation and assisting the development of new businesses in the industry (Porter, 1990).

Although some forest industry clusters have existed for many years, interest in their development has increased in the last couple of decades and significant forest industry clusters now exist in parts of most developed countries (Australia, Europe, Japan, New Zealand and North America). For example, according to the Harvard Business School Cluster Mapping Project (www.isc.hbs.edu/cmp), one-third of forest industry employment in 2007 occurred in just five states of the United States of America (and over half in just ten states). The development of forest industry clusters has also been actively supported by governments and industry in Europe, where around 200 clusters now exist, linking together firms in the forest industry and other related sectors such as construction, renewable energy and green technology (European Cluster Observatory, 2010).

A few notable forest industry clusters exist in emerging economies (e.g. pulp and paper clusters in Brazil, India and Thailand; furniture clusters in Brazil, Malaysia and Viet Nam). In addition to these, small-scale village clusters have developed for activities such as handicrafts, bamboo and rattan manufacturing and small-scale wood processing in India, Lao People's Democratic Republic, Thailand and Viet Nam (Anbumozhi, 2007). Collection and processing of NWFP is also well organized (with arrangements similar to clustering) in a number of places (e.g. the collection and processing of shea butter in Ghana and Brazil nuts in Bolivia).

The strategy of forest industry cluster development often aims to take advantage of the opportunities for market growth presented by economic growth and globalization, by addressing weaknesses in the industry such as the maturity of some existing end use markets, fragmentation of the industry (and low levels of technology adoption) and increasing competition from newly industrializing regions. Alternatively, new partnerships can occur to build upon the strengths of different partners to meet an emerging market demand.

For instance, forest product companies have entered the markets for liquid biofuels and other biomaterials, through the development of 'biorefineries'. At present, these developments are being driven by the growing demand for biofuels, but many companies working in this field eventually aim to expand and diversify production into a much wider range of chemicals and materials based on biomass. The largest and best known of these include the joint ventures between Weyerhaeuser and Chevron, Stora Enso and Neste Oil, and UPM, Andritz and Carbona, but others are developing at the level of individual facilities.

Product and process innovations

Innovation is the process of developing new goods or services, new markets, new supply sources, better

processes or better ways of organizing production to increase productivity and generate profits and wealth (Schumpeter, 1934). Innovation can occur gradually (evolutionary innovations) or suddenly (revolutionary innovations) and may disrupt existing industries and markets by supplying new products and services in ways that the market does not expect (typically by lowering prices or meeting the needs of a different set of consumers). Revolutionary innovations are often, but not always, disruptive. In addition, contrary to common perceptions, efforts by end users to modify products or use them in new and more useful ways may be a more important source of innovation than the actions of manufacturers (von Hippel, 1988).

Despite the relatively low levels of technology adoption in some parts of the forest industry (and slow rate of technology adoption generally), the forest industry has innovated in many areas throughout the supply chain from harvesting to end user and continues to support innovation through public and industry research and development activities. Some examples of forest industry innovations are outlined below.

Evolutionary innovations

Evolutionary innovations occur when gradual improvements are made to existing processes and products to increase productivity, lower costs or expand quantity or quality of production to meet an existing market need. In forest harvesting, there have been numerous evolutionary innovations, such as the development and implementation of log grading systems; the gradual move from manual to mechanized harvesting; and the use of low-impact harvesters that reduce soil compaction, and enable year-round harvesting and access to softer soils. These innovations are quite common now in most countries with a modern forest industry. More recently innovation to improve real-time communication between harvesters, transport operators and processing facilities (using global positioning system (GPS) and optimization software) allows just-in-time deliveries of roundwood and reduces the amount of working capital tied up in raw material stocks.

Processing technologies have also improved in numerous ways with developments such as scanning and optimization of product recovery in sawnwood and plywood production, improvements in stress grading, kiln drying and treatments, development of adhesives technologies, as well as higher levels of automation and gradually faster operating speeds in processing facilities to increase labour productivity. Process innovations in the pulp and paper sector have focused in particular on environmental performance in recent years, with reductions in water, bleaching chemicals and energy use (and greater use of bioenergy), plus changes to processes (speed, fibre pre-treatment, etc.) and adoption of abatement technologies to reduce emissions of water and atmospheric pollutants.

