AN INDUSTRY PERSPECTIVE ON FOREST PRODUCTIVITY RESEARCH NEEDS IN THE UNITED STATES

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ABSTRACT.—The long-term competitiveness of the U.S. forest products industry depends on achieving substantial and sustainable increases in the productivity of U.S. forests that are available for wood production. Rapid progress is needed in several critical research areas. These include biotechnology and tree improvement, physiology, soil productivity, remote sensing, economics and policy, and environmental protection. The U.S. has some excellent research programs in these areas, but the overall effort is fragmented and inadequately funded. Traditional models for cooperative forestry research need to be updated in some cases (e.g., biotechnology) and used more effectively in others.

The U.S. forest products industry is large, diverse, and rapidly changing. It comprises hundreds of organizations and many thousands of people. Interconnections between the U.S. industry and the global forest products industry are increasing rapidly. We face great opportunities and daunting challenges.

Industry interest in forest productivity research is driven primarily by wood cost, wood quality, and international competition. The U.S. industry faces intense and growing competition from foreign producers with access to low-cost, high-quality supplies of wood. At the same time, environmental constraints are restricting wood supplies in the United States. Simply put, the long-term competitiveness of many U.S. mills depends on achieving substantial and sustainable increases in the productivity of U.S. forests.

Research is the key to increasing the productivity of U.S. forests. The industry perceives outstanding productivity potential in U.S. forests, but our current knowledge is insufficient to overcome technical, economic, and political barriers. Many industry scientists are confident the barriers can be overcome. A key question is whether we can overcome the barriers rapidly enough to affect wood supply futures during the next cycle of capital investment decisions.

FOREST MANAGEMENT TECHNOLOGY

The United States has been supporting research on technical barriers to forest productivity since the 1930's. Early research efforts produced significant advances in fire control and reforestation technologies. These efforts also established a tradition of cooperative forestry research involving industry, universities, and the USDA Forest Service. Cooperative approaches to forest technology research have since proven effective in a variety of areas including tree improvement and various aspects of stand management.

Substantial progress in forest productivity research over the past several decades provides reason for optimism about our ability to overcome additional technical barriers. However, many industry scientists are concerned that the current mix of government, university, and industry research is not sufficient to support substantial and sustainable increases in forest productivity.

To address this concern, the industry is supporting a forest science and technology initiative through the Agenda 2020 Program at the American Forest and Paper Association (AF&PA). The initiative is based on cooperative efforts of AF&PA, the U.S. Department of Energy's Office of Industrial Technology, the USDA Forest Service Research and Development organization, universities and national labs, the industry's National Council for Air and Stream Improvement (NCASI), and individual forest products companies. The mission is to identify and support high priority projects in four research focus areas: (1) Biotechnology and Tree Improvement, (2) Basic Physiology of Forest Productivity, (3) Sustainable Soil Productivity, and (4) Remote Sensing Technologies to Improve Forest Inventory and Stand Management. Project selection is guided by four research pathways (fig. 1) and by technical panels of industry scientists. With eight new projects funded this year, the Agenda 2020 forestry portfolio comprises 21 projects with combined budgets totaling more than $13 million over the period 1996-2001 (table 1). Total project support in 1999 will be close to $3 million. About 25% of the 1999 support will be from industry and other non-federal sources.

Agenda 2020 is an important step in the right direction, but a small step relative to the size and complexity of the

