TECHNOLOGY CHALLENGES FOR CANADA'S FOREST SECTOR

Dr. Clark S. Binkley, Dean,
Faculty of Forestry, 270-2357 Main Mall, University of British Columbia,
Vancouver, BC. Canada V6T 1Z4

Summary

Sustaining high levels of productivity and productivity growth in the Canadian forest sector depends on rapid development and adoption of relevant, sophisticated technology. Yet R&D expenditures in Canada lag those for most of its major competitors, suggesting that Canada is unlikely to produce the necessary technology on the schedule it s needed. This lack of investment in R&D stems at least in part from three factors: (i) the specific problems associated with being a net exporter with a large share of many of the markets we serve, (ii) the comparatively small size of Canadian firms, and (iii) Canada's collective failure to articulate a widely accepted forest sector strategy which guides the daily policy and management decisions of all sector participants. This analysis suggests that an effective R&D strategy for Canada will involve rapid deployment of technological innovations, R&D targeted on the special features of Canada's forests and polity, and better links between strategies fro the forest industry and the forest resource.

Introduction

Beginning with beaver pelts, Canada's economic prosperity has been inextricably linked with the health of its natural resource enterprises. Relying on vast expanses of accessible, high-quality virgin timber, Canada's forest sector gained enormous market share internationally, and now stands as the country's leading export industry by far.

But the source of our historical comparative advantage is waning. Some timber has been depleted and logging much of the rest becomes more costly and more controversial by the day. The productivity declines that are closely associated with the depletion of virgin timber mean that the industrial strategies which produced Canada's leading position in international forest products markets will not sustain those positions in the future. If the Canadian forest sector is to continue its role as the country's major exporter, its technological sophistication--of its products, manufacturing processes and the forest resource itself--must improve dramatically (Binkley, 1993).

The argument is in three parts. First, why is declining productivity associated with the evolution of the Canadian forest sector as it moves from old- to second-growth timber? Why is increasing the technological sophistication of our forests, the products derived from them and processes used to do so the only viable strategy for offsetting this

decline? Second, given the overwhelming case for improved technological sophistication in the forest sector, why does Canada--both individual firms and the government--do so little R&D? Finally, how can we overcome the technological challenges facing Canada's forest sector?

1. The Setting: Endogenous Decline in Productivity

Economists define "productivity" simply as the ratio of the value of an industry's outputs to the cost of its inputs. Increases in productivity are obviously a prerequisite for increases in material standard of living.

In his study of Canada, Porter (1991) described the situation well:

> Canada's economy, and especially its export economy, is heavily based on natural resources. Some argue that resource industries are inherently less desirable than manufacturing or"high tech" industries. This logic is flawed. There is nothing inherently undesirable about resource-based industries provided they support high levels of productivity and productivity growth. Such industries can make a country wealthy if its resource position is highly favourable, as has been the case for Canada during most of its history. If resource-based industries continually upgrade their sophistication through improvements in their products and processes, competitive positions can be sustained and productivity growth insured.

Canada is largely in the midst of a transition from a hunter/gatherer stage of forestry to a husbandry/stewardship stage (Binkley, 1992a), with predictable implications for downward pressure on forest-sector productivity (Binkley, 1992b; Vincent and Binkley 1992):

- As virgin timber is depleted, timber costs will rise. Harvesting costs will increase as logging pushes into increasingly remote and rough sites. Real timber rents--the value of the standing timber itself--will increase as a consequence of old-growth depletion and the link between timber markets and capital markets (Sedjo and Lyon, 1990).

- As timber costs rise in Canada, new competitors can profitably enter Canada's markets--S.E. Asia and the Russian Far East with old-growth timber, and New Zealand, Chile and Brazil with fibre derived from intensively-managed exotic plantations. Competition from these new suppliers along with competition from nonwood products will prevent Canadian producers from increasing the prices of their products. Productivity is squeezed between upward pressures on the cost of wood and downward pressure on product prices.

- In response to increasing timber costs and comparatively high labour costs, Canadian producers substitute capital for timber and capital for labour. As more and more capital is utilized, the single-factor productivity for new capital declines because of diminishing returns to any one factor of production. Lower returns on capital mean less capital investment and a self-perpetuating downward spiral of declining productivity.

- Increased environmental concerns add to production costs as these formerly free externalities are internalized through direct regulation or other means.

Taken together, these factors all constrain productivity growth and may in fact reduce absolute levels of productivity. There are three logically possible solutions to counteract these declines:

(i) reducing the price of inputs,
(ii) increasing the value of outputs, or
(iii) becoming more efficient in transforming inputs into outputs.