Revolutionary innovations

Revolutionary innovation occurs when there is a radical improvement in processes or products to meet an existing or new market need. Whereas evolutionary innovations often occur as a result of learning from existing processes and uses of existing products and services, revolutionary innovations more often occur as a result of research and development programmes. A number innovative forest harvesting machines have been developed and introduced in recent years to supply wood for the expanding bioenergy market. These include combined industrial roundwood and bioenergy wood harvesters and forest processor–harvester machines for extracting forest residues. The use of acoustic tools fitted to harvester heads to improve and automate strength grading of standing trees at the time of harvest is a revolutionary innovation currently being tested (Mochan, Moore and Connolly, 2009).

Revolutionary innovations are less common in forest processing. One notable example, however, is the development of the rubberwood processing industry in Malaysia. Until the late 1970s, most rubberwood was used as fuelwood for drying and smoking sheet-rubber, curing tobacco, making bricks and producing charcoal. Malaysia has since become the world leader in the processing and utilization of rubberwood, with the value of its processing currently estimated at a little under US$2 billion per year.

Revolutionary innovations in the forest industry are more common in product markets and numerous examples exist. New types of panel products (e.g. oriented strand board and MDF) have substituted for more expensive sawnwood and plywood. The development of engineered wood products for structural applications (laminated veneer lumber, building components and I-Joists) followed panel innovations. A key feature of structural innovations has been the combination of solid wood pieces, reconstituted panels and non-wood materials in novel and useful ways that either reduce costs or improve the strength and durability of these composite products compared to previously utilized materials.

Low-end disruptive innovations

Disruptive innovations occur when an innovation leads to new products, new markets or new market segments that meet existing or new customer needs. Disruptive innovations can be evolutionary or revolutionary and occur infrequently in most manufacturing industries (although they can be quite common in the service and high-technology industries). Low-end disruptive innovations tend to occur gradually over time, when new products and processes capture first the bottom end of a market, then move upwards to displace other existing high-value products.

One example of this type of innovation in the forest industry is the use of low-cost particleboard with a variety of overlays and finishes for manufacturing some types of furniture (e.g. kitchen and bedroom furniture). This started with the emergence of cheap, ready-to-assemble furniture in the 1970s and 1980s, which replaced expensive solid wood furniture, the only alternative available at the time. Gradually, with improvements in quality, design and marketing, this type of furniture has moved into higher-end markets so that it is now by far the most common type of furniture available in these market segments in many countries.

Other examples of low-end disruptive innovations are the substitution of wood-based panels (e.g. oriented strand board and MDF), glue-edged panels and finger-jointed wood products for sawnwood and plywood in some applications. These are following the same pattern of development as that described above and are even starting to compete in the high-end furniture markets previously captured by particleboard, such as the use of MDF as a higher-quality base material for the production of kitchen cabinet doors.

New market disruptive innovations

The other main type of disruptive innovation is new market disruptive innovation. This occurs when an innovation satisfies new consumer needs or presents a radically different way of production or service delivery. New market disruptive innovations are often revolutionary and can appear quite quickly in an industry.

The rapid expansion in the use of wood pellets in the energy sector provides an example of a new market disruption. Renewable energy policies have created rapid growth in demand for wood energy that will require large amounts of fuelwood to be moved within and between countries. Wood pellets are an entirely new way of delivering fuelwood to end users that partly overcomes one of the main costs of traditional fuelwood supply (the cost of transportation), by reducing water content and increasing the energy content (or energy density) of the fuelwood. Other benefits of wood pellets include the greater ease of handling (e.g. by using existing equipment available at ports for grain handling), the more consistent properties of wood pellets as a fuel (i.e. more predictable energy content) and the greater ability with wood pellets to automate and regulate the feeding of the fuel into generating equipment such as boilers.

Measures to strengthen fibre supply

Measures to strengthen fibre supply include a number of policies and activities to promote good forest management through supply-chain initiatives, trade measures and procurement policies. The rationale for these strategies is very clear: they aim to address the weakness of poor social and environmental performance in the harvesting sector in some parts of the industry so that the opportunities for promoting forest products as 'green' products can be fully realized.

