Matrix Benefit Analysis
USDA Section 9008 Program

Requested by William F. Hagy III
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Presented to the
Biomass R&D Technical Advisory Committee
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Outline

- Purpose
- Objectives
- System of Measurements
- Baseline Metrics for USDA Section 9008
- Tracking Measures to Assess Benefits

Study Purpose

- To evaluate the USDA Section 9008 program and awards from fiscal years 2002 to 2005 solicitations.

- To provide a general assessment of performance measures that could lend themselves to tracking of current and future benefits of the program

Strategic Plan of Rural Development is a driver: Evaluation of Programs and integration of the results of those evaluations into budget decision-making processes

Objectives

- Document alignment with USDA strategic goals
- Document alignment with the guiding legislation
- Analyze processes and inputs
- Identify award outputs
- Evaluate outcomes by analyzing completed or nearly completed projects
- Assess potential impact of the program
- Suggest potential metrics for program implementation and offer recommendations.

Definition

Metrics – a **system of measurements** that includes the

- *Item being measured,*
- *Unit of measurement, and*
- *Value of the unit*

are a tool for

- *Measuring progress,*
- *Improving program performance, and*
- *Demonstrating program successes to*
  - Congress
  - Office of Management and Budget (OMB), and
  - Public

NRC, 2005, "Thinking Strategically, The Appropriate Use of Metrics for the Climate Change Program" ISBN 0-309-09659-6 (Book), http://www.nap.edu/catalog/11292.html

Benefits Accrue Over Time

- To assess benefits follow the research outputs through to commercialization and their transformation into products and services used in our society
- Called **impact metrics**

Geisler, E. 2002, “The metrics of technology evaluation: where we stand and where we should go from here,” International Journal of Technology Management, Vol. 24, No.4 pp. 341-374

Geisler, E. 2000. The Metrics of Science and Technology. Westport, CT: Quorum Books.

