THE POTENTIAL FOR NEW TECHNOLOGIES IN CANADA'S FOREST SECTOR

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by

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SUMMARY

The Ministry of State for Science and Technology (MOSST) commissioned this study as part of an overall assessment of the potential for new technologies in Canada's resource sectors. The purpose of this study is to review the trends and problems facing Canada's forest industry, assess the level of application of technology, identify newer technologies which might enhance competitiveness, identify requirements and constraints for the development and/or implementation of newer technology, and recommend federal policy initiatives which might enhance the development and application of newer technology in the forest sector.

The forest sector is by far the country's leading resource-based industry in terms of overall economic contribution and regional economic impacts, and is arguably Canada's most important industrial sector. It is the country's main export earner as well as a leader in manufactured shipments and value added. The forest industry is the country's primary generator of manufacturing employment.

By virtue of the constitution, ownership of most of the country's forest land (82%) is vested with the provinces. The federal role relative to the forest sector is limited to taxation, employment/investment programs, research and development, external linkages such as tariffs and export market assistance, and management of federal forest lands. Federal lands account for less than 0.5% of Canada's annual timber harvest.

The Canadian Forestry Service (CFS) in the Department of Agriculture is the principal source of federal expertise and involvement in forestry. Its two main functions are research and development, and the negotiation and administration of federal-provincial forestry development agreements. Numerous other federal agencies are involved in the forest sector through broader, cross-sectoral programs.

Each province has devised its own array of forest tenure systems providing the statutory basis for the various forest industry players to extract and often manage the timber resources on provincially owned lands.

The forest industry is characterized by its diversity, huge size, mostly Canadian ownership and dependence on export markets. There are over 5,000 corporations in the industry with 7,000-8,000 manufacturing establishments in the following sub-sectors: pulp and paper, sawmilling, panel products, harvesting and transportation, and other (shake, shingle, wood preservation, sash and door, etc.).

Canada is the world leader in value of export trade of forest products. But indications are that Canada may drop in terms of overall market share of its conventional export products sold to traditional customers.

The recent period of very low earnings in the forest sector has resulted in an industry with a deficient financial base, unable to raise enough capital to make investments in required, available technological improvement. In this regard, existing federal taxation incentives tend to be meaningless because of the collective inability to make use of them to improve competitiveness. Withdrawal of forest land from timber production, an undermanaged resource base, interdepartmental conflicts over jurisdiction, timber supply shortages, and growing protectionism in world trade are other major problems facing the sector.

Canada's ability to adapt and respond to global and domestic trends in the sector will depend on the capacity of the forest resource base to supply a suitable quantity and quality of timber, the degree to which manufacturing operations are upgraded and made more market oriented, and the efficiency with which we operate the sector as a whole.

Although there are some notable exceptions, Canada's forest sector in general (and almost all its sub-sectors) is technologically unsophisticated. Also, due to past heavy reliance on primary manufactured products (lumber, pulp, newsprint) and the capital-intensive nature of many of the manufacturing processes, technological developments have emphasized process development and specialization much more than product development. The industry now realizes that it must manufacture considerably more value-added products which are

more market oriented. However, this is more easily said than done, at least partly because the major players, the large integrated companies, are not well suited to respond quickly and efficiently to demands for relatively small quantities of materials manufactured to non-traditional specifications.

Expenditures on forestry R & D in Canada are well below the levels of our major competitors and of other industrial sectors in Canada. In comparison to our compétitors, Canada's approach to forestry R & D is unfocused, uncoordinated, under financed and lacks problem - or goal - orientation. From an industrial point of view, the main difficulty is that the industry as a whole suffers from too much debt, too little shareholders' equity, and too small a return on invested capital. Until the industry gets its collective balance sheet in order, the opportunity to fully take advantage of existing technology is not there and the commitment to developing new technologies will not be total. From a governmental perspective, lack of both strong political influence and an easily defined and united constituency at the federal level, coupled with provincial control of the resource base, have left the forest sector without the political influence of other resource sectors. Without this strong political presence the forest sector is unable to establish itself in the federal governmental process which traditionally leads to the development and application of technology to the degree possible in the other resource sectors.

The major organizations providing technological support to the sector are the universities (mainly in forest management, harvesting and pulp and paper), equipment manufacturers, provincial governments (forest management and harvesting), the Canadian Forestry Service (forest management and harvesting), the private companies (in all sub-sectors), FORINTEK (a cooperative - sawmilling, panel products), FERIC (a cooperative - harvesting and forest management), PAPRICAN (a cooperative - pulp and paper), FEPA (the U.B.C./C.F.S. sectoral modelling project). There are numerous coordinating councils for forest research at the federal and provincial levels, most of which have only advisory functions.

There is much technology which is available to Canada's forest sector and which has already proven that it could have a positive economic impact on the industry.

Electronic technology is increasingly being introduced into sawmills and product advances are continually being introduced (e.g. machine stress rated lumber, finger-jointing, laminated veneer and edge-glued lumber, etc.).

The major "new" technology in the panel products sub-sector is the composite wood panel manufacturing process which can convert low-quality and low value wood (e.g. hardwoods and residues) into panel products which compete in price and performance with construction plywood.

If the pulp and paper sub-sector is to maintain or expand its position in the world market and at the same time maintain profit margins, it will have to shift its output from commodity type products towards higher value-added products. This shift can be brought about by upgrading existing products, carrying out more secondary manufacture of existing products, and/or making products which are more market-specific.

To offset the trend toward small log sizes, there are several newer harvesting systems available such as mechanized felling, whole-tree extraction with reduced site degradation, processing of logs and waste materials before transportation to the mill, plus related improvements through the application of ergonomics and systems analysis techniques.

In forest management, the main areas in need of the application of newer available technologies are forest protection (fires, insects, disease) and forest resources evaluation. (Much of the know-how in reforestation and forest stand tending is in place; the follow-through is awaited.)

Biotechnology is probably the most studied and talked about "new" technology in Canada. Yet biotechnology in the form of genetic tree improvement has been on the Canadian forestry R & D scene for about 40 years. So its merits relative to the forest sector are well understood.

The more promising fields of technology which warrant encouragement and support include: mechanized silviculture, enhanced engineering expertise in equipment development and manufacture, forest resource evaluation, flexible manufacturing systems, centralized fire management, biotechnology, and several pulp and paper products/processes.

Numerous recommendations for federal policy/program changes to encourage more technology development and application include:

- revision of Canada's corporate tax laws in order to provide a better system of incentives to technologically innovative companies while doing away with arbitrary, politically influenced and inconsistent R & D grants to industry;

- have joint industry/research committees decide how federal R & D money is to be spent and by whom, based on proposal evaluations by technical sub-committees;

- a general increase in the overall level of federal support to forestry related scientific and educational organizations and institutes;

- gear Government procurement programs more toward nurturing technological implementation and innovation;

- make longer-term commitments (say 5 years) to basic levels of R & D funding with annual reviews to look only at incremental funding;

- review all federal industrial and R & D subsidy and grant programs and eliminate those which fail to meet their intended purposes and those which are able to be influenced politically;

- develop a national strategy for research related to forestry;

- establishing a federal department of forestry would do much to focus federal efforts in forestry, particularly in forestry R & D;

- shift federal support efforts to the sector away from industrial modernization grants and concessions toward more forest resource management and R & D in general;

- step up efforts in managing federal lands to improve timber supplies, provide intensive forest management demonstrations to the provinces and give the C.F.S. an operational vehicle for testing, implementing and transferring the technology it develops;

- make a commitment to long-term funding of the cooperative research institutes (FERIC, FORINTEK, PAPRICAN) subject, not to an annual ceiling, but to a foundation level which would automatically increase on a matching basis with incremental industry and provincial financial input;

- have the CFS facilitate and lead joint R & D programs and centres of excellance involving government labs., the cooperative institutes, universities, industry, consultants, etc. as applicable;

- set up a joint federal-provincial effort (perhaps as a sub-program in the federal-provincial forestry agreements) linking wood supplies, venture capital sources and overseas/domestic market development;

- develop comprehensive strategic plans (including benefit/cost analyses) for large-scale, multi-disciplinary R & D efforts (such a plan should be prepared immediately for forest biotechnology);

- a stronger peer review process is required in the C.F.S.;

- the various provincial and federal forestry research councils should either be given more authority or else be disbanded.

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A. INTRODUCTION

1. Background on the Study

The Ministry of State for Science and Technology (MOSST) has a mandate to formulate policies to encourage the development of science and technology in support of Canada's economic and social goals. At the same time, the Ministry is responsible for establishing priorities for science and technology, for making recommendations on related resource allocations, for coordinating federal science and technology programs with other government activities, for cooperating with the provinces, industry and the universities in related policies and programs, and for space research and development policy and activity coordination.[1]

MOSST recently set out to assess the potential for new technologies in Canada's resource sectors - agriculture, forestry, fisheries, mining and energy. The purpose of this assessment is to formulate proposals for increasing federal support for technology development and application in Canada's resource industries. Each

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(1) Ministry of State for Science and Technology, Annual Report, 1983-84, 1984.

of the five resource sectors was to be assessed individually, but with a view to identifying commonalities and overlapping technologies among them. These five sectoral studies will be used as a basis for discussion leading to a proposed national science policy.[2,3]

Assessment of the forest sector is the subject of this report.

2. Background on the Forest Sector

Canada's forest sector is a vast, complex and increasingly interdependent amalgam of government agencies, private corporations, associations, institutions and individuals operating, for the most part, on a publicly held raw material supply, using privately owned manufacturing capacity, selling to foreign markets. In combined social, economic and environmental terms, the forest sector is one of the country's most important industries. It is the largest contributor to the country's balance of payments and involves or directly influences land use and the environment on nearly half of Canada's total area. At the same time, the forest sector is a major economic and employment generator in every region of the country.

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[2] MOSST. New Technologies and the Resource Sectors, 1985; Internal Report.

[3] R. Lawford. Background to a Study of the Potential for New Technologies in the Resource Sectors, 1985, MOSST Internal Report.

The most comprehensive study of Canada's forest sector is the 1981 federal cabinet discussion paper entitled "A Forest Sector Strategy for Canada".[4] This study identified the most important issues facing the sector as:

- Timber supply shortages (in terms of quality and quantity);
- Canada's ability to compete in world markets;
- The inadequacies of research and development;
- Shortages of trained personnel.

Over the past five years, these issues have received attention from governments and industry. However, it is evident that the attention received has not matched the degree to which these issues have been exacerbated by such influences as:

- An inadequate commitment to renewing, managing and protecting the forest resource;
- Increasing competition and a tendency toward protectionism in world forest products markets;
- For all components of the sector, inadequate information upon which to base policies, strategies, forecasts, plans and budgets;
- The general inability of the industry to generate or raise enough capital to modernize and/or produce more value-added outputs;

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[4] Canadian Forestry Service, Environment Canada.

- The pervasive fiscal restraint imposed by the world recession of the early 1980s;
- The reluctance of the major forestry "players"[5] to work together to solve common problems.

Since these issues and influences are all related in one way or another to the development or implementation of technology, this study of the potential for new technologies provides a timely opportunity to assess old approaches and identify new ones for maintaining and enhancing one of Canada's most important industrial and resource sectors.

3. Purpose

The purpose of this study and assessment is to summarize information regarding the development and application of technology in the forest sector, and to identify opportunities and policy options for increasing the contribution of new technology to the productivity of the sector.

In particular, the study's objectives are to:

- Review some of the trends and problems facing the Canadian forestry industry in its efforts to maintain its international competitive position;

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[5] Governments, industry, labour, academic institutions, the profession, environmental groups.

- Identify specific new technologies being developed for application in all aspects of forestry;
- Discuss the potential of these new technologies to enhance the international competitive position of the forest industry;
- Identify important requirements for successful development and commercialization of technological innovation in forestry-related activities (and significant constraints);
- Identify federal policy initiatives which might be effective in enhancing the development and application of new technologies in the forest sector.

B. OVERVIEW OF CANADA'S FOREST SECTOR

1. ECONOMIC CONTRIBUTION

a) Overview

Canada's forest lands cover 436 million hectares and are relatively evenly dispersed across the country. Comparisons of forest land area with total land area for each region show reasonably close correlation (see Table 1).

Table 1

Distribution of Forest Land in Canada

Region	Share of Canada's land area (percent)	Share of Canada's forest area (percent)
Atlantic (Nfld., N.S., P.E.I., N.B.)	9.6	7.4
Central (Que., Ont.)	24.5	30.8
Prairie (Man, Sask., Alta.)	18.7	20.3
West Coast (B.C.)	16.4	16.5
Territories (Y.T., N.W.T.)	30.8	25.1

Source: G. M. Bonnor. Canada's Forest Inventory, 1981, C.F.S.

However, distribution of wood resources is not so even. About one-third of Canada's forest land is considered to be non-productive. That is, it is incapable of producing a merchantable stand of timber within a reasonable length of time. Furthermore, forest lands vary greatly in their productive capacity and so the forest resource in

terms of volume of timber becomes much less evenly distributed. As can be seen in Table 2, the Central and West Coast provinces, with 43 percent of the country's land, possess 77 percent of the resource volume.

Table 2

Distribution of Productive Forest Land and Timber Volume

Region	Share of Canada's Land Area (percent)	Share of Canada's Productive Forest Area (percent)	Share of Canada's Gross Merchantable Timber Volume (percent)
Atlantic	9.6	8.1	6.2
Central	24.5	41.3	37.3
Prairies	18.7	20.2	12.9
West Coast	16.4	20.8	39.9
Territories	30.8	9.6	4.6

Source: G. M. Bonnor. Canada's Forest Inventory, 1981, C.F.S.

The contribution of the forest industry to Canada's total Gross Domestic Product over the decade 1973 to 1982 has averaged 3.95 percent. Table 3 shows the annual contribution for components of the main forest industry sectors. (It is evident that 1982 was a poor year and this reflects the severe impact of the recent recession on the industry.) See Table 4 for province-by-province contributions to Gross Domestic Product.

Table 3

Forest Industries Contribution to Canadian Gross Domestic Product

Year	Forestry Services		Wood Industries		Paper and Allied Industries		Total Forest Industries	
	$000,000	%	$000,000	%	$000,000	%	$000,000	%
1973	980.1	0.9	1,663.6	1.5	2,149.4	2.0	4,793.1	4.4
1974	1,111.8	0.9	1,480.5	1.2	3,406.8	2.7	5,999.1	4.7
1975	1,080.9	0.7	1,456.6	1.0	2,945.5	2.0	5,483.0	3.7
1976	1,339.8	0.8	1,936.0	1.1	3,436.3	2.0	6,712.1	3.9
1977	1,494.0	0.8	2,440.8	1.3	3,561.6	1.9	7,496.4	4.0
1978	1,681.0	0.8	3,010.2	1.4	4,027.1	1.9	8,718.3	4.1
1979	2,026.9	0.8	3,436.2	1.4	5,051.3	2.1	10,514.4	4.3
1980	2,133.1	0.8	3,019.5	1.1	5,934.7	2.2	11,087.3	4.0
1981	2,037.4	0.7	2,935.2	1.0	6,124.8	2.0	11,097.4	3.5
1982	1,824.2	0.6	2,333.1	0.7	5,316.3	1.6	9,473.6	2.9

Source: Statistics Canada, Cat. No. 13-213 and 61-202.

In 1984, the forest industry shipped $27.8 billion worth of manufactured goods, more than any previous year. Despite this, its share of total Canadian manufacturing shipments has dropped slightly from the peak of 13.8 percent in 1979. Only the food and beverage industry group, with 17.5 percent, exceeds the forest industry's share.

Comparisons of the ten leading manufacturing industries over the three-year period 1980 to 1982 show that the pulp and paper industry is third in value of shipments although in terms of value added it ranks first, far outdistancing the miscellaneous machine and equipment manufacture category.

Table 4

Forest Industries Contribution to Canadian GDP by Province, 1982

Province or Territory	Forest Industries as a percentage of Total GDP
Newfoundland	confidential
Prince Edward Island	-
Nova Scotia	2.7
New Brunswick	5.6
Quebec	3.8
Ontario	2.1
Manitoba	1.2
Saskatchewan	confidential
Alberta	0.8
British Columbia	7.3
Yukon and Northwest Territories	0.1
Canada	2.9

Source: C.F.S., Selected Forestry Statistics, Canada, 1984.

Approximately three quarters of Canada's forest products shipments are exported and the United States is the major market, consuming 72 percent of the exported value.

Over the five-year period 1978 to 1982, forest products accounted for an average of 17 percent of Canada's total export effort. Newsprint, lumber and pulp are the three commodities making up the bulk of the exports.

With such a large proportion of the forest sector's shipments being exported, it is not surprising to find that forest products, as a commodity group, has an enormous positive effect on Canada's balance of trade position. Table 5 lists the main Canadian trade commodity groups, showing the balance of export versus import values.

Table 5

Balance of Trade With the World by Commodity Group, 1980 - 1983
(millions of dollars)

	1980	1981	1982	1983
Forest products	+10,654	+10,809	+ 9,931	+10,676
Live animals	+ 141	+ 29	+ 184	+ 210
Food, feed, beverages and tobacco	+ 3,398	+ 4,350	+ 5,130	+ 5,289
Oil, gas and minerals	+ 3,475	+ 2,952	+ 6,207	+ 7,185
Petroleum products, aluminum & electricity	+ 6,127	+ 5,933	+ 6,095	+ 5,664
Automotive, machinery and electronic	-16,387	-18,773	-10,981	-12,739
Special transactions	- 524	- 240	- 735	- 747
Other	+ 1,909	+ 2,308	+ 2,507	+ 2,503
Total merchandise trade balance	+ 8,793	+ 7,368	+18,338	+18,041

Source: Statistics Canada: Quarterly Estimates of the Canadian Balance of International Payments, Cat. No. 67 - 001.

More Canadians are directly employed in the forest industry sector than in any other industrial group. An average of almost 300,000 people has been employed in this industry during each year of the five-year period 1978 to 1982.

During the five-year period 1978 to 1982, Canada's labour force averaged 11.5 million people, of whom 10.5 million were employed.[6] The forest industry, therefore, directly employed almost 3 percent of Canada's employed population. The indirect and induced employment resulting from the industry activities can only be estimated. One authority suggests that for every two people employed in the primary industry there is one person indirectly employed. These three people in turn induce the employment of at least three others.[7,8] With this assumption, it can be concluded that approximately 900,000 jobs owe their existence to the forest industry. These would represent 8.5 percent of the employment base in Canada.

In many communities across Canada the forest industry provides the only employment generator. In such cases the health and vigour of the local economy directly reflects the performance of the local forest industry. There are estimated to be 358 municipalities (half of them in Quebec) which are reliant on the forest industry.[7,8]

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[6]Statistics Canada, Cat. No. 71 - 201.

[7]F.L.C. Reed and Associates Ltd. The British Columbia Forest Industry, Its Direct and Indirect Impact on the Economy, 1975.

[8]Danielson, R. Sector Profile: Forestry, 1985, MOSST Internal Report.

In terms of wages, the forest industry is also dominant among Canada's manufacturing industries. During the 3-year period 1980 to 1982, the pulp and paper industry led all others and alone paid an average of $1.81 billion in wages and salaries each year. Sawmills followed with $1.71 billion, and iron and steel mills were third with $1.14 billion.[9] In total, the forest industry paid annual wages of $4.83 billion to its direct employees, averaged over the same period.[10] This represents an average of 20 percent of the total wages paid ($23.65 billion)[11] for all Canadian manufacturing activities.

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[9] Statistics Canada, Cat. No. 31 - 203.

[10] Statistics Canada, Cat. No. 25 - 202.

[11] Statistics Canada, Cat. No. 31 - 203.

The employment contribution of the forest industry varies from province to province and, of course, by community. Table 6 shows that the industry directly employs about 2.5 - 3.0 percent of the working population of Canada with a range of between 0.3 percent in Prince Edward Island and 6.3 percent in British Columbia. If indirect and induced jobs are added to direct jobs, the industry accounts for 7.4 - 8.4 percent of all jobs, with a range of 0.9 percent for Prince Edward Island to 18.9 percent for British Columbia.

As an employment generator among the primary resource sectors, the forest sector ranks first or second in ten out of sixteen economic regions in Atlantic Canada, in eight out of ten in Quebec, and in all six of those of Ontario. In British Columbia the forest sector is first in eight economic regions and second in only two, where mining and smelting dominate.[14]

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[14]Danielson, R. Sector Profile:Forestry, 1985, MOSST Internal Report.

A trend toward higher productivity and efficiency has resulted in a decline in the number of forest industry jobs. This trend is reflected in Table 6.

Table 6

Employment by Province 1978 - 1982

(Both sexes, 15+ years)

Province	Population	Total Employment	Forest Industry Direct Employment	% of Total Employment	Forest Industry Direct, Indirect & Induced Employment	% of Total
Newfoundland	405,000	174,000	X	X	X	X
Pr. Edward Is.	92,500	45,000	140	.31	420	.93
Nova Scotia	656,200	313,000	5,717	1.83	17,151	5.48
New Brunswick	503,100	243,000	12,037	4.95	36,111	14.86
Quebec	5,097,200	2,584,000	76,344	2.95	229,032	8.86
Ontario	6,839,600	4,067,000	70,466	1.73	221,398	5.20
Manitoba	797,200	454,000	4,547	1.00	13,641	3.00
Saskatchewan	739,200	426,000	3,304	.78	9,912	2.33
Alberta	1,763,900	1,132,000	9,220	.81	27,660	2.44
B.C.	2,199,100	1,204,000	76,046	6.32	228,138	18.95
Yukon & NWT	48,700	n/a	n/a	n/a	n/a	n/a
Canada (1982)	19,166,300	10,644,000	262,207	2.46	786,621	7.39
Canada (1981)	18,860,200	11,006,000	294,435	2.68	883,305	8.03
(1980)	18,518,100	10,708,000	304,524	2.84	913,572	8.53
(1979)	18,151,100	10,395,000	309,932	2.98	929,796	8.94
(1978)	17,817,200	9,987,000	301,483	3.02	904,449	9.06
5-yr averages	18,502,580	10,548,000	294,516	2.79	883,549	8.38

X = confidential

Source: Statistics Canada, Cat. No. 71-529, Cat. No. 25-202.

b) Discussion

The preceding information indicates that the forest industry is arguably Canada's number one industrial sector and that it is by far the leading resource-based industry in terms of overall economic contribution as well as regional impact.

During the general economic recession of the early 1980s and even through the industry's own cyclical depression period of 1981-1983, the forest sector still maintained its position as the country's main export earner and as a leader in manufactured shipments and value added.

At the same time, the forest sector has continued to be the primary generator of manufacturing employment in the country. Nevertheless, the recent decline of the forest sector's percentage of total Canadian employment is an unmistakable trend resulting from increased mechanization in harvesting, modernization in manufacturing, and belt-tightening throughout. DRIE says this trend will continue and that there will be 10 percent less employment in the sector than the "currently depressed levels" if new investment and modernization take place; 20 percent less if not. Some sub-sectors and regions will suffer more. The pulp and paper sub-sector will probably suffer least.[15]

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[15]From: Macdonald, D. Report of the Royal Commission on the Economic Union and Development Prospects for Canada, 1985.

As will be explained in following sections, the industry faces timber supply problems (in terms of delivered cost, quality and quantity) due to depletion of old-growth timber stands, inadequate management (i.e. insufficient protection, tending and reforestation) as well as alienation of productive forest lands to other uses. Opportunities to expand employment in the traditional ways through increased exploitation of virgin timber stands and installation of new manufacturing capacity have become limited, due to current and pending timber supply problems in many regions.

Forest management is highly labour intensive and represents an investment in maintaining timber supplies to a vital industry. An opportunity exists in forest management for creating at least 20,000 new jobs[16] and thereby reversing the recent trend toward reduced employment in the sector.

Since the forest industry generally exploits the better quality stands of selected tree species and, for the most part, produces primary manufactured products, other opportunities for increased economic output and employment lie in the areas of more secondary (value-addded) manufacturing and improved utilization of the timber resource. These opportunities will also be discussed in following sections of this report.

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[16] C.F.S. A Forest Sector Strategy for Canada, 1981, Environment Canada.

The technologies necessary to realize these opportunities for increasing or maintaining economic contribution are, in many cases, already available. What needs to be looked at first is how to bring about the conditions necessary to take advantage of them and then how to appose incremental technological development.

2. FOREST RESOURCE MANAGEMENT AND GOVERNMENTAL ROLES

a) Overview

In order to address logically the forest sector in relation to the terms of reference for this study, it is necessary to distinguish between the forest resource (i.e. the renewable raw material supply) and the industry (i.e. the processing plants).

Since the resource is almost totally owned by governments and managed directly by them, governments' roles and responsibilities in the sector are major in that they have a near monopoly on raw material supply. On the other hand, the industrial processing side of the sector is almost totally owned by private corporations.

Canada has 436 million hectares of forest land, with about 214 million hectares of this area classed as productive and non-reserved (i.e. available for harvesting). Ownership of this productive, non-reserved forest land is as follows:

Provincial governments	82%
Federal government	10% (mostly in the Territories)
Private	8%[17]

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[17] Bonnor, G. M. Canada's Forest Inventory - 1981, 1982, C.F.S.

b) The Federal Government's Role

Constitutionally, ownership of the country's forest resource is vested with the provinces. Thus, the role of the federal government relative to the forest sector is limited to such areas as taxation, various investment/employment programs, research, and external linkages such as tariffs and export market assistance. But it also plays a role in forest management through jointly funded federal-provincial forest development agreements and through its own holdings of 10 percent of the productive, non-reserved forest land base.

The Canadian Forestry Service (C.F.S.) is the principal source of federal expertise in forestry. Lodged within the Department of Agriculture, its general objective is to promote the wise management and use of Canada's forest resources for the economic, social and environmental benefit of Canadians.

At its zenith in 1968, the C.F.S. (which at that time had full departmental status and a different name) had a staff of about 2,200, compared to approximately 1,300 today. Its duties included forest and forest products research as well as a series of federal-provincial forest improvement agreements which had federal contributions totalling about $200 million (in 1985 dollars) over the period 1954-1967. After 1968, federal interest in forestry waned, the C.F.S.'s size and status were reduced dramatically, and other departments assumed responsibility for some C.F.S. functions, notably the federal-provincial agreements[18].

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[18] McCredie, A. Federal-Provincial Forestry Agreements, Forestry Chronicle, August, 1985.

Since 1980-81, federal interest in forestry has gradually increased and in 1982 the C.F.S. was once again given responsibility for negotiating and administering federal-provincial forestry agreements. In 1985-86, federal contributions will total approximately $46 million under these agreements. The ten agreements are summarized in Appendix I. This summary shows a heavy commitment in each of R and D and technology transfer.

The Canadian Forestry Service is comprised of a Headquarters Unit, six regional Forest Research Centres and two National (Research) Institutes. The regional Research Centres address regional priorities and maintain liaison with the respective provincial forestry departments and other clients. The National Institutes provide the focus for programs of national scope.

The following are the stated functions of the C.F.S.:

- Coordination of federal policies, for the promotion of better resource management and forest industry development.
- Provision of scientific and technological leadership in forestry through research and development.
- Provision and analysis of national and international statistics and information as a basis for policy formation.
- Development and certification of codes and standards for wood product performance.
- Protection of Canada's forests from foreign pests.
- Fostering the potential use of the forest resource for energy.
- Contributing to the environmental objectives of the Canadian government.

The C.F.S.'s main function remains in research and development. It's work in this area is described in a later section of this report.

A number of other federal agencies are involved in forestry programs and a Federal Forest Sector Strategy Committee has been established to coordinate federal forestry activites. The Canadian Forestry Service has been designated the lead agency role.

Other than the C.F.S.'s duties, the federal government's role in the forest sector mainly involves trade issues and export marketing (Industry, Trade and Commerce; External Affairs), regional development and employment incentive/grant programs (Department of Regional Industrial Expansion; Employment and Immigration), taxation (Finance), and federal land management (Indian and Northern Affairs; Environment Canada). Mostly, these involvements are part of broader, cross-sectoral programs. They rarely arise from or address the forest sector per se.

Lands directly under federal administration comprise 920,000 hectares, or about 25 percent of the forest land in Canada. These holdings include the Northwest and Yukon Territories, Indian Reserves, Department of National Defence areas, National Parks, and other smaller holdings such as airports and forest research areas. The areas of federal forest land by productivity, stocking and agency are shown in Appendix II, along with background on the agencies directly responsible for these lands.

Although 920,000 hectares is a significant land area, 81 percent is located in the Territores, far from economically viable markets, and other vast areas are unproductive or unavailable for harvesting. Thus, federal lands account for less than one half of one percent of Canada's annual timber harvest.[19]

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[19]Canadian Forestry Service. Forest Harvest on Federal Lands, 1976 - 1981, Petawawa National Forestry Institute, 1984.

A 1984 tally listed 27 federal programs or systems of assistance to the forest sector, all in some way related to the development or application of improved technologies. Sixteen of these were applicable but not specific to the forest sector, including: regional development grants, loans, guarantees and subsidies for installation of new manufacturing facilities or upgrading of old; grants and jointly funded technology transfer and R and D programs; job creation and training assistance; rural development studies and base data collection; development of industrial infrastructures; taxation measures.

The eleven programs or systems specific to the forest industry included: grants to install renewable energy systems; forest biomass energy R and D; the C.F.S.'s programs; job creation; cost shared overseas marketing programs; funding of forestry R and D organizations; federal-provincial forest management/development agreements; pulp and paper mill modernization grants and subsidies.

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[20]Larose, P. Federal Assistance to the Forest Sector, 1984, C.F.S. Internal Report.

Of particular note is DRIE's Pulp and Paper Modernization Program.[21] Begun in 1979 and ended in 1985, PPMP was aimed at reducing pollution and improving international competitiveness. Industry, provincial governments and DRIE shared the costs, with the federal contribution totalling $294 million. This program particularly helped reduce oil consumption, reduce water and air pollution and improve paper machine efficiency.

No province west of Ontario was involved. Western companies apparently felt their pulp and paper mills were fairly modern and therefore wanted the federal government to invest in helping the provinces manage and renew the forest resource. However, federal contributions to the joint federal-provincial Forest Development Agreements between 1979/80 and 1983/84 were $45 million for the western provinces and $278 million for the eastern ones.

These figures and other C.F.S./DRIE information show a substantial federal involvement at the operational level in the application of technologies in the forest sector. But there is an unevenness in this involvement which reflects political and regional influences more so than just needs.

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[21]Personal Communication with DRIE, 1985.

c) Provincial Roles

Compared to the federal government's involvement in the forest sector, a far more intimate and complex role exists for the provinces by virtue of the constitutitional structure of the country relating to forest land ownership. The historic trend in Canada (unlike most Western countries) has been to maintain public land ownership and, constitutionally, this ownership is vested in the provinces. The proportion of provincial ownership increases from east to west because of settlement history.

This ownership pattern has required each province to devise, over time, an array of forest tenure systems (leases, licences, permits and agreements) providing the statutory basis for the forest industry to extract and often manage the timber resources on provincially owned lands. Imposed on these tenure systems is a complex body of regulation, policy and resource revenue collection procedures devised by each province.