Activities to improve social and environmental performance in harvesting start with basic requirements such as the development and implementation of harvesting codes, forest management plans and health and safety legislation. These are then reinforced by reliable and robust tracking systems (e.g. chain-of-custody tracing systems) so that wood from well-managed forests can be clearly identified throughout the supply chain. Finally, some sort of certification, labelling or verification scheme can be used to differentiate forest products from well-managed forests from other products to gain competitive advantage in the marketplace.

Although many of the measures to strengthen fibre supply have been led by governments and/or NGOs, there is growing awareness and recognition within the forest industry that these measures may deliver benefits to individual firms as well as the industry as a whole. However, some considerable challenges remain, including:

- the lack of technical capacity in some countries to develop and implement improved harvesting practices;
- the administrative burden and costs of compliance for governments, producers and end users wishing to demonstrate improved performance;
- the complexity caused by the lack of standardization and varying procedures and requirements in different

countries and between different verification and certification schemes;
- the difficulty of translating improved performance into competitive advantage in countries and end uses where environmental concerns are not a major concern for consumers.

There are numerous examples of different measures being developed and implemented to strengthen fibre supply around the world. For a long time these focused on supply-side measures, but a more recent development has been the use of trade and procurement policies to stimulate demand for wood products that meet high social and environmental standards. A very brief summary of some of these initiatives is given below.

Supply-side measures

Supply-side measures to strengthen social and environmental performance in forest harvesting include a wide range of activities to develop and implement improved harvesting practices, such as codes and best practice guidelines for harvesting, forest management planning, and consultation with local communities; research, development and training in reduced impact logging; activities to support forest law enforcement; industry-led voluntary initiatives to source legal raw material; and the development of chain-of-custody and similar tracking schemes.

The basic requirements for sustainable forest harvesting (set out in codes, guidelines, etc.) have existed for many years now in most developed countries. In developing countries many international agencies (e.g. FAO and the International Tropical Timber Organization (ITTO)) and bilateral donors have provided technical support for the development of such materials. Most countries with significant forest industries should now have the codes and guidelines necessary to implement sustainable harvesting. However, what appears to be lacking is dissemination and training in the application of these codes and guidelines, as well as implementation and monitoring in the field. For example, a recent study to examine the monitoring of harvesting codes in the Asia and the Pacific region revealed that many aspects were only partially implemented and monitored and some aspects were not monitored at all (Pescott and Wilkinson, 2009).

Initiatives to support forest law enforcement

As noted above, supply-side measures to improve performance will have little impact if they are not implemented and monitored or there is no mechanism to differentiate between the social and environmental performance of different producers and reward those that meet higher standards. One such demand-side mechanism is to verify that forest products come from forests that are managed according to all local laws and regulation (legal verification).

Initiatives to strengthen forest law enforcement started about a decade ago with several international conferences to discuss the problems of illegality in the forestry sector and propose possible mechanisms to deal with this issue. Since then a number of different strategies have been adopted, including the following:

- Amendment of the Lacey Act (of 1900) in the United States of America. The Lacey Act originally prohibited the transportation of illegally captured or prohibited animals across state lines. It has been amended several times since 1900, with the latest amendment (in 2008) making it unlawful to import, export, transport, sell, receive, acquire, or purchase in interstate or foreign commerce any plant in violation of the laws of the United States of America, a State, an Indian tribe, or any foreign law that protects plants (and their products, including timber, derived from illegally harvested plants). The purpose of the amendment is to prevent trade in roundwood and wood products from illegally harvested trees. Different wood products are gradually phased in to comply with the Act, and the associated penalties are enforced more stringently to tangibly influence trade practices.
- The European Union has used a number of different approaches to combat illegal activities in the forestry sector, including: procurement policies (see below); a regulation entitled ‘Obligations of Operators who Place Timber and Timber Products on the Market’ (which will take some time to implement); and the development of Voluntary Partnership Agreements (VPAs) between the EU and other countries to support the EU’s Forest Law Enforcement, Governance and Trade process. The first VPAs with Cameroon, Ghana and Republic of the Congo came into effect in 2009, so the first VPA licensed timber could arrive in the EU in 2011. VPA negotiations are proceeding with a number of other countries.
- When implementing these initiatives, both the United States of America and the EU encourage wood industries and traders to apply ‘due care’ and ‘due diligence’ in their procurement practices to avoid the entry of illegal wood products into their supply chains.
- Several countries have issued government procurement policies banning the use of forest