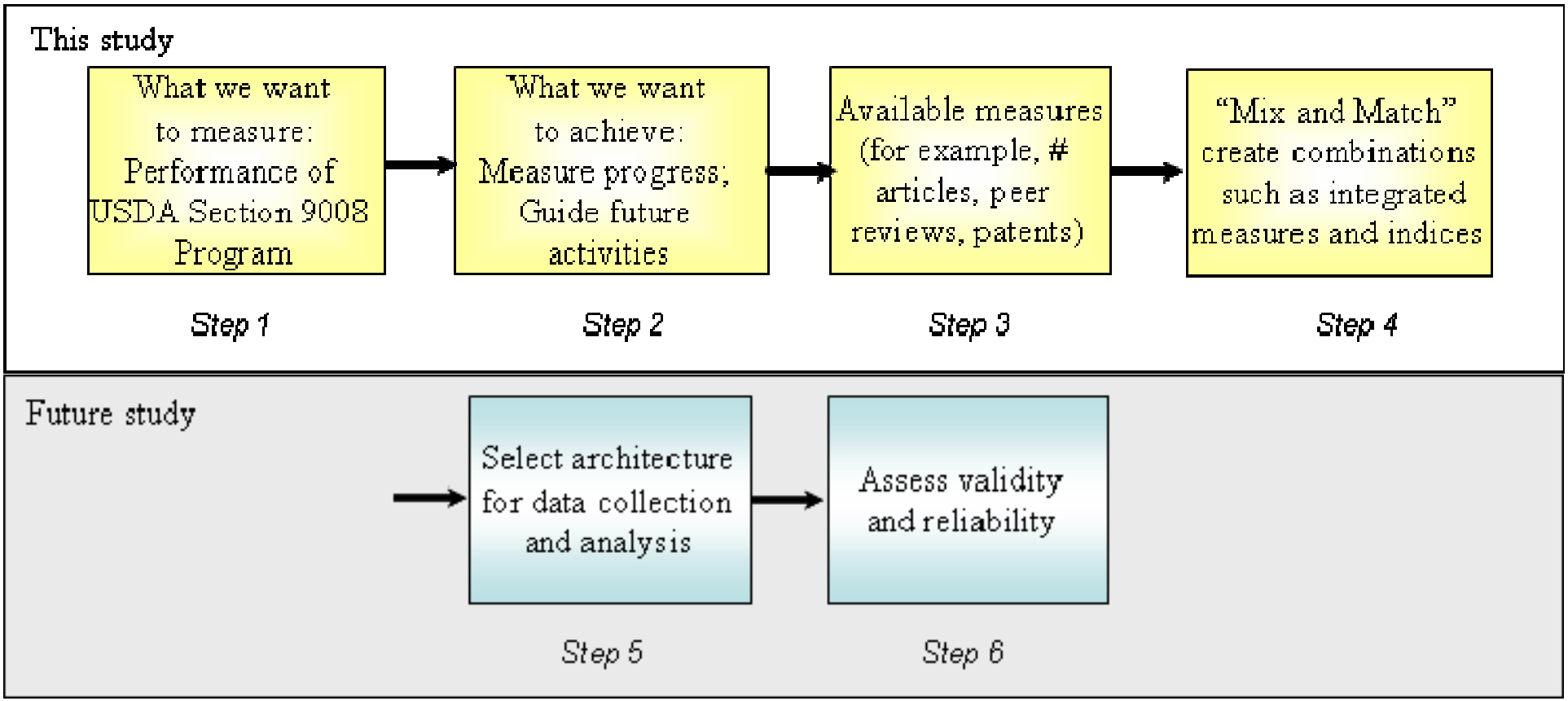
Qualities of Good Metrics

- Promote strategic analysis
- Serve to advance scientific progress or inquiry
- Promote continuous program improvement
  - Poor metrics can encourage actions to achieve high scores that could lead to unintended consequences
- Should be easily understood and broadly accepted by stakeholders
- Promote quality as a key objective
  - Quality is best assessed by independent, transparent peer review
- Assess process as well as progress
- Focus on multiple measures of progress
  - Single measures are often misguided

Challenges in Applying Metrics

- Require significant human, financial, and computational resources to develop and apply meaningful metrics to a program
- Need to evolve to keep pace with scientific and technological progress and program objectives.
- Require good leadership if programs are to evolve toward successful outcomes.

Steps Used to Construct Metrics for Section 9008 Program



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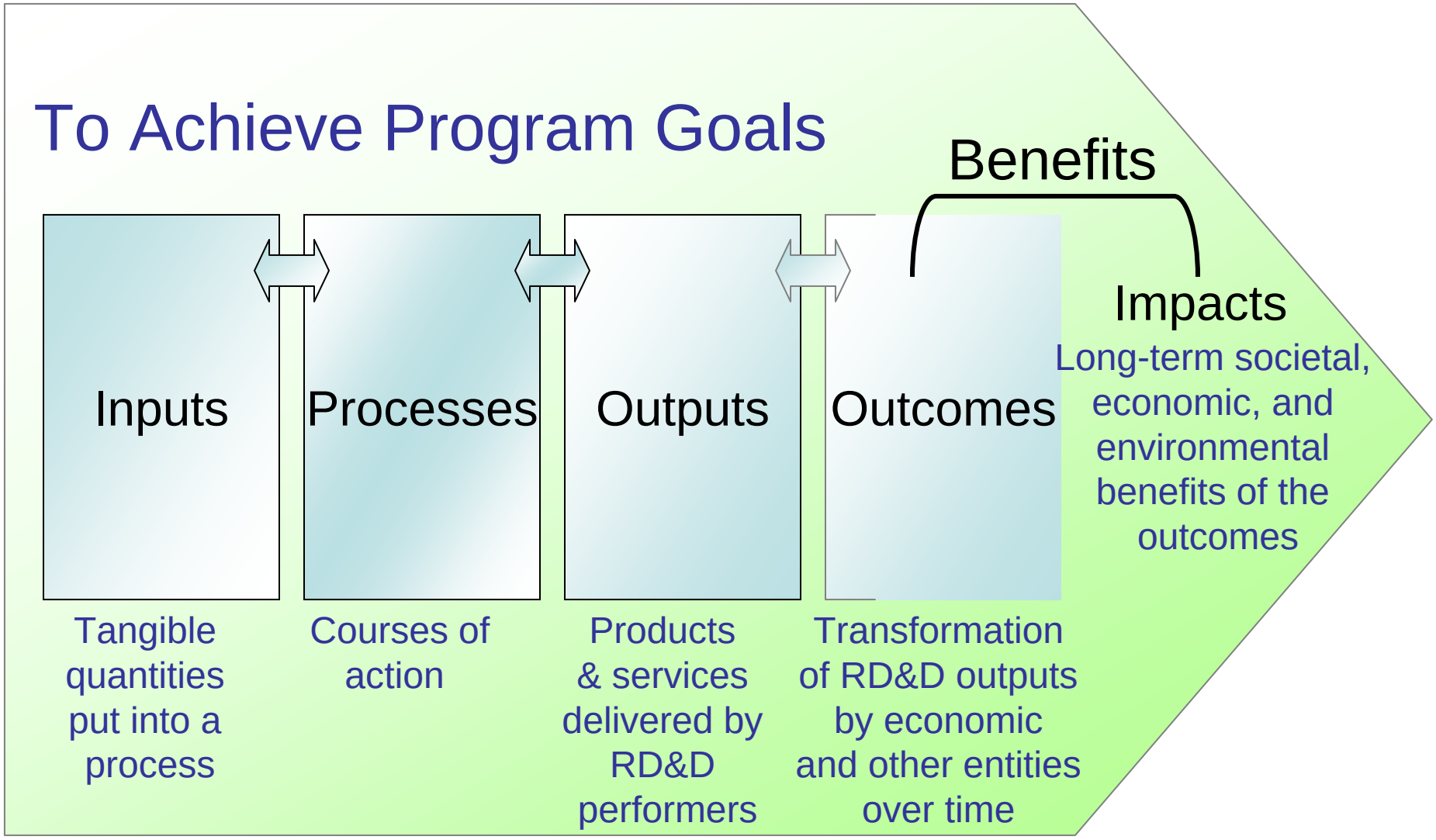
Section 9008 RD&D System of Measurements



