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**BIOTECHNOLOGY AS A COMPETITIVE
EDGE FOR THE
FINNISH FOREST CLUSTER**

The Research Institute of the Finnish Economy (ETLA)
Publisher: Taloustieto Oy

Helsinki 2007

Cover: Mainos MayDay, Helsinki 2007

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ISBN 978-951-628-456-2

ISSN 0356-7443

Printed in Yliopistopaino, Helsinki

Summary

In this study we have collected information by interviewing all identified parties within the Finnish forest sector who might have a potential biotechnology connection: university research groups, research institutions, small and medium-sized biotechnology companies and up to the largest forest companies. The ultimate goal was to assess how resources have been allocated and biotechnologies utilized within the value chain of the entire forest sector.

This study aimed at providing answers to the following questions:

- What are the current Finnish academic resources and projects related to forest industry biotechnology?
- How much does the Finnish forest cluster invest in biotechnology R&D, and what are the key application areas in the value chain?
- How well do the academic resources, company R&D investments, and research needs converge to help secure the future competitiveness of the Finnish forest industries?

In order to answer the above questions, the study approached the matter in consecutive steps. First, the existing forest industry related biotechnological knowledge base within academia on the one hand, and the resource base among firms, on the other, were mapped. Following up on that, we evaluated the sales expectations of forestry related biotechnological applications within the domestic forestry cluster itself, other potential domestic industries, and global export markets. The third step assessed whether the development of forestry related biotechnological applications is justifiable in the framework of comparative advantage. This was accomplished by comparing the relevant existing knowledge and other resource bases to their sales expectations.

In order to evaluate the potential of biotechnology in the entire forest industry value chain, the study assessed four value chain modules. Module 1 represents the beginning of the value chain: forestry applications. Module 2 consists of the development of wood products, Module 3 is related to the pulp and paper industry, and Module 4 to utilization side-streams for bioenergy, biochemicals, and other food or pharmaceutical applications.

The assessment of Module 1 implies that there is a constant lack of resources. Basic research conducts some relatively long projects, which often seem too time-consuming in applied research and corporate R&D. There seems to be only few active links between the academic research projects and companies. Many new technologies already exist but since the individual forest owners hardly have incentives to invest in R&D due to, for example, the long breeding cycle, collaboration with companies seems the only potential way to the commercialization of forestry related biotechnologies. Indeed, 62% of the interviewed company leaders expressed that non-transgenic breeding is one of the main opportunities in sustaining the competitiveness of the Finnish forest cluster.

There were a few biotechnology-based projects within the Module 2. The research and product development seems to focus on physical modifications, and composite research is based on chemistry.

Module 3, paper, pulp and board industry, seems to be the most active in research and product development activity. Their products generate positive cash flows, and research projects are abundantly funded. The companies are closely involved in the research projects as financiers and collaborators. This involvement impacts on the nature of the research, which seems highly applicable and linked closely to industrial applications. Consequently, biotechnology applications are already used in the pulp and paper industry. Some biotechnology applications are rapidly adopted. They, such as enzymes in reducing paper machine runnability problems, do not affect the quality of the fibers, intermediate or end products and are thus easier to adopt on a production scale.

We observed the research and product development within Module 4 as a high priority for both academia and industry. It is anticipated research will grow strongly and even more than in other modules; 38% of the company leaders mentioned side stream utilization as one of the main business opportunities of the future. Biotechnologies are applied as substitutes for chemical and thermal technologies. However, all of these fields of technology are developed and applied by the industry. This provides some important implications for technology development and innovation policy. Due to the fuzziness between technology border-lines, it seems misleading to prioritize biotechnologies over some other technology; in contrast, the most efficient technology should be preferred. Accordingly, technology subsidies might be most efficient if the public technology programs were based on application segments instead of a specific technology.

Our assessment of international patenting activity raised some interesting notions. Finland seemed to be comparatively most specialized in plant genetic engineering, food and food additive, and waste disposal and the environment applications. However, biotechnology based biofuels are not included as a source of comparative advantage, which also stresses the importance of parallel development of biotechnologies and other technology fields.

A potential source of value creation could be the utilization of process side-streams more efficiently, including refinement of by-products such as tall oil, to products with higher value added in other application areas. The paper and board making might also be strongly influenced by new packaging solutions, materials and methods; however, these only rarely or never utilize biotechnologies as such.

Finland has a good overall and mostly publicly maintained infrastructure. If the raw material's high quality and some special features can compensate for the relatively low growth rates, Finland should be able to attract the multinational pulp and paper industry also in the long term.

We conclude that the development of biotechnologies should not contain any intrinsic value *per se*. The commercial value of the biotechnology could be benchmarked with the value of alternative technologies; and consequently, biotechnology could become part of the technology options for companies active in established and conventional industries.

The Finnish forest cluster has financial resources to commercialize any new technology that can increase efficiency or provide other economic benefits in new application areas. This is why we consider this area exceptionally promising compared to any other high technology field without such a financial backbone.

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