There are common elements in all the many tenure systems, but there are also wide variations arising from the particular historical, political, social and economic priorities of each province. The result is that the forest industry in the provinces exists mostly in a state of an unavoidably close but tense "partnership" with the provincial governments. Because of the inescapable need for cooperation between the timber using industries and the timber owning provinces, the federal government is largely an interested observer (and recently a significant funder) of the forest land management process. Generally

the system does work, however.

Provincial government policies tend to be relatively balanced and coherent towards the forest industry in most provinces. Policies tend to be supportive throughout the country but mostly so in those provinces where the relative economic significance of the industry is greatest. The major areas of inconsistency and conflict arise in the areas of revenue extraction, land withdrawal for non-forestry uses and funding of forest management.

An array of public forest tenure, management and timber pricing systems has evolved, reflecting the needs of each province. Despite the bewildering variety of forest tenure forms, there are certain fundamental similarities among the provincial systems:

- The aspect of industrial pioneering in frontier areas is pervasive in all systems and has been an historic and continuing philosophical element for a hundred years to the present.

- Many of the older tenure systems in the earliest developed provinces contain residual, historic, quasi-private property rights. Many of these are more analogous to private than to public timber ownership.

- All are based on some form of sustained yield management criteria in the establishment of allowable annual cut.

- There is a general sharing of responsibility and cost for forest management and the development of infrastructure, again with a pervasive frontier-pioneering element.

- The extraction of revenue by statute and regulation usually involves a land rental charge, various user taxes and fees, and a stumpage charge. Stumpage dues are nearly always based upon some form of residual value or transactional analysis, either periodic or continuous.

- In all tenure systems there is a strong theme of fiat and trust required of the parties. This arises from widespread use of government discretion. As a result, people have

learned to "live with the system" to a degree that is difficult for outsiders in other sectors to comprehend.

- The aspect of progressive concentration of timber cutting rights into the hands of fewer private holders does not appear to be a significant trend. In any province where such a process has occurred, it has almost exclusively been one of government, not private, ownership concentration.

Most provinces have developed, or are in the process of developing, a package of tenure forms which can be characterized as follows:

- Large, area-based licences awarded by negotiation to support large investment, such as pulp mills, which require long periods for capital amortization. These are normally for terms of 25 years or more and are renewable by negotiation.

- Medium-sized, volume-based agreements awarded on the basis of negotiation, historic performance or auction to support investments such as sawmills, which require shorter amortization periods. These are usually for terms of 10 years or more and are renewable by negotiation.

- Small, non-renewable licences usually sold at auction to supply discontinuous operations. These are mainly for terms of five years or less.

- A variety of permits based on direct award for purposes of obtaining fuelwood and harvesting minor products, particularly by rural populations.

The provincial governments' role in forestry R and D is described later in this report.

d) Taxation

The forest industry in Canada has recently sustained a period of very low earnings. This has resulted in an industry with a deficient financial base which is unable to raise capital through debt or equity financing in order to make investment in required and available technological improvement. The result is a process of expanding obsolescence in the industry, particularly in pulp and paper, which is diminishing in international competitiveness. The industry requires additional capital to apply the required technology. Because of corporate financial deficits and large pre-tax losses, present incentives in the tax system (accelerated write-offs, deferrals, tax credits, etc.) tend to be meaningless in terms of accumulating investment capital for technological change.[22]

What appears to be required is some form of negative tax, some type of refundability of tax credits, or a method of transferring losses through the system to investors (such as has been applied in oil and gas exploration). This subject has been reviewed exhaustively[22,23]

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[22] Puusepp, J. Mobilizing Private Sector Investment - The Developed World, 1985, Speech to the 12th Commonwealth Forestry Conference.

[23] Macdonald, D. Report to the Royal Commission on the Economic Union and Development of Prospects for Canada, 1985.

and is beyond the scope of this report. But without some type of tax reform aimed at promoting or maintaining technological improvement during the depressed periods of the industry's cyclical nature, the development and introduction of new technologies will continue to be below par.

In 1984, the C.F.S. carried out a detailed examination of Canada's tax system to ascertain its impact on forest management in general and intensive forest management specifically.[24] This study's findings apply equally well to the tax system's impact on private sector R and D. The following key observations were made in the C.F.S. report:

- The Canadian tax system's preference for tax incentives "favouring capital spending through investment credits and for accelerated capital cost allowance over labour spending, appears to have become more or less permanently imbedded in the tax structure without any empirical evidence of the consequence of this non-neutrality aspect in the long term."

  The "long-standing problem of failing to induce private investment in forest management activities and (R and D) on public forest lands because of barriers to an equity in the future crops seems insoluble, despite the expensive provision of expenditures for essentially longer term capital gains."

- The Income Tax Act and regulations "afford no particular preferential treatment to commercial (or R and D) activities in forestry."

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[24] Boulter, D. Taxation and the Forestry Sector, Economics Branch, C.F.S., 1984.

e) Coherence of Governments' Policies

By definition the industry, as the source of both resource user fees to the provinces and income and other taxes to the national government, is in constant conflict with both governments over the amounts and categories of revenue extracted from it. Because of the constitutional authorities of each of the governments, this leads to a conflict between the provinces and the federal government over the relative shares which can be extracted from the industry either as resource user fees or as income tax. The incentive for the provinces is to extract as high a proportion as possible in the form of their own resource user fees before federal income tax. The incentive of the federal government is obviously the reverse. The industry is the reluctant object of this conflict.

A second major area of conflict between provincial and federal governments and between both governments and the industry is the withdrawal of land from timber management to other forms of exclusive use such as parks. This process gives rise to an array of conflicts at all levels. Industry faces problems of curtailed raw material supply and loss of infrastructure investments. The province loses resource-user income and employment base. The federal government loses tax base and so on. These issues are a constant factor impinging on the entire sector and are amply documented elsewhere.[25]

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[25]Anonymous. Forest Land for the Future, 1981, Forest Industry Task Force on Forest Land for the Future.

The major area of policy inconsistency by both the provincial and federal governments is that of forest management and related R and D funding. Forest management requires sustained long-term funding programs which are consistent over time. This is a simple and obvious requirement for the necessary long-term nature of timber crops, but it has been historically unattainable anywhere in the country. Programs have been repeatedly devised to provide workable long-term funding mechanisms but all have failed to be consistent or sustained. The result is an undermanaged forest resource, the extent and implications of which are documented in various studies and reports.[26,27]

Apart from the expected and regular complaints from the forest industry concerning the array of regulation applied by the provinces under the forest tenure systems, and by the federal government under its jurisdictions, there exist other issues of particular difficulty. Because of the size of the forest resource, the forest industry "occupies" a very large area of the land base of the country. This occupation includes both area under licence and area not yet under licence but reserved by the provinces for future forestry use.

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[26] F. L. C. Reed and Associates. Forest Management in Canada, 1978. Consultant's Report to the C.F.S.

[27] C.F.S. A Forest Sector Strategy for Canada, 1981, Environment Canada.

The extensive land area required to sustain forestry operations leads inevitably to conflict with other potential land and resource uses, and these conflicts involve both provincial and federal governments.

These jurisdictional issues take three major forms: provincial interdepartmental conflicts, federal/provincial conflicts, and "public works" conflicts.

Provincial interdepartmental conflicts arise where different land uses are administered by different departments on the same industrial licence area. In these cases the industrial licensee must contend with separate agencies of the same government, each administering separate statutes and policies which are sometimes in conflict with one another. These conflicts create difficulties for the industry in terms of administrative time, operational delays, imposed cost, diminished supply base, and so on. Common examples are forestry in conflict with wildlife management, fisheries management, grazing activities, recreational use, aesthetics and conversion of productive forest land to marginal agricultural use.

Federal/provincial conflicts arise where the two levels of government contend for the use of the same forest land or where federal and provincial agencies have separate statutory authority for resource management on the same area. An example of the first situation is the periodic effort by the federal government to establish national parks on forest lands within the provinces. This impinges on the industry when it occurs, leading to added administrative costs and, in the most drastic situations, loss of forest cutting rights with which to sustain

manufacturing. An example of the second situation is the effect of federal jurisdiction in the management of the ocean fisheries resource through imposition of regulation and constraint on the management of fresh water spawning streams located on provincial forest lands (mainly B.C.). Again there can be an array of costs, closures, legal actions, delays and so on imposed on the industrial user. Similar examples relate to pollution control regulation where cost is imposed on the forest resource user in order to protect some other resource.

A constant and recurring source of difficulty between the provincial governments and industry arises from "public works" requirements on many licence agreements. This takes the form of requiring the industrial user to provide facilities or adhere to engineering or other standards which would not normally be required in the process of timber extraction. Examples are provision of excessive standards to road design or location to accommodate public access, provision of recreational facilities, and so on. There is usually a financial compensation mechanisn for this, but it is often not adequate and leads to conflict. In addition, this process leads to a "leakage" of provincial resource income to subsidize other uses.

Mainly through the adoption by the federal Cabinet in 1981 and 1982 of the policy/strategy documents entitled A Forest Sector Strategy for Canada and A Framework for Forest Renewal, Canadian Forestry Service policies and programs (particularly the "new generation" of federal-provincial forestry agreements) have become much more coherent and in tune with provincial forest management policies and programmes.

Federal-provincial cooperation in the area of forest management policy and related R and D responsibilities has been strengthened and abetted by the Canadian Council of Resource and Environment Ministries (CCREM)[28] and, more recently, the Canadian Council of Forest Ministers.

From an industrial viewpoint, the major difficulty, both in dealing with government (provincial) and in the coherence of forest management policies, lies almost entirely in the issue of timber supply (quality and quantity).

One aspect of this timber supply problem relates to the forest tenure systems described earlier, which vary widely in refinement as well as in degree of licensee security. The trend across Canada is toward long-term, area-based forest management agreements between the provinces and individual licensees (companies which usually operate at least one manufacturing facility) which provide secure, long-term wood supplies. At the same time, these agreements call for more of a "partnership" in terms of sharing operational and financial

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[28]CCREM. Forestry Imperatives for Canada: A Proposal for Forest Policy in Canada, 1979.

responsibilities for forest management activites. This trend in tenure policy seems to be heading in the right direction toward providing security of timber supply and concomitant responsibility for forest land stewardship, but success in terms of maintaining modern manufacturing capabilities and appropriate timber supplies is far from proven at this time. However, increasing industry's responsibilities in forest management will lead to an increased role in related R and D. This increased R and D involvement can only be beneficial.

The other aspect of the timber supply problem stems from too little funding of forest protection renewal, follow-up management and related R and D. The consensus is that the current rate of timber supply (both in terms of quality and quantity) cannot be maintained without a substantial increase in silvicultural and protection funding. The public, governments and industry seem to know, and generally agree upon, what must be done. Most of the necessary policies are formulated, if not actually adopted. Effective implementation and follow-up are still to come.

As Donald Macdonald put it, "It will be difficult to design a policy that will embody enough patience to wait for trees to grow to maturity. Nevertheless, a policy of intensive forest management, that is, of forest husbandry, is essential."[29]

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29Macdonald, D. Report of the Royal Commission on the Economic Union and Development Prospects for Canada, 1985.

Through a series of formal R and D agreements, the provincial forestry departments and the C.F.S. regional research centres have divided the various aspects of forest management oriented research and development between themselves so as to coordinate efforts and minimize duplication. Since both provincial and federal representatives usually sit on the boards or steering committees of the various cooperative forestry R and D organizations, government backed or delivered R and D programs are usually coherent and coordinated. Where industry has problems in gaining support and/or guidance for new R and D initiatives is in fields that overlap both federal and provincial R and D responsibility areas, as well as in fields which are outside the approved program areas of the two levels of government.

Government R and D budgets are normally tight and programs so rigidly defined that there is little room to consider peculiar industrial initiatives. In other words, discretionary R and D budget allocations, unplanned initiatives and, consequently innovation, are limited. This is particularly true of the provincial forestry departments. The federal government has a way around this problem with its unsolicited R and D proposal program under the Department of Supply and Services, but the C.F.S. still needs to use its budget to pay for part of the costs of an unsolicited project and sometimes this unsolicited proposal program is used to augment ongoing R and D programs, not start new ones.

Where government policies are particularly incoherent is in the area of assistance to industry to modernize (introduce improved or new

technology). Because large amounts of money are involved (tax concessions, loans, guarantees of loans, grants, retraining allowances, timber royalty concessions, etc.), the process of acquiring assistance is highly politicized and discretionary.

Characteristically, provincial and federal government policies related to supporting private sector R and D and technological innovation are conservative and administratively burdensome. Support programs and opportunities open to the private sector are heavily weighted toward supporting low-risk projects of short duration. Red tape and heavy administrative requirements discourage participation by many entrepreneurs and genuine innovators.

f) The Level of Forest Management

Total expenditures by industry and governments on forest management[30] in Canada increased from $660 million in 1977 to $1,248 million in 1981.[31] See Table 7 for a province-by-province breakdown of the 1981 total. In real terms, this equates to an annual 4.75 percent increase, compounded.[31] Provincial governments spent 63 percent of the 1981 total, the federal government 11 percent and industry 26 percent.[31]

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[30]Forest management, for the purposes of this report, includes the range of activities associated with administering and developing Canada's forests: renewal, access roads, research, protection, tending, inventory, etc.

[31]Smyth, J. H. et al. Forest Management Expenditures in Canada, 1977-1981, Great Lakes Forest Research Centre, C.F.S. and CPPA, 1984.

Table 7

Expenditures on Forest Management by Province and Activity - 1981

Province	Silviculture	Protection	Access	Research	Other	Total
			$000,000			
Newfoundland	4.0	7.6	4.8	3.4	9.4	29.2
Pr. Edward Is.	1.7	0.1	0.1	0.3	1.0	3.2
Nova Scotia	8.7	3.7	6.1	0.3	7.2	26.0
New Brunswick	17.9	15.6	2.9	6.5	19.0	61.9
Quebec	43.1	29.9	53.7	7.7	73.9	208.3
Ontario	80.4	52.3	43.6	17.5	35.9	229.7
Manitoba	1.3	11.6	2.4	0.0	2.8	18.1
Saskatchewan	4.0	26.4	6.3	0.0	4.5	41.2
Alberta	12.8	76.8	7.7	5.7	28.4	131.4
British Columbia	98.4	65.3	137.7	15.0	157.6	474.0
Subtotal	272.3	289.3	265.3	56.4	339.7	1,223.0
Yukon & NWT	0.0	22.3	0.0	0.0	2.4	24.7
TOTAL	272.3	311.6	265.3	56.4	342.1	1,247.7

Source: Smyth, J.H. et al. Forest Management Expenditures in Canada, 1977-81, 1984, C.F.S., G.L.F.R.C., C.P.P.A.

The 1981 provincial and federal governments' forest management expenditures' total of $928.2 million[32] compares to expected 1983 revenues of about $3,000 million, including stumpage, sales and excise taxes, income tax and import duties from the forest industry and its employees.[33]

More particularly, direct provincial forest service revenues from commercial timber operations[34] averaged $372 million per year over the period 1976/77 to 1981/82. Over that same period, commercial forestry expenditures[35] on public forest lands related directly to timber harvesting operations averaged $111 million per year[36]. These figures serve to show that commercial timber harvesting operations on

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[32] Smyth, J.H. et al. Forest Management Expenditures in Canada, 1977-1981, 1984, C.F.S., G.L.F.R.C., and C.P.P.A.

[33] Reed, F. L. C. The Case for Investing in Forestry, Faculty of Forestry, University of British Columbia, 1985.

[34] Direct revenue forms typically include stumpage, tenure fees and rental, royalties, scaling charges, protection taxes and charges, reforestation levies, insect protection levies, road charges, fines and penalties, and other miscellaneous charges, such as interest.

[35] Commercial forestry expenditures involve administration, road building, monitoring performance of licensees, revenue collection, scaling, field layout of harvest blocks, appraisal and valuation, and calculation of timber availability.

[36] Woodbridge, Reed and Associates Ltd. Report on Revenues and Expenditures of Canadian Provinces Relating to Commercial Timber Operations, prepared for the Canadian Softwood Lumber Committee, 1983.

provincial lands netted about $261 million per year in income to the provincial forestry services, with 85 percent of this total belonging to British Columbia. This $261 million in net income compares to the $196 million spent by the provincial governments in 1981 on silviculture, $263 million on protection and $16 million on research.[37]

The 1981 total silvicultural expenditures (from all sources) of $272 million (Table 7) compares to the $600 million per year called for by 60 "senior decision-makers" from government, industry and the universities in 1981 at the "Banff Forestry Conference".[38] The 1981 expenditure of $312 million on forest protection compares to the $500 million recommended by the Conference.

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[37] Smyth, J. H. et al. Forest Management Expenditures in Canada, 1977-1981, Great Lakes Forest Research Centre, C.F.S. and CPPA, 1984.

[38] Banff Centre and Institute for Research on Public Policy, Canada's Forests: Transition to Management - An Agenda for Action, 1981.

In operational terms, Table 8 compares silvicultural activity to harvesting activity in order to roughly show the level of forest management in one of the two key forest management categories (the other being protection). The compilers of the data in Table 8[39] conclude that, while the levels of site preparation, planting and seeding in Canada are increasing, they are totally inadequate if a policy of sustained yield management is to be implemented, and that the level of stand tending is of minor significance in Canada as a whole.

Table 8

Comparison of Areas of Silvicultural Treatments to Areas Harvested in Canada

Five-year average for the period 1975/76 to 1979/80

(hectares)

Area Harvested		759,438
Area of Site Preparation	165,916	
Area Planted and Seeded	166,096	
Area of Stand Tending	66,869	
Area of Silvicultural Treatment	398,881	
Area treated as a % of the Area Harvested		53%

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[39] Brace, L. G. and Golec, P. J. Silvicultural Statistics for Canada, 1975-80. Northern Forest Research Centre, C.F.S., 1982.

As indicated by the preceding data, Dr. Gordon Weetman[40] of the University of British Columbia has pointed out that the average level of silvicultural practice and forest management in Canada is extremely low in terms of its development toward an intensive, integrated stage of practice. He concludes that the level of silvicultural practice in all provinces except British Columbia is constrained by a shortage of stumpage revenues from timber harvesting and in British Columbia by "perceived higher priorities for timber revenue". He speculates that, over the next 20 years, whether or not Canadian silviculture on Crown lands will move from an extensive (low) level of practice towards an intensive (high) level "will largely depend on the success of provincial/federal/industrial mechanisms to put more than one nickel of every dollar generated back into the forest."

In the most comprehensive quantitative study of the management of Canada's forests[41], the authors conclude:

- "Overall, Canadian forests still contain a physical supply of... timber...that is sufficient to maintain or modestly expand current levels of harvest....But the (forest land) base is being

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[40] Weetman, G. F. The Evolution and Status of Canadian Silvicultural Practice, Forestry Chronicle, April, 1982.

[41] Honer, T. G. and Bickerstaff, A. Canada's Forest Area and Wood Volume Balance, 1977-1981, Pacific Forestry Centre, C.F.S., 1985.

eroded by regeneration failures and land withdrawals (for non-forestry uses). To maintain the (forest land) base, substantial investments in expanded forest renewal programs are required. Such investments must be safeguarded by reducing volume losses from fire, insect and disease which now almost equal the total volume harvested, and dissipate almost one half of the long-term sustainable growth. Silvicultural input... (is) not yet having significant impact on current productivity."

- "Is Canada running out of wood? Current statistics indicate that (overall) a surplus of old growth timber is available for, harvest, however, these data tend to mask the local and regional shortages that do exist."

- "Are we planting enough trees? About 20 percent of the lands that are depleted annually due to harvest, fire and pests go out of production, i.e. no longer produce commercial tree crops, even though efforts in forest renewal have increased markedly."

- "Are we cutting too many? The data suggest that harvesting levels can increase to take advantage of forecasted demands for forest products, however, all cutover lands must be restocked immediately to ensure continued prosperity from our forests."

3. PROFILE OF THE CANADIAN FOREST INDUSTRY

a) General Description

The flowchart diagram on the following page outlines very simply the structure of Canada's forest sector.

There are over 5,000 corporations in Canada's forest products industry, with 7,000 - 8,000 manufacturing establishments. Timber is processed in 141 pulp and paper mills, about 1,100 "larger" sawmills, roughly 150 shake and shingle mills, just over 100 panel products plants, and up to 2,000 other types of facilities (e.g. sash and door, boxes, coffins, wood preservation plants).[42-47] Appendix III contains more detailed statistics, including provincial breakdowns.

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[42] Forest Industries Advisory Committee. Interim Report to the Minister of Industry, Trade and Commerce, 1983.

[43] C.F.S. A Forest Sector Strategy for Canada, 1981, Environment Canada.

[44] C.F.S. Selected Forestry Statistics - Canada, 1984, 1985, Economics Branch.

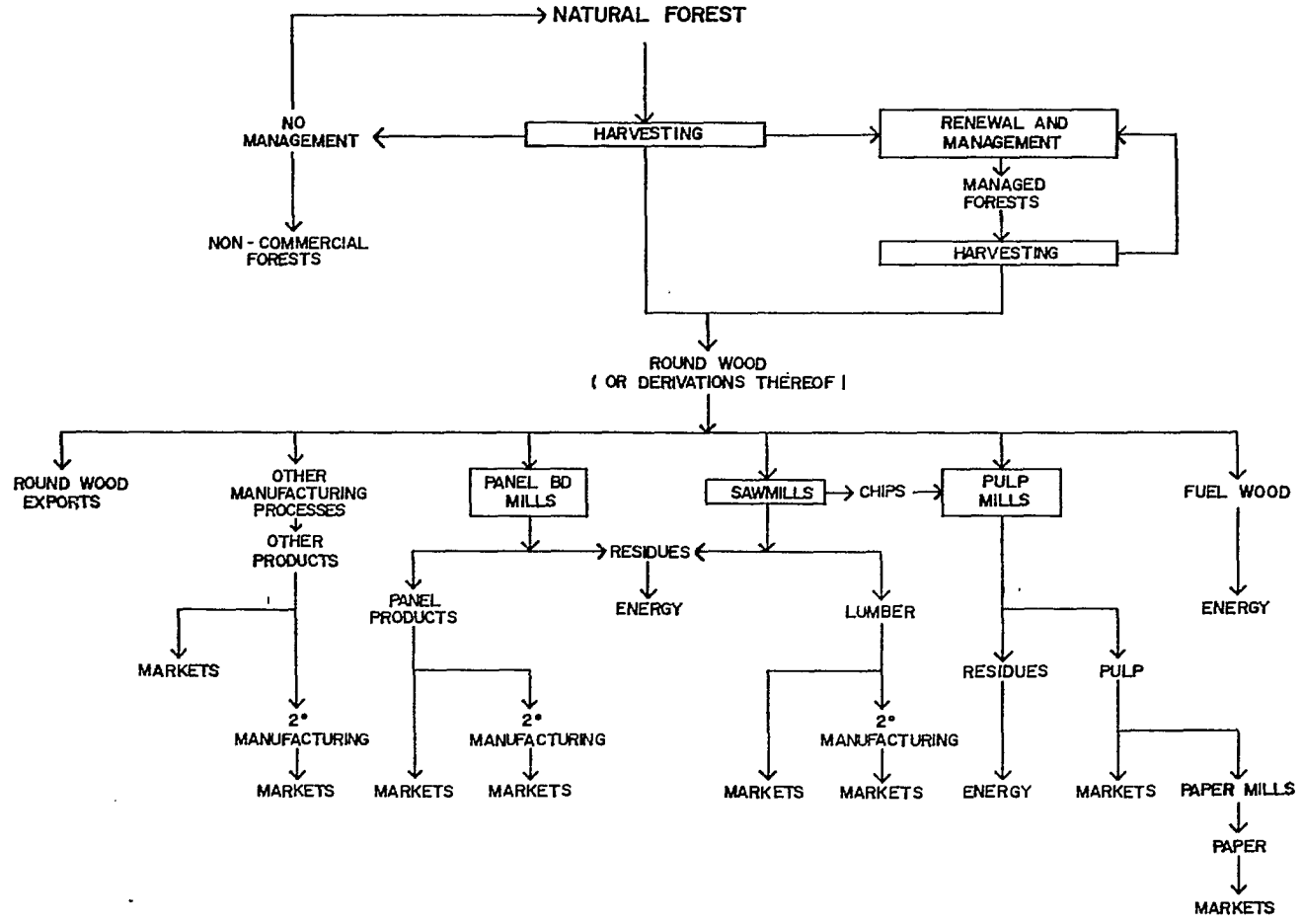
[45] Canadian Pulp and Paper Association. Reference Tables, 1983, 1984.

[46] Statistics Canada. Various catalogues.

[47] Sterling Wood Group Inc. The Canadian Forest Resource, Tenures, and Timber Pricing Systems, 1985. Consultant's report to the Canadian Forestry Service.

FIGURE I

SIMPLIFIED SCHEMATIC
OF
CANADA'S FOREST SECTOR PRODUCT FLOWS



PRIMARY SUB - SECTOR

FIGURE I

The lumber and pulp and paper sub-sectors, which on average account for 60-70 percent of total shipments, are mainly aimed at export markets and operate in a relatively duty/tariff/quota free environment. The other sub-sectors mainly serve domestic markets.[48,49]

Early in 1984, the C.F.S. prepared a very brief report on inter-corporate ties in the Canadian forest sector. The key points in the report were:

- Almost all the major companies in the industry are linked in some way;
- Since 1971, U.S. ownership has decreased markedly, while provincial governments have become increasingly involved in ownership.[50] (No statistics are provided.)

The report attributes these findings to: corporate uncertainty caused by "a clear lack of consistent land use policy"; a desire to secure timber supplies; and an anticipated increase in world demand for forest products.

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[48] Forest Industries Advisory Committee. Interim Report to the Minister of Industry, Trade and Commerce, 1983.

[49] C.F.S. A Forest Sector Strategy for Canada, 1981, Environment Canada.

[50] Larose, P. Inter-Corporate Ties in the Canadian Forest Sector, Unpublished report, Economics Branch, C.F.S., 1984.

The pattern of corporate size and concentration in terms of value of shipments is presented in general terms in Figure 2.[51] It shows that production in the more capital intensive pulp, paper and allied products sub-sector is concentrated in much fewer firms than in the harvesting and solid wood products sub-sectors. In numerical terms, the corporate concentration pattern in Canada's forest industry is as follows:

- In harvesting:
  25% of total shipments from 0.15% of enterprises
  50% of total shipments from 0.61% of enterprises
  70% of total shipments from 1.60% of enterprises

- In wood industries:
  25% of total shipments from 0.16% of enterprises
  50% of total shipments from 0.59% of enterprises
  70% of total shipments from 1.50% of enterprises

- In paper and allied:
  25% of total shipments from 0.32% of enterprises
  50% of total shipments from 1.13% of enterprises
  70% of total shipments from 2.44% of enterprises.

In general, concentration in all sub-sectors has increased markedly over the past ten years. This pattern reflects the economics of scale and the inability of smaller firms to raise the necessary capital to compete effectively in world markets.

Latest Statistics Canada reports concerning ownership and control are available only to 1981. It is reported that, of the 7,428 harvesting and manufacturing establishments within the industry, 95 percent is Canadian owned, 4 percent is U.S. controlled, and one percent is controlled by other foreign ownership (see Table 9).

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[51] Detailed statistics from which Figure 2 is derived are presented in Appendix III.

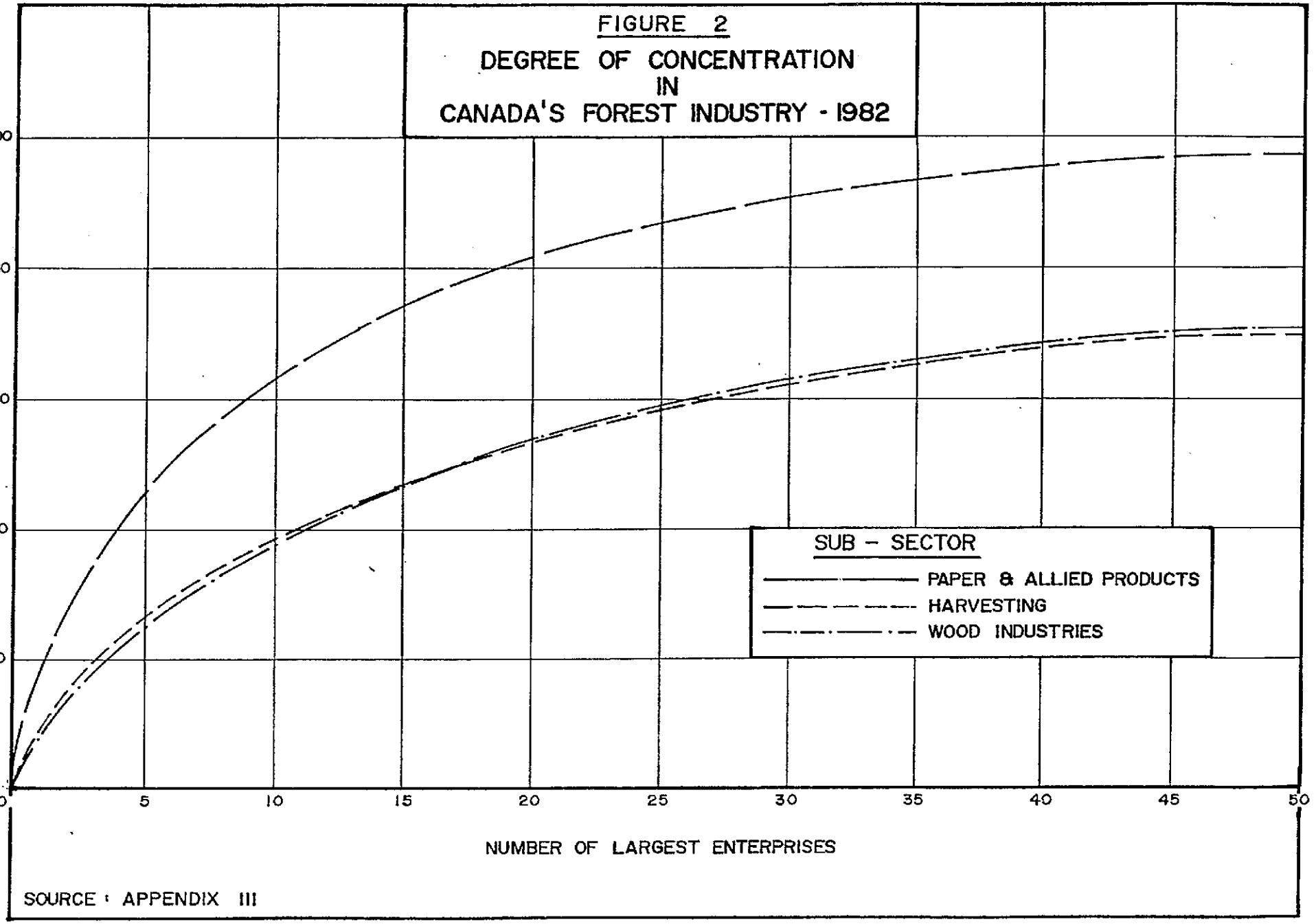
FIGURE 2
DEGREE OF CONCENTRATION
IN
CANADA'S FOREST INDUSTRY - 1982
PERCENT OF SHIPMENT VALUES
100
80
60
40
20
0
5
10
15
20
25
30
35
40
45
50
NUMBER OF LARGEST ENTERPRISES
SUB - SECTOR
PAPER & ALLIED PRODUCTS
HARVESTING
WOOD INDUSTRIES
SOURCE : APPENDIX III

Table 9

Ownership of Establishments in the Canadian Forest Industry (1981)

Sector	Total	Ownership		
		Canadian	U.S.	Other foreign
		(Numbers of Establishments)		
Harvesting	3,276	3,192	63	21
Wood	3,394	3,262	98	34
Paper and Allied	758	602	110	46
TOTAL	7,428	7,056	271	101
Percent		95%	4%	1%

Source: Statistics Canada, Cat. No. 31 - 401 (1985).