Input and Process Metrics

Investments in a variety of categories

Organization, Strategic, and Managerial metrics indicate how well the activity is being performed

Legislative

2000 Biomass R&D Act

2002
Purposes

Entities
Areas

2005
Objectives

Purposes
Entities
Areas
Targets

Technical Advisory Committee

Vision 2006
Roadmap 2003
Oversight
Feedback

Biomass R&D Board

Interagency Coordination
Oversight/Approval
Strategic Plan Goals

Executive

USDA Strategic Goals
Outcomes

DOE

OMB GPRA and PART

USDA-DOE
Joint Solicitations Processes
FY02-FY05

- Topics
- Criteria
- Review
  - Internal
  - External
- Award Selection

41 USDA projects

- Award negotiation
- Project manager (distributed)
- Project Reviews
- **Metrics Analysis – This work**

Peer review metrics indicate the degree to which the managed processes are reviewed to achieve the scientific and technical goals

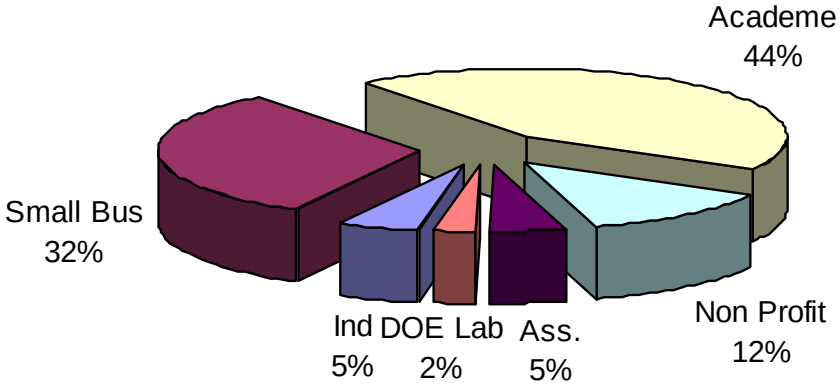
USDA Agencies, Offices, and Councils

- Rural Development, **RD** – Current Manager
- Cooperative State Research Education and Extension Service, **CSREES** – Peer Review Process – External R&D arm
- Natural Resources Conservation Services, **NRCS** – Stewardship of Agricultural Lands – Initial Manager
- Agricultural Research Service, **ARS** – Internal R&D arm
- Forest Service, **FS** – Stewardship forest/grasslands and R&D
- Farm Service Agency, **FSA** – CCC funding and commercialization
- Office of Energy Policy and New Uses, **OEPNU** – Biobased Products FBP4 and biodiesel education program
- Intragency Collaboration and Coordination
  - USDA Biobased Products and Bioenergy Coordination Council, **BBCC**
  - **USDA Energy Council**
    - •R&D
    - •Commercialization
    - •Outreach and Marketing
    - •International

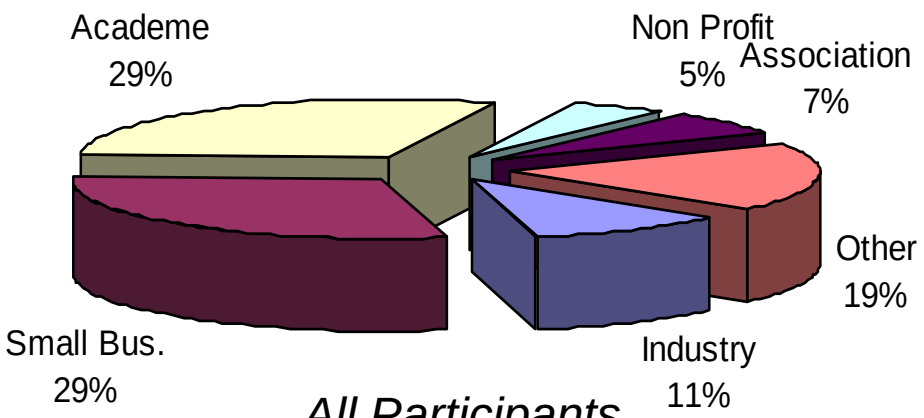
Alignment Strategic Goals/Outcomes/Measures:
- Increase use of renewable fuels and biobased products (bbp)
- Increase production of economically viable alternative enegy
- Researched, demonstrated, promoted new bbp and energy technologies
- Enhanced capital formation to support sustainable business creation
- Provide new opportunities for ag producers and rural businesses