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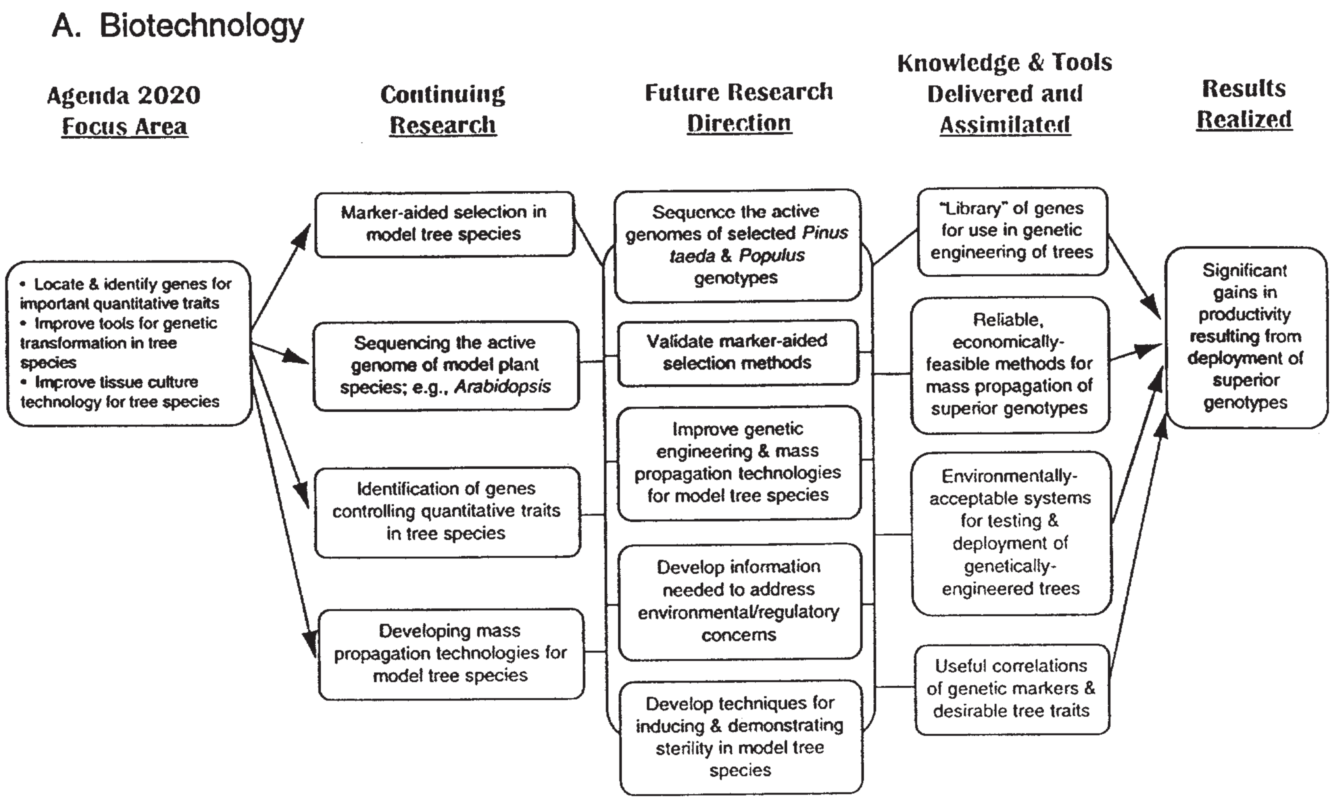
Figure 1.—*Agenda 2020 Research Pathways.*