Reducing the price of inputs is not a socially acceptable or politically attractive option. The key input costs for most Canadian forest products are labour, timber, and energy. Reducing wage rates means a reduction in material standard of living. Reducing timber prices will reduce provincial revenues at a time when provincial budgets are already in deficit, and may run afoul with the GATT and NAFTA. Similar arguments hold for energy costs.

The only attractive options to sustain or increase productivity are (i) to increase the value of outputs and (ii) to develop and adopt more efficient production processes. Both strategies require investments in research, development, technology transfer and training. How is Canada doing in these areas?

According to several different statistical sources, the Canadian forest sector--both government and the firms themselves--spends about 0.85% of gross sales on R&D. In contrast, our competitors in the United States, Japan, and Sweden spend about twice as much (respectively 1.5 %, 1.5% and 1.75%; Binkley and Watts, 1992). Such low levels of expenditure on R&D mean that Canadian firms cannot produce new technology rapidly enough to sustain gains in forest-sector productivity in face of the significant downward pressures exerted by

- the endogenous dynamics of the sector,
- exogenous shocks such as upward movements of the Canadian dollar, and
- policy interventions that increase producer costs such as increased stumpage fees and socially desirable environmental legislation.

The result will be steadily worsening standards of living in Canada, especially in those many places where the forest sector dominates the economy.

2. Specific Problems of Forest Sector R&D in Canada

If R&D is so central to long-term prosperity of the Canadian forest sector, why does Canada do so little of it? The answer lies in

(i) the specific problems associated with being a net exporter with a large share of many of the markets Canada serves,
(ii) the small size of Canadian forest products firms, and
(iii) the collective failure of Canadian society to articulate a widely-accepted forest-sector strategy.

The Problems of Being a Net Exporter

To understand the problem Canada faces in using research as part of an industrial strategy to increase productivity, it is necessary to understand how competitive markets distribute benefits among the various market participants. Consider a technological improvement that reduces production costs (for example, an optical log scanning system combined with optimized, computer controlled setworks that would increase the lumber recovery factor and reduce the cost of producing a specified amount of lumber.) If one firm finds the innovation to be financially attractive, it is likely that others will as well. As many firms adopt the innovation, output will increases and the market price will fall. A price reduction obviously makes consumers better off. However, the lower market price also reduces the profits that the firm was anticipating from the technological innovation.

Conceivably, prices can fall enough so that producer profits are actually lower after the innovation has been widely adopted than they were before it was conceived. If this occurs, the return on R&D may be negative. Of course, the firm would be still worse off if it had not adopted the technology. It faces a kind of prisoner's dilemma: pursuing technical innovation can keep it from losing, but cannot help it win.

This outcome clearly depends on how much product prices fall in response to technological innovation. Unfortunately for Canada, a definitive empirical study of forest sector research in North American markets suggests that consumers generally receive most the benefits in the form of lower prices (Hyde et al., 1992). In three of the four cases studied (softwood plywood, softwood lumber, and wood pulp) aggregate producer profits actually fell in response to technological change. Only in the case of wood preservative did R&D activities improve both consumer benefits and producer profits.

These results stem from the comparatively inelastic demand for most forest products, a situation that is the case even for such commodities as North American construction lumber, market pulp and newsprint that comprise the vast majority of Canada's forest-sector output (see, e.g. Phelps, 1993; Cardellichio, et al. 1989; Kallio et al. 1987). Inelastic demand means that any increase in output produces a disproportionately large decline in prices. As a large participant in many of the markets we serve, the demand curves faced by Canadian producers will tend to be less elastic than are those for less significant participants. As a consequence, those who consume Canadian forest products will tend, all else equal, to receive a large share of the benefits of Canadian investments in forest-sector R&D. Most of these consumers reside outside of Canada, so the benefits of Canadian R&D--whether public or private--will tend to flow out of the country unless great care is taken to target R&D strategically.

There are no similar, definitive studies for Canada. However, because Canada is a net exporter of most of its wood products, broadly applied R&D--particularly those activities that reduce production costs--will not necessarily produce higher profits for Canadian producers. One of my UBC colleagues, Prof. Tom Maness, recently examined the relationship between productivity and profitability in the BC softwood lumber industry Between 1976 and 1989, physical productivity increased by 56%, but profit margins remained more or less constant, and actually fell if measured on a peak-to-peak basis over the last business cycle (Binkley, 1994).

As a result of these market effects, Canadian producers logically "fail" to invest in many kinds of R&D. The benefits of broadly-based government investment in forest sector R&D may accrue primarily to customers in other countries. To produce greater economic prosperity in Canada, Canadian forest-sector R&D must be carefully targeted and must be rapidly reduced to practice in the market place.