Table 39: Government procurement policies to stop the use of illegal forest products

Country	Year of enactment	Requirements for public procurement
Netherlands	1997 (revised in 2005)	Legal and preferably sustainable timber
Germany	1998 (revised in 2007)	Sustainable timber
Denmark	2003	Legal and preferably sustainable timber
UK	2004	Legal and preferably sustainable timber
New Zealand	2004 (mandatory in 2006)	Legal and preferably sustainable timber
France	2005	Legal and/or sustainable timber
Mexico	2005	Preferably sustainable timber
Belgium	2006	Sustainable timber
Japan	2006	Legal timber (sustainability as factor for consideration)
Norway	2007	Tropical timber excluded

Source: Lopez-Casero, 2008.
Note: some other countries are considering similar measures (e.g. Australia).

products harvested illegally and/or encouraging the use of forest products from sustainably managed sources (see Table 39).

- In addition to the demand-side measures above, international and bilateral agencies have continued to support activities to strengthen forest law enforcement in producer countries through technical assistance for policy and legal reform, training in law enforcement, development of chain-of-custody and other monitoring systems and other capacity building activities.

Forest product certification

Forest product certification was developed during the 1990s as a mechanism to identify forest products that come from sustainably managed forests. Four main elements of the certification process are: the development of agreed standards defining sustainable forest management; auditing of forest operations and issuance of certificates to companies that meet those standards; auditing of the chain-of-custody to ensure that a company's products come from certified forests; and the use of product labels so that certified products can be identified in the marketplace. There are presently more than 50 certification programmes in different countries around the world, many of which fall under the two largest umbrella organizations: the Forest Stewardship Council (FSC) and the Programme for the Endorsement of Forest Certification (PEFC). The area of certified forests covered by the two main organizations has steadily increased since the 1990s to reach about 350 million hectares in 2010.

A number of barriers to more widespread adoption of certification have been identified. Two of the most important of these are the costs of certification (especially for small forest owners) and the lack of a price premium for certified forest products in the marketplace. Although the latter has been noted in almost all developed country markets for forest products, one benefit of certification is that it facilitates entry to those markets, where prices generally may be higher than in countries where there is no demand for certified forest products.

Although forest certification has so far failed to stimulate widespread changes in forest management and harvesting practices in all parts of the world, it remains an important tool for companies in the forest industry to demonstrate their commitment to meeting high social and environmental performance standards. Indeed, many of the largest forest products companies are certified and can use this to gain competitive advantage by differentiating their products and communicating their superior performance to consumers. One question that remains unanswered is whether the net benefits from certification are sufficient to counter the generally negative perceptions of the industry that have developed in some places over the last couple of decades.

Industry restructuring

One of the major weaknesses of the forest industry in recent years has been the failure to translate the improvements in material efficiency (output of products per cubic metre of wood used) into higher value-added.

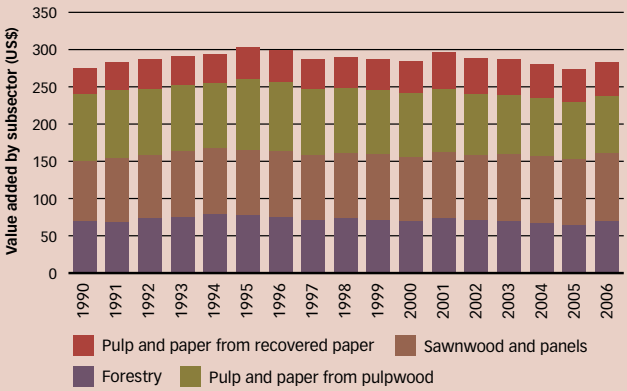
Box 10: Trends in value-added per cubic metre of industrial roundwood production

Value-added in the forestry sector comprises value-added from forestry (mostly industrial roundwood production), value-added in woodworking (production of sawnwood and wood-based panels) and value-added in pulp and paper manufacturing. Table A shows how value-added per cubic metre of industrial roundwood production can be calculated.