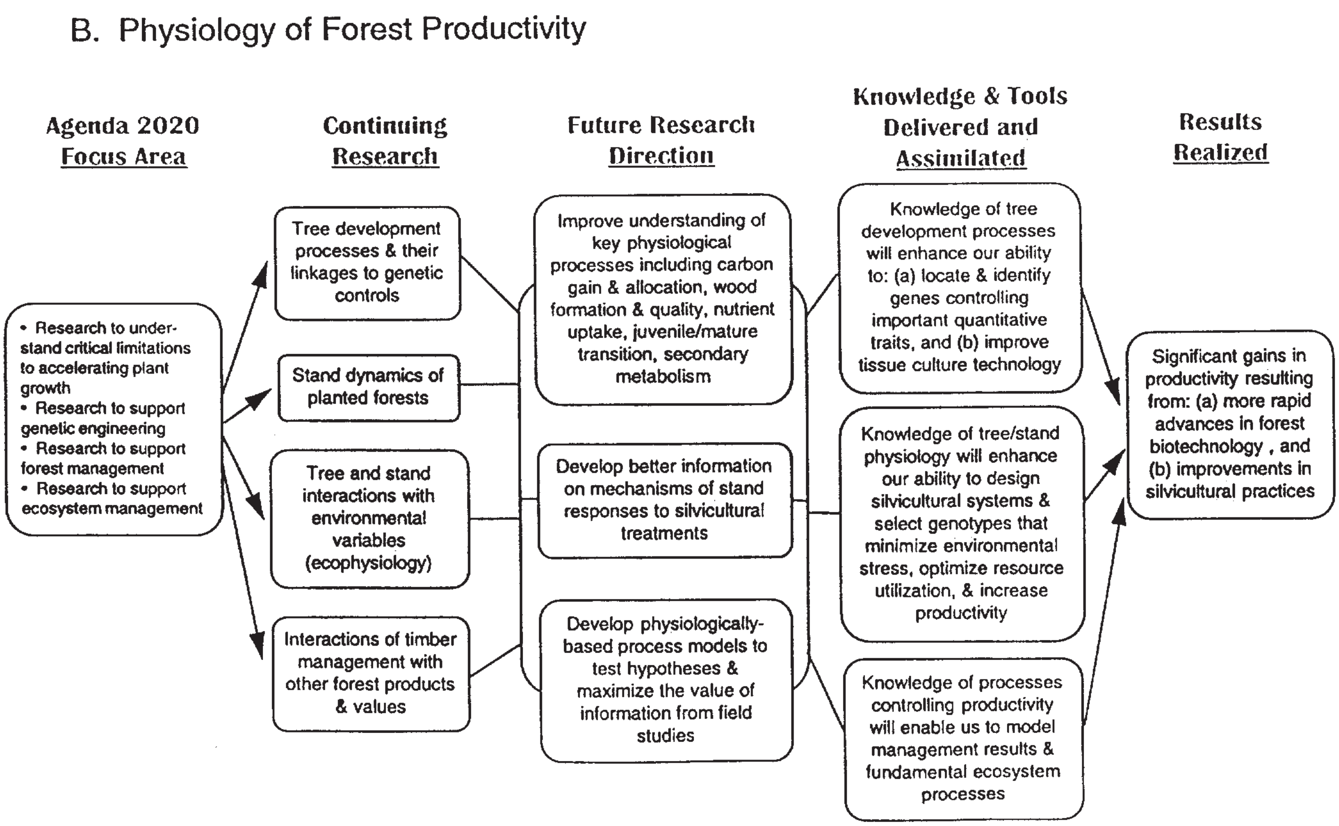
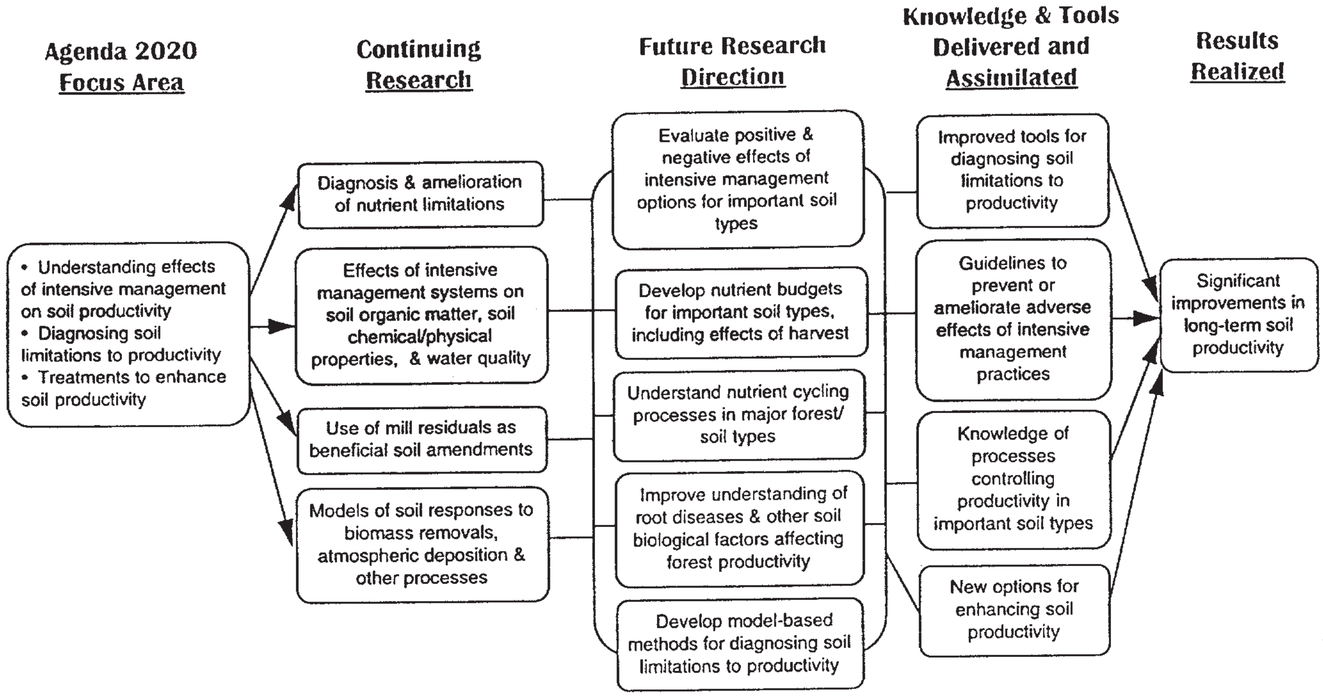