The Problems of Small Size

Firms realize the benefits of R&D through capital investments, whether in incremental improvements to existing equipment or in altogether new facilities. Because of the high cost of transporting raw materials to a pulpmill or sawmill, forest-sector firms typically produce similar products at several similar production facilities. Capital investments often involve installing the same equipment at several location. Examples include trimmer- and edger-optimizers that would typically be installed at all mills within a lumber firm, or extended delignification pulping that would be installed at all locations of a firm that produced bleached kraft pulp. Obviously, the larger the number of facilities operated by a single firm, the smaller the cost per facility of mastering a specific technological innovation common to all locations. As a result, larger firms face a lower cost of bringing new technology on line than do smaller firms (Hayter, 1988; Science Council of Canada, 1992). It is therefore not surprising that expenditures on R&D are

positively correlated with firm size, whether measured in absolute terms or as a fraction of sales (Warda, 1994).

Canadian forest sector firms are quite small when viewed by international standards. Ranked on the basis of total sales in 1992, Noranda Forests--the largest Canadian forest products company--ranked 17th in the world with sales of $US 3.7 billion (Price Waterhouse, 1993). In contrast, the largest firm--International Paper Co.--had sales of $US 13.6 billion.

Of course what matters for understanding relative investments on R&D is not sales *per se* but gross investment. To a very good first approximation, forest products companies invest their cash flow.

The average cash flow per firm for the three largest Canadian firms is more than an order of magnitude less than that for their three largest US competitors (Binkley, 1994). Because of their much smaller investment programs, Canadian firms operate at a considerable disadvantage when compared with their much larger international counterparts who can amortize the costs of R&D over much larger investment programs. The problem of small firm size is especially acute for the secondary manufacturing firms that many in Canada hope will expand in the future (ISTC, 1991).

The R&D challenge is particularly daunting given the current federal emphasis on small and medium-sized enterprises. Except for those firms that are specifically based on technology products (e.g. communications, biotechnology), smaller firms are less-well positioned to utilize an R&D-based business strategy (Hayter, 1988). Available cash typically flows to output expansion and not to R&D. Smaller firms typically have few of the "technology receptors" that are needed to gain high returns from R&D (Science Council of Canada, 1992). The bankruptcy rate for smaller firms is much higher than that for larger firms, so the benefits of R&D conducted by small firms are less likely to be captured internally.

Before turning to ways R&D programs can create higher returns for Canadian producers and Canada as a whole, let us examine a third reason why Canadian forest sector firms do not invest much in R&D: the absence of a clear industrial strategy for the sector.

Third Generation R&D and the Need for a Forest Sector Strategy

Even the conservative economists who oppose the development of industrial strategies by governments would agree to their necessity for Canada's forest sector. Nearly everywhere in Canada, a basic factor of production--standing timber--is held primarily by the public sector. As a result, public decisions inevitably influence the size, structure, output levels, and profitability of the forest products industry. Indeed the

capacity to influence the characteristics of the forest products manufacturing industry is one of the primary reasons that the public continues to support governmental control over forests. While a national forest strategy (CCFM, 1992) has been developed and widely endorsed, it does not draw clear and detailed links between R&D activities and gains to Canadian producers and consumers. In the absence of a government industrial strategy for the forest sector, no individual firm can create a meaningful strategic plan.

Why is the lack of effective public or private strategic plans in the forest sector consequential for forest-sector R&D? Roussel et al. (1991) explain that in order to be effective, R&D should support strategic aims. Planning this "third generation" R&D involves answering such questions as: What 'knowledge products' are needed to support the strategy? When are they needed? Should they be developed internally, or purchased from someone else? What are the downstream manufacturing and marketing implications of a particular R&D program? Only by answering these questions can a firm tailor an effective R&D program. And, only by relating R&D to the achievement of larger organizational aims can a firm's management make a convincing case for spending scarce corporate capital on R&D.

Without a clear understanding of society's objectives for its forests it is impossible to craft a R&D program that is compelling in either the public or private sector. As a result, R&D in the Canadian forest sector is relegated to the status of charity. This, of course, precludes realizing the most important strategic benefits of R&D, and guarantees that both public and private investment in R&D is far less than is socially optimal.

3. Conclusions: Towards an R&D Strategy for Canada's Forest Sector

High productivity in the forest sector has been the key to economic prosperity in many parts of Canada. The vast quantities of high quality, easily accessible old-growth timber that, in the past, underpinned this high productivity no longer confers the competitive advantage it once did. Increased efficiency and expanded production of higher value-added products are the only ways to sustain the high levels of productivity and productivity growth that are essential for continued prosperity. Attaining these objectives requires substantial investments in R&D. But current R&D expenditures in Canada are low when compared with those of our chief competitors. The low levels of expenditures in Canada can be explained--at least in part--by Canada's position as a net exporter, by the small relative size of Canadian forest products firms, and by the lack of a clear forest sector strategy. Given these circumstances, what are the elements of an effective forest sector R&D strategy?