USDA Section 9008 Program

- 41 projects funded at $46 Mi and $36 Mi of non-federal cost share
- Project partnerships include 150 participating organizations in 36 states, DC, and a few international
- Integrated RD&D projects across multiple disciplines
- Average 5 partnering organizations/project
- Projects with 60 participants common. Has + and - impacts
- All Act eligible entities participated



Award Recipients



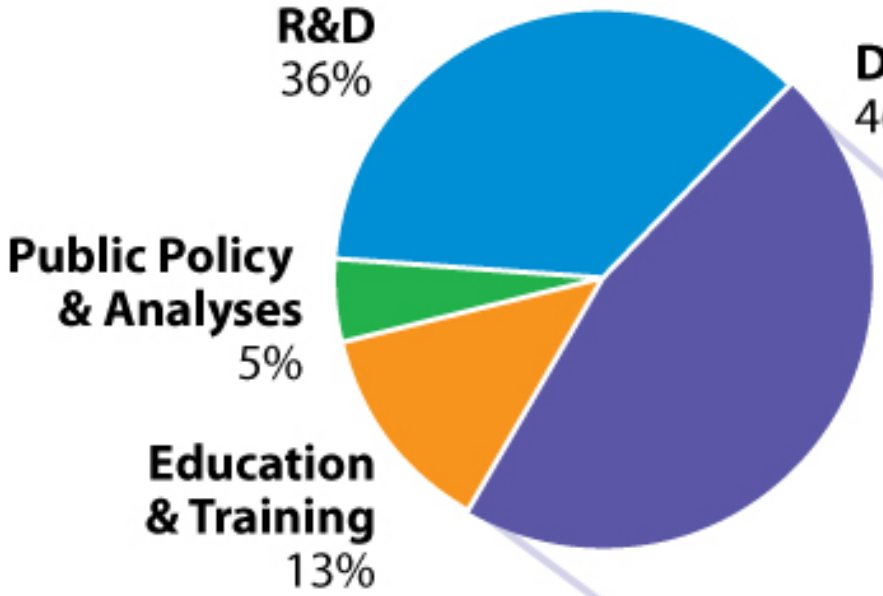
All Participants

Other	%
USDA Lab	32
DOE Lab	32
State Org.	21
Indian Tribe	7
EPA	4
Public/Private	4

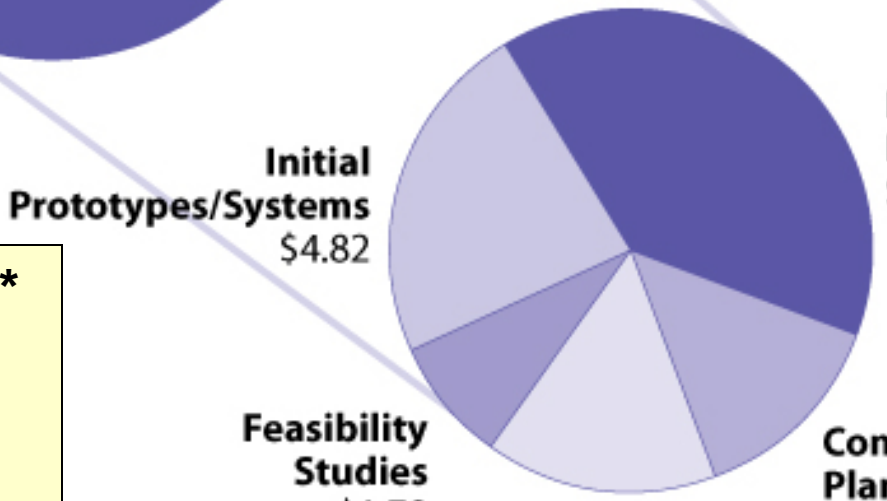
2002 Act's **Purpose** emphasized partnership formation, decreasing silos among RD&D contributors, and fostering multidisciplinary partnerships.

- Many effective networks of RD&D were created.
- Industry partners in most projects facilitated technology transfer.

Funding Proportion by Stage of Development
Total: $46 Million



Demo Areas Funding in M $,
Total $20.9 M



2005 Act Amendments Future Targets	**Current***
• 50% Demonstration	46%
• 35% Innovation	35-40%
• 15% Applied Fundamentals	17%

* Categories are not mutually exclusive

2003 TAC Roadmap Categories

Technical Area	USDA Section 9008 FY02-FY 05 Funding Thousand $
Feedstock Production	**$7,823 (17%)**
a. Biotechnology and Plant Physiology b. Agronomic Practices c. Feedstock Handling	a. $2,840 b. $2,614 c. $2,369
Processing and Conversion	**$20,395 (44.5%)**
a. Thermochemical Conversion Pathways b. Bioconversion c. Products	a. $4,034 b. $10,953 c. $5,408
Product Uses and Distribution	**$7,582 (16.5%)**
a. End-Products and Distribution Systems b. Biorefineries – Pilots, Demos, and Commercial [includes integrated thermal/bioconversion]	a. $483 b. $7,099 [$2,000]
Public Policy Measures to Support Biomass Development	**$10,179 (22%)**
a. Economic Analysis b. Life Cycle Assessment c. Procurement and Markets d. Regulatory Measures e. Incentives f. Biomass Resource Supply g. Education, Outreach, and Training h. Financial Assistance i. Environmental Impact, Emissions Reductions	a. $1,006 b. $674 c. $2,080 d. $340 e. $778 f. $2,478 g. $1,395 h. $- i. $1,428