Figure 1 continued

C. Soil Productivity



D. Remote Sensing Technologies to Improve Forest Inventory and Stand Management

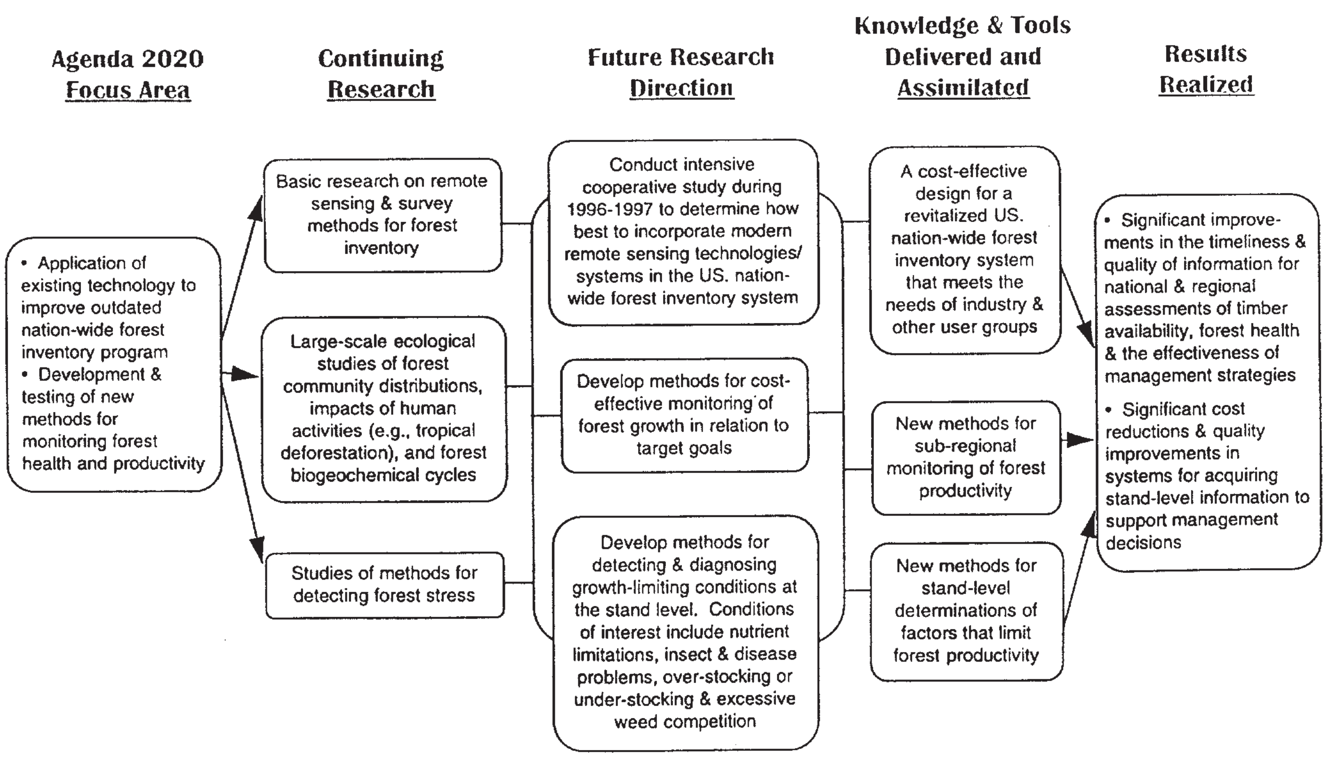


Table 1.—*Agenda 2020 Forestry Research Portfolio as of December 1998.*

Focus area	PI	Project Title	Institution	Lead funding	Fun ding agency
Biotechnology	Tuskan	Marker-aided selection for wood properties in loblolly & hybrid poplar	Oak Ridge NL	DOE	1996-1998
Biotechnology	Ellsworth	Molecular analysis of carbohydrate regulation in loblolly pine	Brookhaven NL	DOE	1996-1998
Biotechnology	Tschaplinski	Biochemical and molecular regulation of crown architecture	Oak Ridge NL	DOE	1996-1999
Biotechnology	Dimmel	Trees containing built-in pulping catalysts	IPST	DOE	1997-1998
Biotechnology	Strauss	Dominant negative mutations of floral genes for engineering sterility	Oregon State U.	DOE	1997-1999
Biotechnology	Whettin	Pine gene discovery project	NCSU	DOE	1997-2000
Biotechnology	Johnson	Molecular physiology of nitrogen allocation in poplar	U. Florida	DOE	1997-2000
Biotechnology	Li	Search for major genes using progeny test data to accelerate development of superior loblolly pine plantations	NCSU	DOE	1999-2001
Physiology	Samuelson	Control of growth efficiency in young plantation loblolly pine and sweetgum through irrigation and fertigation enhancement of leaf carbon gain	Auburn	DOE	1997-1998
Physiology	Yoder	What causes the “density effect” in young forest plantations?	Oregon State U.	DOE	1997-1999
Physiology	Topa	Assessing the significance of belowground carbon allocation of fast- and slow-growing families of loblolly pine	Boyce Thompson Inst.	DOE	1997-2000
Physiology	Hendrick	Intensive management effects on nutrient allocation and stand physiology in loblolly pine plantations	U. Georgia	DOE	1999-2001
Soil Productivity	Tolbert	Sustainability of high intensity forest management	Oak Ridge NL	DOE	1996-2001
Soil Productivity	Luxmoore	Model-based diagnosis of soil limitations to forest productivity	Oak Ridge NL	DOE	1996-2000
Soil Productivity	Burger	Sustaining the productivity and function of intensively managed forests	VPI	DOE	1997-1999
Soil Productivity	Allen	Influence of surface and subsurface tillage on soil physical properties and soil/plant relationships of planted loblolly pine	NCSU	DOE	1997-1998
Soil Productivity	Richter	Sustainability of soil nutrient supply in rapidly growing southern forests	Duke	USFS	1998-2000
Soil Productivity	Turco	Enhancing soil as a sustainable growth medium	Purdue	USFS	1998-2000
Soil Productivity	Comerford	Diagnosing and correcting soil nutrient limitations in intensively managed southern pine forests	U. Florida	DOE	1999-2001
Remote Sensing	Biging	A test of digital photecometrics as a forest inventory tool	Univ. California Berkley	USFS	1998-2000