The Canadian share of the industry drops to 73 percent if ownership is measured in terms of the value of shipments, as can be seen in Table 10. This demonstrates that foreign controlled firms are generally large in size, usually branches of multi-national corporations.

Table 10

Ownership by Value of Shipments from Canada's Forest Industry (1981)

Sector	Shipments ($000,000)	Percent Ownership: Canadian	U.S.	Other foreign
Logging	4,430*	74	19	7
Wood industries	8,436	80	16	4
Paper & Allied	15,729	69	22	9
TOTAL	28,595	73	20	7

*Note: Shipments in the logging industry are interpreted as the value of logging activity.

Source: Statistics Canada, Cat. No. 31 - 401 (1985).

The data in Appendix III show that most foreign interest is in Ontario, British Columbia and Quebec, and that most of this is in the paper and allied products sector.

For the larger companies, control is heavily weighted to Canadian ownership. Five of the companies in the Financial Post 500 list of the 10 largest forest products companies are wholly Canadian owned (see Table 11).

Table 11

Canada's Top Ten Forest Products Companies

by Sales or Operating Revenue in 1984

Rank	Company	Sales or Operating Revenue $'000	Ownership %	
			Canadian	Foreign
1	Abitibi-Price Inc.	2,137,169	100	-
2	MacMillan Bloedel Ltd.	2,127,600	100	-
3	Domtar Inc.	2,044,300	100	-
4	Consolidated Bathurst Inc.	1,622,984	81	19
5	Canfor Corp.	1,029,532	100	-
6	British Columbia Forest Products Ltd.	1,014,726	54	46
7	Crown Forest Industries Ltd.	740,763	4	96
8	Weldwood of Canada Ltd.	572,348	24	76
9	Kruger Inc.	451,248	100	-
10	Boise Cascade Canada Ltd.	450,000	-	100
	TOTAL TOP TEN	12,190,670	81	19

Note: This list does not include subsidiaries of companies which have been classified and compiled under another category, e.g. Westar Timber is a subsidiary of B.C.R.I.C., but would probably be ranked 6 or 7 if included; other than MacMillan Bloedel, the Noranda group of forest products companies is missed.

Source: The Financial Post 500, Summer 1985, MacLean Hunter Publications.

b) The Lumber Sub-sector

Canadian sawmills produced 21,134 million board feet of lumber in 1984. Most of this was from British Columbia (see Table 12).

Table 12

Canadian Lumber Production (1984)

(hardwoods and softwoods)

	million bd.ft.	% of Canada
B.C. Coast	3,903	18.5
B.C. Interior	9,175	43.4
TOTAL B.C.	13,078	61.9
East of Rockies	8,056	38.1
TOTAL CANADA	21,134	100.0

Source: Forest Industries Magazine, July 1985, Miller Freeman Publications.

Almost a quarter of Canada's lumber production came from five companies: Canfor Corp.; British Columbia Forest Products Ltd.; West Fraser Mills, Ltd.; Weldwood of Canada Ltd.; and, MacMillan Bloedel Ltd. Over half of the 1984 production derived from 20 mills. There is a 35 percent foreign ownership in these 20 highest producing mills and, although no figures are available beyond that first 20, it is likely that foreign ownership decreases as the size of establishments becomes smaller. Table 13 ranks the contribution toward the first 80 percent of Canadian lumber production and shows the ownership pattern for the 20 largest lumber producing companies. Detailed listings of companies,

production and ownership are presented in Appendix III.

Table 13

Hierarchical Production of Lumber and Ownership in the Canadian Lumber Industry

Rank	Ownership %		Production	% of Canada total
	Canadian	Foreign	million bd.ft.	
First 5	66	34	4,853	23.0
10	65	35	7,674	36.3
20	65	35	10,766	50.9
30			12,601	59.6
40			14,016	66.3
50			14,923	70.6
75			16,347	77.3
100			16,952	80.2

Sources: 1. Forest Industries, July 1985.

2. Ownership from the Financial Post 500, 1985, MacLean Hunter Ltd.

c) The Panel Products Sub-sector

Readily obtainable information on ownership in this sub-sector was not available. However, its products are included within the Wood Industries category by Statistics Canada, and it is likely that the sector as a whole reflects the 80 percent Canadian ownership determined for wood industries in 1981. Production of panels in 1984 is presented in Table 14.

Table 14

Canadian Panel Production (1984)

Panel Type	Volume (m^3)	Change from 1983
Waferboard/O.S.B.	1,190,254	+ 37.8%
Particleboard	843,346	+ 17.5%
Softwood plywood	1,846,369	- 10.5%
Hardboard	160,855	- 5.6%
TOTAL	4,040,824	+ 6.6%

Source: Forest Industries Magazine, April 1985.

It is evident that the cheaper priced waferboard and oriented strand board outputs are outpacing traditional plywood products and have had a spectacular production increase in the last two years. In 1982, production was only 492,447 m^3, so production has increased 242 percent in two years. This pattern is expected to continue at least until the early 1990s.

d) The Pulp and Paper Sub-sector

Pulp and paper production figures in Table 15 show that 1982 was a poor year, but 1984 levels have recovered to match those of 1980.

Table 15

Production of Pulp and Paper Commodities in Canada, 1980-1984

(millions of metric tons)

	1980	1981	1982	1983	1984
Newsprint	8.6	8.9	8.1	8.5	8.9
Market Pulp	5.9	5.5	4.7	5.8	5.8
Fine papers	0.7	0.7	0.6	0.7	0.8

Source: Price-Waterhouse, Forest Products Industry Survey, 1985.

As noted earlier, the pulp and paper sub-sector as a whole is 69 percent Canadian owned (Table 10) as of 1981. Specific ownership details beyond this fact are difficult to obtain, but data in Appendix III list production and ownership for the 15 largest producers (public companies only) in Canada.

More recent data[52] show Canadian ownership of pulp, paper and allied products, in terms of capacity, reached 71.4 percent in 1985. This is an increase of 8.1 percent in the past 10 years, resulting not from building increased capacity, but mainly from mergers and acquisitions from American interests.

e) Equipment Supply

Very little information is available with regard to equipment manufacturers and supply for the forest industry. The relevant Statistics Canada data are presented in Table 16. Summarized by category, the 1982 figures show the following import/export equipment supply relationships:

Sawmill equipment	- Imports	$106 million
	- Domestic and Export	$136 million (56%)
Pulpmill equipment	- Imports	$145 million
	- Domestic and Export	$766 million (84%)
Harvesting	- Imports	n/a
	- Domestic and Export	$643 million.

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[52]Noble, K. Investing Off by Foreigners in Pulp Firms, 1985, The Globe and Mail, November 18.

If the obvious gaps and deficiences are ignored, these statistics indicate that, although Canada has substantial sawmilling and harvesting equipment manufacturing industries, there is plenty of room for expansion. The pulpmill figures likely indicate that, any time a new pulpmill is built, the percentage of imported equipment would rise considerable. However, the domestic equipment manufacturing industry appears to produce a very healthy percentage of the equipment needed to maintain and refurbish existing facilities.

The difficulty in obtaining data regarding equipment manufacturing indicates that a specific study is in order.

Table 16

Canadian Imports, Exports and Domestic Shipments of Forestry Equipment

Class (StatsCan)	Description (StatsCan)	Imports ($000) 82	83	84	Exports ($000) 82	83	84	Domestic Shipments ($000) 82
5192111	4-wheel log skidders	n/a	n/a	n/a	n/a	n/a	n/a	48,360
519213	Hydraulic log loaders	n/a	n/a	n/a	n/a	n/a	n/a	2,805
51931	Woodland Log Hand. Equip.	5,152	15,564	19,988	1,104	1,798	2,227	n/a
51939	Woodland Log Handling Equipment Parts	22,630	64,194	117,239	12,385	16,492	21,826	n/a
5192	Woodland Log Handling Equipment and Parts	n/a	n/a	n/a	n/a	n/a	n/a	82,528
524	Wood Harvesting, Cutting and Forming Machinery (excl. power hand tools)	–	–	–	–	–	–	219,122
52403	Chain Saws	15,357	20,765	26,673	–	–	–	–
52414	Chain Saws	–	–	–	159,574	115,248	91,941	–
52425	Saws, Sawmill Machinery Equipment and parts	27,508	34,779	46,524	17,988	13,560	28,262	–
5241	Tree Harvesting Equip.	–	–	–	–	–	–	14,612
5243	Sawmill & Woodwkg Mach.	–	–	–	–	–	–	58,029
524312	Band Saws	–	–	–	–	–	–	10,720
524323	Planing Machines	–	–	–	–	–	–	6,035
5244	Parts for Sawmill and woodworking Machines	–	–	–	–	–	–	26,088
52448	Planers, Routers & parts	7,443	8,527	11,316	–	–	–	–
52468	Veneer Drying Mach & Parts	1,283	433	3,909	–	–	–	–
52469	Veneer & Plywood Machines & parts NES	3,990	4,758	6,772	–	–	–	–
52499	Woodworking Machinery, Equip. and parts NES	66,020	52,280	80,814	16,693	17,531	41,419	–
5245	Chain Saws	–	–	–	–	–	–	43,716
5246	Chain Saw Parts	–	–	–	–	–	–	59,172
525	Pulp & Paper Industries Machinery and Parts	–	–	–	–	–	–	338,107
5251	Pulp & Paper Machinery	–	–	–	–	–	–	273,126
52515	Pulp Mill Mach. & Parts	53,920	38,059	46,839	–	–	–	–
5252	Pulp & Paper Mach. Parts	–	–	–	–	–	–	63,368
52539	Rolls used in Manuf. of Paper and Parts	21,116	10,132	20,337	–	–	–	–
52560	Paper Conv Mach & Prts NES	69,774	52,278	81,871	–	–	–	–
52589	Pulp & Paper Ind. Mach.	–	–	–	41,982	30,811	31,601	–
52598	Parts for Pulp & Paper Industry Machinery	–	–	–	49,590	37,442	43,653	–

NES = Not Elsewhere Specified

4. INTERNATIONAL OVERVIEW

a) Canada from a Global Perspective

Canada's forests make up a sizeable proportion of the world's timber resources, particularly of the coniferous component. The country possesses about one-sixth of the world's forest area. The Food and Agriculture Organization of the United Nations (F.A.O.) estimates that Canada's annual coniferous supply of logs will be about 13 percent of the total world supply of 1,027 million cubic metres over this decade.[53]

In forest products trade Canada is a major participant. Its share of the world's industrial production of various forest commodities appears quite modest (see Table 17) but in terms of world trade it leads every other country in export value of forest products. Canada provides 63 percent of world newsprint exports and is also the world's largest exporter of pulp by a wide margin.

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[53] F.A.O. World Outlook: Phase V - World Outlook for Timber Supply, 1979.

Table 17

Comparison of Canada to the World
in Production of Forest Commodities

Commodity	Units	World	Canada	% of World
Roundwood Production	million m^3	2,958	142	4.8
Softwood Roundwood Prodn.	million m^3	936	127	13.6
Lumber Production	million m^3	396	37	9.3
Panel Products	million m^3	94	3	3.2
Pulp Production	million tonnes	121	17	14.0
Paper and Plywood	million tonnes	165	12	7.3

Source: Canadian Forestry Service. Selected Forestry Statistics, Canada, 1984.

b) Competition

In world forest products markets, our traditional competitors have been the Scandinavian countries, the U.S.S.R. and the U.S.A.[54] Competition from the Scandinavian countries is increasing; the U.S.A. has the potential to become a net exporter of forest products; New Zealand, Chile and Brazil have emerged in recent years as major exporters of forest products which compete directly with Canada's traditional outputs.

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[54]Despite being Canada's largest forest products market, the U.S.A. is itself a major exporter of roundwood, pulp and paper/paperboard.

The Scandinavians are able to develop, employ and even export the most up-to-date equipment and techniques because of their:

- Strong political and social commitments to forestry;
- Comprehensive, intensive forest management plans and programs which have been in place for a century or more;
- Proximity to European markets;
- In the case of Sweden, distinct pricing advantages due to a devalued currency;
- Highly skilled workforces.

The Scandinavian weaknesses are:

- Relatively high labour costs;
- Relatively high timber supply costs (compared to fast-growing tropical plantations);
- Raw material (roundwood and chips) is increasingly being imported, indicating a limit to sustainable harvests as well as reflecting a reluctance by the many private landowners to cut their timber without substantial increases in log prices.

The strength of the U.S.S.R. lies in its vast areas of virgin forests. However, these forests are located far from markets and in inhospitable climates. The Russian economy has so far been unable to make full use of its timber supply advantage.[55]

The U.S.A.'s strengths are:

- A huge domestic market;
- Vast areas of well managed second-growth forests which are ready for harvest;
- A well developed transportation system.

The U.S.A.'s weaknesses include:

- A strong environmental lobby which may block increased timber output;
- Relatively high wages and production costs.

The emerging competitors' (New Zealand, Chile, Brazil) strengths relate to the huge areas of fast-growing plantations which are ready to harvest and, except in the case of New Zealand, extremely low labour costs. The weakness of these competitors, again with the exception of New Zealand, has been an inability to produce reliable supplies of quality products for export.

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[55]Pacios-Rivera, F. Soviet Forestry: A New Power, 1985, International Forestsearch (Canada) Ltd.

The federal government's approach to trade and monetary matters is critical to the health of Canada's forest sector and has a direct bearing on the industry's ability to compete internationally. Appendix VII outlines some of the restrictive factors encountered by selected Canadian forest products in overseas markets. Federal policies or actions which might affect these types of restrictions include:

- Any move toward freer trade with other countries, especially the U.S., will assist the forest products industry;
- Any federal policy or action which works to either prop up or artificially inflate the Canadian dollar against other currencies, especially the U.S. dollar, will be detrimental to the forest sector;
- Federal policies and programs which result in financial assistance (grants, loans, etc.) at no cost or cheaper than market rates to no-longer competitive manufacturing facilities will continue to penalize firms who themselves have invested in modernization or otherwise stayed competitive and innovative.

As evidenced by a situation where almost every resource sector but forestry has full departmental status in the federal government, long-standing and continued federal policy which treats the forest sector as a less important political and economic factor than agriculture, mining, fisheries and energy, will continue to be a roadblock to the realization of the full potential of Canada's forest

industry as an economic generator.

Federal regional development policies which seek to superimpose hi-tech or other industrial developments on rural areas (without first considering reinvestment of even a fraction of past received renewable resource revenues) work to the detriment of the forest sector. The forest industry is often viewed as a "sunset" industry which must be replaced or at least moved away from. So reinvestment in renewal and management is neglected and the renewability of the forest resource and related regional economic stability are lost.

Programs (such as the Cooperative Overseas Market Development Program) aimed at promoting (in cooperation with industry) Canadian forest products on their own merits in underdeveloped overseas markets will continue to be advantageous to the sector.

5. TRENDS IN THE FOREST SECTOR

a) Global Trends

In a global context, the major trends which are affecting and will continue to affect the Canadian forest sector include:

- A reduced growth rate in world consumption of forest products;
- Over-capacity of wood processing plants in all sub-sectors;
- Increased timber supplies from fast-growing plantations in developing and developed countries;
- New processes for manufacturing hardwoods;
- A movement toward protectionism in world trade;
- Manipulation (devaluation) of currency exchange rates by forestry trading nations;
- High labour costs in Canada;
- Inadequate investment in modernization and forest renewal in Canada;
- Growth in the U.S. domestic supply of timber.

A recent C.F.S. study of future Canadian domestic markets concludes ("suggests") that:

> ...the high growth rates in the Canadian consumption of wood products that existed throughout the 1960s and 1970s are unlikely to be present in the 1980s and 1990s. It also suggests that it is the higher value-added products, like culture paper in the paper and paperboard group, and panels in the solid wood group, whose consumption is projected to grow at the fastest rates. This has clear implications for the relative importance of the domestic and export markets, particularly given that the same general trend is occurring throughout the industrialized world. It will result in the increasing relative importance of the domestic market to our industry because Canada, like most industrialized nations, has historically satisfied most of its domestic demand for

higher-valued forest products itself.

The increasing relative importance of higher-valued products also means that our industry will have to become increasingly consumer oriented and expend greater effort in analyzing end-use markets.[56]

In a highly theoretical ("one must be well aware of the limitations of the approach") yet very interesting analysis of Canadian forest exports covering the period 1970-1980, the C.F.S. concluded that "Canada's exports value share of total forest products decreased over the period" and that "Canada is exporting to slow-growing regions" of the world and "supplying products whose demands are also growing relatively slowly."[57]

Country-by-country trends in forest products markets are presented in Appendix IV for selected Canadian forest products.

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[56] Roberts, D. and Luck, D. Canada's Domestic Consumption of Forest Products: 1960-2000, 1985, C.F.S. Economics Branch.

[57] Samson, R. and Lamarche, N. An Analysis of Export Growth in Canadian Forest Products: 1970-1980, 1985, C.F.S. Economics Branch.

A new report out of the U.S. suggests that demographic trends coupled with changing lifestyles will cause a substantial and lasting drop in U.S. housing starts in the medium to long terms.[58] This of course spells bad news for Canadian softwood lumber producers.

While Canada and the Scandinavian countries will continue to dominate in the export of paper grade pulp, and the world market in this important commodity will continue to grow, the market's rate of growth over the next 10-15 years will decline from what it has been over the past 10-15 years. Canada is in a good position to expand its pulp exports but its "rate of growth in additional capacity may be restricted by wood and capital availability constraints".[59]

Thus, the indications are that Canada may drop in terms of overall market share of its traditional bread and butter export products (pulp, newsprint, lumber) and that market size for such products will be reduced for our largest customer, the U.S.A. However, the developing countries' growing needs for such products could very well sustain

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[58] Lomas and Nettleton Co. But Demographic Trends Suggest a Subdued Future, Business Week, December 9, 1985.

[59] Jegr, K. Overview of the North American Pulp and Paper Industry, 1985, Consultant's Report to F.E.P.A.

overall demand.[60,61] U.B.C. Professor F. L. C. Reed's projections in this respect are worth quoting:

> A summary statement would show that incremental supply of industrial softwood should be one-third lower than that projected for 2000 by the FAO Working Party. Coupled with these reductions in available timber supply will be a parallel drop in consumption of forest products. While the product demand side is not examined in this report, those who are preparing the next series of timber trend studies have already signalled lower targets for the years ahead. Moreover, it is the majority view that the consumption of softwood lumber will, in fact, be constrained by diminishing availability of prime sawlogs in most producing areas.
>
> For the purposes of this study, however, it is safe to conclude that British Columbia will not find its markets, for either lumber or fibre products, swamped by competing plantations or by intensively managed natural forests in other countries. The only prudent course is to regard British Columbia's forest resource as a major natural asset which will increase in value. It should, therefore, be managed more intensively and with a confident eye to the future.[62]

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[60] Roberts, R. Third World Forestry Imperatives and Canadian Prospects for Meeting Future Wood Product Requirements, 1983, CIDA, Presentation to the C.I.F.

[61] Cameron, F.A. Canada's Proposals to Third World Housing, Seaboard Lumber Co., quoted in the United Nations "Development Forum", October, 1985.

[62] Reed, F.L.C. Synopsis of World Softwood Timber Supplies, 1984, Report to the B.C. Ministry of Forests.

b) Canada's Ability to Respond

Canada's ability to adapt and respond to these sectoral trends will depend on the capacity of the forest resource base to supply a suitable quality and quantity of timber, the degree to which manufacturing operations are upgraded and made more market oriented, and the efficiency with which we operate the sector as a whole.

In doing these things, the country will have to cope with changes in the profile of the resource as well as in the way it is used by other interests. There will be an accelerating transition from harvesting old-growth, virgin forests to second-growth stands of timber which regenerated naturally after previous harvesting or forest fires. This transitional phase will be overlapped and then followed by the harvesting of forests which have been managed (tended) in the past 25 years.

It is likely that the provinces will continue to transfer responsibility for renewing and managing public forests to the private sector in return for allocating more secure timber supplies.

Continued land-use conflicts and environmental disputes will result in reduced industrial access to timber supplies and the use of more environmentally sound harvesting practices.

Indian land claim settlements and increasing forest management activity on Indian Reserves will add a new social and cultural dimension to the industry in several regions of the country.

Canada has an abundant unused supply of hardwood timber which has traditionally been viewed as inferior compared to the softwood timber

supply. New processes in pulping and in the manufacture of particleboard and other wood composite products have made it possible to produce many products from hardwoods which are comparable in quality to our traditional softwood outputs.

Canada also has relatively abundant supplies of energy (hydro-electric, natural gas, wood residues, in particular). The trend toward more secondary manufacturing should be aided by cheap energy.

The country's unemployment picture indicates that Canada has abundant labour. However, most of our unemployed people are unskilled relative to forest sector needs and are located in urban areas away from the forest resources which need managing. But the potential is there if retraining were undertaken.

Canada is geographically well suited to service the Pacific Rim and U.S. markets. The Pacific Rim situation augurs well for the Canadian forest sector due to the many emerging markets in rapidly developing Asian countries. However, the U.S. market is expectd to become smaller and more competitive in light of demographics and increasing domestic timber supplies.

There is an abundance of harvesting wastes, mill residues and "non-merchantable" forest biomass which presents a two-fold opportunity when coupled with related newer technologies:

- Improved mill and harvesting recovery to make better use of timber supplies;
- Increased use of wastes and biomass for energy production.

There are a number of forestry fields in which Canada is already a

technological leader (e.g. forest fire management systems, forest inventory techniques). So we have something to build on technologically in the forest sector.

Although there are notable exceptions (see page 74), the sawmilling sub-sector in general is not overly sophisticated in its application of technology. Nevertheless, it is very efficient. In numerous studies arising from the U.S. softwood lumber trade dispute, Canadian lumber manufacturers are shown to be much more efficient than their American competitors. This Canadian efficiency advantage is, for the most part, attributable to increased worker productivity and streamlining measures adopted over the past few years and not to major technological changes.[63]

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[63] See:
- International Woodworkers of America. Employment and Employee Hours in the Softwood Lumber and Wood Products Industries of North America, 1977 to 1984, 1985, Submission to the U.S. International Trade Commission.
- International Woodworkers of America. Productivity and Unit Production Costs in the Softwood Lumber Industries of the United States and Canada, 1977 to 1984, 1985.
- Constantino, L. Sawlog Prices and Quality Differences in Canadian and United States Pacific Coastal Log Markets, 1985, F.E.P.A.
- Francis, D. Storm Looms Over Lumber Exports, 1986, Christian Science Monitor.
- St. Louis, J. Forestry Jobs to Stay Flat, Victoria Times-Colonist, February 15, 1986.

Canada's potential and limitations for expansion/adaptation are discussed on a province-by-province basis in Appendix V. It is evident that the limit of high quality, easily accessible softwood timber has been reached, except in Alberta. Opportunities to maintain and/or expand present levels of timber supply include:

- Increased utilization of vast hardwood forests in nearly every province;
- Expansion into poorer quality, geographically remote forests;
- Increased forest management activity;
- Utilization of more of the forest biomass, especially for energy purposes;
- Improved protection from insects, diseases and fire of harvestable forests.

In every case, development and implementation of appropriate existing and new technologies are in order if Canada's forest industry is to maintain or expand its current level of economic output.

C. TECHNOLOGICAL SUPPORT

1. The Level of Technology in the Forest Sector

a) Degree of Technical Sophistication

According to the C.F.S., the forest sector in general "has not been particularly innovative in implementing new technologies."[64] "...the capital plant of the sector has been heavily run down and has simply not kept pace with international competitors."[65]

In an exhaustive, long-term economic analysis of the British Columbia forest sector, the University of British Columbia's Forest Economics and Policy Analysis Project[66] paints a "gloomy outlook" for significant portions of B.C.'s pulp, sawmill, and plywood and veneer capacities which are, or soon will be, "economically obsolete". To overcome this obsolescence, the author calls for:

- Intensified investments in new technology to improve recovery and productivity;
- Production of more higher value-added products;
- A stronger market orientation of outputs.[67]

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[64] Quoted by Macdonald, D. Report of the Royal Commission on the Economic Union and Development Prospects for Canada, 1985.

[65] Ibid.

[66] See pages 120-122 for a full description of this project.

[67] Nilsson, S. An Analysis of the British Columbia Forest Sector Around the Year 2000, 1985, U.B.C. Forest Economics and Policy Analysis Project.

A recent study of Ontario's sawmilling industry basically concluded the same things:

- Ontario's wood products industry is not benefiting from advanced technology to the same extent as other industries;
- Greater mechanization and automation could extract more lumber from the same trees at reduced costs;
- There is too much production of low-value products and not enough capability to manufacture higher value-added products.[68]

The B.C. and Ontario situations are typical of the rest of the country. Particular obsolescence is evident in B.C.'s coastal sawmilling industry and the Quebec and Ontario pulp and paper industries. The potential for applying newer technologies is greatest in these segments of the industry.

In terms of size, ownership or specialty, there really are no clearcut patterns in technological sophistication. There are some foreign corporations which operate at the state-of-the-art level, while others keep on turning out the same old products using the same old equipment. The same is true for Canadian controlled firms. Certainly the larger corporations have more ready access to the huge capital requirements needed to maintain technological leadership but many of them have chosen other ways of deploying capital, such as diversification, takeovers, debt retirement, dividends, overseas expansion, etc.

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[68]H.A. Simons (International) Ltd. reported in the Toronto Globe and Mail. Forest Firms Termed Technological Laggards, December 6, 1985.

At the same time, there is no shortage of small and medium sized firms throughout the sector who are world-class employers of technology. So the only things that can be said about the overall level of use of technology is that it varies depending upon management priorities and styles, and, to some extent, ability to access federal and provincial industrial modernization grants or other funding sources.

In contrast with this generally unsophisticated level of technology, there are some notable bright spots.

Canada has a long-standing involvement with technical problems at the operational level in pulp and paper mills (systems engineering, environmental protection, papermaking, mechanical pulping, chemical pulping, bleaching, etc.).

Probably due to the huge geographic distribution and wide variation (even at the local level) of our forest, Canada is at the forefront of technological development in forestry-related computer mapping/geographic information systems, remote sensing, and forest resource data collection/compilation/manipulation systems.

Canadian companies are among the most efficient in the world at getting wood from the forest to the mill. Our harvesting and transportation systems and techniques provide a real competitive edge.

Various firms throughout the sawmilling industry have installed and perfected the use of state-of-the-art electronic and laser technology for improved productivity, maximized utilization, and optimized grade output. The sawmilling industry in the Interior of

B.C. is reknowned for staying at the leading edge of technological implementation. Despite low market prices for their products over the past few years, these manufacturers have been able to operate profitably because of remarkable productivity. This can in part be attributed to changes in labour and management attitudes, but mainly to development and adoption of state-of-the-art technology. In the central interior of B.C. a 5-year old mill is an old mill.

Throughout Canada there are examples of manufacturing facilities which produce advanced products with maximum value in terms of sale price and wood utilization efficiency (e.g. machine stress rated lumber, finger-jointed lumber, laminated veneer lumber, and edge-glued lumber).

These examples clearly illustrate the variation in technological sophistication within and between the various forestry sub-sectors. This variation in sophistication in turn reflects the diverse nature of the sector itself.

b) Comparison with Other Canadian Industrial and Resource Sectors

Table 18 presents total Canadian R and D expenditures by industrial category (excluding in-house government expenditures) for the period 1976 to 1983, along with proposed 1984 and 1985 data. Wood based industries rank eighth in the manufacturing sector in total R and D expenditures (1985 basis).

Table 19 shows total R and D expenditures over the same 1976-1983 period for selected industries or industry groups in constant 1976

dollars. Although spending in 1985 on wood based industries R and D is projected to increase 37 percent over the 1976 level, in comparison to the other industrial groups the wood based industries have fallen off badly in R and D spending over the past ten years. In fact, wood based industries' R and D in real terms have remained unchanged since 1980.

It is noteworthy that, although 40 - 50 percent of forestry industrial activity takes place in British Columbia, 71 percent of its R and D expenditures occur in Ontario and Quebec.[69] This is probably due to historical and political influences related to the development of Canada as a country.

Table 20 shows that wood based industries in Canada rank at the bottom of the manufacturing industries (tied for fourteenth position out of 18 groupings) in terms of R and D expenditures as a percentage of corporate sales. Whereas the manufacturing sector as a whole has raised R and D spending as a percentage of sales from 0.9 to 1.4 since 1973, wood based industries R and D spending has basically remained constant at 0.3 - 0.4 percent.

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[69]Statistics Canada, Cat. No. 88 - 202, 1985.

Table 18

Total Canadian Intramural R & D Expenditures by Industries, 1976 - 1985
($'000,000)

Industries	1976	1977	1978	1979	1980	1981	1982	1983	1984[P]	1985[P]	Rank
A. Manufacturing											
Communications equipment	144	151	175	218	264	387	521	657	769	857	1
Aircraft and parts	72	95	131	153	176	256	295	278	276	314	2
Business machines	12	14	18	27	45	60	90	108	125	159	3
Other chemical products	49	49	55	67	89	103	132	117	129	139	4
Petroleum products	47	72	98	116	132	208	201	156	154	136	5
Other electrical products	29	31	37	53	67	78	85	90	102	111	6
Primary metals (non-ferrous)	51	45	50	60	85	86	86	81	94	100	7
Wood based industries	36	36	36	53	65	82	76	72	87	91	8
Food, beverages, tobacco	30	29	32	35	45	57	72	74	77	84	9
Drugs and medicine	26	28	31	40	53	53	58	65	69	76	10
All others (manufacturing)	107	118	128	165	204	272	311	304	297	298	
SUB-TOTALS MANUFACTURING	603	668	791	987	1,225	1,642	1,927	2,002	2,179	2,365	
B. Mines and Wells	43	49	55	109	129	195	175	115	134	133	
C. Services	110	140	160	170	2116	289	392	402	482	546	
TOTALS, ALL INDUSTRIES	755	857	1,006	1,266	1,570	2,126	2,494	2,518	2,795	3,044	

[P] Proposed

Source: Statistics Canada, Cat. No. 88 - 202, 1985.