Technical Area Distribution

Areas	2005 Amended Act, %	Based on Solicitation Topics and Project Areas, %	Based on 2003 Biomass R&D TAC Roadmap Categories, %
Feedstock Corn, stover, DDG 37% Animal residues 22% Wood & residues 21% Switchgrass 13%	20	18-20	17 (R&D) 25 (with biomass resource supply)
Conversion (Overcoming Recalcitrance)	45	45-50	45
Product Diversification	30	25-30	16 (5%-10% in conversion)
Strategic Guidance	5	4-6	

USDA Technical Area Distribution is consistent with the legislation

USDA Section 9008 Projects

Solicitation FY, Managing Organization	Awards Announced	#	Grants Started	Grants Reviewed
2002 - DOE	10/2002	2	1/2003	DOE Stage Gate; 8/2005
2003 - USDA	9/2003	15	9/2003 – 1/2004	3-5/2005 (USDA)*
2004 - DOE	9/2004	13	12/2004-1/2005	5-6/2006 (USDA)* 3 feedstocks projects - DOE Stage Gate 3/2005
2005 - USDA	10/2005	11	--	Not reviewed yet

*Led by Professor M. Hanna from Industrial Agricultural Products Center at the University of Nebraska who selected members of the Multistate Committee S-1007: Science and Engineering for a Biobased Industry and Economy knowledgeable and available on the topics

Peer Review Metrics

Level	Focus	Type	Mechanism
1	Solicitation Process (and Program)	a) Biomass R&D TAC b) Biomass R&D Board	a) External statutory FACA b) Interagency federal government (statutory)
2	Solicitation Proposals	a) Internal agency review for fit b) External peer review for quality	a) USDA b) Industry, academia, labs, and government experts
3	Individual Project	a) Peer Review (all) b) Stage Gate (select)	a) On site with two independent experts from academia b) External Panel Review

Section 9008 program management processes include multi-level reviews to achieve the scientific and technical goals of the program:

- Overall solicitation process
- Individual solicitations
- Individual projects
- Feedback loops built into all these processes through TAC and Board

Proposed Output Metrics	Baseline of 20 projects Weight Average of 3 Years After Award
• Direct Measure of R&D Quality • Bibliometric measures coupled with quality assessments • Special honors or awards	Examples: **1** most downloaded; **1** most cited pub Production of peer reviewed and broadly accepted results and knowledge base increase. **40 publications**. - None
• Resource Development • Human • Infrastructure	**81** faculty, industry, other led subprojects **39** graduate students, **12** students, **5** postdocs In academia, industry, research organizations
• Business Development foster creativity and innovation • Patents (Pat.) and licenses • Growth of new and of existing businesses • Development of Products/ Processes/Systems	Partnerships in all projects **1** Pat. Issues; **19** Pat. Filed; **2** licenses granted **40** companies (75% small) can capitalize on IP **10-12** processes; **17-25** products; **3** systems under investigation
•Quality Education and Information Transfer Products • Quality and impact • Special honors or awards	Multilevel outreach Biomass Encyclopedia Network Bioenergy tool; Policy development information; social/env. issues None

Outputs Moving to Outcomes (examples)

- Early Outcomes from Direct RD&D Outputs result from the increased understanding of scientific and technical areas
  - Number of licenses granted while conducting RD&D – 2
  - Number of projects that obtained financing for commercial plants – 1 from USDA RUS and 1 from private equity
  - Number of advanced technology developments near commercialization – 1 bioavailable cattle feed

Intermediate Outcome Metrics from demos or advances from prior R&D

by economic entitites

- Number of improved processes/products under commercialization
- Number of integrated biorefinery systems developed and tested moving to commercialization
- Number of new products developed
- Number of licenses granted post RD&D at various times
- Number of companies/cooperatives/ventures created
- Number of technology packages resulting from the RD&D in operation – 1 for advanced cogeneration of heat and power from biomass residues in a dry mill in Minnesota

Final Outcomes

- Number and amount of biobased products directly incorporated into manufactured products
- Existing biorefineries commercializing process improvements and products from the RD&D
- New commercial biorefineries