Remote Sensing	Evans	Estimating forest area by type and delineating stand characteristics with high-resolution aerial sensors	Mississippi State University	USFS	1998-2000

challenges that lie ahead. The biotechnology area is especially challenging because technical barriers are intermixed with economic and institutional barriers. Traditional informal models for cooperative forestry research are proving ineffective in the high-tech, legalistic world of biotechnology. Leaders in industry, government, and academia must find new models for cooperative research that can deal effectively with biotechnology's high costs, established power structures, and complex intellectual property issues.

Traditional approaches to cooperative forestry research still have a lot to offer in areas such as forest nutrition, silviculture, growth and yield, and basic tree improvement. In the Lake States, ongoing cooperative programs are developing new plantation systems for *Populus* and *Larix,* for example. The industry's Lake States Regional Research Committee and the North Central Research Station are currently reviewing research needs and opportunities, with the goal of strengthening cooperative research efforts in the region.

Clearly, an ambitious and coherent vision of forest technology is an essential element of a national or regional research agenda on forest productivity. Also essential is a strategy to understand the social and economic forces that will constrain or enable progress in forest management technology. Two issues are paramount: Environmental Performance and Global Markets.

ENVIRONMENTAL PERFORMANCE IN FOREST MANAGEMENT

Environmental concerns about forest management are major factors affecting timber supplies and forest management in the United States. Simultaneous efforts to improve forest productivity and environmental performance raise a number of interesting research questions that can affect the development and deployment of technology. The forest products industry is addressing several of these questions through NCASI and other programs.

A clear and urgent challenge is to maintain high water quality in forested watersheds while capturing the proven and potential benefits of intensive management regimes that include several applications of fertilizers, herbicides, and perhaps insecticides during a rotation. NCASI is addressing several key information needs and is intensifying its research efforts in this area. Significant progress has been made in reviewing existing information, improving a model of chemical drift from aerial spray operations, assessing potential for chemical leaching to groundwater at seedling nurseries, and organizing new field studies to fill information gaps. The high cost and complexity of needed watershed studies are significant obstacles.