Table 19

Total Intramural R & D Expenditures for Selected Industries in Constant Dollars, 1976 - 1985
(1976 dollars - $000,000)

Industries	1976	1977	1978	1979	1980	1981	1982	1983	1984[p]	1985[p]	Change since 1976
Wood based industries	35	33	31	42	47	53	44	40	47	48	+ 37%
All other manufacturing	567	589	659	738	823	999	1,077	1,065	1,119	1,188	+110%
Mines and wells	43	46	58	85	91	125	102	63	72	69	+ 60%
Services	110	128	139	134	154	186	228	222	258	285	+159%

[p] Proposed

Source: Statistics Canada, Cat. No. 88 - 202, 1985.

Canadian controlled firms account for 89 percent of R and D expenditures on wood based industries R and D (1983 basis), compared to an average of 54 percent for the manufacturing industries as a whole.[70]

For the 1983 wood based R and D expenditures of $72 million, 57 percent was derived from the performing company, 14 percent from the federal government, 26 percent from other Canadian sources, and 3 percent from foreign sources.[71]

The number of persons (person-years) engaged in wood based industrial R and D in 1983 was 1,220 (530 professional, 455 technicians/technologists and 235 others). Of this total, 900 were located in Ontario and Quebec.[72]

The 1983 total is actually a drop of 96 persons from 1982. Over the period 1975 - 1982, the number of persons engaged in wood based industries R and D increased by 15 percent, the third lowest increase of the 15 manufacturing industries listed by Statistics Canada.[73]

These statistical comparisons need to be looked at in terms of the factors which make R and D and its application in forestry different from other industrial and resource sectors.

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[70,71,72] Statistics Canada, Cat. No. 88 - 202, 1985.
[73] Statistics Canada, Cat. No. 88 - 203, 1985.

Table 20

Current Intramural R & D Expenditures as a Percent of Company Sales, by Industry, 1973 - 1983

(Percent of Company Sales)

Industry	1973	1975	1977	1979	1981	1982	1983	Rank
Manufacturing								
Food, beverages, tobacco	0.3	0.2	0.2	0.2	0.3	0.3	0.4	(14)
Rubber and plastic products	0.6	0.6	0.7	0.7	1.3	1.1	0.8	11
Textiles	0.5	0.7	0.5	0.5	0.8	1.0	1.2	9
Wood based industries	0.3	0.3	0.3	0.3	0.3	0.4	0.4	14
Primary metals (ferrous)	0.4	0.4	0.3	0.3	0.3	0.4	0.3	18
Primary metals (non-ferrous)	0.8	0.8	1.1	0.8	0.7	0.9	1.3	8
Metal fabricating	0.5	0.5	0.5	0.5	0.6	0.9	0.7	12
Business machines	2.5	0.9	0.8	1.2	1.8	2.2	2.3	6
Other machinery	1.2	1.2	1.2	0.8	1.4	2.2	2.4	5
Aircraft and parts	15.6	8.0	9.8	9.8	12.6	14.5	17.6	1
Other transportation & equip.	0.3	0.2	0.3	0.3	0.4	0.4	0.4	(14)
Communications equipment	6.2	6.8	5.4	8.2	8.8	10.6	12.1	2
Other electrical products	1.3	1.2	1.1	1.3	1.3	1.6	1.7	7
Non-metallic mineral products	0.4	0.3	0.3	0.4	0.5	0.5	0.6	13
Petroleum products	0.4	0.4	0.4	0.4	0.6	0.5	0.4	(14)
Drugs and medicine	4.2	3.8	3.9	2.4	4.7	5.2	5.0	3
Other chemical products	1.1	1.0	0.9	0.9	0.9	1.1	1.0	10
Scientific & professional equip.	1.6	1.5	1.4	1.5	1.7	2.2	2.7	4
Other manufacturing industries	0.9	0.9	0.8	0.4	0.9	1.0	1.0	-
SUB-TOTAL MANUFACTURING	0.9	0.8	0.8	0.8	1.1	1.3	1.4	
Mines and Wells	0.7	0.9	1.0	0.8	1.1	0.9	0.7	
Services	0.6	0.6	0.6	0.7	0.7	0.9	0.9	
TOTAL ALL INDUSTRIES	0.9	0.8	0.8	0.8	1.0	1.2	1.2	

Source: Statistics Canada, Cat. No. 88 - 202, 1985.

The forest industry is so broad that it lacks clear definition and understanding in some minds. The harvesting and forest management sub-sectors are rurally based; the manufacturing sub-sectors often lose their association with the forest by being located in urban environments. Thus, the forest sector is not as focused for the R and D decision makers as, say, the fisheries resource sector.

The wide diversity and geographic expanse of the forest industry seem to take it beyond the direct involvement and interest of any particular level of government. It is as if the sheer size of the forest resource base and the diversity of manufacturing processes give authority over it to all governments (municipal, provincial, federal), but ultimate responsibility for it to none.

The lack of a clear, united constituency at the federal level coupled with provincial control of the resource base have left the forest sector without the political influence of other resource sectors such as agriculture, fisheries, oil and gas, and mining. This lack of strong political influence (despite overwhelming economic impact) is readily evident in the inferior status of forestry in the federal government's bureaucratic and political hierarchy. Forestry, more so than any other major resource industry except trapping, guiding and hunting, is rurally based, far from the media and voting centres. Without a political presence, the forest sector is unable to establish itself in the governmental process which traditionally leads to the development and application of technology to the degree possible in agriculture, fisheries, oil and gas, and mining which have much less

economic and social impact.

Other resource sectors are more clearly defined and specialized in their application of technology. A mining operation is in one specific location and will deal with one type of ore used in one or two refining processes. Whereas a forestry operation will cover thousands of hectares, involve a variety of tree species and tree sizes which could be used in a variety of manufacturing processes. The difficulty in specializing and the immense scope and variety of the resource base cause constraints in developing and implementing technology in forestry which are far beyond those of most of the other resource sectors.

Certainly the agricultural sector has the same basic array of biological, engineering, chemical, manufacturing, climatic, etc. conditions as forestry. However, relative to forestry, agriculture is practiced in a much more confined and controllable environment. The wide range of scientific fields which are applied in the forest sector makes it a complicated and difficult sector in which to apply and develop appropriate technology.

The forest sector in Canada is similar in many ways to the forest sectors of other countries, especially in terms of timber harvesting, sawmilling, pulp and paper production and panel products manufacturing techniques. This allows for much more borrowing of technology between countries than might be the case in other resource sectors and allows Canada to avoid having to develop all of its own equipment and systems.

Corporate managers in the forest industry frequently come under criticism for being too conservative and near-term oriented.

Woodbridge, Reed and Associates Ltd. has been one of the more vocal critics in this respect, stating that the basic issue facing the Canadian forest industry is the need for management to recognize and act upon the need/opportunity to increase its manufacturing of products with more value-added.[74]

c) Comparison with Other Countries

Because of different currencies, definitions, sectoral overlaps and data shortages, it is difficult to make absolute comparisons of R and D levels with our competitors in forestry. Canada itself does not have a complete, up-to-date tally of its forestry R and D performance (although one is currently being prepared by the C.F.S.). Even the Science Council of Canada in its recent statement on forestry[75] did not (could not?) compare Canada's forestry R and D level with those of other countries.

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[74]Woodbridge, P. Quoted in Forest Industry Must Change to Prosper, Financial Post, November 9, 1985.

[75]Science Council of Canada. Canada's Threatened Forests, 1983.

An indirect but clear indication of Canada's relative level of R and D is provided by the fact that B.C.'s forest sector invests about 30 percent of the amount invested for the forest sector in Sweden in forestry R and D (on a per cubic metre of harvested wood basis).[76] In 1981, it was estimated that Canada spent less than 0.7 percent of its forest products sales dollars on R and D, compared with 1.5 percent in the U.S.[77] Comparisons with other countries are more difficult to determine, but Canada is certainly not ahead of too many developed countries in its commitment to forestry R and D.[78]

In terms of the application of R and D as measured by the implementation of newer technologies, there is one example of a competing country which best puts the Canadian situation into perspective. In Finland, a high degree of forest resource management has been achieved for many years, so modernization and construction of new facilities is expected to be the main thrust of industrial

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[76] Nilsson, S. An Analysis of the British Columbia Forest Sector Around the Year 2000, 1985, U.B.C. Forest Economics and Policy Analysis Project.

[77,78] C.F.S. A Forest Sector Strategy for Canada, 1981, Environment Canada.

investment during the 1980s. It is estimated that about one-third of industrial buildings and facilities and one-half of the machinery and equipment that will be in use by the year 1990 was not yet in existence in 1980. The exception to this is the pulp industry, which is predominantly very modern - about one-half of Finlands's market pulp capacity has been built or thoroughly modernized since 1974.[79]

Comparisons of levels of forestry R and D should also be looked at in terms of content, direction and applicability, rather than in dollars only. Scandinavian forests are very similar to Canada's boreal forest region and the Scandinavian countries compete head-to-head with Canada in world forest products markets. Appendix VI contains a case study that looks at technological development, implementation and direction in the forest management and harvesting sub-sectors in Scandinavia. What stands out about this report is the confident, comprehensive approach plus the emphasis on people (training, involvement, organization) that the Scandinavians are using. In distilled version, the Scandinavian directions in developing and applying forest management and harvesting technology are:

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[79]Hirvonen, R. Forestry Report: Finland, 1984, C.F.S.

The development of Scandinavian forest technology will proceed in much the same way as in the past, although there will be a move towards greater simplicity. It is not totally possible to predict future innovations that will have an impact on current techniques. Nonetheless, a few trends can be identified:

- microprocessors will be employed on a wider scale;
- the diesel engine will be superceded by other power plants such as gas turbines and Stirling engines;
- lighter but stronger materials will be used in equipment, e.g. fibre-reinforced plastics and other composite materials;
- new vehicles, capable of operating without damaging the ground, will be developed (possibly of the hovercraft type) for use in thinnings and energy forests.

Extensive changes have taken place in forest management during the last ten years which have created new conditions for the organization of future work. Thus, the organization of forestry operations in the eighties must be far better than it was during the seventies.

Greater decentralization and delegation are important factors here. This assumes that some form of management by objectives will be employed. Apart from the psychological effects it has, management by objectives also creates a greater interest in the results of operations throughout the organization. Where there is delegation, different demands are made on managers (higher demands are made on their social competence, for instance).

Wage forms represent another important factor. Wage forms are linked to results where everybody in the organization shares in the profits. They also enhance the business consciousness of the employees and increase efficiency. It should be possible under present collective agreements to experiment with new wage forms that are linked more closely to results than they are today.

Some important trends that will affect the selection of future logging systems are as follows:

- the supply of wood will diminish;

- greater efforts will be made to buck the wood to suit the end-user;

- greater priority will be given to graded wood;

-the demand for energy wood will increase.

In the light of these trends, the tree-length and tree-section harvesting methods will become more and more appealing. Current development work on mechanized methods looks no further ahead than to harvesters. Forest managers and machine manufacturers are totally absorbed in the shortwood method. The number of machine manufacturers is out of proportion to the size of the market, and production runs are too short.

In the medium term, Scandinavian countries must adapt to the international situation by reducing the number of regulations, by making working environment demands more reasonable, by improving the operational reliability of machines, and by making forestry fully receptive to the employment of the full-tree and tree-length methods.

Forestry must also adopt a more rational approach to biological uncertainties.

Thus, R and D work during the eighties should proceed along the following lines:

- continue in the same direction as during the 1970s, but with increasing mechanization of logging using limber-buckers and harvesters;

- immediately commence applied research into tree-length methods, as these will probably be the methods of the nineties.

Most of the faults occurring in logging machines concern electrical and hydraulic systems and it is here, in the monitoring and control systems, that new developments will be taking place during the next few years.

The relays in the automatic control equipment on processors will be replaced by microprocessors. Microprocessors will also be used to measure the taper of a stem, to register wood that has been processed, in fault tracing and in automatic crane operation. On planting machines, microprocessors will control the entire operating cycle and will check that the correct number of seedlings is planted per hectare.

To an increasing extent, analogue transmitters will be superceded by digital transmitters. Experiments will also be made on the use of fibre optics for the transmission of signals.

As regards hydraulics, new types of valves, which make much more precise control possible, are already being tested. The valves are pressure-compensating and load-sensing. The latter feature implies that the fuel consumption of the machine will be more economical.

During the 1970s, much creditable work was put into the promotion of Scandinavian forest technology abroad; nonetheless, in spite of a wide range of excellent products and for a variety of reasons, success was rather limited. However, with the experience gained from the 1970s and the improved situation in

terms of costs compared with those in the potential markets abroad, prospects for growth are now brighter.

Forestry machines in Scandinavian countries are usually produced in small batches and it is therefore desirable to standardize the machines to facilitate production. To start with, the most obvious step would be to incorporate components in the machines that are also used in the manufacture of other machines. Typical components include engines, transmissions, loaders, hydraulics, etc. Thanks to overall restructuring of the manufacturing industries, this is now much more feasible.

The U.S.A. also takes a calculated, comprehensive (although less people-oriented and less centrally controlled) approach to its forestry R and D.[80]

Except for the southern (pine) region, the U.S.A. faces, to a certain extent, forest resource management and manufacturing problems similar to Canada's. The U.S. is by far Canada's largest forest products market and, at the same time, a growing competitor to Canada

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[80] See: - U.S.D.A. 1980-1990 National Program of Research for Forests and Associated Rangelands, 1982, Forest Service Report WO-32.

- National Task Force on Basic Research in Forestry and Renewable Natural Resources. Our Natural Resources: Basic Research Needs in Forestry and Renewable Natural Resources, 1983, University of Idaho.

- Congress of the U.S. Wood Use, U.S. Competitiveness and Technology, 1983, Office of Technological Assessment.

in world markets.[81] Here are the trends, needs, and related research goals as seen on a regional basis by the U.S. Forest Service for both the forest resource and the forest products manufacturing sub-sectors:[82]

Forest Resource Management

Western Region
- Improve forest land productivity and protection
- Increase rangeland productivity
- Enhance water yield and quality
- Improve integrated pest management techniques
- Increase energy production
- Enhance wilderness values and opportunities for recreation

North Central Region
- Improve forest regeneration, growth, yield and composition
- Discover new ways to remove, process, and market harvested trees
- Improve techniques for management of insects, diseases and wildfires
- Create new forest inventory methods and procedures to evaluate alternative forest investment strategies
- Improve the quality of life through the use of urban and rural resources

Southern Region
- Develop integrated pest management techniques
- Improve vegetation management procedures
- Produce better regeneration techniques for southern forests
- Increase forest land productivity
- Devise ways to use wood for energy

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[81] This situation exists because Canada can more cheaply deliver to particular U.S. regions than can certain U.S. regional wood producers, who then export their outputs.

[82] U.S.D.A. 1980-1990 National Program of Research for Forests and Associated Rangelands, 1982, U.S.F.S. Report WO-32.

Northeastern Region

- Increase understanding of the amount, quality and availability of the eastern hardwood resource
- Improve utilization , harvesting and marketing techniques for low quality hardwoods
- Increase supply of wood fibre for energy production
- Enhance management, use and productivity of forest lands
- Develop methods to evaluate multiple-use potential of land
- Find substitutes for chemical forest pesticides
- Consolidate control techniques to manage insect populations
- Devise ways to reduce disease and decay in trees through silvicultural, biological, genetic and chemical methods
- Improve mineland reclamation measures
- Increase understanding of effects of atmospheric deposition and how forests can help ameliorate the problem
- Develop ways to increase the availability of outdoor recreation opportunities

Forest Products

- Optimize material properties of wood
- Improve production of wood-based chemicals
- Extend timber supplies through improved processing
- Improve structural applications of wood
- Improve ways to utilize residues and recycled fibre
- Reduce energy consumption through improvements in utilization technology.

These Scandinavian and U.S. overviews of where they see their forest sectors going should be instructive and, in many cases, directly relevant to Canada. Perhaps the most telling point is that Canada has no similar, comprehensive R and D strategy in place, nor is one being developed.

In comparison with the U.S. and Scandinavia, Canada's approach to forestry R and D is unfocused, uncoordinated, underfinanced and, in the opinion of some, not problem- or goal-oriented.[83] Later sections will explore this further, but the point is made that Canada's forestry R and D level does not come close to that of its competitors in terms of quality and quantity.

Forestry R and D has not been emphasized in Canada since the late 1960s, while it has been stepped up (especially in terms of focus and funding) by at least two of our competitors. There does not seem to be a simple explanation for this, since the resource and the industry are both Canadian controlled. Perhaps the previous abundance of high-quality wood and growing world markets made Canada over-confident or sloppy in its approach to R and D. Also, the U.S. and Scandinavian countries have strong federal governments which play large roles in the forest sector. Canada's geography and constitution have created a less centralized, and therefore less focused and coordinated, approach to forest management and R and D.

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[83] Nilsson, S. An Analysis of the B.C. Forest Sector Around the Year 2000, 1985, U.B.C. Forest Economics and Policy Analysis Project.

d) Discussion

The preceding questions and overview have shown that, although there are some bright spots, Canada's forest sector in general (and almost all its sub-sectors) is technologically unsophisticated. Also, due to past heavy reliance on primary manufactured products (lumber, pulp, newsprint) and the capital-intensive nature of many of the manufacturing processes, technological developments have emphasized process development and specialization much more than product development.[84] So, simply put, the industry now realizes that it must manufacture considerably more value-added products which are more market oriented.[85] However, this is more easily said than done, at least partly because the major players, the large integrated companies, are not well suited to respond quickly and efficiently to demands for relatively small quantities of material cut to non-traditional specifications.[86]

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[84]Forest Industries Advisory Committee. Interim Report to the Minister of Industry, Trade and Commerce, 1983.

[85]Among many others, Woodbridge, Reed and Associates. Achieving Higher Market Values from Canada's Timber Resources - The Nordic Challenge, 1983. Submission to the Royal Commission on the Economic Union and Development Prospects for Canada.

[86]Schwindt, R. An Analysis of Vertical Integration and Diversification Strategies in the Canadian Forest Sector, 1985, McDaniels Research Ltd., for F.E.P.A.

The main difficulty is that the industry as a whole suffers from too much debt, too little shareholders' equity, and too small a return on invested capital.[87,88] Until the industry gets its collective balance sheet in order, the opportunity to fully take advantage of existing technology is not there and the commitment to developing new technologies will not be total.

Other than to list several suggestions for solving this problem, it is beyond the scope of this report to do an in-depth analysis of this financial roadblock.

Potential solutions include:

- An "extraordinary" increase in federal R and D tax credits;[89]
- Federal legislation authorizing the creation of forest industry oriented "capital cost allowance flow-through shares";[90]
- Provide taxation or other incentives to foreign investors in an effort to stimulate investment in the sector;

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[87,90] Puusepp, J. Mobilizing Private Sector Investments - the Developed World, 1985. Speech to the 12th Commonwealth Forestry Conference.

[88] Ritchie, C. Forest Industry Must Change to Prosper. Reported in the Financial Post, November 9, 1985.

[89] Forest Industries Advisory Committee. Interim Report to the Minister of Industry, Trade and Commerce, 1983.

- Continued, increased federal and provincial assistance for modernization in the forms of grants and interest-free loans;[91]
- Replacement of government grants to "non-competitive" corporations with "tax incentives" which would "reward innovative firms".[92]
- Discourage government intervention in rescuing the industry from a poor situation into which it got itself. Those companies which have not kept pace with technological developments will die, leaving the surviving companies stronger.

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[91]Noble, K. Forest Industry Attempts to Kick the Grant Habit, The Globe and Mail, December 31, 1985.

[92]Council of Forest Industries. Submission to the Royal Commission on the Economic Union and Development of Prospects for Canada, 1983.

2. TECHNOLOGICAL INPUT TO THE FOREST SECTOR

a) Organizations Performing Forestry R and D

As the following information will show, one of the difficulties in looking at forestry related R and D in Canada involves trying to get a handle on the various agencies' contributions and involvements. The forest sector is so broad that there are cross-overs from and into other sectors, so defining what is forestry-related R and D and finding out who is doing it or paying for it are not simple tasks. These statements apply to industry as well as government. Nobody really has an up-to-date picture of Canada's forest sector R and D. The C.F.S. undertook a special study in 1979 of forestry R and D expenditures. The C.F.S. only recently let a contract to update that report, but the results are not yet known.

The 1979 C.F.S. (Solandt) report on forest sector R and D showed the following breakdown of expenditures:[93]

	$ million	%
C.F.S.	45.6	
Other Federal Agencies	7.9	38
Provinces' Forestry Departments	19.7	
Other Provincial Agencies	5.7	18
Industrial Resource Corporations	20.8	
Major Companies	23.0	
Industrial Suppliers	11.8	39
Universities	7.4	5
	141.9	

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[93]Quoted in C.F.S. A Forest Sector Strategy for Canada, 1981, Environment Canada.

The following forestry R and D organizations and programs are in place. See Figure 3 for a picture of how they relate to and support the various sub-sectors of the industry. The following information and Figure 3 show that technological support within the forest sector in Canada is logical and well defined. The firms and agencies with mandates in forestry R and D are, with minor overlap, working within clearly defined sub-sectoral parameters.

FIGURE 3

THE ROLES OF THE VARIOUS ORGANIZATIONS PERFORMING FOREST R & D IN CANADA

AGENCY	SUB - SECTORS					
	FOREST RESOURCE MANAGEMENT	FOREST HARVESTING & TRANSPORTATION	SAWMILLING	PULP & PAPER	PANEL PRODUCTS	OTHER MANUFACTURING
UNIVERSITIES	X	X	X	X	X	X
CONSULTANTS / CONTRACTORS	X	X	X	X	X	X
FORINTEK			X		X	X
PAPRICAN				X		
FERIC	X	X				
PRIVATE COMPANIES	X	X	X	X	X	X
PROVINCIAL GOVERNMENTS	X	X				
CFS	X	X				
EQUIPMENT MANUFACTURERS	X	X	X	X	X	X
FEPA	X	X	X	X	X	X
COFI			X		X	

Forest Engineering Research Institute of Canada (FERIC)

FERIC is a cooperative research organization funded by 45 member corporations and the federal government. Membership is voluntary and member corporations contribute 2 cents per cubic metre of logs harvested and the federal government (through the C.F.S.) matches the annual industrial contribution. Government grants and contracts are obtained to supplement this 50-50 federal-industrial funding.

FERIC concentrates on applied operations research involving short-term, low overhead projects in the areas of:

- Harvesting - evaluation of machines and systems for extracting and processing trees;
- Secondary Transportation - improving the efficiency of all types of transport of wood from the forest to the mill;
- Mechanization of Silviculture - productivity and performance studies of silvicultural equipment and related systems;
- Private Woodlots - identify related land management problems and advise on needs (a relatively new area of involvement).

FERIC's main efforts are in the area of testing and rating equipment and systems, not in equipment development.

FERIC operates out of two regional offices in Vancouver and Montreal. It has a staff of 55, with 25 in the west (17 professional/technical) and 30 in the east (approximately 19 professional/technical). FERIC's 1985 budget was $4.3 million.

FERIC operates under a board of directors made up of representatives from the C.F.S., senior industrial executives, Industry, Trade and Commerce, and the National Research Council. Two

advisory committees (one for the east, one for the west) made up of representatives from the C.F.S., universities and industrial logging managers provide advice and direction at a technical level, as does a mechanized silviculture sub-committee. The mechanized silviculture sub-committee is the only one with provincial government representation and the provinces do not contribute financially to FERIC (reasons unknown).

FERIC recently produced a plan for the period 1985-89 evaluating its current program and proposing a doubling of its budget and R and D output, with expansion of effort in each of its current mandate areas (see above). Without such an expansion of its capabilities, FERIC (and its member companies) questions its own ability to continue to make a meaningful contribution to the forest sector.

Pulp and Paper Research Institute of Canada (PAPRICAN)

PAPRICAN's function is to supplement and complement the technical effort of individual pulp and paper firms by providing its members with basic research data and improved technology in order to improve competitiveness. It carries out research that no single company could usually justify carrying out alone. PAPRICAN's mandate requires that it have "a strong program of fundamental studies" along with the capability "to carry forward from inception to commercialization major developments of interest to the industry." At the same time, it supplies a variety of technical services to its member companies such as library facilities, computer-based information retrieval services,

seminars, calibration services, consultation and "technological forecasting".

In its own words, PAPRICAN's structure and financing are as follows:

> The Pulp and Paper Research Institute of Canada is a non-profit research and educational organization.... It has a Board of Directors composed of eighteen members, thirteen of whom are appointed by the Canadian Pulp and Paper Association, three by McGill University and two by the Federal Government.
>
> The costs of the basic program of pulp and paper research are borne largely by the Institute's Maintaining Member Companies, who represent nearly all of the pulp and paper producers in Canada. Some financial assistance is provided for a number of research projects through the...Federal Government.
>
> The Federal Government provides, at no cost to the Institute, the building located at Pointe Claire.
>
> McGill University participates in the post-graduate education program. It makes available, for students identified with the Institute, the former Institute building located on the McGill campus. Students are admitted to the University's faculty of graduate studies and research, and carry out their thesis work under the direction of Institute staff members.
>
> In 1978, a similar cooperative arrangement was started with the University of British Columbia.

A Research Program Committee provides program direction, planning and evaluation. This committee is comprised of 12 - 20 people, mainly senior industrial representatives, along with federal government and university officials. Sub-committees are set up by the Research Program Committee to develop project proposals in specific areas.

The major areas of current research activity include:

- Chemical pulping and bleaching
- Mechanical pulping
- Papermaking
- Materials development
- Environmental science
- Biological science
- Systems engineering
- Basic oriented research
- Technological forecasting.

Some notable developments of the organization over the past ten years include:[94]

- Production of a prototype sensor for monitoring the oxidation of sulphur compounds in black liquor in kraft pulping. The sensor provides, for the first time, continuous, on-line control for minimizing "malodorous" gas emissions from pulp mills;
- Development of the "PAPRITECTION" system of controlling the rate of corrosion in bleached pulp washes;
- Formulation of the Temperature Gradient Calendering technique to obtain newsprint with smoother surface properties and less compression;

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[94]PAPRICAN. Annual Report, 1984, 1985.

- Development of a more effective scrubbing process ("PPRIC/BCRC") for removing malodorous sulphides from kraft mill emissions;

- Development of both off-line and on-line operational modelling systems, respectively, for analysis/prediction of operational and economic behaviour of the industry's operations and for the control of various mill processes;

- A study of the colloidal and chemical properties of pitch which has led to new ways of controlling pitch deposition under various circumstances;

- Production of a moderately priced dirt counter involving a microcomputer, video camera, digitizer and a PAPRICAN software package.

PAPRICAN's research facilities include the Pointe Claire facility as well as a new $6 million laboratory which was opened (although not completed) in January, 1986 on the U.B.C. campus in Vancouver. The capital cost of this facility was borne by the B.C. government. PAPRICAN will provide the $1 million per year operating costs plus scholarships for post-graduate students in the associated U.B.C. pulp and paper engineering centre. The B.C. facility's focus will be different than the one at Pointe Claire. B.C. research will concentrate on the kraft pulping process and on better utilization of the forest resource - two areas of particular relevance in B.C.

PAPRICAN had a budget of $19 million in 1985. Its staff level is about 330, including 20 in B.C. (growing to 160 in 8 - 10 years). Its work is well regarded throughout the world, but transfer of its technology would be much easier and more efficient if there were a larger equipment manufacturing/supplier industry in Canada (although no suggestions on how this might be brought about were put forward for this study).

FORINTEK Canada Corp.

FORINTEK is a cooperative wood products research organization funded by industry, the federal government and provincial governments, plus additional grants and contracts.[95] Its aim is to carry out a research program and related technical services which will provide the wood products industry with the technology needed to enhance its competitive position through higher productivity and new and improved products at competitive prices.

FORINTEK'S stated mission is "to be the leading force in the technological advancement of the Canadian Wood Products industry, through the creation and implementation of innovative concepts, processes, products and education programs." The following fields are emphasized:

- Research and Development - in the areas of wood properties, forest resource utilization, wood processing, product quality and product utilization and development;
- Codes and Standards - techniques and procedures for assuring the reliability of performance of wood products and structure plus the establishment of performance criteria;
- Training and Education - collaboration with universities in training students, industrial seminars and training programs.

Some of FORINTEK's achievements include:

- Demonstration of stellite tipped saws to improve wear and corrosion resistance;
- Design of a new type of bandsaw roller guide which reduces maintenance costs;

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[95]Funding is roughly 50% federal government, 25% provincial governments and 25% industry.

- Development of an evaluation procedure to help sawmillers to determine the efficiency of various green trimmer operations;
- Evaluation of the spindleless lathe and development of a prototype which will enable plywood manufacturers to peel logs unsuitable for peeling with conventional lathes;
- Development of a new system to measure the moisture content in unseasoned veneers and lumber on the production line;
- Development of new processes for the improvement of the dimensional stability of waferboard which will expand current application and increase competitiveness;
- Evaluation of wood density for plus-trees in support of genetic improvement programs;
- Development of a new adhesive system for the production of waferboard.[96]

FORINTEK is organized on a regional basis (laboratories in Vancouver and Ottawa) with related program emphasis as follows:

- National Programs - biotechnology, wood engineering, wood science economics;
- Eastern Programs - manufacturing technology (lumber, composite products), wood using technology (treated wood, building systems), secondary manufacturing;
- Western Programs - manufacturing technology (primary manufacturing, remanufacturing), product development (treated wood, composite products).

Industrial members come in two categories: companies engaged in the manufacture and marketing of wood products, and associations with at least 70 percent of the members (by shipments) belonging to FORINTEK. Member companies each pay FORINTEK a small fee per unit of their manufactured output.[97]

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[96]FORINTEK. Annual Report, 1984-85, 1985.

[97]15 cents/Mbm of lumber, 9.4 cents or 5.6 cents/Msf of panel board, 1.3 cents/sq of shakes or shingles.

FORINTEK operates through a board of directors made up of senior industrial, federal government, provincial government and university officials. Research Program Committees are appointed to provide advice and guidance on specific R and D programs.

FORINTEK's 1985-1986 budget is $11.4 million, including a $0.8 million appropriation to a capital fund for long-term R and D projects. It has a staff of about 200 (approximately half scientists and engineers), equally divided between its eastern and western laboratories.

FORINTEK recently went through an interesting and thorough strategic planning process with a heavy business orientation. The result is an administrative emphasis on management by objectives, financial control and a strong marketing and promotion program. Corporate objectives are specific, measurable and deadline oriented. They cover the areas of marketing, finances, innovation, social responsibilities and organizational functioning.

Council of Forest Industries (COFI)

COFI is the major forest industry association in British Columbia. It is a cooperative forest products marketing group, a government lobbying body, a focus for dealing with industry-wide issues and a media voice for the industry (particularly the larger companies which it mostly represents).

In addition to these functions, COFI has a small laboratory in Vancouver which carries out research, mainly on the structural use of

plywood, but recently on lumber as well. It has an R and D staff of seven, three of whom are scientists or engineers.