In 2006, about 1.5 billion m^3 of industrial roundwood was produced, with a total value-added of US$100 billion (US$72 per m^3). About 1 billion m^3 (60 percent) was used for sawnwood and panel production, generating value-added of US$146 billion. This is equal to US$146 per m^3 of wood used or US$89 per m^3 of wood harvested (taking into account that only 60 percent is used for sawnwood and panels). Pulp and paper production uses three main fibre inputs (pulpwood, non-wood fibre and recovered paper) and, based on their shares in production, value-added from pulpwood use is US$180 per m^3, or US$71 per m^3 of wood harvested. In addition, the use of recovered paper (which originally comes from wood fibre) generates an additional US$47 per m^3 of total production. Thus, each cubic metre of wood harvested generates a total of US$279 in value-added in the sector as a whole.

The figure below shows the global trend in value-added per cubic metre of industrial roundwood production since 1990. The value-added in forestry and woodworking have both increased slightly over the period (by about 8 percent in total), but value-added in pulp and paper manufacturing has declined by about 4 percent (resulting in a total increase of 2 percent). Thus, although the sector has made considerable improvements in increasing the volume of products manufactured from each cubic metre of wood (see Box 7), it has been much less successful in translating this into increases in value-added.

Figure A: Value-added per cubic metre of industrial roundwood production (in US$ at 2010 prices and exchange rates)



Sources: based on FAO, 2010b and Lebedys, 2008.

Sources: based on FAO, 2010b and Lebedys, 2008.

Table A: Value-added by forestry operations, sawnwood and panels, and pulp and paper manufacturing

Global production and value added in 2006 (at 2006 prices and exchange rates)	Forestry	Sawnwood and panels	Pulp and paper		
			Pulpwood	Non-wood fibre	Recovered paper
Wood production/consumption (million m^3)	1 519	998	644	n.a.	n.a.
Gross value-added (US$ billion)	110	146	116	10	78
GVA per m^3 used (US$)	n.a.	146	180	n.a.	n.a.
GVA per m^3 harvested (US$)	72	89	71	n.a.	47

For example, Box 7 on page 42 shows that the use of recovered and recycled fibre has almost doubled since 1990, but the total value-added per cubic metre of wood used has only increased by 2 percent over the same period (Box 10). Furthermore, some parts of the industry suffer from overcapacity and continue to expand production despite level or declining product demand. This is less of a problem for the sawnwood and panel industry where innovation has, perhaps, enabled companies to maintain or improve product prices, but it is a major problem in the pulp and paper industry (Box 11 on page 54).

There are two main routes to consolidation in the forest industry: first by closing old and inefficient mills, and second through mergers and acquisitions. Consolidation through mill closures and extended downtime started before the current financial crisis, but accelerated during 2008 and 2009. For example, seven pulp and paper mills were closed in Finland in

2008, followed by three more in 2009. Employment was cut by 9 000 jobs and industrial roundwood use fell by 20 percent. When market pulp prices increased in early 2010, two pulp mills were restarted, but the other mills had either been refurbished and converted to other uses or dismantled and the equipment shipped to emerging economies.

Mergers and acquisitions usually remain at a low level until growth prospects improve and the potential benefits of such deals become more obvious. Following the 2008–2009 downturn it may take another two years before large-scale restructuring through mergers and acquisitions resumes in developed regions. However, interest in mergers and acquisitions remains high in some emerging economies. For example, Chinese companies are active in Viet Nam and the Lao People's Democratic Republic and may be seeking stronger collaboration with other countries in the region. Latin American firms are also exploring opportunities for restructuring. Aracruz and Votorantim have already merged their activities to form Fibria and other high-profile mergers are expected. Stora Enso and UPM (from Europe) also have some significant investments in Latin America and plan additional expansion in the next two to three years.