Protecting biodiversity while increasing productivity is a somewhat ambiguous goal because wildlife responses to management are species and scale dependent. This goal is nevertheless essential and urgent because the public cares about wildlife and the government has proven it can use the Endangered Species Act and other means to stop forest management activities it considers harmful to biodiversity.

Studies by NCASI and others are showing that wildlife populations in managed forests are generally larger and more diverse than expected. Comparisons of managed and unmanaged areas often reveal differences in wildlife communities, but the differences are often surprising. A significant number of species, including some considered rare or declining, are more abundant in managed forests. Species that are missing or greatly reduced in managed forests are relatively few in number. Opportunities to accommodate both wildlife and timber production in managed forests may be much greater than previously thought.

Biodiversity research is moving beyond comparisons of managed and unmanaged forests into studies of wildlife responses to alternative management regimes and habitat conservation measures. Several ongoing studies are examining effects of corridors, thinning regimes, slash management techniques, snag retention, and other options. To date, few studies have examined potential biodiversity consequences of forest biotechnology and fiber farming. It is reasonable to assume these technologies will not create ecological risks beyond those already accepted in agriculture, but there will be a need to test and refine this coarse general assessment in rigorous case studies.

An important priority in NCASI's ongoing environmental research is development of "spatially explicit" models that can simulate the environmental and economic consequences of alternative management regimes applied in landscapes ranging in size from 10,000 to 1,000,000 acres. In our work on such models, two key concepts are emerging: (1) flexible harvest scheduling routines that can simultaneously consider several economic and environmental goals or constraints, and (2) programming strategies that facilitate interorganizational cooperation (e.g., developing model components that are reusable and easy to adapt for testing/application in a variety of hardware/software environments).

GLOBAL MARKETS FOR WOOD AND FOREST PRODUCTS

The U.S. forest products industry faces growing competition in its domestic and overseas markets from emerging industries in Southeast Asia and Latin America. At the same time, a global movement toward capitalism is creating new markets and new investment opportunities. These forces, coupled with rapid change in manufacturing technology and product lines, add great uncertainty to predictions about future wood demand and prices.

Nevertheless, forest policy and economics must provide the strategic assumptions that justify and shape priorities for forest productivity research. Indeed, economics and policy studies are themselves integral parts of the productivity research agenda. Among the fundamental threshold questions are these:

1. Does the United States have the capability and will to remain a world leader in the forest products industry?

1. How would improvements in U.S. forest productivity affect the long-term competitiveness of the U.S. forest products industry?

1. What are the economic and environmental costs of <u>not</u> developing new forest technologies in the United States?

ORGANIZING FOR SUCCESS

Wood is a major industrial material used in a wide range of products. Most industrial wood goes into commodities that meet human needs for shelter, communication, artistic expression, personal hygiene, and packaging. On a volume basis, the world's annual consumption of wood in forest products is greater than its consumption of steel, cement, plastic, and aluminum combined.

The United States is the world's leading producer and consumer of forest products. Social and economic benefits of having a strong forest products industry in the U.S. are substantial. The industry provides good jobs, support for rural communities, exports, incentives for active forest management, and renewable energy. The industry has greatly reduced its environmental footprint over the past few decades and is committed to further improvements. In short, there are good reasons for optimism about the future of the forest products industry in the United States. But there are also reasons for serious concern, including intense international competition and a domestic policy environment that often seems indifferent or hostile to the industry's long-term viability in the U.S.

Forest productivity research is a small but important part of the equation that will shape the future of the U.S. forest products industry. Over most of the past half century, the U.S. has been a world leader in forest productivity research. In recent years, we have fallen off the pace while needs for new information and technology have been expanding rapidly. Now is an excellent time to renew and revitalize our efforts.

There are some excellent productivity research programs in the U.S., but the overall effort is fragmented and inadequately funded. Traditional models for cooperative forestry research need to be updated in some cases (e.g., biotechnology) and implemented more effectively in others (e.g., applied silviculture, especially in regions outside the South). Industry is becoming more proactive in defining its precompetitive research needs and priorities. Scientists interested in forest productivity need to do a better job of organizing disciplined communities across institutional boundaries in order to develop necessary scientific infrastructure and compete more effectively for funds and students. Research funding agencies can enable a transformation of forest productivity research through partnerships with industry and creative grant programs.