Impact Metrics

- Indices for economic/financial outputs per dollar of program investment (total or by technical area that generated the impacts)
  - Energy security index: Value of fossil fuels substituted with renewable fuels – a surrogate for imported fuels substitution
  - Economic development index: Value of biobased products generated also a surrogate for diversification in agriculture and forestry
  - Economic development index: Number of jobs created in rural America and industry from the application of the program outputs
  - Energy diversification index: Value of the biomass energy as thermal or combined heat and power, or power generated also a surrogate for rural development
- Environmental quality and sustainability indices:
  - A climate change mitigation index: tons of fossil carbon emissions (and other green house gases) mitigated per dollar of program investment
  - A sustainability index could be generated for biomass feedstock, water use, fertilizer use, soil carbon measurements and soil fertility, and land/water stewardship with appropriate development of life cycle based measures
  - A green engineering index could take into account energy efficiency, plant water closure level, and overall emissions from the biorefineries thus providing energy, water, and emissions indices for the plants incorporating RD&D outputs of the research

Long-term societal, economic, and environmental benefits of the outcomes of the Program

Proposed Measures for Tracking

Measures	Measure Amount	Index Measure/ Million $	Comments
USDA Funding, Million $	$22.4		
Cost Share, Million $	$22.7	1:1	50 % cost share
# Proj. FY02 (2), FY03 (15), FY04 (4)	20	0.9	One FY03 project continued in FY04. Counted as 1
Cumulative # Publications	40	1.8	Easy to track but best associated with quality index
Cumulative # Patents (applied and issued)	20	0.9	Upper limit. Later separate applied and issued patents. Index is 0.04 for issued patent.
Cumulative # technologies under commercialization	2	0.08	One 1st commercial (Project # 14, FY03) and one commercial prototype (Project # 14 FY03)
Cumulative # Processes, products, systems under development	36	1.6	Difficult to track. Expert judgment on the overall portfolio.
Cumulative # Licenses	2	0.08	Easy to track
Cumulative # Companies involved ith IP generation	40	1.8	Requires detailed analysis of projects
Cumulative # Projects financed	2	0.08	Easy to track. USDA RUS Loan (Project # 3 FY03). Equity financing (Project # 14 FY03)
Cumulative # Feasibility studies	5	0.2	Decrease investment risk. Downselection tool
Cumulative # Outstanding training/ education courses/policy analysis	3	0.12	Not just numbers; counts only if quality is built into it.
Cumulative # of students to Post-docs	56	2.5	Human resource development dimension of training of professionals. Easy to track
Cumulative # of project investigators and lead collaborators	81	3.6	Human resource dimension of complexity of projects with multiple investigators at different organizations.

Comparison with DOC/NIST Advanced Technology Program (ATP)

	ATP Development only 1990-present	RD&D - USDA Section 9008
Cumulative # Publications/Mi$	0.34 mid program 1.0 early 2000	1.8 includes earlier R&D phases
Cumulative # Patents/Mi$	0.42 mid program 0.67 early 2000	0.04 issued 0.9 applied
Cumulative # Techn. Under Development/Mi$	0.10 mid program 0.17 early 2000	0.08 0.24 estimated based on 36 tech under development and the ratio 9:1 from prototypes to successful commercialization*

NIST = National Institute for Standards & Technologies

*Stevens, G.A.; Burley, J. 1997. “3,000 Raw Ideas = 1 Commercial Success”. Research Technology Management, Vol. 40(3) pp. 16-17

First Integrated Dry Mill Biorefinery Outcomes/Impacts Sebesta, Blomberg and Associates

Technological Growth Existing Business

- 1st integrated dry mill with biomass cogeneration.
- Reduced cost volatility by replacing NG with biomass energy
- NG savings/yr 735,000 MiBTU/yr
- Pay back of cogen facility 3-6 yrs depending on NG price
- Increased diversity of products from plant

Foundation

- Infrastructure creation for biomass residue for energy
- Partnership development model can be replicated
- Outreach papers – 5

Energy & Environment

- 1 MW green power operational. Green electricity sold to grid
- Reduced water use in plant by 50%
- Reduced VOC emissions to compliance or better

Jobs

- 20 jobs added in the infrastructure of biomass residues with Woodline Mfg.
- Sebesta already requested to analyze 6 other dry mills and other industries
- Primenergy and other gasification companies contacted

Advanced Anaerobic Digestion Technology
Utah State University-Andigen

Technological Growth Existing Business (Dairies) and New (Andigen and its licensees)

- 1st Commercial Plant (USDA funded – 4 tanks) spurred sales of 7 tanks.
- Two licenses developed – ID and Central CA

Foundation

- Technology modularity, automation, and remote control will facilitate penetration of technology at farmer level. Patents and improving testing in UT
- Partnership and dissemination through NRCS – Texas, Montana, Oregon, Utah farmers and USDA staff visits
- Outreach papers – 5; 4 research students trained