Equipment Manufacturers

Statistics Canada lists only one forestry equipment company carrying out R and D in Canada. Ontario's Timberjack Division of Eaton Yale Ltd. conducts in-house R and D involving the manufacture of forest harvesting equipment. Timberjack has an R and D staff of 93, including 14 scientists or engineers, but not all of them are strictly forestry oriented. No further details are provided. However, this is very misleading. There are large numbers of machine works, fabricators and equipment manufacturers throughout Canada who supply all phases of the forestry industry. A large number of them carry out equipment development and refinement, often in conjunction with the harvesting, transportation and manufacturing companies they supply or service. To more fully define their R and D contributions would require much further investigation.

Industrial Corporations

Table 21 shows that there are 42 firms carrying out R and D related to the manufacturing wood based industries, most of them (81%) in the paper industry group. Sixty percent of these firms are Canadian controlled.

Table 21

Number of Firms Performing R and D in the Wood Based Industries, 1983

Wood Industry Group	No. of Firms
Logging	1
Sawmills, Planing Mills, Shingle Mills	1
Veneer and Plywood Mills	1
Sash, Door, Other Plywood Plants	3
Wood Box Factories	-
Coffins and Caskets	-
Miscellaneous Wood	2
	8
Paper Industry Group	
Pulp and Paper Mills	23
Asphalt Roofing Manufacturers	-
Paper Box and Bag Manufacturers	6
Miscellaneous Paper Converters	5
	34
TOTAL	42

Source: Statistics Canada, Cat. No. 88 - 202 (1985).

Only about 20 of these firms carry out significant amounts of R and D. Most carry out operationally oriented R and D related to forest resource management of the lands they own or hold under licence from the provinces, or else they are consulting firms carrying out contract R and D projects.

Most companies in the forest sector rely on the governments or the cooperative R and D organizations described above for the development of technology. Only a few of the large corporations carry out significant R and D related to manufacturing. They are:

- Abitibi-Price Inc.: R and D staff of 62 (30 scientists or engineers) pulp and paper field;

- Consolidated-Bathurst Inc.: R and D staff of 36 (8 scientists or engineers) - pulp and paper field;

- Domtar Inc.: R and D staff of 105 (45 scientists or engineers) - pulp and paper and treated wood products;

- Fraser Inc.: no staff levels given - pulp and paper and lumber products;

- MacMillan Bloedel Ltd.: R and D staff of 113 (52 scientists or engineers) - pulp and paper, lumber and panel products, plus 23 (12 scientist or engineers) in land use planning and forest resource management;

- Ontario Paper Co.: R and D staff of 14 (5 scientists or engineers) - pulp and paper field.

These companies' R and D programs focus on developing new and better products in which they specialize so as to gain a competitive edge and on improving processes and systems specific to their manufacturing facilities and wood supply sources.

Universities

Three universities carry out R and D in the pulp and paper field, all in conjunction with PAPRICAN: McGill University, the University of British Columbia and Montreal University.

Most of the six universities with forestry schools[98] conduct harvesting and solid wood products R and D (the latter usually in cooperation with FORINTEK.

Approximately 15 universities, and particularly the six mentioned with forestry schools, carry out some forestry or forestry related R and D in the broad area of forest resource management.

Since 1982, the C.F.S. has made "a large and positive impact" on the country's forestry schools through the implementation of the "Human Resources Component" of its Forest Sector Strategy for Canada[99]. The Program (called PRUF), which increased in funding from $1.3 million in 1981-82 to $6.1 million in 1985-86, consisted of:

- university student summer employment;
- grants to the university forestry schools;
- scholarships;
- R and D contracts to universities in the areas of forest renewal forest protection and forest resource development;
- post-doctoral fellowships;
- C.F.S. staff development.

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[98] Laval, Lakehead, B.C., Alberta, Toronto, New Brunswick.

[99] Dendron Resource Surveys Ltd. Evaluation of Canadian Forestry Service Human Resource Strategy for Research Programs, 1985, Consultant's Report to the C.F.S.

The National Science and Engineering Research Council (NSERC) had a 1984 budget of $311 million[100], totally directed at funding university research. No record of the amount directed towards forestry R and D is kept. NSERC has established a sub-program with access restricted to the six university forestry schools.

Largely due to the C.F.S. and NSERC funding boosts, university research levels are up almost 300 percent in the past five years to over $9 million in 1984-85 at the six forestry schools.[101]

The Canadian Forestry Service

The overall mandate and range of activities of the C.F.S. were related earlier (see page 19). One of the primary functions of the C.F.S. is to carry out forestry research and to provide related technical services. The following is a description, in its own words, of the C.F.S.'s Forest Research and Technical Services objectives and scope of activities:

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[100] NSERC has a request before MOSST to raise its budget to $700 million by 1990 so that Canada can have enough scientists to "move to the leading edge of industrial technology".

[101] Murphy, P. Increase in Research and Support of Graduate Students at the University Forestry Schools, 1985, Forestry Chronicle, August, 1985.

Objective

To enhance the forest resource base through researh and transfer of information in support of increasing forest productivity and improving forest management.

Description and Scope

Through the Forest Research and Technical Services element, research is conducted in the areas of forest environment, production, utilization and forest protection from fire, insects and disease. Research results are published to transfer knowledge and improvement in technology to the forest sector. This research is carried out at two national research institutes and six regional research centres which are located across Canada. Each establishment is independently managed...with overall coordination and integration being provided by Headquarters. The research establishments provide technical advice and scientific information to federal departments and agencies, the provinces, industry, academic institutions and other countries. Through this element, the C.F.S. administers special cooperative research programs and provides financial support for forestry research to universities and other eligible organizations.

The C.F.S.'s Research and Technical Services budget by activity grouping for the 1985-86 fiscal year is as follows:

Administration	$ 3.2 million
Support Services[102]	10.6
Forest Environmental Research	3.8
Forest Productivity Research	8.5
Forest Protection Research	11.2
Forest Utilization Research	7.7
Forestry Technical Services	10.9
	$55.9 million

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[102] Includes support services such as libraries, computers, etc., plus physical plants, but not the umbrella financial and administrative services of the C.F.S. as a whole.

These figures include a budget for salaries of $33.1 million, $13.0 million for operating costs, $0.8 million for capital expenditure, and $9.0 million for contributions which include grants and donations of about $8.1 million specifically earmarked for FERIC, FORINTEK, and the universities own in-house R and D programs.

The C.F.S has the equivalent of 842 persons engaged in R and D, 463 of them being support staff and 379 at the professional level.

R and D conducted in each of the above-noted activity groups is as follows:

Forest Environment Research is carried out to assess the impact of forestry practices on the environment, the impact of environmental problems on the forest resource and to further the knowledge of forest ecosystems. Of particular concern is the impact of acid deposition on the long-term productivity of forest ecosystems and, conversely, the degree to which these systems modify the toxic composition of the acid deposits.

Forest Management Research is conducted to improve: the genetic quality of major tree species; methods of reforestation; tree and stand growth; and forest management systems. The long-term goal of this research is to increase the productivity of the forest sector.

Forest Protection Research is directed toward the development of knowledge of forest biology, management of forest insects, disease and weeds, improved methods of prediction, detection, prevention and control of forest fires, and pest control including biological and chemical agents. In addition, research is conducted on the most urgent forest pest problems in order to develop methods that will reduce damage from insects and diseases with minimal adverse effects on the environment.

Forest Utilization Research is directed towards the utilization of forest resources and the development of new products (e.g. composite wood products such as waferboard) and codes and standards which are required if Canada is to retain foreign markets. Cooperative agreements with the private sector support research activities in wood products and harvesting. Research on the use of forest resources as an energy source is administered through the Energy From the Forest Program (ENFOR) in cooperation with Energy, Mines and Resources.

Forestry Technical Services are directed toward a surveillance program which detects, monitors and reports on the forest and is also responsible for the compilation and maintenance of a computerized inventory of Canada's forest resource base. Technical advice, forest resource data, technology transfer and publication of scientific information provide forest managers, industry and the general public with information necessary for sound management. In addition, transfer payments in the form of grants and contributions are provided to universities and other eligible organizations for the conduct of forestry research.

Achievements or breakthroughs are difficult to quantify and the returns from these R and D efforts are rarely tallied up. However, there are some notable examples of dramatic results. Between 1952 and 1980, the C.F.S. spent approximately $50 million on spruce budworm research. The results enabled control programs in New Brunswick alone which allowed a doubling of the forest industry's productive capacity and an increase in the value of sales from $225 million (1980 dollars) in 1961 to $1.2 billion in 1980. Another example is the spending of less than $5 million developing a forest fire hazard rating system which now results in annual savings of at least $20 million in fire control. The European spruce sawfly threat was potentially as serious as the budworm. The C.F.S. research, costing less than $100,000, eliminated the sawfly problem.[103]

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[103] C.F.S. A Forest Strategy for Canada, 1981, Environment Canada.

Other Federal Government Agencies

Besides NSERC, which was mentioned above, the following federal agencies conduct or provide grants for forestry related R and D: Agriculture Canada (mainly in the areas of pesticides and soils/land use classification and mapping), Energy, Mines and Resources (renewable energy and remote sensing), National Research Council and DRIE/ITC (industrial research grants), Environment Canada (pollution control).

The Provincial Governments

Each provincial forestry agency carries out some amount of R and D, usually related to forest resource management and harvesting. B.C., Alberta, Quebec and Ontario carry out the bulk of the provincial R and D effort.

Based on provincially supplied information, the C.F.S. and the Canadian Pulp and Paper Association estimate that the provincial governments themselves spent $16.5 million in 1981-82 on forest management/harvesting research.[104,105] This information was not published until 1985. Two things are apparent in relation to this $16.5 million figure:

- More up-to-date information is not available because R and D is not reported in many provincial reports;

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[104] Smyth, J.H., Ramsay, K.L., and Baron, D.E. Forest Management Expenditures in Canada, 1977-1981, 1985, C.F.S. and C.P.P.A. Joint Report No.1.

[105] On top of this, several provinces also have other government branches or councils which provide contracts or grants for industrial R and D, with forestry qualifying, and sometimes even designated, for portions of available funds.

- Based on the following information, the level of provincial government spending has not changed much since then.

Provincial government R and D programs in forestry are outlined below.

Ontario

The Ontario Ministry of Natural Resources does not report separately on its forestry research program, expenditures or manpower allocation. There is no particular branch or department responsible for forestry R and D; it appears to be part of the responsibilities carried out at the regional level through regional foresters and biologists. There is a Science Advisor and Research Coordinator in the Deputy Minister's office.[106]

Field Centres for Technological Development are, or will be, located in various regions. Technological development appears to focus on identifying the most productive forest sites, draining bogs to promote faster tree growth, tree breeding, herbicides, rehabilitation of degraded forest sites and low quality forests, and a centralized forest fire management system.[107]

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[106;107]Ontario Ministry of Natural Resources. Annual Report 1985.

Ontario has a unique and once-reknowned forest research centre called The Ontario Tree Improvement and Forest Biomass Institute. Housed in the Ministry of Natural Resources (OMNR), its purpose is to carry out studies in tree breeding, reforestation, forest stand management and site productivity. Particular emphasis is placed on breeding, productivity and requirements of fast growing hardwoods (especially hybrid poplars).[108]

The Institute had a budget of $3.3 million in 1981-82[109] but suffered a severe budget cutback and attempt at privatization in 1983. An annual report has not been produced since then.

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[108,109]Ontario Tree Improvement and Forest Biomass Institute. Forest Research 1981-1982, 1983.

Quebec

The Quebec Ministry of Energy and Resources carries out an extensive forestry R and D program through a separate research and planning branch in the Lands and Forests Department. Recent levels of funding were:[110]

1978-79	$2.2 million
1979-80	2.4 million
1980-81	2.6 million
1981-82	2.8 million
1982-83	2.8 million
1983-84	2.9 million.

Eighty-three people are involved.[111]

Three areas of R and D are covered in Quebec's program:[112]

- Protection of the forest environment;
- Improvement of forest land:
  - maximization of fibre production
  - forest protection, including the husbandry of young stands and mechanization of silvicultural activity
  - resource management;
- Optimum resource use:
  - research into industrial technology
  - new products
  - providing a suitable climate for corporate research.

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[110,111] Quebec Ministry of Energy and Resources. Annual Report, 1983-84.

[112] Quebec Ministry of Energy and Resources. Batir une Foret pour l'Avenir, 1985.

Research priorities include:[113]

- Classification and mapping of ecosystems to determine those sites best suited for each use and also to identify fragile ones;

- Research into the dynamics of forest ecosystems, particularly nutrient cycles, vegetative successions, and ecosystem degradation;

- Evaluation of the impact of atmospheric pollution - notably acid rain - on forest ecosystems and the possibility of correcting these phenomena;

- Research into growth of the principal types of regeneration (natural or artificial) and the development of various growth modelling systems to test different management intensities and silvicultural treatments;

- Research into methods of encouraging natural regeneration and its preservation;

- Genetic research to develop improved strains for more rapid growth and for greater resistance to disease;

- Accelerate research into seed quality and seedlings destined for reforestation and also the techniques of reforestation;

- Give greater emphasis to research and development into weed suppression and vegetation control in plantations and the effect of these measures on the environment;

- Accelerate research into silviculture and management of degraded forests on high sites generally located in the populated areas of Quebec;

- Research into the system of management of forestry activities within the populated and industrial areas of Quebec;

- Research into the socio-economic relationships of forest management for the optimum benefit of the citizens of Quebec.

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[113] Quebec Ministry of Energy and Resources. Batir une Foret Pour l'Avenir, 1985

British Columbia

British Columbia has a separate Research Branch within the Ministry of Forests, with research officers in each region. The 1983-84 expenditure on research was $8.4 million, including $0.5 million spent on projects undertaken by private companies (licensees) and $0.9 million in contract R and D. Ninety-six full-time employees are involved.[114]

Research focuses on the following areas:[115]

- Harvesting - wildlife habitat needs and protection; fisheries/forest harvesting interactions; computer applications in the area of timber harvesting engineering;
- Silviculture - breeding, seed and nursery operational research for important tree species; classification and mapping of forest ecosystems; protection and rehabilitation of sites from degradation due to harvesting and road construction; vegetation control and management (weeds, brush and non-commercial tree species);
- Protection - forest fire management; insect behaviour;
- Range - effects of fertilization; range management techniques;
- Growth and Yield - analysis and quantification for managed forests.

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[114] B.C. Ministry of Forests. Annual Report 1983-84, 1985.

[115] B.C. Ministry of Forests. Forest Research Review 1983-84, 1985.

Nova Scotia, Newfoundland, New Brunswick, Prince Edward Island, Manitoba, Saskatachewan

No specific mention of R and D is made in these provinces' Annual Reports. Their federal-provincial forestry agreements and local C.F.S. research centres are probably responsible for most of the R and D undertaken (see Appendix I).

Alberta

The Alberta Department of Energy and Natural Resources has within it the Alberta Forest Service and its Research Department. The Department's 1983-84 budget was $1.0 million, down from $1.8 million the previous year.

The Research Department's annual funding is augmented by a Forest Development Research Trust Fund. R and D is concentrated on reforestation, watershed management and protection, forest growth and yield studies, site productivity classification, and tree breeding (done in cooperation with private licensees).

Forest Economics and Policy Analysis Project (FEPA)

The FEPA Project is unique to Canada and noteworthy in terms of its structure and purpose. Begun in late 1983[116] and running until early 1987, FEPA's aim is to "investigate the outlook for Canada's forest industry in the face of a changing resource base and shifting market patterns". An advanced analytical system has been set up to investigate economic and policy problems facing Canada's forest sector.

Five computer-based models are being developed or adapted and tested to analyse timber supply, lumber and plywood markets, pulp and paper markets and the forest sector as a whole.

Located on the campus of the University of British Columbia, FEPA is an amalgamation of full-time staff, consultants, post-graduate students, seconded C.F.S. personnel and U.B.C. forestry faculty members. The B.C. Ministry of Forests, the forest industry and various C.F.S. branches are acting as co-operators. Sten Nilsson, a reknowned Swedish forest economist and forest sector modeler, spent a year with the project and was the principal author of FEPA's pilot project study of the B.C. forest sector.[117]

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[116] As a joint venture between the University of B.C. and the Forestry Statistics and Systems Branch and Economics Branch of the C.F.S.

[117] Nilsson, S. An Analysis of the B.C. Forest Sector Around the Year 2000, 1985, FEPA.

FEPA is Canada's first attempt at looking interactively at the entire forest sector - the resource base, the industry and the markets. It has been criticized as a "cadillac" project (a $1 million grant was secured through C.F.S., plus U.B.C. support, C.F.S. personnel, etc.), but this attitude probably comes from researchers who have traditionally had to operate on restricted budgets.

FEPA is not only providing the sector for the first time with a holistic look at itself, including various alternative scenarios, but it is also providing a vehicle for developing some much needed Canadian expertise in a variety of applied analytical and systems fields.

b) Coordination of Forestry Research and Development

R and D in the forest sector is coordinated by numerous committees, government agencies and advisory groups. The following provincial R and D advisory bodies exist:

- Forest Research Council of B.C.
- Alberta Forest Research Advisory Council
- Groupe de travail pour la production d'un rapport de conjuncture sur la recherche dans le secteur forestier au Quebec
- New Brunswick Forest Research Advisory Council
- Nova Scotia Forest Research Committee.

In addition, each C.F.S. regional research establishment has either a federal-provincial or federal-provincial-industry regional advisory committee on R and D.

These provincially or regionally oriented bodies are strictly advisory and, for the most part, have no financial or legal powers.

Nationally, the following R and D advisory bodies exist:

- Advisory Committee for the (Federal, C.F.S.) Forest Pest Management Institute
- (C.F.S.) National Committee on Mechanization of Silviculture
- Canadian Forest Inventory Committee
- Forest Research Advisory Council of Canada.

These are generally characterized by participants and interested observers as vehicles of information, suggestion and acquaintance more than bodies with real authority.

The Forest Research Advisory Council of Canada (FRACC) is worthy of special note.

FRACC was set up over two years ago to:

- Review and participate in the development of the Canadian Forestry Services research policies and strategic plans;
- Examine broad research priorities in relation to policies and strategic plans;
- Review the regional distribution and orientation of Canadian Forestry Service research programs and funding;
- Review and advise on the role of the Canadian Forestry Service in the context of other related research agencies;
- Review and advise on technology transfer, i.e. the development and application of new and existing knowledge;
- Review and advise on effective means of communication and information exchange between the C.F.S. and other regional, provincial and national research and research advisory bodies;
- Make recommendations to the Associate Deputy Minister on any or all of the above; either on its own initiative or at the request of the Associate Deputy Minister.

Members are appointed by the ADM of the Ministry of State for Forestry (MSF) and FRACC's function relates solely to the C.F.S. and is strictly advisory. Members are drawn from industry, "the provinces" and the university forestry schools, with ex officio members from the C.P.P.A. and C.F.S. FRACC has an operating budget of $30,000 per year

for travel expenses.

Members (past and present) and interested observers generally agree that FRACC:

- Has a weak mandate and no authority;
- Has not been able to get high-level industrial backing (or input);
- Has been ineffectual, often due to lack of C.F.S. and MSF responsiveness;
- Has no role or influence (i.e. provincially or industrially) outside the C.F.S./MSF.

The Canadian Forest Inventory Committee (CFIC) should also be mentioned. This Committee is made up of the heads of the provincial and federal forest inventory departments plus an industrial representative. CFIC is sponsored and coordinated by the C.F.S.'s Forestry Statistics and Systems Branch. The committee meets once or twice a year to communicate, observe new technology, define technological needs and formulate strategies and projects (often cooperative) for filling these needs. CFIC is probably more effective than its other forestry counterparts because it directly involves the managers responsible for and benefitting from new technologies. At the same time, the sponsor (FSSB) is directly responsible for federal R and D and technology transfer in the CFIC's field of interest. So the provincial users and federal developers at the managerial level work together to get results.

c) Technological Linkages with other Resource Sectors

This sub-section is intended only to point out some of the directions in which an in-depth MOSST study might look at potential R and D linkages between forestry and other resource sectors.

Agriculture and forestry share many of the same scientific "roots" and therefore almost any biologically or botanically based technology can be linked between forestry and agriculture. The more obvious agriculture/forestry R and D linkages are:

- herbicide and insecticide testing and rating for effectiveness as well as environmental and human health hazards;
- development of plant community management systems which obviate pesticides;
- genetic improvement for better growth and pest resistance (an aspect of biotechnology);
- fertilization methods;
- soil productivity and land use classifications, including economic ratings;
- farming equipment adaptation to small-scale forest harvesting, seedling nursery, site preparation for tree planting and forest thinning operations.

There is a strong possibility of a three-way linkage between the forestry, agriculture and energy sectors in the development of technology for the harvesting, conversion and utilization of biomass for energy production. Much effective R and D effort and expense has taken place in this field through the federal Department of Energy, Mines and Resources' renewable energy program and its C.F.S.-managed offshoot, the Energy From the Forest (ENFOR) program. However, emphasis has shifted away from renewable energy R and D since world oil

prices began to stabilize and drop about 3 years ago and because of an apparent emphasis of "frontier" gas and oil exploration and development by the federal government.

The linkage between forest resource development (and related manufacturing) and the environments is complex and not well understood. The solutions to problems and interactions between forestry and other renewable resource values (such as fish) are, for the most part, handled and interpreted in isolation (see page 33). But basically the knowledge of these interactions is there. The skill and the will to use this knowledge in a responsible, non-partisan manner have not been fully demonstrated. More cooperation in developing mutually acceptable land management techniques is required.

Energy, Mines and Resources' Canada Centre for Remote Sensing provides satellite data and images to the various resource sectors, including forestry. The Centre itself is a link between the various resource sectors, as is the Image Analysis Systems and Artificial Intelligence Working Group of the Canadian Advisory Committee on Remote Sensing (chaired by the Head of the Centre). With forestry representation on the Working Group and on other related working groups, the future coordination of remote sensing activities in the resource sector looks promising if the necessary funding can be obtained to develop much needed operational systems.[118]

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[118] Woodham, R.J. Trends in Quantitative Remote Sensing, Forestry Chronicle, October, 1985.

d) Technology Transfer, Accountability and Strategic Planning

The major problem in conducting R and D and transferring technology in the forest sector is the current shortage of funds to modernize and/or implement newer technologies. A reluctance on the part of corporations doing R and D to share breakthroughs with competitors is a lesser, naturally prevalent problem. In the pulp and paper sub-sector, a major difficulty stems from the almost total lack of Canadian firms manufacturing major components for mills.

For new technology to be implemented, the following conditions are necessary:

- There must be an awareness of the new technology by the potential user(s);
- The new technology must result in a cost reduction, value improvement or combination of both;
- Management must be enlightened, adaptable and amenable to change;
- The potential user must have a financial foundation sound enough to allow implementation.

Previous sections of this report have indicated that both the development and implementation of forestry technology could be much improved. In other words, the forest sector in Canada needs more R and D but, at the same time, it is not making full use of the technology that is already available. This situation exists in spite of the fact that all of the major organizations doing forestry R and D in Canada

(see Section C.2.a) have technology transfer mechanisms of varying degrees of sophistication in place.[119]

It has already been shown that managerial and financial capabilities in the forest industry are impediments to improving the level of technology. Overcoming these impediments is not a function of the technology transfer process, but bringing about awareness and demonstrating profitability are.

The R and D organizations in Canada make use of all the "tech-transfer" tools: newsletters, publications, seminars, workshops, brochures, advertising, news releases, lectures, employee exchanges, demonstration projects, etc.

Where it makes financial sense, new, Canadian developed technologies are exported just like any other country's. CIDA helps in this regard by preferentially hiring Canadian consultants and supplying Canadian-made goods in our aid programs, with future trade potential (in services and goods) as a primary consideration at all times ("tied aid"). CIDA also has assistance programs for Canadian consultants and suppliers of goods for market development and joint ventures in developing countries.

The federal government has other overseas market development assistance programs which apply directly and indirectly to the forest sector and DRIE tries to play a catalyst/advertiser role also.

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[119]The cooperative research institutes normally make their patented/licenced processes and products available to their members at no charge.

However, most users of forestry technology and even the researchers themselves say a better, more goal-oriented job of technology transfer, marketing and export is required.

It appears that the problem of ineffectual tech-transfer stems from three main sources:

- the administration of R and D programs;
- the qualifications of the people involved;
- the degree of accountability for R and D performance.

In the past, most Canadian R and D programs were administered by scientists and technology transfer was carried out by the scientists who did the R and D. Communication and entrepreneurial skills as well as an understanding of business needs were often deficient.

This situation is changing because the forest sector as a whole has become more aware of the importance of technology, partly as a result of the federal-provincial forestry agreements and the privatization of much forestry R and D. The forestry agreements have provided the C.F.S. with some much needed manpower and funding for technology transfer. The so-called privatization of some R and D (through the creation of FORINTEK, FERIC, FEPA and the western PAPRICAN lab) has involved industry and other technology users in the direct (shared) funding of R and D. Now that industry has this direct funding responsibility - rather than the governments handling most of it, as in the past - it takes more interest in how the money is spent and what is being returned (transferred) for this money.

So the situation is changing for the better, but there is still

need for improvement in overall accountability for R and D performance and in the way R and D is administered, especially in the governmental R and D organizations, if tech-transfer is to be more efficient and R and D more applicable.

To illustrate, two basic organizational planning and decision-making tools will be looked at: Benefit/Cost Analysis and Critical Path Planning.

The Science Council of Canada says that a 1980 agricultural study in Canada showed benefit/cost ratios for research expenditures ranging from 80:1 to 790:1 and that the average U.S. forestry research ratio is 50:1.[120] In an evaluation of its own R and D, the U.S. Forest Service was "unable to analyse benefits or to determine internal rates of return to research investments."[121] However, in looking at the gross dollar value of an innovation during only the first year it was applied, the USFS found that for "22 of its innovations studied, the first-year benefits alone, $2.6 billion (U.S.), exceed the cost of all prior (U.S.) Forest Service Research or would pay for the next 24 years of (U.S.) Forest Service Research at current costs.[122]

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[120] Science Council of Canada. Canada's Threatened Forests, 1983.

[121] Callahan, R.Z. Criteria for Deciding about Forestry Research Programs, 1981, USDA, USFS.

[122] Ibid.

The USFS study decided, "Considering that many other quantifiable benefits and innumerable nonquantifiable benefits have resulted from (U.S.) Forest Service Research, a logical conclusion is that investments in such research yield a high rate of return."[123] "All indications are that substantially more public funds should be committed to research in renewable natural resources and that returns on investments will be justifiably high."[124]

One of the striking things about the field of forestry R and D in Canada, in both the private and public sectors, is the almost total lack of data on the rates of return or benefit/cost.[125] What is more distressing is the apparent lack of concern and understanding for the need for such data. Neither the forestry R and D agencies, companies and committees/councils interviewed for this study nor their governing bodies carry out audits of the pay-back on their basic or applied research and related technology transfer. Most said it could not be done and/or was unnecessary. Some organizations could point to studies

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[123]Callahan, R.Z. Criteria for Deciding about Forestry Research Programs, 1981, USDA, USFS.

[124]Ibid.

[125]Some of the exceptions are presented on page 113.

of the savings gained by harvesting or manufacturing companies as a result of implementation of new technologies but none could relate these savings to the cost of developing the technologies themselves. Those involved in and responsible for forestry-related R and D do not correlate proof of performance or the need thereof with public, political and bureaucratic support.[126]

Critical Path Planning is also difficult to apply to basic research projects and programs, but still it is an effective managerial tool for rating performance and maintaining focus.

Our R and D programs must assume a more businesslike approach if they are to achieve full industrial support. Critical Path Planning and Benefit/Cost Analysis are two ways of demonstrating the credibility and accountability needed to gain this support.

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[126]For more detail see: Reed, F.L.C. Respond to Change, 1983, Talk by the Assistant Deputy Minister to the C.F.S. Internal Science Symposium.

A good illustration of taking a more business oriented approach to R and D and technology transfer is FORINTEK. As mentioned, FORINTEK went through a lengthy and wrenching strategic planning process prior to May 1985. The process has, by FORINTEK's own admission, provided much needed focus and relevance to its R and D effort. The organization has become more goal and end-product oriented, with built-in accountability functions. Some examples of corporate objectives will illustrate the deadline/ responsibility/accountability orientation of FORINTEK's functions:

- Inform FORINTEK financial supporters at least semi-annually of progress toward achieving research program results;
- Build and maintain an industry membership base in the primary manufacturing sector;
- Create a system which provides market and economic information which enables FORINTEK to identify, assess and focus on technological renewal of the Canadian wood products industry by March, 1985;
- To implement the FORINTEK strategy, management will have written and agreed to job area responsibilities by March, 1985, individual objectives by July, 1985, and individual results evaluation by December, 1985, and quarterly thereafter.

It is too early to fully assess the success of FORINTEK's planning strategy but the approach is one that should be taken by more forestry R and D organizations if R and D efforts and related technology transfer are to be improved to any degree.

D. NEWER TECHNOLOGY

1. TRENDS

There is much technology which is available to Canada's forest sector and which, through implementation, has already proven that it could have a positive economic impact on the industry. Here are some of the areas and systems of technology and specific technologies which are having, or would probably have, significant effects on the various forestry sub-sectors.

Sawmilling Technology

Because of anticipated timber supply deficits, the general increase in pricing competition, and the diminishing overall quality of log inputs, the major objective in introducing newer sawmilling technology is to optimize lumber value recovery (as opposed to volume recovery). Technological needs are to:

- handle smaller sized and lower quality logs;
- reduce labour costs;
- improve recovery while maintaining consistent output quality.

System advances include:

- Log Deck - Use of electronic scanners to check length, taper and straightness.
- Bucking - Can be fully computerized and automated through a linkage with data acquired at the log deck.
- Primary Breakdown - Sensors measure each log and a computer directs them to appropriate batch stations.
- Computer-controlled equipment saws each log to

provide the optimum value in lumber. This may not be the maximum volume recovery.

- Stellite tipping of sawteeth and new sawteeth designs for more efficient cutting.

- Sorting and Packaging - Electronics and computers can govern the handling of these phases too.

- Dry Kilns - Computers are playing a greater role in controlling kiln conditions.

- Dehumidifying equipment is starting to be used much more for sensitive woods such as hardwoods.

- Heat for kilns is being provided by plants using sawmill waste such as bark and shavings.

- Planer Mills - Rather than the use of knives, planing may be superceded by high-speed sanders, which can give a better finish with less waste.

- Lumber Grading - The industry is rapidly approaching the transition from lumber graded according to visible characteristics to grading according to the actual physical properties of each piece, e.g. strength, compression and stress.

- M.S.R. Lumber (Machine Stress Rated) - Machines automatically rate each piece of lumber for modules of elasticity and fibre stress in bending. The product is lumber classified by stiffness and strength groupings which commands a premium in the market place.

- Finger-Jointed Lumber - Process involves gluing machine-matched pieces of lumber end to end. Allows lumber to be upgraded by cutting out the defects and rejoining, and to recover short lengths which would otherwise be wasted.
- Laminated Veneer Lumber - Reconstituted lumber manufactured from sheets of veneer with all veneers parallel to the length of the panel. When the desired thickness is achieved the panel is sawn into required widths.
- Edge-Glued Lumber - Enables lumber to be glued together to form panels which may be resawn into wide boards.