First, recognize the distinctive problems of being a net exporter.

Both our public and private sector R&D strategies should examine the market conditions (especially demand elasticities and likely competitor responses) as part of research plans.

We should attempt to forecast how an innovation will influence the market prior to initiating the research that will produce that innovation. In some cases, this will suggest pursuing research as a means to defend ourselves against innovations elsewhere, including competition from forest products firms in other countries and competition from other products. In other cases it will suggest opportunities for lasting productivity gains.

Because of high capital costs and the infrequency of major capital investments, (particularly by the smaller firms that dominate the Canadian forest sector), equipment suppliers tend to provide most of the R&D for process improvements. In these circumstances, equipment suppliers logically learn more about the process technologies than do individual firms. As a result, any firm in the forest sector can purchase the most advanced technology, so there can be no lasting competitive advantage from widely-available processing technology per se.

The benefits of ubiquitous technology will depend on the dynamics of how innovations diffuse through the market. As a net producer, an effective R&D strategy for Canada will, of necessity, generally involve adopting innovations before our competitors do. Surprising little research analyzes the time it takes for an innovation to be adopted in the forest sector, and the factors that determine the rate of adoption. As a consequence, it is difficult to predict a priori the rate at which the market advantages of a particular innovation will dissipate. Some evidence suggests that the rate of diffusion is slow enough that firms can gain advantage from ubiquitous technology if they move quickly enough (Binkley, 1994).

To be effective, our R&D strategy must be one of continued technical innovation with the producers in the major consumer countries following our lead. This strategy will require:

(i) management that understands the economic leverage R&D can provide,
(ii) a well-educated and technically adept work force that can quickly adapt new technologies to old problems (Science Council of Canada, 1992),
(iii) a closer-than-average relationship between forest products firms and their suppliers, and
(iv) explicit allocation of management time to the process of technological innovation. A key step is to plan how R&D results will be implemented at the same time that the R&D itself is planned

As a second component of an effective R&D strategy, capitalize on the distinctive features of Canada. For example, Canada's forests harbour some tree species that have comparatively unusual and rare wood properties (e.g. clear western redcedar). Our R&D strategy should emphasize work on these species rather than generic work on such species as Douglas fir where the benefits of the research will accrue more broadly. Similarly, because of comparatively low electricity costs and the particularly qualities of northern

conifers, we have a natural advantage in mechanical pulps. R&D can help move these pulps into higher value papers and into applications that more costly and higher priced kraft pulps currently dominate. As another example, Canada is one of the world's leaders in its public desire for environmental protection and for secondary manufacturing of wood products. In both cases, innovations in these areas will help us twice, once as our own forest products industry becomes more competitive, and a second time as Canada develops the home-based manufacturing industry that produces the equipment needed for environmental protection or secondary manufacturing.

Finally, link a forest industry strategy with a forest resource strategy. Since trees cannot be easily moved, R&D on how best to utilize our particular forest resources can create unique competitive advantages for Canada. Unfortunately, Canadian institutions for forest ownership are not well suited to take advantage of this opportunity. Unlike the situation for many of our competitors--New Zealand, the U.S., Chile, and Brazil--Canada divorces the ownership of the forests from the ownership of the forest products manufacturing capacity. As a consequence, it is virtually impossible for Canadian firms to coordinate planning for the future forest resource with planning for the future forest products and processing technology. In contrast, Canada's competitors in these other countries can design future wood fibre characteristics, processing facilities and products at the same time. Under current tenure arrangements the kind of planning that lead to the clearwood regime for Pinus radiata in New Zealand--an approach that permits fast-grown second growth timber to substitute in many uses for British Columbia's old growth Pinus ponderosa--would not be possible. Similarly, exceedingly low wood costs for Brazil's technical development. Public ownership of forest lands confers a degree of patience in awaiting the returns from R&D and from investments in silviculture that is unequaled by the private sector. To take advantage of this feature of public ownership, Canada needs a much more tightly articulated public forest-sector strategy. Absent that, Canada should privatize those lands where commercial crops of trees will be grown.

Unless Canada can develop a clear sense of strategic direction for its forest sector, it is unlikely that either the public or private sectors will provide support for the levels and kinds of R&D that are needed to sustain the prosperity of Canada's forest sector. The costs of declining productivity will fall broadly across the country, but will be particularly burdensome for the many rural communities where the forest sector is the principal source of employment and the alternatives for basic economic activity are few. Dislocations in these communities will place added burdens on urban areas and on social welfare programs. Strategically targeted forest sector R&D that recognizes Canada's unique market circumstances can offset declining productivity, and can help the forest sector maintain its capacity to support Canada's economic prosperity.

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