The desire to acquire or secure raw material supplies is also driving interest in mergers and acquisitions. Chilean giants Arauco and CPMP are looking for opportunities in Brazil and Uruguay, in response to domestic roundwood supply constraints. Stora Enso and Arauco also bought ENCE's forest plantations in Uruguay in 2009 (130 000 ha, plus an additional 6 000 ha of leased forest plantations) to add to the 250 000 ha of forests that they already own in Uruguay. On a smaller scale, an interesting acquisition was the purchase of most of Sabah Forest Industries in Malaysia by Ballarpur Industries of India. Wood supply is a major constraint for India's forest industry and this acquisition included a 289 000 ha concession (to the year 2094), which was an important motivation for the deal.

The country reports for FAO's 51st Advisory Committee on Paper and Wood Products (FAO, 2010c) provide further evidence of how some of the 'old' producer countries are starting to restructure their forest industries. Two examples of the strategies for restructuring, and the scale and impact of mill closures, are given below.

- Canada has closed or halted production at its predominantly old pulp and paper mills with the result that 39 000 jobs were lost in 2009. Falls were reported in shipments of newsprint (down 27 percent), graphic paper (21 percent) and market pulp (10 percent). Under its 'BioPathways' project, the forest industry is examining the potential to develop new sawnwood and building systems, new value-added wood products and to transform pulp and paper mills into biorefineries that can produce bioenergy, valuable chemicals and high-performance fibres for advanced applications.
- In Germany, the paper industry is undergoing restructuring in three ways. The first is a shift in production away from graphic papers (which are oversupplied) towards the more attractive packaging, speciality papers and personal care (tissue) segments. The second is a move towards increasing competitiveness in the small and medium-sized industries, which must either focus on market niches or expand scale. The third is through the different impacts of climate change policies and trading systems (e.g. the EU Emissions Trading Scheme) on companies that have or have not invested in low carbon technologies such as biomass boilers. Carbon costs for biomass-based plants will be lower than for fossil fuel plants, especially those that use coal. In terms of more general trends in Europe, CEPI reported that newsprint output fell by 12 percent, woodfree graphic papers by 15 percent, mechanical papers by 19 percent and packaging grades by 6 percent in 2009. Chemical pulp output also decreased by 11 percent.

In addition to the emphasis on cutting costs and production during periods of consolidation, the forest industry needs to change the predominant business model towards one that will provide a more sustainable future for the industry. In particular, the current focus on low-cost, high volume commodity production has to change and move towards multiple products with higher value-added, greater flexibility and more resilience to market fluctuations.

The current financial crisis is limiting investment in many of the countries where forest industry consolidation is needed most desperately. However, as the examples above and in previous sections have shown, it appears that both governments and industry are now interested in a transformation to a more profitable and sustainable forest industry, with innovation as a major driver of future competitiveness. It is to be hoped that this interest will be maintained when economies fully recover, and that the industry will be able to implement such a transformation as part of future consolidation.

Box 11: The impact of cost, price and output changes on value-added in the forest industry

Changes in total value-added in the forest industry can be divided into three main components: changes in the quantity of production, price changes, and cost changes. Using national account statistics (where available) and production statistics (from FAOSTAT), trends in these three components of value-added were examined for the period since 2000 to identify changes in the competitiveness of different countries.

Sawnwood and wood-based panel production

Table A shows the average annual increase in total gross value-added for a number of countries, with the countries grouped into different combinations of output, cost and price changes. The first row shows the countries where both costs and prices are improving in the sector (i.e. falling costs and rising prices). In the countries on the left, output is also increasing, so value-added is increasing in all of these countries. Output is declining in the countries on the right, most likely due to scarcity of, or increasing competition for resources. However, with the exception of Japan, total value-added is also increasing in these countries.

The second row shows countries where the combination of cost and price changes is favourable. In other words, prices are increasing faster than costs (e.g. Finland) or costs are falling faster than prices (e.g. Canada). Again, the countries that have also been able to expand output (on the left) have increased total value-added. Some of the countries on the right may be constrained by resource availability (e.g. Estonia), but in a number of cases it is likely that declining output has been the result of deliberate measures to reduce production and cut costs or focus on higher value-added markets (e.g. Canada and Finland).

The third row shows the countries where cost and price changes have been unfavourable. In all of these countries except Chile, costs have increased and prices have either fallen or not increased by enough to cover the increased costs. On the left, Chile and Turkey are the only countries that have been able to increase total value-added (despite the unfavourable cost and price trends) by simply increasing production (by over 5 percent per year in both cases). In all of the other countries, total value-added has fallen at the same time that production has increased. All of the countries on the right have cut production but not sufficiently to improve competitiveness.