Energy & Environment

- Penetration in ID will replace 10% of NG residential heating with green natural gas or 2 Trillion Btu/yr (250,000 homes)
- 15-yr contract with InterMountain Gas for purchase of compressed BioMethane in ID
- Reduced emissions, odor control, which will enable increased rural economic development in Magic Valley, ID
- Electricity production in UT Dairy will be sold to grid at 4.7 cents/kWh to Pacificor (took 1 yr for agreement and 7 mo for permitting).
- Potential additional products in fertilizers

Jobs

- 6 employees at Andigen; spurring job creation in Idaho (Intrepid) and California (AgriMass EnviroEnergy)
- Andigen already receiving proposals from potential licensees to other states and countries

Biomass R&D for Fuels, Chemicals & Improved Cattle Feed

1. Dry Mill Improvement – fractionation of the germ, pericarp, and endosperm
2. Bioavailable cattle feed from corn processing by products and pretreated agriculture residues

Pellet extrusion

Pellets

Offset cracked, rolled and flaked corn feed with these products liberates corn for increased ethanol production. Potential increase is 40% of today's 4.4 billion gallons at full market penetration.

Prime, Location: Archer Daniels Midland Co., Decatur & Champaign, IL; Decatur, IN
Participating Orgs: USDA ARS, EERC; Univ Illinois; ADM Animal Nutrition
Funding: $1.4 M ; Cost share: $600,000
PoP: Jan 04 to Dec 06 ***P.I.:*** *Charles Abbas; abbas@admworld.com*

Fuels, Chemicals, and Improved Cattle Feed
ADM

Technological Growth Existing Business

- Increased production of ethanol and biodiesel from improved fractionation
- Increased diversity of products from dry mill plants.

Foundation

- Farmer/cooperatives could establish animal feed pellets production on site.
- Partnership model can be replicated in many places
- 2 PhD students, 2 post docts, interdisciplinary areas of research in three organizations involved.

