


Biobased Industrial Products



*Priorities for
Research and
Commercialization*

Suranaree University of Technology



31051800600763

NATIONAL RESEARCH COUNCIL

Contents

EXECUTIVE SUMMARY	1
Raw Material Resource Base, 3	
Opportunities: Range of Biobased Products, 5	
Processing Technologies, 8	
A Vision for the Future, 10	
Recommendations, 11	
1 OVERVIEW	15
Potential Benefits of Biobased Industrial Products, 18	
Federal Agricultural Improvement and Reform Act, 19	
International Markets, 19	
Environmental Quality, 19	
Rural Employment, 23	
Diversification of Petroleum Feedstocks, 23	
Setting a Course for the Future, 24	
Report Coverage, 25	
2 RAW MATERIAL RESOURCE BASE	26
Silviculture Crops, 26	
Agricultural Crops, 27	
Enhancing the Supply of Biomass, 29	
Waste Materials, 29	
Conservation Reserve Program, 31	

	Filling the Raw Material Needs of a Biobased Industry, 32	
	Current Resources, 32	
	Improving Plant Raw Materials, 39	
	Introduction of New Crops, 52	
	Summary, 53	
3	RANGE OF BIOBASED PRODUCTS	55
	Commodity Chemicals and Fuels, 57	
	Ethanol, 57	
	Biodiesel, 58	
	Intermediate Chemicals, 60	
	Ethylene, 60	
	Acetic Acid, 62	
	Fatty Acids, 62	
	Specialty Chemicals, 62	
	Enzymes, 63	
	Biobased Materials, 65	
	Bioplastics, 66	
	Soy-based Inks, 67	
	Forest Products, 67	
	Cotton and Other Natural Fibers, 68	
	Targeting Markets, 70	
	Capital Investments, 71	
	A Case Study of Lignocellulose-Ethanol Processing, 72	
4	PROCESSING TECHNOLOGIES	74
	The Biorefinery Concept, 75	
	Existing U.S. Prototypes, 75	
	Comparison of Biorefineries to Petroleum Refineries, 79	
	Lessons from Petroleum Refinery Experience, 80	
	Processes for Converting Raw Materials to Biobased Products, 81	
	Lignocellulose Fractionation Pretreatment: A Key Step, 81	
	Thermal, Chemical, and Mechanical Processes, 81	
	Biological Processes, 88	
	Needed Developments in Processing Technology, 95	
	Upstream Processes, 95	
	Bioprocesses, 96	
	Microbiological Systems, 97	
	Enzymes, 98	
	Downstream Processes, 100	
	Summary, 101	

5	MAKING THE TRANSITION TO BIOBASED PRODUCTS	103
	A Vision for the Future, 104	
	Investments to Achieve the Vision, 109	
	Niche Products, 110	
	Commodity Products, 111	
	• Public Investments in Research and Development, 111	
	Federal-State Cooperation, 113	
	Incentives, 113	
	Providing a Supportive Infrastructure, 115	
	Education of the Public, 115	
	Technical Training, 115	
	Information and Databases, 116	
	Research Priorities, 117	
	Biological Research, 117	
	Processing Advances, 118	
	Economic Feasibility, 123	
	Environmental Research, 124	
	Conclusion, 124	
	REFERENCES	126
	APPENDIX A: CASE STUDY OF LIGNOCELLULOSE-ETHANOL PROCESSING	137
	Feedstock Supply and Demand, 137	
	Transportation Costs, 140	
	Processing Costs, 141	
	Fuel Efficiency, 143	
	APPENDIX B: BIOGRAPHICAL SKETCHES OF COMMITTEE MEMBERS	144