Electronic technology is increasingly introduced into sawmills. In fact, the B.C. Interior is probably the world leader in sawmill automation. Mills elsewhere introduce new technology as finances permit.

Product advances are coming in slowly. M.S.R. is especially successful with lodgepole pine and it has a market advantage. The others - finger joint, laminated veneer and edge-glued lumber, must compete with regular lumber with no price advantage, coupled with much higher investment costs. Therefore they are slower to be introduced.

Panel Products Technology

The major "new" technology in this sub-sector is the composite wood panel manufacturing process which can convert low-quality and low value wood (e.g. hardwoods and residues) into panel products which

easily compete in price and performance with construction plywood. Research in this area centres around improving the performance of waferboard (new uses, moisture resistance, improved surface characteristics, quality).

Waferboard plants are being installed as fast as capital and markets will allow, with consequent reduction in plywood capacity.

Pulp and Paper Technology

If the pulp and paper sub-sector is to maintain or expand its position in the world market and at the same time maintain profit margins, it will have to shift its output from commodity type products towards higher value-added products. This shift can be brought about by upgrading existing products, carrying out more secondary manufacture of existing products, and/or making products which are more market-specific.[127]

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[127] Larose, P. Higher Value Added Products in the Canadian Forest Sector, 1985, C.F.S. Internal Report.

There are excellent opportunities for market expansion into higher value pulp and paper products and processes. A few examples are:

- Specialty Kraft Paper - value added; market specialization; requires mill upgrading rather thn replacement; more stable markets.
- Lightweight Coated Paper - value-added; demand exceeds supply.
- Supercalendered Offset Paper - the Finns developed this very uncomplicated process which maximizes paper quality for printing from relatively low-grade pulps.[128]

On a more general level, the improved technological processes for mechanically producing pulp can substantially increase yield, thereby reducing wood requirements. Thermomechanically and chemi-mechanically produced pulps are now of sufficient quality to replace portions of chemical pulps normally used in newsprint and printing paper production. These processes also make it possible to increase the use of hardwoods for producing pulp and paper similar in quality to certain types of softwood pulp and paper.[129]

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[128]Woodbridge, Reed and Associates Ltd. Expansion Opportunities in B.C. for Higher Valued Papers and Paperboards, 1984. Report to the B.C. Ministry of Forests.

[129]Congress of the U.S. Wood Use - U.S. Competitiveness and Technology, 1983, Office of Technology Assessment.

However, for Canadian mechanical pulp mills to continue to be successful exporters, they will increasingly have to produce a high quality, bleached pulp, "marketed on a technical basis, not as a commodity."[130]

In terms of pulp and paper manufacturing processes, a major area of technological advancement involves the introduction and use of electronic sensors to measure and help analyse the quantity and quality of wood flow into mills and to measure and control various processes within the mills (see page 101).

C-I-L Inc. of Ontario developed a new catalyst for the kraft pulping process from an organic compound called anthraquinone (AQ). AQ increases the speed and efficiency of the pulping process, improves wood-fibre yields and reduces air polution. Few North American pulp mills have adopted this new technology because, according to DRIE, its main benefit is increased pulp output and these mills are currently overstocked. Over 70 mills elsewhere in the world have installed the AQ process under licence from C-I-L.[131]

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[130] Woodbridge, Reed and Associates Ltd. Market Mechanical and Chemi-mechanical Pulp: a Growth Opportunity for Canada, 1982. Report prepared for the C.F.S.

[131] DRIE. Kraft Pulping Invention is Expected to Save the World's Wood Mills Tens of Millions of Dollars Annually, 1986, Magazine advertisement.

Timber Harvesting and Transportation Technology

As pointed out earlier, Canada's forest industry is very efficient at getting timber from the forest to the mill. However, this efficiency will be tested as log sizes and quality diminish. To offset this trend, major newer technologies are available for implementation in whole-tree harvesting and pre-transportation processing systems which will:

- maximize sawlog quantities and grades;
- maximize pulp chip production;
- make available large quantities of material for energy production.

These new systems involve mechanized felling, whole-tree extraction with reduced site degradation, processing of logs and waste materials before transportation to the mill, plus related improvement through the application of ergonomics and systems analysis techniques.

Forest Resource Management Technology

The main areas in need of the application of newer available technologies are forest protection (fires, insects, disease) and forest resources evaluation. (Much of the know-how in reforestation and forest stand tending is in place; the follow-through is awaited.)

A centralized forest fire management system (computerized) has been developed through the C.F.S.'s Petawawa National Forestry Institute at Chalk River. This system is in place in parts of Ontario and Quebec with consequent annual savings in administration,

firefighting, detection, and reduced timber losses of several million dollars a year.

Biological, silvicultural and non-pesticidal methods of insect and weed prevention and control are available or at least developed to stages where it will not be long before they will be economical. These methods could greatly reduce current reliance on pesticides. As usual, cost is the problem. Forestry budgets are so limited that the cheaper pesticide methods are the only viable options to field foresters.

Canada is without doubt a leader in the development of forest resource evaluation technology.[132] The C.F.S.'s Forestry Statistics and Systems Branch at Chalk River has done a good job acting as a technology "clearing house" and systems testing/development agency. However, the provinces lack consistent and effective implementation and application of this technology. "Forest Inventory", as it is anachronistically referred to, is one of the poorest forestry efforts in Canada and continues to be, along with forest research, one of the first cut programs when the provinces and federal governments go into austerity modes. Yet basic resource data are fundamental to all

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[132] Including application of remote sensing techniques, geographic information systems, resource data storage and manipulation systems, microcomputers as field-level tools, large-scale photographic interpretation and measurement techniques, digital mapping, ortho-photography, measurement and analysis of forest growth and yield, etc.

decisions related to forest resource development, management and consequent industrial activity. In other words, we are flying blind, despite our overwhelming capabilities in resource evaluation.

Biotechnology

Biotechnology is probably the most studied and talked about "new" technology in Canada. It has been called a "genuine frontier in biology". Yet biotechnology in the form of genetic tree improvement has been on the Canadian forestry R and D scene for about 40 years. So its merits relative to the forest sector are well understood and many aspects of this broad field are in use or at least well developed.[133] Canadian foresters are even supposed to be ahead of their American counterparts in at least one aspect - cloning.[134]

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[133] See: - National Biotechnology Advisory Committee. Annual Report - 1984, 1985.
- University of B.C. Workshop on Biotechnology in Forest Science, 1985.
- Forest Research Council of B.C. Biotechnology Forum - Show, Tell and Plan, 1985.
- Science Council of Canada. Seeds of Renewal: Biotechnology and Canada's Resource Industries, 1985.
- National Research Council. NRC Industrial Biotechnology Conference, 1985.
- Various authors. The New Genetics. Series of articles in the Journal of Forestry, January, 1986.

[134] Krugman, S.L. The Ethical Question, Journal of Forestry, January, 1986.

Most of our forestry R and D performers have biotechnology programs under way.

PAPRICAN has undertaken a program in basic biotechnology research leading toward the development of operational methods of biologically treating kraft pulp mill effluents, upgrading of pulp by biological treatments, and cloning of industrial enzymes for decreased cost and improved purity in pulping.

FORINTEK's efforts in biotechnology concentrate on developing a process for converting wood wastes and mill residues into higher value products such as sugars, chemicals and resins, the use of micro-organisms to increase the durability of wood, and improving the permeability of wood for more effective preservation treatments. FORINTEK's objective in this regard is to achieve a technological breakthrough with biotechnology for the Canadian wood products industry to which there is a pilot plant commitment by 1990.

The universities (particulary Laval and U.B.C.), provincial forest research departments, the C.F.S. and private corporations have developed operational methods which allow:

- the use of micro-organisms to promote nitrogen fixation for enriching soils;
- the cloning and reproduction of "super" trees which produce more and better wood and are resistant to pests.

The C.F.S.'s National Pest Management Institute has successfully developed operational pest management systems and biological control methods for insect pests such as the spruce budworm, which have

substantially reduced the amounts of insecticides used in eastern Canada.

Hi-tech firms backed by venture capital funds are entering the field and developing commercial biotechnical applications in areas such as protection of trees from insects (Safer Agro-Chemical Ltd. in Victoria) and developing plant strains which are resistant to herbicides (BioTechnica International Inc.).

Although still in an early transplanted-embryonic stage, some impressive developments have already taken place in biotechnology relative to Canada's forest sector. They demonstrate that there are no biological barriers to improving the sector's overall productivity and performance.

Renewable Energy

The ENFOR Program developed much technology in the areas of growing, inventorying, harvesting and converting forest biomass for energy production. Notwithstanding reduced world oil and natural gas prices, special federal/provincial non-renewable energy exploration and pricing programs, and the many recent mega-hydro-electric dam proposals, the potential contribution of biomass to Canada's energy picture should not be forgotten. Nor should this potential be neglected for much longer if Canada is to take advantage of it when another "oil crisis" takes place.

2. POTENTIAL NEW TECHNOLOGIES

Based on the foregoing, there are some promising fields of technology which warrant encouragement and support from the various forest sector players.

Mechanized Silviculture

Much of the equipment, technical know-how and systems needed to do a reasonably adequate job of forest management in the near-term in the areas of reforestation and immature forest tending are available. They only await commitment to proper execution by the provincial and federal governments and the forest industry. Basically, we know what needs to be done and pretty much how to do it.

However, in order to improve techniques, optimize limited resources, reduce costs, increase efficiency and successfully tackle difficult/awkward forest sites, increased mechanization of silvicultural operations will be mandatory in the future.

A very timely and logical proposal in this regard was put forward by FERIC in October, 1985.[135] It calls for a cooperative, provincial-federal-industrial 4-year program of R and D aimed at developing technology for more efficient silvicultural operations. This is not to say that nothing is being done in Canada in the mechanized silviculture field of R and D. But the FERIC proposal outlines a problem-oriented, comprehensive, systems approach

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[135] FERIC. A Joint Provincial-Federal-Industry Research and Development Program for the Mechanization of Silviculture in Canada, 1985.

and budget proposal designed to get results applicable to all regions of the country, within a reasonable time period.

The FERIC proposal (to its board of directors) warrants full and immediate support if Canada intends to truly manage its forests.

Equipment Development and Manufacture

Canada has been unsuccessful in maintaining a strong domestic equipment manufacturing and related technology base in support of the various forest sub-sectors. This is probably due to:

- Difficulties in competing with the American and Japanese industrial giants and the Swedish specialists;
- The social and environmental "unacceptability" of heavy industry in many parts of Canada in the 1960s and 1970s;
- Poor political and bureaucratic commitment to the forest sector;
- Huge variations in operating conditions (soils, tree size, climate, terrain) across the country;
- The easy and relatively cheap availability of other countries' technologies and equipment.[136]

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[136]It should be pointed out that certain Canadian companies within some sub-sectors are extremely adept at scouting, buying and adapting foreign produced state-of-the-art equipment for successful employment in Canada.

The at least partial exception to this situation is the harvesting and silviculture equipment fields. Here Canada has a fairly large and competitive group of manufacturing companies. Where we are deeply deficient is in related engineering expertise. FERIC and FORINTEK do a good but limited job in this regard. FERIC is limited to testing and FORINTEK is limited by mandate.

Support of FERIC's proposed expansion plan (see page 99) would go a long way toward supplying the engineering and equipment testing/development support needed by the silviculture/harvesting equipment manufacturers. However, it would probably be even more effective to link FERIC and its new (proposed) program to one or more universities (the ones near FERIC's two centres) so as to fully develop the human resources needed over the long-term.

In the fields of sawmill and pulpmill equipment manufacturing and supply, the U.S.A. and Scandinavia lead. The U.S.A.'s strength lies in its huge industrial infrastructure, while the Scandinavians have built up an impressive engineering expertise geared to servicing their dominant forest industries. It would be difficult for Canada to soon duplicate these competitive advantages on a broad scale because of our small population, limited industrialization, modest commitment to educational and technological excellence, and intrinsic difficulties in accessing necessary capital. If the commitment were to emerge, the development of the necessary concentration of manufacturing capacity and expertise would have to go hand in hand with the creation of a capital investment pool.

Linking Canada's fairly substantial agricultural equipment manufacturing industry with the forest harvesting and silvicultural equipment manufacturers would hold advantages for both groups.

Resource Evaluation

The national and provincial data bases for evaluating, planning and implementing more intensive forest management operations are still extremely weak.[137] Not only are our data poor, but so are our tools for analysing that data for economic, market and industrial planning as well as government policy making.

The FEPA project is a step in the right direction and should be extended past its early 1987 deadline so that its models can be refined and made available as an operational tool for analysing the forest sector regionally, provincially and nationally. It would be logical for the C.F.S.'s Forestry Statistics Branch and its Economics Branch to continue their involvements and to take active parts in applying the FEPA technology across the country.

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[137] Honer, T.G. and Bickerstaff, A. Canada's Forest Area and Wood Volume Balance 1977-1981, 1985, C.F.S.

To bolster the data base upon which FEPA and each province's forest sectoral decisions are made, the following forest resource evaluation technologies warrant further emphasis:

- large scale photography applications in forest surveys, especially with direct computer interactive functions (photo scanning, tree stem "mapping", related data analysis and manipulation);
- remote sensing applications in general;
- hi-tech growth and yield systems and equipment (electronic locators and remote electronic mensurational devices, etc.);
- geographic information systems, especially relative to remote sensing and computer mapping/data interactions and analysis;
- orthophotography.

All of the above needs to be done in an integrated approach, not individually. More private sector involvement (and risk taking and entrepreneurship) is needed in order to develop manufacturing and systems development expertise. Governments should rethink their roles in developing and running these systems in-house. The technology changes so fast and the risk of being stuck with an incomplete system is high. Private sector contractors are more flexible and adaptable to rapid technological shifts.

Flexible Manufacturing Systems

A rapidly emerging technology which is really an integration or systemization of a number of hi-tech developments is the field of

Flexible Manufacturing Systems(FMS) (or Computer Integrated Manufacturing Systems). FMS integrates numerically controlled machine tools and computer aided design and manufacturing (CAD/CAM) with the computer.[138] FMS in the resource sectors provide a vehicle for application of hi-tech.

Certainly many of the components of FMS are available and used in sawmills, panel product plants, and pulp and paper mills - in particular, scanners, sensors, and various microelectronic CAM systems.[139] But at this stage, robotics[140] has not even entered the forestry R and D picture.[141] The use of lasers as a process control tool (not simply as a manufacturing guide/reference device) is emerging, particularly in the sawmilling sub-sector. The continued development of sensor technology throughout the pulp and paper making industry and in its various processes will be of vital importance. Thus the

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[138] Eley, N.G. Robotics: What Lies Ahead in Canada, 1984, in FORINTEK'S Proceeding from a Series of Regional Seminars on Microelectronics in the Wood Products Industry.

[139] Ibid.

[140] Eley defines a robot as a programmable multifunctional manipulator designed to move material, parts, tools or specialized devices through variable programmed motions for the performance of a variety of tasks.

[141] See: Vadas, O. Robotics, 1985, PAPRICAN Speech.

development of forest industry FMS is far from complete. Only 10 percent of the wood sawn in Canada is processed using "technologically advanced equipment".[142]

FMS are expensive to install, but the pay-off is apparently there if the initial capital outlay can be found. Also, FMS provide mills with improved ability to manufacture multiple types of products in relatively small volumes. So FMS are vital tools in moving toward more value-added, market-oriented products.

Of course, FMS technology applies to manufacturing processes in other resource sectors. Because of the integrated nature of FMS and the cross-over potential of the involved individual technologies and systems for the pulp/paper, sawmill and panel product sub-sectors, multi-agency collaboration is in order. PARICAN [143], FORINTEK and several universities are well into various aspects of FMS and a joint effort with a pooled budget and outside (non forest sector) involvement are in order.

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[142] French, T. Closing Remarks in FORINTEK's Proceedings from a Series of Regional Seminars on Microelectronics in the Wood Products Industry, 1984.

[143] PAPRICAN is already into robotics in a small way. Because of the forest industry's complete unfamiliarity with robotics, a separate pre-feasibility study by PAPRICAN is recommended.

There is also an opportunity in aspects of such an R and D effort to involve manufacturers and consultants so as to lead to development of specialized manufacturing in Canada of selected components and design systems (e.g. sensors).

Centralized Fire Management

The C.F.S.'s Centralized Fire Management System has proven to be effective, but R and D aimed at improving the computer models used in the system are fundamental to refining currently operational programs and to expanding the applicability of the system to other parts of Canada.

Pulp and Paper Manufacturing Processes and Products

The new mechanical pulping processes discussed in the previous section can result in improved pulp quality, reduced energy consumption and increased utilization of hardwoods. U.S. experts feel that further, "substantial technical improvements are possible in mechanical pulping processes within the next 20 years, providing that economic incentives exist and capital formation is possible".[144]

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[144]Congress of the U.S. Wood Use, U.S. Competitiveness and Technology, 1983, Office of Technology Assessment.

A promising tie-in with this newer mechanical pulping technology is the production of Solid Bleached Boards which Woodbridge, Reed and Associates Ltd. calls, in some respects, "the greatest technological challenge" to the bleached kraft pulp industry, particularly B.C.'s, in terms of moving into more value-added production. The technology is largely available, but adapting it to Canadian conditions and mills calls for a major developmental effort since it requires integration of the bleached board process with a market bleached kraft pulp mill, the addition of new pulping technology such as chemi-thermomechanical pulping, and a significant increase and adaptation of marketing infrastructure.[145]

In respect to chemical pulping, it is anticipated that the following pulping and papermaking processes are the most promising for future commercial application: press-dried paper, green liquor pulping, autocausticizing, pyrolic recovery of chemicals from spent pulping liquor, organosolv (alcoholysis) pulping, and oxygen pulping.[146]

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[145] Expansion Opportunities in B.C. for Higher Valued Papers and Paperboards, 1984, Report to the B.C. Ministry of Forests.

[146] Congress of the U.S. Wood Use, U.S. Competitiveness and Technology, 1983, Office of Technology Assessment.

PAPRICAN is working on various aspects of these processes but lacks pilot plant capability.[147] Commercial application of these processes is up to 30 years away, but the promise is there, evidenced by a recent announcement. The Ester Pulping Procedure was recently developed at the University of Wisconsin. This new procedure recycles the chemicals that separate wood fibres through the combination of water, acetic acid and ethyl acetate to create a solvent for dissolving liquor. The process may cut energy and other production costs by 80 percent, double pulp yields and cause almost no air or water pollution. A U.S. pilot plant will begin operation in 1986.[148]

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[147] U.B.C.'s Dr. L. Paszner has patented an organosolv process which he also has been unable to bring to the pilot plant stage.

[148] Anonymous. Will New Pulping Methods Revolutionize Industry? Journal of Forestry, February, 1986.

Biotechnology

Basically there is consensus in the forest sector that further biotechnology R and D would benefit every forestry sub-sector and is essential to our well-being as a forestry power. The biotechnological foundation which is established in Canada needs further support and development in the following directions, according to the Science Council of Canada:[149]

- Cloning of superior tree varieties via tissue culture.
- Improved nitrogen nutrition via nitrogen fixing bacteria, including actinomycetes.
- Improved nutrition and field hardiness via mycorrhizal fungus selection and management.
- Greater use of microbial insecticides.
- Rapid laboratory selection from cell cultures of trees with some superior traits such as resistance to disease, frost and drought.
- Trees with properties outside the species limit, such as lignin content, increased fibre length, and high turpentine content.
- New "species" of trees with combined features of several current species.
- Symbiotic N_2-fixation in trees that do not naturally fix nitrogen.
- Genetically improved mycorrhizal fungi and N_2-fixing bacteria.
- Development of new microbial insecticides.

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[149] In: Seeds of Renewal: Biotechnology and Canada's Resource Industries, 1985.

- Biopulping.
- Biobleaching.
- Biotechnical improvement of mechanical pulps.
- Biological pretreatment of wood for fermentation.
- Waste treatment systems microbially "tailored" to pulp and paper industry needs.
- Biological conversion of by-product lignins.
- Use of low-value trees and wood residues via mushroom production.
- Fermentation of wood hydrolysates.
- Fermentation of waste carbohydrate streams.
- Improvements in existing waste treatment processes.
- Biological decolorization of bleaching effluents.
- Wood and pulp chip protection during outside storage.

E. POLICY/PROGRAM RECOMMENDATIONS

Based on the foregoing information, the following federal policy/program initiatives and/or changes are recommended in order to encourage more technology development in Canada, more appliction of new technologies in forestry industries and more technology transfer between separate resource industries.

1. FEDERAL POLICIES AND PROGRAMS IN GENERAL

A recurring theme in the literature reviewed for this study is a call for revision of Canada's corporate tax laws in order to provide a better system of incentives to technologically innovative companies while doing away with arbitrary, politically influenced and inconsistent R and D grants to industry.[150]

Until the balance sheet of the forest industry as a whole is improved, modernization, movement into value-added products and more R and D will be hampered. This situation will continue until the industry gets itself into a position where it is able to make full use of federal R and D incentives.

MOSST is working to develop a national policy of science and technology.[151] Without it there is no context or accommodation within which a forest science strategy can fit.[152]

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[150] Among others: Macdonald, D. Report of the Royal Commission on the Economic Union and Development Prospects for Canada, 1985.

[151] MOSST. Science and Technology and Economic Development, 1985, Working paper.

[152] Reed, F.L.C. National Policies for Investment in Temperate Forestry, 1985, University of British Columbia.

In conducting interviews for this study, a repeated complaint was that there is too much red tape and too little trust involved with federal R and D grants and contracts. The suggestion is that the bureaucracy makes for too much administration from the grant/contract recipients. Federal R and D money could be more effectively used if industry/research committees decided how it would be spent and by whom, based on proposal evaluations by technical sub-committees. Bureaucratic time and effort would be better spent if project selection processes, including benefit/cost analyses, were stepped up so that ongoing administration after contract award could be reduced.

A general increase in the overall level of federal support to scientific and educational organizations and institutes would be very helpful to the forest sector in that:

- A shortage of scientists both in the forestry field and in related sciences may hamper any increased forestry R and D efforts in the future.[153]
- An increase in basic research in the numerous natural and engineering sciences associated with forestry is required as a necessary foundation for certain applied R and D efforts in the forest sector.

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[153]Blackwell, R. What's Needed to Nurture our High Tech, Financial Post Magazine, October, 1985.

Government procurement programs should be geared toward nurturing technological implementation and innovation. For example, the C.F.S. could promote further development and implementation of computer mapping systems if it insisted that any project it sponsored (which had a mapping component) would have to utilize computer mapping techniques.

R and D is like forestry in that it needs long-term strategies and funding if it is to be successfully performed. The federal government should recognize this fact by making longer-term commitments (say, 5 years) to basic levels of R and D funding with annual reviews to look only at incremental funding.

A review of all federal industrial and R and D subsidy and grant programs should be carried out with the purpose of phasing out those which fail to meet their intended purposes and those which are able to be influenced politically.

2. FEDERAL POLICIES AND PROGRAMS SPECIFIC TO THE FOREST SECTOR

The Macdonald Royal Commission (1985) has some very pertinent and worthwhile comments on forestry related R and D:

- "...there must be renewed Canadian effort in fundamental research especially in the traditional resource industries, if Canada is to match progress in competitor countries."
- Canada needs "to take a more integrated view of the problems and opportunities in the resource area as a whole."
- The federal government should increase its efforts, support and financial commitment to forest management (renewal, silviculture, protection) and R and D, but such an increase must be contingent upon, and tied to, performance and modernization improvements (investments in product and process

innovation) by industry.[154]

- Adequate resources should be devoted to obtaining and disseminating information about foreign technological developments by maintaining a "network of contacts in other countries" and within Canada.

A national strategy for research related to forestry would be a natural extension of the proposed national policy on science and technology. The elements for such a forest research strategy developed by the C.F.S. in 1981 are still applicable:[155]

- Clarify the level of support for research required in the forest sector;
- Conclusion of federal/provincial agreements to clarify respective responsibilities related to research;
- Better coordination of the national effort to set priorities and to prevent unnecessary duplication of effort;
- Strengthening of the forestry research capability within the universities;
- Greater support for technology transfer.

The continued reluctance or failure of the federal government to take a leadership role within the forest sector is manifested in the lack of departmental status for forestry. The presence of a full department of forestry would do much to focus federal efforts in forestry, particularly in forestry R and D.

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[154]The Science Council of Canada proposes that federal-provincial forest research agreements be the vehicles for stimulating greater provincial and industrial R and D investment (in Canada's Threatened Forests, 1983).

[155]C.F.S. A Forest Sector Strategy for Canada, 1981, Environment Canada.

The federal government is exploring free-trade possibilities with the U.S. The forest sector is one which would probably benefit from a free-trade agreement. The current mood of protectionism facing Canadian forest products in the U.S. would be somewhat relieved and the future competitiveness of the Canadian forest industry more assured if the federal government were to shift its support efforts to the sector away from industrial modernization grants and concessions toward more forest resource management and R and D in general.

In this vein, federal policies and resultant actions in the area of federal lands forest management have been, and continue to be, detrimental to the involved people (Indians, northerners and communities adjacent to federal lands) and to the forest industry as a whole.[156] This situation results from:

- General neglect of forest renewal and sustained yield principles in managing federal forest lands;
- Minimal integration of federal forest lands into provincial forest management and development programs.

Stepped up efforts in managing federal lands would improve the country's timber supplies, provide intensive forest management demonstrations to the provinces and give the C.F.S. an operational vehicle for testing, implementing and transferring the technology it develops.

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[156] Among others: Canadian Federation of Professional Foresters' Associations. The Role of Forest Management in Improving the Economic Union and Development Prospect for Canada, 1983, Report to the Royal Commission.

The cooperative research institutes are well organized with pretty clear mandates and their administrative and financing structures seem to be effective. It would be helpful if the federal government were to make a commitment to long-term funding of the cooperative research institutes (FERIC, FORINTEK, PAPRICAN) subject, not to an annual ceiling, but to a foundation level which would automatically increase on a matching basis with incremental industry and provincial financial input. This would provide these institutes and their members with an incentive to go after new members and/or funding sources as well as an opportunity to tackle larger ad hoc projects outside regular programs.

Some of the promising new forest technologies are multi-faceted and/or involve other resource sectors and are therefore too large for one R and D organization to handle. In such cases, joint programs should be established (facilitated and led by the C.F.S. who would also supply some seed money?) between government labs, the cooperative institutes, universities, industry, consultants, etc. as applicable. The cooperative institutions are heading in this direction, but a catalyst is needed to make it happen sooner so that Canada's forest sector can take advantage of some available opportunities. In line with this joint effort approach, the "centre of excellence" concept needs to be pushed. None of the six university forestry schools can carry out multi-discipline R and D programs effectively. So why not have each specialize (and gain recognition) in one or two fields only, with the C.F.S. and the cooperative institutes providing facilities, projects, expertise, etc. as appropriate? (This approach is taking shape at U.B.C., which now has an on-campus forestry faculty, PAPRICAN

lab, FEPA, and FORINTEK lab.)

Small and medium sized firms seem to be more innovative and able to more quickly take advantage of new technology. In the forest sector these types of companies are often held back by shortages of capital and insecure wood supplies. A joint federal-provincial effort (perhaps as a sub-program in the federal-provincial forestry agreements) linking wood supplies, venture capital sources and overseas/domestic market development would help. Such a program would be complicated to establish and operate but the feasibility of such an idea should be explored.

Through its "tied aid" policy and assistance program to Canadian companies setting up joint ventures in developing countries, CIDA does a good job of promoting and supporting the Canadian forest sector. However, through CIDA's efforts, some foreign countries end up with Canadian technology before some parts of the Canadian forest sector do. In exploring ways to improve the overall level of technological sophistication in Canada's forest sector, the C.F.S. and MOSST should look at the CIDA model when patterning technology transfer mechanisms.

There is a need for comprehensive strategic plans, including benefit/cost analyses for large-scale, multi-disciplinary R and D efforts. This is rarely done in the forest sector. Such a plan should be prepared immediately for forest biotechnology.

The C.F.S. and the cooperative research organizations need to treat technology transfer more as a marketing and public relations effort and, in that context, employ specialists in business, sales, and communications to improve results. In conjunction, a stronger peer

review process is required in the C.F.S. Each C.F.S. research centre should have a board of directors with representatives from its main clientele, including the private sector and provincial governments. Such boards should have full mandates to define priorities, set goals and monitor performance (just as they do for the cooperative forestry R and D organizations).

Paralleling this recommendation is the suggestion that the various provincial and federal forestry research councils should either be given more authority or else be disbanded. There are cheaper and more effective ways to maintain communication, which seems to be the main function for these councils.

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APPENDIX I

SUMMARY OF THE CURRENT

FEDERAL-PROVINCIAL FORESTRY AGREEMENTS

Source: McCredie, A. Federal-Provincial Forestry Agreements, Forestry Chronicle, August, 1985.

SUMMARY OF FEDERAL PROVINCIAL FORESTRY AGREEMENTS

Canada-Newfoundland Subsidiary Agreement:Forestry 1981-86

Objectives: To maintain and, where possible, increase the contribution from the forestry sector to the provincial and national economies; lessen the future negative impact of projected reduction in the allowable annual cut of established industries in the main economic supply zone; to promote increased utilization of the forest resources; and to maximize employment and training opportunities with forest improvement projects under a Forestry Economic Stimulation Program.

Programs

A) Silviculture

B) Forest Access Roads

C) Forest Protection

D) Forest Resource Inventory and Planning

E) Forest Industries Development

F) Forest Economic Stimulation Program.

Total agreement funding: $60,793,000

Cost share ratio: federal 90%, provincial 10%.

Canada-Prince Edward Island Forest Resource Development Agreement 1983-88

Objectives: To increase the volume and quality of timber resources, promote the development of the sawmilling industry, and lessen the dependence on imported fuel oil.

Programs

A) Private Woodlot Management Assistance

B) Crown Land Management

C) Forest Development

D) Administration.

Total agreement funding: $20,100,000

Cost share ratio: federal 68%, provincial 32%.

Canada-Nova Scotia Forest Resource Development Agreement 1982-87

Objectives: To encourage and support forest management for the purpose of endeavouring to increase the sustainable supply of softwoods; to improve and increase the utilization of the forest management and renewal in Nova Scotia.

Programs (1982-87 Agreement)

A) Forest Resource Enhancement

B) Forest Industry Development

C) Human Resources Development

D) Education/Information/Evaluation .

Programs (1984-87 Agreement)

A) Forest Renewal

B) Group Management Ventures

C) Research, Development and Strategic Planning

D) Forest Nursery Improvement

E) Education, Technology Transfer and Evaluation.

Total agreement funding: $70,900,000

Cost share ratio: federal 57%, provincial 43%.

Canada-New Brunswick Forest Renewal Agreement 1984-89

Objectives: To encourage and support forest management; to increase the sustainable supply of softwoods; to improve forest management planning and development; and to improve private woodlot management through technical and financial assistance.