These figures show that the majority of countries remain competitive in sawnwood and wood-based panel production. The countries in the first row and left-hand side of the second row have managed to increase the value-added per unit of output and, in most cases, increase output as well. A second group of countries are increasing the value-added per unit of output

Table A: Average annual increase in total gross value-added in sawnwood and wood-based panel production since 2000

Countries with:	Increasing output		Decreasing output	
Costs and prices improving	Viet Nam	+32.0%	Indonesia	+5.4%
	China	+26.4%	Latvia	+4.0%
	Ukraine	+16.8%	Belgium	+2.6%
	India	+16.3%	Netherlands	+1.6%
	Russian Federation	+14.1%	United Kingdom	+1.1%
	Romania	+5.6%	Japan	-2.3%
	Brazil	+5.4%		
	Lithuania	+4.6%		
	Sweden	+3.4%		
Favourable cost and price changes	Republic of Moldova	+17.7%	Estonia	+0.7%
	Bulgaria	+13.3%	Portugal	0.0%
	Poland	+6.1%	Mexico	-0.4%
	South Africa	+5.9%	Finland	-1.6%
	Czech Republic	+3.6%	Canada	-1.6%
	Switzerland	+2.7%		
	Austria	+2.6%		
	New Zealand	+2.0%		
	Ireland	+1.5%		
	Republic of Korea	+0.8%		
Unfavourable cost and price changes	Chile	+1.1%	Spain	-0.5%
	Turkey	+0.8%	Norway	-1.2%
	Australia	-0.1%	Italy	-2.2%
	Hungary	-0.8%	United States of America	-3.0%
	Malaysia	-0.8%	France	-3.3%
	Germany	-2.1%		
	Argentina	-6.4%		
	Greece	-8.3%		

(i.e. 'favourable costs and price changes') by reducing production (e.g. Canada and Finland) or are increasing total value-added by producing more (e.g. Chile and Turkey). The countries facing the most problems are those in the third row where the cost and price trends are unfavourable and the industry has been unable to cut or refocus production to increase value-added.

Pulp and paper production

Table B shows the same information for the pulp and paper sector. This shows that both costs and prices are improving in four countries and production is increasing in another four countries where the combined cost and price trends are favourable. Production is declining in Australia and Hungary, but the cost and price trends are favourable and these countries have increased total value-added. As in the sawnwood and wood-based panel industry, Canada has also achieved improvements in value-added per unit of output (through significant cost reductions), but total output and total value-added have both fallen significantly.

In contrast to the sawnwood and wood-based panel industry, a large number of countries appear in the third row, including many of the largest pulp and paper producing countries. In almost all of these countries, prices are falling and costs increasing, resulting in declining value-added per unit of output. A few countries have managed to increase total value-added in the industry by increasing production, but many more have not increased total value-added. Furthermore, the majority of countries that have started to cut production have not yet managed to restructure their industries into a position where value-added can be improved.

To some extent the figures below could reflect cyclical changes in the industry, but this is unlikely to be a major factor in these results. For example, over each of the three previous decades, most of these countries managed to increase both total value-added and value-added per unit of output. A particular concern is that falling prices (due to reductions in demand) are a major cause of the declining value-added, yet the majority of countries are increasing production, putting further downward pressure on prices. Existing overcapacity in developed countries combined with rapid increases in capacity in some emerging economies suggest that significant industry restructuring and reorientation will be required to overcome the currently unfavourable trends in costs and prices.

Sources: based on FAO, 2010b and Lebedys, 2008.