Programs

A) Forest Management/Private Lands

B) Forest Management/Federal Lands

C) Forest Management/Crown Lands

D) Planning and Development

E) Development of Private Woodlots

F) Public Information, Education and Evaluation.

Total agreement funding: $77,400,000

Cost share ratio: federal 55%, provincial 45%.

Canada-Quebec Forest Development Subsidiary Agreement 1985-1990

Objective: To promote cooperation and coordination in stimulating forest resource development and in increasing the economic impact of forestry activities in Quebec. Both governments will support forest management activities to increase the available wood supply, put productive Crown (provincial and federal) as well as private woodlands back into production, and promote applied forest research as well as technology transfer.

Programs

A) Crown Land Forest Management

B) Management of Private Woodlands

C) Management of Federal Lands

D) Greenhouse Infrastructures

E) Administration, Communications and Evaluation.

Total agreement funding: $300,000,000

Cost share ratio: federal 50%, provincial 50%.

Canada-Ontario Forest Resource Development Agreement 1984-89

Objectives: To ensure the long-term availability of economically accessible timber resources necessary for the continued viability and competitiveness of the province's wood based industry, and to promote human resource planning and development to improve employment opportunities.

Programs

A) Forest Management and Renewal

B) Forest Management and Renewal Support

C) Innovative Programs

D) Administration, Communications and Evaluation.

Total agreement funding: $150,000,000

Cost share ratio: federal 50%, provincial 50%.

Canada-Manitoba Forest Renewal Agreement 1984-89

Objectives: The enhancement of forest renewal and intensive management in Manitoba through field programs, nursery modernization and applied research and technology transfer.

Programs

A) Forest Renewal

B) Intensive Forest Management

C) Applied Research, Technology Transfer and Opportunity Identification

D) Public Information, Evaluation and Administration.

Total agreement funding: $27,160,000

Cost share ratio: federal 50%, provincial 50%.

Canada-British Columbia Forest Resource Development Agreement 1985-90

Objective: To manage the forests of British Columbia so as to sustain and increase the forest resource base and strengthen the employment potential of the forest industry. This will be achieved through regeneration of non-satisfactorily restocked lands, intensively managing selected forest stands, supporting forestry research, product development and market studies, and the transfer of forestry technology to the industry.

Programs

A) Backlog Reforestation

B) Intensive Forest Management

C) Implementation, Communications and Evaluation.

Total agreement funding: $300 million

Cost share ratio: federal 50%, provincial 50%.

Canada-Saskatchewan Forest Resource Development Agreement 1984-89

Objective: To assist in developing and maintaining timber supplies for the long-term viability of Saskatchewan's forest industry; to ensure efficient utilization of this resource, and to improve employment and human resource development opportunities in this sector.

Programs

A) Forest Renewal

B) Growth Enhancement and Stand Tending

C) Technology Advancement and Transfer

D) Administration, Public Information and Evaluation.

Total agreement funding: $28,000,000

Cost share ratio: federal 50%, provincial 50%.

Canada-Alberta Forest Resource Development Agreement 1984-89

Objective: To ensure that economically accessible timber supplies are available to meet the long-term requirements of Alberta's forest industry; to ensure that the timber supply is utilized efficiently; and to improve employment opportunities in Alberta's forest industry.

Programs:

A) Reforestation

B) Applied Research, Technology Transfer and Opportunity Identification

C) Public Information, Evaluation and Administration.

Total agreement funding: $23,000,000

Cost share ratio: federal 50%, provincial 50%.

APPENDIX II

BACKGROUND ON FEDERAL FOREST LANDS

Area of Federal Forest Land by Productivity, Stocking and Agency: Summary for Canada (km^2)

Productivity and Stocking	Agency: NWT and Yukon	National Parks	Indian Reserves	National Defense	Forest Experiment Stations	Other (*)	Undetermined (**)	Total
Productive								
Stocked(+)	186,743.24	32,502.50	9,952.03	1,904.92	81.70	362.52	1,121.18	232,668.09
Non-stocked(++)	18,167.00	1,175.59	1,400.08	156.57	.35	26.94	146.10	21,072.63
Undetermined(**)	0.00	154.38	33.02	6.38	0.00	0.00	0.00	193.78
SUB-TOTAL	204,910.24	33,832.47	11,385.13	2,076.87	82.05	389.46	1,267.28	253,934.50
%	81	13	4	1	-	-	1	100%
Unproductive	613,517.44	20,606.02	960.52	21.91	4.57	79.67	232.67	635,422.80
Undetermined(**)	25,734.95	5,296.81	13.13	111.72	0.00	0.91	0.00	31,157.52
TOTAL	844,162.63	59,735.30	12,358.78	2,201.50	86.62	470.04	1,499.95	920,514.82
%	92	7	1	-	-	-	-	100%

(*) Other: Other federal lands, such as airports and greenbelts.
(**) Undetermined: Areas where forest productivity has not been classified or the responsible agency identified.
(+) Stocked: Land supporting tree growth.
(++) Nonstocked: Land capable of producing but generally lacking in tree growth - includes cutover and burned.

Note: Columns and rows may not add up exactly as totalled due to rounding of the original data for presentation.

Source: Canadian Forestry Service. Forest Harvest on Federal Lands, 1976-1981, Petawawa National Forestry Institute, 1984.

The Northwest and Yukon Territories

Harvesting in the Territories has been mainly in the form of sawlogs from a few excellent stands of white spruce found on alluvial sites along some of the rivers. Fuelwood accounts for 24 percent of the average harvest and represents a larger proportion of the harvest in each successive year. Forests in the Territories are administered by the Department of Indian and Northern Affairs (DINA).

Indian Reserves

Indian Reserves are administered by the Department of Indian and Northern Affairs. Responsibilities for management of their forests are delegated to DINA's regional offices.

There are 2,212 Indian Reserves in Canada, of which about 890 have significant areas of productive forest land. Indian Reserves contain only 4 percent (9,952 km^2) of the federal stocked productive forest land, but they support 50 percent of the harvest. Sixty percent of the total volume harvested on Indian lands is in the form of sawlogs. Fuelwood accounts for 21 percent of the volume harvested but this forest product would be difficult to monitor and it is likely that the actual amount of wood used for domestic heat is considerably greater than that reported. There has been a steady decline in forest harvest on Indian lands in the past 25 years due to the minimal amount of forest renewal activity undertaken.

National Parks

National Parks are managed by Parks Canada Branch, Environment Canada. The 28 National Parks in Canada contain an estimated 33,832 km^2 of productive forest land. Parks Canada policy is that there shall be no forest harvest other than the wood produced in clearing campgrounds or roadway development. The exception is Wood Buffalo National Park, Alberta, where an existing agreement with a lumber company is still in effect.

Department of National Defence Properties

Department of National Defence (DND) lands have a total of 1,905 km^2 of stocked, productive forest land, with almost half in New Brunswick. Camps Gagetown and Petawawa together account for about 85 percent of the average annual harvest from DND lands.

Harvests from DND lands have increased steadily over the past ten years.

The Canadian Forestry Service, when requested, manages the forests on DND lands through forest management agreements.

Other Federal Lands

Any forest harvesting or management activity on other federal holdings goes unreported.

APPENDIX III

STATISTICAL DATA

ON THE

CANADIAN FOREST PRODUCTS INDUSTRY

(see Section B.3)

DATA ON THE CANADIAN FOREST INDUSTRY

APPROXIMATE NUMBER OF MILLS BY TYPE AND PROVINCE

	Shakes & Shingle	Sawmill & Planing >1MM fbm per year	Sawmill & Planing <1MM fbm per year	Veneer & Plywood	Other Panel	Pulp[1] & Paper
British Columbia	80	310	n/a	24	4	24
Alberta	-	394	n/a	3	3	2
Saskatchewan	-	11	271	1	1	1
Manitoba	-	24	152	-	-	3
Ontario	-	146	613	25	9	35
Quebec	71	182	1008	31	6	57
New Brunswick	4	47	52	-	1	11
Nova Scotia	-	31	326	-	1	5
Pr. Edward Is.	-	-	60	-	-	-
Newfoundland	-	-	1700	-	-	3
Yukon and NWT	-	2	n/a	-	-	-
CANADA	155	1149	4171+	84	25	141

n/a = data not available.

Sources: C.P.P.A. Reference Tables, 1983.

Sterling Wood Group Inc. The Canadian Forest Resource, Tenures and Timber Pricing Systems, 1985.

Various Statistics Canada Catalogues.

[1]These C.P.P.A. figures differ from Statistics Canada's counts due to definition differences. StatsCan lists 120 pulp and paper mills in total. Thirty of the paper mills in this total of 141 do not make pulp from wood, but some produce it from secondary fibre.

DEGREE OF CONCENTRATION IN THE FOREST INDUSTRY (1982)

Industry Sector	No. of Enterprises in census	Shipments $'000,000	Concentration Ratios: % of total shipments from largest "n" enterprises					
			n= 4	8	12	16	20	50
Logging	2,931	3,998*	23.8	34.5	42.4	48.9	55.0	70.7
Sawmills & Planing mills	1,081	4,373	18.1	29.4	38.7	44.6	48.9	69.3
Shingle mills	105	87	32.7	52.8	64.9	72.6	77.9	94.6
Veneer and Plywood	57	650	43.0	59.6	69.4	77.2	83.8	99.7
Sash, Door & Millwork	1,358	1,335	17.5	26.3	32.5	37.3	41.2	58.7
Wooden boxes	203	188	25.0	37.9	44.2	49.4	54.2	75.6
Coffins and Caskets	33	36	47.6	66.5	79.1	86.7	92.1	100.0
Misc. wood products	35	166	62.5	76.0	84.7	90.2	94.4	100.0
Pulp and Paper Mills	57	10,650	40.3	57.3	68.7	77.8	84.1	99.8
Paper boxes and bags	259	2,280	45.2	63.2	73.0	78.4	82.1	95.8
Other paper products	217	1,854	37.5	51.1	57.9	63.0	67.6	86.9
SUMMARY								
Logging	2,931	3,998	23.8	34.5	42.4	48.9	55.0	70.7
Wood industries	2,872	6,835	22.0	33.5	42.2	48.1	52.5	71.5
Paper and Allied	533	14,784	40.7	57.4	68.0	76.0	81.7	97.6

*value of logging activity.

Source: Statistics Canada, Cat. No. 31-402P (advance release).

DOMESTIC AND FOREIGN CONTROL OF THE CANADIAN FOREST INDUSTRY (1981)

LOGGING SECTOR

Province	No. of Establishments				Shipments			
						------%------		
	Total	Can	U.S.	O.F.	$000,000	Can	U.S.	O.F.
Newfoundland	23	22	–	1	89.4	x	–	x
Pr Edward Is.	4	4	–	–	0.1	100	–	–
Nova Scotia	183	179	2	2	98.8	25	x	x
New Brunswick	243	239	4	0	275.2	78	22	–
Quebec	528	526	1	1	841.7	x	x	x
Ontario	418	405	13	0	717.8	67	33	–
Manitoba	34	34	0	0	48.1	100	–	–
Saskatachewan	74	74	0	0	74.9	100	–	–
Alberta	101	99	2	0	93.0	x	x	–
B. C.	1668	1610	41	17	2190.5	74	18	8
CANADA	3276	3192	63	21	4429.6	74	19	7
		97%	2%	1%				

Note: x = confidential
– = not applicable

Shipments are interpreted as logging activity for the logging industry.

Source: Statistics Canada, Cat. No. 31 - 401 P (1985).

DOMESTIC AND FOREIGN CONTROL OF THE CANADIAN FOREST INDUSTRY (1981)

WOOD INDUSTRIES

Province	No. of Establishments				Shipments			
						------%------		
	Total	Can	U.S.	O.F.	$000,000	Can	U.S.	O.F.
Newfoundland	65	65	-	-	21.5	100	-	-
Pr. Edward Is.	25	25	-	-	6.2	100	-	-
Nova Scotia	143	141	1	1	92.7	x	x	x
New Brunswick	143	134	8	1	250.9	80	x	x
Quebec	1132	1122	7	3	1740.9	97	1	2
Ontario	774	744	24	6	1436.1	87	11	2
Manitoba	96	96	-	-	130.9	100	-	-
Saskatchewan	52	50	2	-	106.2	x	x	-
Alberta	218	208	6	4	510.8	85	x	x
B. C.	741	673	50	18	4137.8	68	26	6
Yukon & NWT	4	4	-	-	2.9	100	-	-
CANADA	3394	3262	98	34	8436.0	80	16	4
		96%	3%	1%				

Source: Statistics Canada, Cat. No. 31- 401 (1985).

DOMESTIC AND FOREIGN CONTROL OF THE CANADIAN FOREST INDUSTRY (1981)

PAPER AND ALLIED INDUSTRIES

Province	No. of Establishments				Shipments			
						------%------		
	Total	Can	U.S.	O.F.	$000,000	Can	U.S.	O.F.
Newfoundland	3	3	-	-	x	100	-	-
Pr. Edward Is.	-	-	-	-	-	-	-	-
Nova Scotia *	15	10	3	2	428.0	14	x	x
New Brunswick *	18	13	4	1	857.0	63	x	x
Quebec	232	198	24	10	5199.9	82	12	6
Ontario	342	265	56	21	5129.8	65	29	6
Manitoba	33	25	5	3	295.2	69	x	x
Saskatchewan	-	-	-	-	-	-	-	-
Alberta	35	26	6	3	387.5	34	x	x
B. C.	69	53	12	4	2898.4	66	x	x
CANADA	758	602	110	46	15729.0	69	22	9
		79%	15%	6%				

* 1980 figures.

Source: Statistics Canada, Cat. No. 31 - 401 (1985).

LEADING CANADIAN LUMBER PRODUCERS, 1984

(hardwoods and softwoods)

Company Name	Production (millions of board feet)	Canadian Ownership (%)
Canfor Corp.	1,223	100
British Columbia Forest Products Ltd.	970	59
West Fraser Mills Ltd.	966	-
Weldwood of Canada Ltd.	849	27
MacMillan Bloedel Ltd.	845	100
Northwood Pulp and Timber Ltd.	695	50
Westar Timber Ltd.	590	100
Whonnock Industries Ltd.	531	100
Eurocan Pulp and Paper Co. Ltd.	509	-
Balfour Forest Products Inc.	496	-
Doman Industries Ltd.	430	100
Crown Forest Industries Ltd.	412	4
Normick Perron Inc.	342	100
Donahue Inc.	319	100
Crestbrook Forest Industries Ltd.	318	36
J. D. Irving Ltd.	275	100
Saucier Forest Products Ltd.	230	100
E. B. Eddy Forest Products Ltd.	219	100
Evans Products Co. Ltd.	207	-
Slocan Forest Products Ltd.	205	100
Rustad Bros. and Co. Ltd.	194	100
Pacific Forest Products	193	100
Forex Inc.	188	100
Abitibi-Price Inc.	181	100
Tahsis Co. Ltd.	180	100
Ainsworth Lumber Co. Ltd.	170	100
Tolko Industries Ltd.	170	100
Materiaux Blanchet Inc.	165	100
Great Lakes Forest Products Ltd.	162	100
Pinette and Therrien Mills Ltd.	156	100
Jacobson Bros. Forest Products Ltd.	152	100
Carrier Lumber Ltd.	150	100
Lignum Ltd.	150	100
TOTAL	13,032	68

Source: Production - Forest Industries Magazine, July, 1985.

Ownership - Public and private information.

PRODUCTION OF PULP AND PAPER IN CANADA, 1984

PUBLIC COMPANIES

Company	Market Pulp	News-print	Fine paper	Other products	Canadian ownership
	(million metric tons)				(%)
Abitibi-Price Inc.	115	1,421	121	374	100
B.C. Forest Products Ltd.	356	345			59
B.C. Resources Investment Corporation, Westar Timber Ltd.	406				100
C. I. P. Inc.	293	1,136		345	100
Canadian Forest Products Ltd.	457			80	100
Consolidated Bathurst Inc.	335	995		320	81
Crestbrook Forest Industries Ltd.	134				36
Crown Forest Products Ltd.	136	357		71	4
Domtar Inc.	96	385	331	393	100
Donahue Inc.	292	383			100
Great Lakes Forest Products Ltd.	559	398	59		100
MacMillan Bloedel Ltd.	358	718			100
Noranda Inc.:					
Northwood Pulp & Timber	350				50
Fraser	60	458		29	68
MacLaren	107	154			100
Rolland Inc.			137		100
Weldwood of Canada Ltd.	218				27
TOTAL	4,272	6,750	648	1,612	87

Source: Company Annual Reports and other public sources.

APPENDIX IV

WORLD MARKET TRENDS BY COUNTRY

FOR

SELECTED CANADIAN FORESTRY PRODUCTS

Source: Sterling Wood Group Inc. Status of the B.C. Coast Forest Industry, 1984, Report to the B.C. Ministry of Forests.

OFFSHORE LUMBER MARKETS

NOTES AND TRENDS

Country	Currency Value Change vs $Can (1980-84)	Average Annual Volume of Lumber Imported ('000 m3)	Market Trends
United Kingdom	-41%	6,189	-Timber frame housing to increase -Home-grown softwoods to provide 15% of requirements by 1990 (now at 10%) -Greater competition from steel and plastics in housing market -Scandinavian producers will manufacture to order
West Germany	-34%	3,994	-Salvage of acid rain damaged forests leading to temporary oversupply followed by prolonged shortage -Substantial potential to supply Hembal for high quality clears and remanufcturing grades
France	-48%	2,180	-Increasing volume available from domestic sources -Scandinavia selling direct to end-user -Greater use of timber-frame housing
Italy	-49%	3,986	-Austria is biggest supplier and will likely remain so -Scandinvia will probably take a greater share -More home ownership and more housing -Presently no wood used in roofs or walls. Earthquake resistant standards likely to help change this

...cont'd...

Benelux	-38%	3,146	-Belgium favours Douglas fir. Holland prefers S.P.F. -Timber frame housing is increasing and cedar cladding market should increase
Australia	-17%	1,024	-Domestic plantations designed to give self-sufficiency but this is not likely until 2020. Even then will continue to import clear grades and cedar
Japan	+ 4%	4,000	-Favours log imports. Average of 36 million m3 of logs imported annually -Expect greater competition from U.S. companies -Japanese domestic log production will increase
China	-34%	?	-Prefers to buy logs. Cheap imports from U.S.S.R. likely to increase -Domestic plantations will increase but imports will also rise.

OFFSHORE PLYWOOD MARKETS

NOTES AND TRENDS

Country	Currency Value Change vs $Can (1980-84)	Average Annual Volume of Plywood Imported ('000 m3)	Market Trends
United Kingdom	-41%	782	-Canada's share should remain at current level but U.S. share likely to rise while Asian share drops -Other wood panel products becoming more competitive
West Germany	-34%	469	-Consumption expected to rise -No OSB or waferboard mills yet -Domestic particleboard industry is major factor -Potential for increased share of packaging, formwork and construction market
France	-48%	298	-Competition from waferboard and particleboard likely to increase
Italy	-49%	94	-Formwork market should increase rapidly. if roof truss market can develop so could roof sheathing and structural market
Benelux	-38%	676	-Canada's share has been declining in favour of the U.S. product due to price
Japan	+ 4%	51	-Canada is largest supplier and share has been increasing -Competition is to be expected from Indonesia -Imports are insignificant compared to production (less than 1%).

OFFSHORE PULP MARKETS

NOTES AND TRENDS

Country	Market Trends
Japan	- 50-100% increase in paper grade pulp imports by 1995
Western Europe	- 5-15% increase in paper grade pulp imports by 1995
China	- projections are not quantifiable but substantially increased imports in pulp and paper are anticipated.

APPENDIX V

THE POTENTIAL FOR EXPANSION
INCLUDING RESOURCE AND PRODUCTION LIMITATIONS
BY PROVINCE AND TERRITORY

Source: Sterling Wood Group Inc. The Canadian Forest Resource, Tenures and Timber Pricing Systems, 1985, Consultant's Report to the Canadian Forestry Service.

The Potential for Expansion Including Resource and Production Limitations by Province and Territory

BRITISH COLUMBIA

Potential for Expansion

The British Columbia forest industry has reached the present limits of wood supply. Some more remote areas still support surplus supply but prevailing economic conditions will continue to detain these stands from harvesting because of the high cost of gaining access to them. Higher harvest levels for the future will depend on implementation of more intense forest management practices.

Improvement of utilization of the forest resource may also lead to increases in harvest levels. Much of the residual material left after logging is unsuitable for manufacture into solid wood products, but increase in its use would provide further supplies of fibre for pulp mills or manufacturers of reconstituted wood products such as oriented strand board or waferboard.

Expansion of sawmilling capacity in the province is possible within a limited extent depending on economic conditions. Strong market demand with sustained higher lumber prices would extend the threshold of economic accessibility into the more remote stands which are presently excluded from the allowable cut.

Plywood mills are facing a decline in their market due to encroachment by cheaper substitute products. While it is likely that plywood will continue to be produced for certain specialty markets, the

overall tendency will be a reduction in production and subsequent closure of mills. This demise will be balanced by a steady increase in production of panels by waferboard and oriented strand board mills, which may or may not be within British Columbia.

The potential for increase in the pulp and paper industry is perhaps the most positive. The provincial government has advertized its intention of providing assurances of raw material supply for new facilities in the southeast and northeast portions of the province. This may induce the construction of a new pulp mill or the expansion of an existing one. Present world capacity, however, is higher than demand, and additional mills in third world countries are being built. Therefore there may not be an economic justification for an increase in the industry at the present time.

Resource and Product Limitations

a) Supply/Demand Imbalances

The previous subsection suggests that the economically accessible raw material supply in British Columbia is presently fully committed to the forest industry. Any increase in supply must be accompanied by some activity or effect which increases the yield. Without it a net depletion of the resource will occur. In certain parts of the province there is a surplus of raw material with little demand but these areas are remote, in rugged terrain, or support timber of low value, and they remain economically inaccessible.

b) Raw Material/Products Imbalance

Coastal sawmills in British Columbia have always had a preference for Douglas-fir. The rate at which Douglas-fir has been harvested has diminished over the last 20 years. In 1965, Douglas-fir contributed 24% of the timber harvested on the coast. Now this portion is down to 8.5% and should remain at this level until the turn of the century, when it could increase sharply as second growth forests mature.

Also significant in the coast industry is the shift in log grade distribution. Figures for the Vancouver log market indicate a declining grade trend for all species except cedar and spruce. This means that future harvests will produce increasing porportions of smaller, slower grown logs with less clear and more tight knotted fibre.

The problem is not as severe in the interior of the province. Here the harvest has been generally in proportion to the natural species profile and timber quality is comparatively uniform. Some specialty mills will suffer similar problems to those experienced on the coast when large size, best quality logs become less available, but the mainstay of the interior mills is the relatively uniform raw material which is so well suited for the production of dimension lumber for construction purposes. Raw material supply is not expected to diminish although costs will rise as mills are forced to reach further and to harvest lower quality stands.

Log supply for interior plywood mills is declining in quality and increasing in cost. Increasing costs and severe marketing pressure from waferboard and oriented strand board indicate a trend of

continuing decline of this sector.

The pulp industry is less affected by increasing raw material costs. The biggest threat to pulp mills in the province lies with the curtailments within the sawmill sector. Because of close integration, most of the raw material for pulp mills comes in the form of wood chips produced as residue from the manufacture of lumber. The decrease of sawmill production directly diminishes the supply of chips. In the past there has been a sufficient surplus of chips for export which has functioned as a domestic "surge bin" for pulp mills. This may not be available if lumber curtailments are severe.

ALBERTA

Potential for Expansion

There is substantial capacity for growth in the Alberta forest industry. The present capacity of Alberta's sawmills is approximately 1.5 billion board feet but Alberta's forests could easily sustain production of 2.0 billion board feet based on the current level of forest management.

At the present time the two kraft pulp mills in the province produce a total of 435,000 tonnes of high quality kraft pulp. There is sufficient softwood fibre to more than double this production, as well as to supply fibre for the production of other forms of pulp.

Two large unallocated softwood timber areas are currently available for major industrial development.

The greatest potential, however, is in the utilization of the hardwood resource (primarily aspen). At present, about 5% of the hardwood allowable cut is allocated. The federal and provincial governments have been conducting research (manufacturing and harvesting) and feasibility studies (marketing and financial) into large-scale aspen utilization for many years. A major initiative appears possible under favourable economic conditions.

Resource and Product Limitations

There are no fundamental limitations on either the level of use or product options in the Alberta forest resource. The provincial Energy and Renewable Resources Department reports that Alberta has managed its forest resources under strict sustained yield principles and that there "has not been any major degradation or depletion of (these) resources. Therefore, Alberta does not experience or anticipate in the near future any supply/demand imbalance either in quantity or type of timber".

SASKATCHEWAN

Potential for Expansion

Technically, Saskatchewan indicates a substantial surplus of softwood AAC. However, there are severe economic constraints on the availability of the indicated surplus. For the foreseeable future, the main opportunities for growth in the Saskatchewan forest industry lie in the expanded use of hardwoods and in achieving technological

advances which will permit development of larger areas of smaller, lower grade timber.

There is sufficient accessible hardwood volume to supply one new pulpmill. Such a facility, with an integrated newsprint operation, has been in the planning stages for several years and its financial feasibility is still being evaluated by the provincial government.

Recent technological developments in such areas as oriented strandboard panelling production offer opportunities to use the plentiful small-diameter timber. However, competition from conventional forest products, scarcity of reliable markets and shortages of investment capital tend to discourage such high-capital development at this time.

Resource and Product Limitations

Saskatchewan is facing timber supply problems in terms of quantity and quality. The previously mentioned surplus AAC is, for the most part, located in inaccessible and undeveloped areas of the province. In addition, uneven age-class distribution could cause a temporary decline in harvestable timber in about 20 years. Low per-hectare volumes of predominantly small diameter trees make harvesting expensive. In some parts of the commercial timber zone, shortages of sawlogs and veneer logs are already becoming apparent.

Inadequate forest renewal has caused a decline in the long-run sustainable yield of desirable softwood species. Stands containing mainly pulpwood are often bypassed by sawmill operators, causing higher production costs and "locking up" sawlogs in these stands until such

time as new pulping facilities come into existence.

Alienation of land for agricultural development is aggravating timber supply shortages in the southern areas of the commercial timber zone.

MANITOBA

Potential for Expansion and Resource Limitations

Any potential long-term expansion of the Manitoba forest industry will depend mainly on the increase in the availability of economically operable wood supplies. Four principal means are available to augment wood supply to ensure future industrial demands: access development into currently inoperable areas; improved utilization; improved protection; and the enhancement of forest land through intensive forest management.

The province has large surpluses of unutilized timber, but much of this surplus is economically inaccessible because of a lack of developed transportation networks. The potential annual product equivalent of these wood surpluses is an extra 263 MM fbm of softwood lumber, 1540 air-dry-tons-per-day (ADTPD) of softwood bleached kraft pulp, and 1073 ADTPD of hardwood bleached kraft pulp. The potential production in the undeveloped far northern forest sections is 189 MM fbm of lumber, 1084 ADTPD of softwood bleached kraft pulp and 444 ADTPD of hardwood bleached kraft pulp. The development of access into these areas would liberate a resource with the potential to support two or

three major sawmills, one large-scale softwood kraft pulp mill and one smaller-scale thermo-mechanical pulp mill utilizing hardwoods. The direct employment opportunities associated with this increase in industrial activity would be approximately 2500 full-time jobs.

Changes in utilization patterns could take two directions. First, the use of aspen in processing could be greatly increased. Less than 10% of Manitoba's hardwood annual allowable cut is currently utilized. Second, a change is necessary in utilization patterns towards greater use of smaller diameter roundwood to produce conventional products such as softwood lumber and by-product pulp chips.

The Manitoba Forestry Branch expects the recently signed federal-provincial forest development agreement and increased provincial funding of forest renewal to make up the shortfall in timber supplies in the southern parts of the province. Nevertheless, the low ratio of sawlogs to pulplogs will be unchanged for the foreseeable future.

ONTARIO

Potential for Expansion

Growth potential lies in five major areas:

- Uncommitted volumes of poplar species which are located in the northeastern and extreme western parts of the province;
- Underutilized volumes of low grade heavy hardwoods in the southern portion of the province;
- Underutilized and poorer quality species, such as white birch and balsam fir, generally present as components of other forest

stands and used to varying degrees by existing industry throughout the province;

- Undeveloped and uncommitted areas in the far northern parts of the province; and

- Promotion of intensive management techniques in order to boost the yield from the growing stock.

Resource and Product Limitations

Ontario has an adequate supply of timber to meet the needs of the existing forest industry for the next 30 years and there is room for limited expansion, particularly in the area of improved utilization. Shortages of particular species and grades are expected to develop over the next few decades (for example, white pine sawlogs and high-quality hardwoods). Also, supply deficits will develop in certain locations where mill capacity currently exceeds available supply.

QUEBEC

Potential for Expansion

On the basis of available information, potential for expansion of the Quebec forest industry appears to lie in greater utilization of hardwoods, intensification of forest management in softwood production and increases in value added products such as paper.

Resource and Product Limitations

Mature softwood stocks in Quebec should theoretically sustain the present harvest for 40 years. However, the largest portion of these stocks is located in the economically inaccessible northern part of the

province or in low quality stands presently not utilized by the industry. The gap between supply and demand for softwood species, such as balsam fir, spruce and jack pine, constitutes the major problem of the forestry sector for the coming decades. If the present management and harvesting practices and the actual level of forest management is sustained, Quebec is facing a deficit of softwood resources required to maintain industry production at its present level.

This is further aggravated by the current practice of selecting stands by preference for higher volume per hectare and per stem, especially in the lumber industry. There is therefore, in most regions, an accelerating shortage of softwood stands suitable for the lumber industry.

There exists a surplus of less desirable hardwood species (such as poplar) which provides an opportunity for expansion. However, supplies of higher quality hardwoods are being rapidly depleted. The supplies of species such as yellow birch, red and white pine, oak and chestnut are available in a very limited quantity for lumber and veneer production. In addition to rapid depletion, there are regeneration and management problems with these species and within a period of 10 to 20 years the present economic supply will probably be liquidated.

In summary, the supplies of suitable raw material in Quebec to maintain the present industry configuration is definitely inadequate, particularly for the softwood lumber industry and for the high quality hardwood industry.

NEW BRUNSWICK

Potential for Expansion

Except for a small amount of poor quality cedar, the softwood resource of New Brunswick has been fully committed to existing industrial capacity. The average harvest over the 5-year period 1978-1982 was within one percent of the allowable annual cut. Hardwood harvest, however, is less than 50 percent of the AAC and there remains potential for growth in industries that can utilize hardwood fibre.

As in all provinces, improvements in utilization practices and intensification of stand management for greater yields could lead to further growth in the forest industry.

Resource and Product Limitations

The general limitations of the softwood resource have been alluded to in the previous section but these limitations are more severe in the long term and for specific users.

New Brunswick's softwood AAC assumes a high level of silvicultural activity to achieve higher yields. At present, the harvest is close to this AAC. Unless the prescribed levels of intensive silviculture are achieved, the AAC would be reduced. The province's existing industry will experience an annual 1,685,000 m^3 deficit as the harvest is restricted to the level which is sustainable at present management levels in the long term. The sustainable harvest will provide only two thirds of the industry's capacity requirements even if 850,000 m^3 of softwood timber is imported. This would be insufficient to maintain

the current industrial base. While a major portion of the total demand is in the form of pulpwood, which has a relatively low quality requirement, sawmills require about 30 percent of the total roundwood volume, and this must be in logs that are of a size and form suitable for conversion into lumber. Based on present sawlog specifications, the current sawlog harvest cannot be maintained in the future. The custom of high-grading the forest for the highest quality components began with overexploitation of white pine and has continued ever since with an inexorable decline in the quality of material available at each successive harvest. This process is common to other provinces as well as New Brunswick. It is a chronic Canada-wide problem.

The estimated AAC of hardwood is 2.7 million m^3. At current capacity levels, industry requires only 1.6 million m^3. However, the apparent surplus is overstated. In addition to the industrial demand for hardwood, there is a substantial demand for firewood. This has been estimated to amount to as much as 700,000 m^3, leaving an apparent surplus of 400,000 m^3.

While there is an overall surplus of hardwood on a province-wide basis, on a regional basis this surplus is concentrated in the northwest and southeast. The combined firewood and industrial demand creates local shortages, particularly in the southeast. In addition, there is a declining supply of the large sawlog and veneer quality hardwood species required by the industry. The apparent surplus is on low quality hardwood, most suitable for fibre-based products.

NOVA SCOTIA

Potential for Expansion

Given the current balance between the AAC and industrial wood requirements, there is no available surplus of softwood roundwood. Logging utilization is very good and generally stems down to 10 cm or less are recovered.

Many of the smallest mills do not have debarkers or chippers, resulting in some potential pulp chip furnish being lost, although most of this volume is utilized as fuel within the rural community.

The current unmanaged AAC for hardwoods exceeds the industrial requirements. The extent of such a surplus is uncertain because of a lack of information available on domestic fuel use. The quality of the resource affords limited potential for sawmilling of hardwoods. There are current specific proposals being considered to increase consumption of hardwood for pulp by up to 158,000 m^3.

Considerable growth in production and export of Christmas trees appears feasible. Industry spokesmen suggest that a 4- to 5-fold expansion over the next 5 to 10 years may be realistic. Expansion in Christmas tree production will be primarily dependent on the availability of export markets & production of a quality product.

The use of unmerchantable species, logging residues and wood wastes are continually being evaluated as wood fired installations are built and supplies of wood-fuel are developed. It is estimated that as much as 1,800,000 m^3 per year may be accessible for energy use.

Resource and Product Limitations

The province is fully aware that it must strive to increase the growth of its forest if the requirements of the industry are to continue to be met. Accordingly, forest management programs have been planned and silvicultural work must be maintained. Considerable disruption of the local supply patterns has already accrued due to losses to the spruce budworm infestations.

The softwood sawlog component in the growing stock is more or less in line with annual sawmill requirements. However, the independent sawmills collectively own or control a relatively insignificant portion of forest land. They have relied on market purchases or alignments with other land owners. While a softwood sawlog component is expected to exist within the maturing growing stock, price levels will be affected by an overall scarcity and by the ability of industrial landowners to satisfy their own needs. Moreover, spruce budworm losses may reduce the supply of raw logs, with serious regional consequences.

Alternatively, the hardwood species afford very limited potential for expansion in sawmilling, given the obvious quality constraints.

The pulp and paper segment is also faced with serious supply constraints. The bleak supply picture is aggravated by the continued catastrophic losses as a result of the spruce budworm infestation. To maintain existing production levels, the industry must find a means to use significantly more hardwoods in the near future.

PRINCE EDWARD ISLAND

There is excellent potential in Prince Edward Island for increasing forest productivity. Inventory data indicate that the

present annual growth rate of merchantable timber in unmanaged stands is 1.8 cubic metres per hectare, whereas in a managed stand, 4.0 to 9.0 cubic metres are obtainable on average sites by carrying out stand improvement. Meanwhile, the greatest opportunitites appear to lie in the increased use of wood for energy. Given today's technology and the cost of fuel and electricity on the Island, this may provide for further expansion in the forest industry.

NEWFOUNDLAND

Potential for Expansion

On the Island, three remote blocks of timber remain unallocated. The sawlog component within these blocks is available to the sawmill industry but each of the blocks appears to be too small to support a major forest industrial development, and are separated by too great a distance to be used collectively. Accordingly, these unencumbered areas may be useful for small scale developments or a source of commercial or industrial wood fuel.

Throughout the commercial forests of the Island there are significant amounts of timber that could be used for industrial or commercial wood chip fuel. These development possibilities are being pursued quite vigorously and are resulting in an increasing number of wood fired boilers at various plants around the province. To date, only residual timber is being used for this fuel. It is anticipated that slash and unused portions of the tree will also become a major source of fuelwood.

There is some potential for expansion of the province's limited

hardwood sawill industry. There are moderate amounts of white and yellow birch and aspen available. Most of this is suitable for sawlogs and fuelwood.

In Labrador, there are timber supplies of a quality and quantity sufficient for a small to medium scale mechanical pulpmill or newsprint mill. Activities are being carried out to encourage such a development.

Resource and Product Limitations

The three pulp and paper mills, which account for 90% of all timber harvested commercially, draw their wood supply from Zone 1, the largest zone, comprising about two thirds of this island's area. A timber supply analysis for this zone shows that there is a current supply surplus. However, this is largely due to a substantial decrease in the short-term requirements of the Corner Brook mill, which is being modernized.

Following this temporary respite, deficits are expected to occur in or around the year 2000. The analysis shows that, in spite of intensive silvicultural work to increase yield from the forest, there will be a persistent and deepening deficit in wood supply until about 2025. The deficit can be lessened by inclusion of steep slopes and stands of lower productivity in the harvesting program, but even with this, it is expected that demand will exceed supply by about 200,000 m^3 per year. This deficit is considered to be manageable and acceptable by the industry, which will be encouraged to make up the shortfall by outside purchases.

The sawmilling industry will experience considerable problems in the future due to a severe lack of sawlog size timber. Most of the balsam fir stands from which sawlogs would have been obtained have either been harvested because of, or killed off by, the recent spruce budworm epidemic in the province. The demand for sawlogs will continue to exceed available supplies for the foreseeable future and, as demand for fibre intensifies during the next 30 to 40 years, sawmill production can be expected to decline, or at best, remain static.

YUKON AND NORTHWEST TERRITORIES

Potential for Expansion

On a national scale, the potential for growth in the Territories' forest industry is relatively small. However, on a local scale, the potential for growth is significant. The average annual harvest of logs and roundwood amounts to 96,000 m^3 which is only about 15 % of the sustainable allowable annual cut for these products.

The most important potential for growth in the forest industry is in energy production. The extensive areas of forests coupled with high "conventional" energy costs provide significant opportunities for renewable wood energy production for home and industrial use.

Resource and Product Limitations

While the present level of forest industrial activity seems reasonably assured in terms of wood supply and demand, there are major limitations to the future expansion of forest manufacturing in the Yukon and NWT. Any significant increase in sawmilling activity is

dependent on the provision of rail access to offshore lumber markets and southern Canadian pulp mills for wood chip disposal. Moreover, the legislation, planning and data base are presently inadequate for response to forest industrial initiatives.

Other barriers to expansion of the forest industry include small tree size, short harvesting seasons, limited access development, high harvesting costs, inadequate forest inventory data, a timber allocation system which provides no security of tenure, the uncertainty surrounding native land claims, and the lack of forest renewal activity.

Within the context of available surplus allowable cuts in the provinces to the south, no major commercial exploitations of the forest resource of the Territories is foreseeable at present.

APPENDIX VI

A REPORT ON
FOREST TECHNOLOGY IN
SCANDINAVIA

Prepared by International Forestsearch (Canada) Ltd.,
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1. INTRODUCTION

The 1970s saw an end to the increase in productivity in Scandinavian forestry that had been taking place since the mid-1950s. Throughout the 1960s, Scandinavian forestry succeeded in keeping costs at a generally constant level, but the situation changed during the 1970s.

It was therefore vitally important for the forest industry to slow down the rate at which costs would increase in the future. To succeed in this task the industry came up with new measures and developments in numerous fields.

Developments during the seventies provided clear evidence of the strong need for continued rationalization in forestry.

The efficiency of current operating systems can be considerably improved if simple, everyday measures of rationalization are taken. It has been estimated that, over a five-year period, costs can be reduced by some 10 percent, revenue can be increased by 3 to 5 percent and considerable improvements in the quality of stand treatment and working conditions can be achieved.

2. PLANNING AND DATA COLLECTION

2.1 Planning

Different planning systems, using new techniques and new methods in several areas with generally good prospects for rationalization, have been put into operation.

The most promising system is the one currently being developed in a joint-venture effort between the The Forest Operations Institute of Sweden and a Swedish forest enterprise.

The main features of the system can best be described using a number of keywords, which are underlined in the following.

The system is decentralized so that the plans produced will be practical and realistic and in order to simplify file maintenance work. The system is also user-friendly (it is assumed that the user is unfamiliar with computerized routines). The planning routines are designed for use as decision-making aids, performing no active planning work themselves but merely assisting the user in the more arduous tasks, such as selecting relevant data from large quantities of data. Finally, in theory the system is portable, being independent of computer make or the data the user has avilable.

2.2 Data Collection

Rapid advances in several fields of technology have opened up new and promising opportunities for improving the collection of forest data.

Many new instruments for forest survey work have been produced or are now under development. Modern electronics has made it possible to measure the diameter and height of trees and record the measured values all automatically. Ultrasonics and lasers are examples of other techniques likely to be used in advanced measuring instruments. Alongside these developments, improvements are also being made to existing instruments.

The new technology is also making it possible to improve methods of data collection. Using the latest instruments, objective random sampling methods can be made much more efficient, thereby reducing the costs and the risk of error, and speeding up the processing of results. Subjective methods on the ground can be greatly improved by being supplemented with satellite photographs, modern computerized techniques for mapping, calculating area, etc. and the use of robust instruments for simpler measurements. The wider use of aerial photographs combined with field surveys opens the door to a considerable reduction in the cost of collecting data while still retaining the highest standards of accuracy.

3. MANPOWER, ORGANIZATION AND TRAINING

3.1 Manpower

The secret of obtaining better results at work involves the identification of what it is that motivates manpower and then making the best use of it. This job motivation implies a reorganization of the work in order to provide the employees with the maximum opportunity to have responsibility at work and knowledge about the results of their work, and also to make them aware of the purpose and significance of their work.

The introduction of new wage forms has not only provided the reason for trying out new forms of work in the forest but also the opportunity to do so. Most companies have already carried out successful experiments which have given greater responsibility to the forest workers and more interesting jobs to the supervisors. The initiative for any changes must come from the field crew and here the supervisor obviously holds a key position. The role of a supervisor has therefore been also widened.

Work impediments are being analyzed as impediments in the work. Many forest workers suffer from physical impediments which make it difficult for them to cope with their job in the forest. Early retirement has often been seen as the way around these problems. However, in many cases, difficulties in the job itself can often be reduced. Arduous work, such as having to move in deep snow, and the dragging and stacking of wood, can be made easier or eliminated altogether through compaction of snow, employment of machines for gathering or felling, etc. Some of these measures make the work so much easier that they can also be profitable in operations employing workers without any physical handicap.

3.2 Organization

By means of questionnaire surveys and interviews with individuals, The Forest Operations Institute of Sweden has endeavoured to find out how those active in the forestry sector would like work to be organized in the future in order to improve efficiency.

The results of the investigations have been arranged using the six-box model, whereby the term work organization is taken to consist of six elements: the purpose of the organization, its structure, relationships, rewards, aids and management.

The results, which represent the same tendencies in the other Scandinavian countries, show a wide consensus of opinion as to what changes are needed in the way the work is organized. The most important of these are as follows:

- greater decentralization
- greater geographical organization
- changes in the delegation of jobs and duties
- a greater number of staff performing consulting functions
- the development of management functions, including management by objectives.

To bring about these changes effectively, two important conditions must be satisfied: first, that the changes are given

the active support of management; and second, that the broad objectives of a company be broken down into elements that can be readily understood by individual employees.

The work of introducing changes and improvements is usually directed from the supervisor level, but it is important that management at district level and executive level are also involved. An overall view of the work is required. The managers should draw up the guidelines and together with the staff, should formulate objectives and decide how the changes are to be implemented.

The employees must be given plenty of information about the changes well in advance. This contributes toward the changes being well received when the time comes to implement them.

A driving force must be present throughout the development work. It is therefore essential that the right individuals be made responsible for it.

Technical and organizational solutions must be explained and the necessary fact-finding work carried out. However, it is also important that the individuals concerned be granted some freedom of action. Finally, a sound follow-up routine must be established for the sake of continuity.

3.3 Training

Personalized training and logical fault-tracing are increasing trends in Scandinavian forestry.

The reliability of a machine revolves around its design, the organization of maintenance work and the competence of personnel.

Consistency in the selection of machines and maintenance organization, in which the responsibilities of individual personnel categories are clearly defined, are vital if staff training is to be effective.

The level and nature of the training required varies from one person to another and, consequently, a training course designed to be suitable for everybody cannot be effective. Conversely, training adapted to the knowledge and interest of the individual can make an important contribution towards increasing efficiency.

As a result of the increasingly advanced technology incorporated in logging machines, the time taken to trace faults on these machines - and thus the time they are kept standing idle - is growing longer. It has led to the development of logical and systematic fault-tracing systems and routines, which are becoming the common approach to all training methods in Scandinavian forestry.

4. STAND ESTABLISHMENT

4.1 Site Preparation for Reforestation

There are currently twenty or more items of equipment for mechanized scarification available in the Scandinavian market. In spite of the technical advances made during the 1970s, today's conventional scarification units still fall short of meeting the demands that have been made on them. For instance, they cannot create acceptable planting spots

- above the ground level
- where there is thick slash cover
- on sloping ground with extensive surface stones

Moreover, fairly recent findings also suggest that greater consideration should be given in scarification to the long-term productive capacity of the soil and to the working environment of machines and operators.

4.2 Planting

On the average, the costs of artificial regeneration during the 1970s increased by 28 percent in real terms. Two lines of development in planting are currently being discussed with a view to curbing the adverse movement in costs and solving the manpower problem.

The first line of development involves the improvement of planting methods in which small containerized seedlings are planted in deep pits after mechanized scarification. The work is directed at increasing the general efficiency of existing methods and at the development of mechanized methods. This line of development mainly concerns soils that are classified as easy to average as regards their biological and technical difficulty.

The second approach concerns the more difficult soils and requires the creation of new concepts whereby an objective and integrated view will be taken of scarification principles and of planting.

In addition to this development work, a close study and analysis is needed to determine the influence of spacing on costs, production and stand quality.

4.2.1 Manual Planting

In the future, most artificial regeneration work will still be carried out manually. For this reason, improvements are necessary in seedling-handling techniques and in the motivation and productivity of the workers. Some ways in which this could be achieved are:

- better communications between the nurseries and the regeneration site
- the drawing-up of rules governing the distribution and handling of seedlings, thereby eliminating the risk of calamities
- new methods of treating seedlings to provide protection against insect infestation
- new forms of oganization and training
- the drawing-up of assessment criteria for comparative studies and evaluation of new planting systems.

As far as possible, this development work will be coordinated and the results published widely.

4.2.2 Mechanized Planting

During the mid-1970s, a number of mechanized scarification-planting systems was tested in semi-practical operations. The results of the machines used then were unsatisfactory and operational reliability was generally low.

However, since then, mechanized planting and scarification techniques (mechanized drilling, for example) are now employed effectively.

A cost analysis has been made of mechanized planting in technically easy to average terrain, and it was assumed in the analysis that capital and energy costs would increase at a faster rate than labour costs. The analysis found that mechanized planting, in conditions that may be regarded as average for Scandinavian forestry, would initially be slightly more expensive than manual planting. However, it is believed that the achievement of low costs is much more likely in mechanized planting than in manual planting. Mechanized surface planting could well be the method having greatest potential, although its success would hinge on the development of a technically, biologically and economically satisfactory type of seedling.

The machine properties having the greatest influence on profitability at present are productivity, reliability and the reliable setting-out of seedlings. The number of operators needed

and the machine-acquisition costs are of minor importance.

Existing development projects hinge on planting units being mounted on or attached to base machines that can be deployed in other work during the winter. However, because of the importance of reliable operation in mechanized planting, it could well be viable to develop a special machine for use only during the planting season. Such a machine should be built using standard components.

Both mechanized and manual planting are more expensive on small areas than on sites of ten hectares of more. Substantial reductions in costs (of up to 20 percent) can be achieved through the use of different methods of spacing on the planting site.

With the assumed relationship between the cost of energy, capital and labour during the next ten years, it is estimated that the cost of mechanized planting will rise more sharply than that for mechanized scarification followed by manual planting. This may result in mechanized planting being regarded as a less attractive proposition, unless the development potential in terms of technology and different regeneration methods is fully exploited. If the "best" projected alternative for mechanized planting could be realized, it is unlikely that the additional cost would significantly affect the economic potential.

The use of mechanized planting can reduce the manpower requirement for a given site by more than half.

In an alternative reflecting the regeneration conditions in tracts where the biological conditions are difficult, the costs of mechanized planting still come out well compared with those of manual planting. However, this alternative is conditional on the development of containerized seedlings suitable for such soils.

Viewed on a national scale, the introduction of mechanized planting could reduce the manpower requirement by 20 percent. It should be emphasized, however, that manpower requirements could be reduced even further by using containerized seedlings instead of bare-root seedlings in existing manual planting operations.

In spite of the good prospects for planting machines, the overall demand for machines will be fairly small. Without taking the size and location of sites into consideration nor any willingness on the part of foresters to purchase machines, it is estimated that when the method is fully developed approximately 110 new machines will be required each year in Scandinavia. This applies to machines that can be used on technically easy to average terrain. As regards terrain classed as technically difficult, the potential demand in Scandinavia will be

approximately 70 machines a year. It would be at least ten years after the introduction of suitable machines before these levels are reached. The demand during the initial period would fluctuate widely.

Terrain suitable for the operation of these types of machines exists in other parts of the world, for example in North America and the Soviet Union. However, the technology currently applied in the development projects is probably too advanced for the forestry organizations operating in these areas.

The commercial risk for the manufacturers on launching machines for mechanized planting will be great, but the use of such machines could be profitable for the forestry sector. However, until such time as bigger markets become available, Scandinavian foresters are taking an active part in the long-term development work, in order to ensure the continued supply of machines from the Scandinavian manufacturers.

5. STAND TREATMENT

5.1 Clearing and Juvenile Spacing

Owing to the rapid rise in costs, the growth in the area requiring clearing/juvenile spacing, the objections being raised by the use of herbicides, and the enormous difficulties involved in mechanizing clearing work, developmental work is urgently needed in a number of related fields. These include:

- Planning: Promising results have been obtained from aerial (helicopter) inventories of the clearing requirements;
- Controlled Spacing: Studies on selective or point clearing have shown that productivity per unit area can be increased substantially;
- Culling: Where more than one seedling survives in an individual spot, culling must be carried out in a way that is biologically and economically defensible.

Under present-day conditions, it is difficult to take any great steps towards rationalizing clearing work. Perhaps planting with a rectangular spacing pattern is the answer on some sites. This would facilitate the technical work in stand establishment, clearing and thinning.

5.2 Thinnings

Fully mechanized thinning has been long in coming, but there are now several types of machines for felling, bunching and processing. Mechanized thinning systems are certainly very attractive compared with motor-manual shortwood cutting.

Experience in mechanized systems may be summarized as follows:

- Mechanized systems require more thorough planning and selection of sites.
- Such systems cannot cope with all logging conditions, but must be supplemented by motor-manual work.
- Costs are low in mechanized systems.
- Thinning results, stem selection and the amount of damage done to the residual stand are all satisfactory.
- Mechanized systems make heavy demands on the operator.

Three types of machine are likely to undergo development in the foreseeable future:

- boom-mounted harvesting units for machines operating from the strip road
- felling and bunching machines operating from the strip road
- stand-operating harvesters.

6. HARVESTING OPERATIONS

6.1 Tree-Section Logging

In logging to the truck-road, the cost of tree-section logging is often 20 to 40 percent lower than that of conventional logging systems. In a given region, if an enterprise is alone in logging and converting tree-sections, it may enjoy an edge over its competitors on the wood market.

Implementation of tree-section logging is an effective means of rationalizing logging, provided there is a market for energy wood. Through energy conservation, those mills that are accepting tree sections have been able to reduce substantially their need for energy from non-timber sources.

Although the handling of tree sections creates a host of problems for the pulp mills, these difficulties must be weighed against the advantages, such as the increased supply of raw material and lower costs in the woods. Much stricter requirements have been enforced by the mills in recent years in terms of the contaminants content in wood, the proportion of hardwoods, the dry solids tonnage of the load, and the proportion of stemwood in the load.

The felling technique used is of great importance in tree-section logging. This has not been fully appreciated in many

quarters.

As a rule, forwarder-loaders have a reach of 10 metres. Special grapple saws and devices for compacting forwarder loads have been developed.

Haulage costs for tree-sections are roughly twice those for roundwood. The tree-section system requires considerably more planning and coordination than do the other systems in use today. In view of the difficulty in handling tree-sections and their sensitivity to storage, there is a marked need for adequate directives and routines right down the line: from felling, forwarding and secondary transportation to storage and comminution.

6.2 Logging Systems

A comparison has been made of the profitability of the following six logging systems:

The Shortwood System

- Motor-manual cutting
- Logging with harvesters;

The Tree-Section System

- Motor-manual tree-section logging
- Mechanized tree-section logging;

The Whole-Tree System

- Logging with processing of whole-trees at a landing
- Logging with processing of whole-trees at a terminal.

Under normal conditions, the highest profit is secured by the system using harvesters. Judged on the basis of cost alone, the motor-manual tree-section system may be the most profitable. A prerequisite for this, however, is that the tree-sections can be limbed effectively and that the haulage distance to the mill is less than 100 km. If terminals for the trees are to be attractive, a high level of output is required, e.g. by achieving a very high degree of utilization.

On the whole, harvester systems are preferred in the short-run. In areas where the local conditions are good, the tree-section system can be employed alongside the harvester system. Whole-tree systems should be tested on a more practical scale in those parts of Scandinavia where tests have already indicated profitability. In this way, a fund of knowledge can be acquired which will be an asset when the time comes to select techniques for use in the 1990s.

6.3 Short-Wood Method

Mechanized logging of roundwood will be subject to continued rapid advances, with the optimization and fine-tuning of individual items of equipment. This applies above all to machine technology, dimension setting, and bucking and control systems. The trend is towards the increased use of harvesters, both in thinning and final felling. Single-grapple harvesters for small dimension logging and twin-grapple (conventional) harvesters for larger dimensions are of most immediate interest. From experience gained in recent years, it will be possible to improve the machines in terms of the tree dimensions that they can handle and the requirements for damage-free infeed of the wood and for bucking. It is estimated that productivity could rise by between 5 and 7 percent per annum, and the value of the wood by 2 percent per annum.

In five years' time, a typical forest enterprise in central Sweden will probably possess, on the average, 1.5 twin-grapple harvesters with suitable bucking equipment for final felling, 1.5 single-grapple harvesters primarily for thinning, and two large and two small forwarders for each 100,000 m^3/year to be felled. The small forwarders will be equipped with grapple saws to handle tree sections in smallwood thinning. This range of equipment will make for a high degree of flexibility and efficiency in both final fellings and thinnings until the end of the 1980s.

6.4 Whole-Tree and Tree-Section Methods

The main findings of the studies and analyses made of the use of whole-tree and tree-section methods in final felling over the last few years are as follows:

- Whole-tree methods, and tree-section methods in particular, are still attractive alternatives to the long-established and well-proven shortwood method in final felling. Under the right conditions in some local areas, these methods are already attractive today. Advances in technology coupled with changes in marketing and working conditions in general can make these methods even more attractive in the future.
- Satisfactory techniques exist today for both whole-tree and tree-section logging. There is also wide scope for development.
- The main obstacles in the path of continued development are current marketing conditions and the apprehensions held by many about the organizational difficulties associated with whole-tree logging in particular.
- For bunch-handling of smallwood to become more widespread in the future, advances in bunch-limbing techniques are needed. Barking and chipping of pulpwood in the future will still be performed most effectively at the mill.

- Even though organizational problems may cause difficulties, operational receptivity to more diversified logging techniques is required. Technical experiments could provide more flexible machines.

6.5 Wood Value

Practical experience has shown that purposeful and long-term measures aimed at improving bucking can result in substantial additional revenue.

The type of work concerned here is everyday rationalization measures - the need for investment in machinery and equipment can be disregarded.

The following must be carried through if satisfactory results are to be achieved:

- specification of the current situation and the formulation of objectives capable of being followed up
- careful and thoughtful introduction of planned measures
- the drawing up of straightforward and practical instructions for bucking, preferably with special directives for each individual tract
- the provision of training and support for supervisors
- the provision of training for all logging staff
- the performance of regular follow-up studies with

feedback of the results.

Also fundamental to the success of the work is that it be carried out on a long-term basis. Good bucking technique should be regarded as a natural element in logging work.

7. SECONDARY TRANSPORTATION

The combined transport and storage costs for pulpwood and tree-sections account for 40 percent of the costs to the mill, excluding administrative costs. A 15-20 percent reduction in this cost could be achieved by better transport techniques, greater matching of logging operations to the requirements of the mills, and smaller stocks of unprocessed wood at the roadside.

Three pre-requisites must be satisfied for this to be possible:

- an identification of the work in the field of motor vehicle technology, on the part of not only the haulage companies, but also forest enterprises, and active cooperation between the vehicle manufacturers and the manufacturers of vehicle bodies and equipment
- improved coordination of, above all, raw material purchases and transport
- the development of short-term transport and storage plans. (In spite of the familiarity that most enterprises have with computer-based routines, this field has not yet been touched on by the majority of enterprises.)

8. HARVESTING/SAWMILLING INTERACTION

In light of developments in production planning and other aspects of sawmill activities, more closely defined specifications for sawlogs are to be expected from the mills. Changes in the marketing approach of the mills are also likely to impose a similar influence. To meet these new requirements, foresters are acquiring additional technical aids, improving their knowledge of the forests and identifying with precision the potential yield available from the use of various predetermined logging systems.

With a view to furthering more intimate cooperation between logging and the sawmills, for about a year the Forest Operations Institute of Sweden has been working on the development of a simulation instrument for analysis and control of the roundwood yield - an instrument known as a bucking yield analyser. Scandinavians are merely at the beginning of a line of development leading the way towards many related opportunities. Conceivable applications for bucking yield analysis are done in conjunction with:

- the development of, and investment in, bucking equipment
- the production of yield estimates, delivery plans and quantifiable bucking objectives
- the production of bucking and operating instructions at enterprise, district or forest-tract levels
- the development of routines for forest tract selection and stumpage evaluation.

9. MACHINE MAINTENANCE

The maintenance of Scandinavian forest machinery costs at least as much as the capital cost of the corresponding downtime. A reduction in this cost is therefore a matter of urgency.

The cost of repairs can be influenced by maintaining a suitable balance between service trucks and permanent workshops, supported by a suitable stock of spare parts. Further savings in these areas are being achieved through collaboration between enterprises.

It has also been shown that the machine operator can make a considerable contribution towards reducing the costs by actively participating in fault diagnosis and repair work. Operators are undergoing better basic and follow-up training by taking part in all repair work and having access to suitable tools in the field.

APPENDIX VII

Restrictive Factors Encountered By

Canadian Forest Products

in Selected Overseas Markets

Source: Sterling Wood Group Inc. Status of the B.C. Coast Forest Industry, 1984. Report to the B.C. Ministry of Forests.

Restrictive Factors Encountered by Canadian Forest Products Selected Overseas Markets

A. Lumber

Country	Tariffs	Restrictions from Standards and Building Codes
United Kingdom	E.E.C. schedule None on rough-sawn, 4.5% on planed lumber	-Moisture content presents greatest problem.
West Germany	E.E.C. schedule	-C.L.S. grade not accommodated by German construction lumber standard.
France	E.E.C. schedule	-Dressed lumber requires entry visa and results in excessive delay at customs. -Use of French language on all documents mandatory.
Italy	E.E.C. schedule	-Mediterranean specifications for sizes are not compatible with Canadian standards. -Greater use of northern European sizes likely.
Benelux	E.E.C. schedule	-Government contracts favour domestic timber. -S.P.F. not recognized in Dutch codes. -Sweden supplying in C.L.S. sizes.
Australia	Basic 2% duty on all imports. Rough cedar duty-free. Dressed, or bevel cedar 20% duty. Shingles and shakes duty-free. Rough sawn lumber 2%-5% duty. Dressed lumber 15% duty.	-N.L.G.A. grades not recognized; must be regraded to Australian standards. -Standard sizes different. -Protectionist measures to frustrate imports and so assist domestic producers.
Japan	10% tariff on S.P.F.	-C.L.S.meets Japanese standards but reinspection required. -Some problems with specifications on wane. -Traditional fear of fires in many places forbids use of exterior wood trim or sidings.
China	None	-Purchasing is through central authority. -Standards and building codes are in their infancy.

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U.S.A.	None	-Lumber grading standards employed in Canada generally accepted. Certainly all major ones. -Geographic location has the greatest impact on ability to trade, e.g. Eastern Canada has 41.7% market share of NE U.S. Conversely, B.C. has 41.0% of market of SE U.S., while Eastern Canada has 10.6%.

B. Plywood

Country	Tariffs	Restrictions from Standards and Building Codes
United Kingdom	Subject to E.E.C. duty-free quota. 1983 quota was 238,000 m3. Duty where applicable is 11.5%.	-8'x4' still standard size except metric lengths for floor sheathing and metric widths for wall sheathing. -Increasing code acceptance of competitive panel products.
West Germany	E.E.C. schedule	-C.O.F.I. production under special licence for wall sheathing. -Exterior glue qualities in C.O.F.I. plywood favoured. -C.O.F.I. plywood does not meet construction grade standards due to open split and knot sizes.
France	E.E.C. schedule	-C.O.F.I. D.F.P. meets engineering codes. -Preferred sizes are 2500 x 1220 m.
Italy	E.E.C. schedule	-No building codes or product standards yet.
Benelux	E.E.C. schedule	-C.O.F.I. plywood meets codes and product standards.
Japan	15% to 20% tariff	-Sizes are 3 x 6 or multiples. -C.S.P./D.F.P. recognized within Japanese standards.
U.S.A.	20% tariff on softwood plywood	-U.S. is self-sufficient in plywood and structural panel board. -Very little plywood is imported from Canada aside from specialty items such as cedar-faced plyeood siding. -Product standards have 2 significant differences: 1) U.S. standards include interior and exterior glue types while Canadian industry produces only exterior type; 2) D grade veneer is acceptable in U.S., not in Canada.