Table B: Average annual increase in total gross value-added in pulp and paper production since 2000

Countries with:	Increasing output		Decreasing output	
Costs and prices improving	Viet Nam	+26.5%	Indonesia	+5.4%
	China	+18.4%	Latvia	+4.0%
	Argentina	+17.9%	Belgium	+2.6%
	Bulgaria	+15.2%	Netherlands	+1.6%
			United Kingdom	+1.1%
			Japan	-2.3%
Favourable cost and price changes	Indonesia	+11.8%	Hungary	+2.1%
	Romania	+8.1%	Australia	+1.4%
	Poland	+6.1%	Canada	-2.6%
	Turkey	+5.5%		
Unfavourable cost and price changes	Estonia	+7.1%	Netherlands	-2.5%
	Lithuania	+6.0%	United States of America	-2.7%
	Latvia	+2.9%	Greece	-2.8%
	Mexico	+2.7%	Japan	-3.2%
	Brazil	+1.3%	France	-5.5%
	India	+0.2%	United Kingdom	-5.7%
	Ukraine	+0.1%	Norway	-8.9%
	Germany	0.0%		
	Czech Republic	-0.5%		
	Chile	-0.7%		
	Switzerland	-0.8%		
	Spain	-0.9%		
	South Africa	-1.2%		
	Austria	-2.3%		
	Italy	-2.8%		
	Belgium	-3.4%		
	Portugal	-4.0%		
	Malaysia	-5.1%		
	Sweden	-6.6%		
	Russian Federation	-7.5%		
	Finland	-7.6%		
	Ireland	-7.6%		

Summary and conclusions

The preceding analysis has described the ways in which different driving forces are shaping developments in the forest industry, with consequences for the sustainability of the industry now and in the future. Many of the driving forces have diverse and sometimes contradictory impacts. For example, economic growth stimulates demand for forest products, but also increases competition for resources; and forest products have positive environmental attributes but environmental performance (or perceptions of performance) remains weak in parts of the industry. However, some of the most important forces are largely negative (e.g. industry structure and the maturity of some product markets) and can only be addressed by changes within the industry.

A number of aspects of forest industry sustainability were noted in the introduction (including energy efficiency, reduced waste production and resource conservation, environmentally compatible materials and safe working conditions) and current trends in these aspects are largely positive. Energy efficiency is generally improving in most regions and most parts of the industry. Resource efficiency and recycling are also improving and the industry is making progress in promoting wood products as more environmentally-friendly than alternative materials. However, these trends are only improving when they are measured in physical terms (i.e. volumes of production). When measured in terms of value-added, the trends are much less positive and are, in some cases, declining. This is due to the generally poor performance of the industry in recent years to increase the value-added per unit of output.

In some respects, the forest industry is facing challenges that have already been seen in other manufacturing sectors. In developed regions, the industry has significant capital assets and large domestic markets, but production costs are relatively high and markets are growing quite slowly, or even declining. In contrast, markets in emerging economies are growing rapidly and production costs are generally lower, with the result that much new investment is being directed towards these countries (further increasing their competitiveness). The result of this is overcapacity in many emerging economies and a generally negative outlook for prices, profitability and value-added both globally and especially in many developed countries.

As other industries have discovered, the solution to this challenge is consolidation and restructuring, to reduce overcapacity and reorient production into areas where each country is most competitive. The industry has been aware of the need for this for some time but, with the recent financial crisis, it seems at last to be moving in this direction. Innovation and the development of new partnerships with firms outside the industry appear to be important features of current restructuring efforts. Product innovation creates new markets that help to reduce overcapacity in existing markets and help to reduce the dependence of the industry on a few end uses. Some of the emerging partnerships are also bringing a number of benefits, such as improved access to finance, risk-sharing and new marketing opportunities. The main strength that the forest industry brings to these partnerships is its ability to manage and develop the raw material supply.

Governments are trying to improve sustainability in the forest industry in a number of ways. They continue to encourage the industry to improve its social and environmental performance, with a strong emphasis on policies and regulations related to wood supply and industrial emissions. Governments are also assisting the industry to improve competitiveness by funding research and development, facilitating the formation of industry clusters and partnerships, and providing support for wood promotion activities.

The overall outlook for the forest industry is one of continued growth with some significant changes in the future. The existing structure and location of the industry are not in line with the main economic driving forces, so new investment and production will continue to shift towards emerging economies. In the countries that can no longer compete with these emerging economies, restructuring of the industry is likely to be a major change. Although the outlook is uncertain, this is likely to result in a greater focus on products that meet high environmental performance standards and new products such as bioenergy, biochemicals and biomaterials. It is promising that a number of companies and countries are already actively pursuing these opportunities.