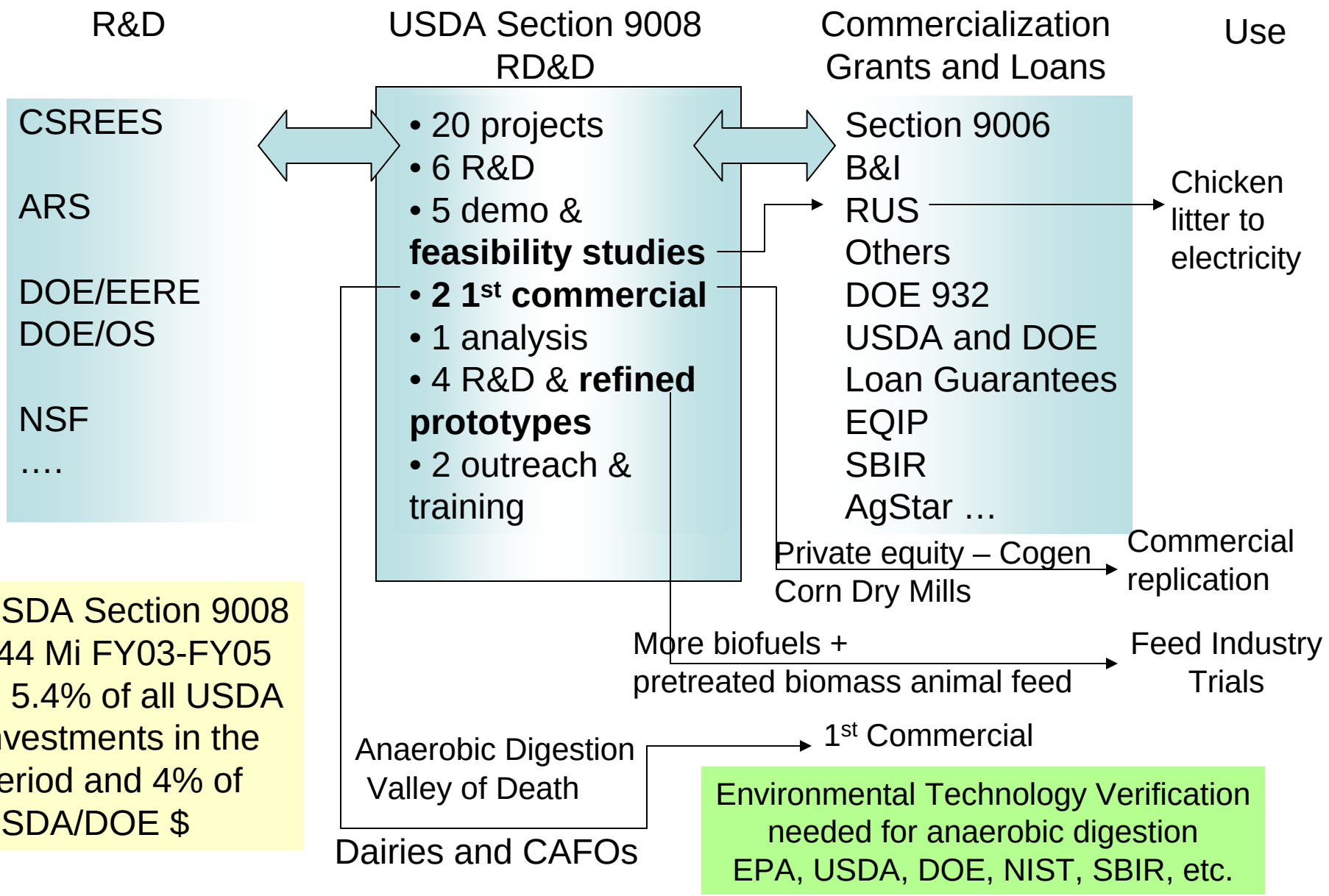
Energy & Environment

- Energy savings/yr about 1,500 Billion BTU per dry mill implementing technology. 60 dry grind mills could use the technology.
- Penetration 70-100 % of technologies can produce additional 1.2-1.7 Billion gal of ethanol from corn (40% of 4.4 billion gal)
- 130 million additional gal biodiesel production possible

Jobs

- Model for feed development with farmers could lead to creation of many businesses for feed manufacturing and distribution close to where the need for the feed is.

Summing Up


R&D
USDA Section 9008 RD&D
Commercialization Grants and Loans
Use
CSREES
ARS
DOE/EERE
DOE/OS
NSF
….
• 20 projects
• 6 R&D
• 5 demo & feasibility studies
• 2 1st commercial
• 1 analysis
• 4 R&D & refined prototypes
• 2 outreach & training
Section 9006
B&I
RUS
Others
DOE 932
USDA and DOE Loan Guarantees
EQIP
SBIR
AgStar …
Chicken litter to electricity
Private equity – Cogen Corn Dry Mills
Commercial replication
More biofuels + pretreated biomass animal feed
Feed Industry Trials
Anaerobic Digestion Valley of Death
1st Commercial
Dairies and CAFOs
USDA Section 9008 $44 Mi FY03-FY05 is 5.4% of all USDA investments in the period and 4% of USDA/DOE $
Environmental Technology Verification needed for anaerobic digestion
EPA, USDA, DOE, NIST, SBIR, etc.

USDA Funding Section 9008 Projects

#	FY	Title	Submitter	Funding	Cost Share*
		Agriculture Feedstock Development			
3	FY03	Advanced Biorefinery Feedstocks	Metabolix, Inc., Cambridge, MA	$ 2,000,000	*$ 1,833,835*
19	FY04	Integrated Size Reduction and Separation to Pre-Fractionate Biomass	University of Tennessee, Knoxville, TN	$ 717,319	*$ 307,180*
21	FY04	Integrated Feedstock Supply Systems for Corn Stover Biomass	Iowa State University, Ames, IA	$ 1,999,724	*$ 738,439*
20	FY04	Biomass Opportunity for Imperial, Nebraska Region: What is the Value?	Imperial Young Farmers & Ranch, Imperial, NE	$ 2,000,000	*$ 1,113,280*
31	FY05	Increasing the Potential for the Utilization of Cellulose from Straw for Biofuel and Bioproduct Production	University of Idaho, Moscow, ID	$ 693,285	*$ 184,277*
32	FY05	Development of Low-Lignin Switchgrass for Improved Ethanol Production	The Samuel Roberts Noble Foundation, Ardmore, OK	$ 670,166	*$ 204,415*
				$ 8,080,494	$ 4,381,426
		Forest Feedstocks - Management Training, Supply, and Outreach			
28	FY04	Sustainable Forestry for Bioenergy and Biobased Products	Southern Forest Research Partnership Inc., Athens, GA	$ 1,801,453	*$ 541,448*
27	FY04	Development of Existing Biomass Resources through Education of Key Supply Bottlenecks	University of Minnesota, Brainerd, MN	$ 397,711	$ 116,386
26	FY04	Technology Transfer and Education Programs for the Southern U.S.	University of Florida, School of Forest Resources & Conservation	$ 1,075,001	*$ 368,704*
			Subtotal	$ 3,274,165	$ 1,026,538

#	FY	Title	Submitter	Funding	Cost Share
		Ethanol and Biobased Products			
2	FY02	Continuous Isosorbide Production from Sorbitol Using Solid Acid Catalysis	Iowa Corn Promotion Board, Johnston, IA	$ 700,000	$ 1,615,756
1	FY02	Value-Added Products from Hemicellulose Utilization in Dry Mill Ethanol Plants	Iowa Corn Promotion Board, Johnston, IA	$ 2,000,000	$2,970,319
11	FY03	Grain Value Process: Pre-Commercialization Trials	Grain Value, LLC, St. Paul, MN (Small Business)	$ 1,763,160	*$ 1,210,800*
10	FY03	Biomass Research and Development for the Production of Fuels, Chemicals, and Improved Cattle Feed.	Archer Daniels Midland Co., Decatur and Champaign, IN	$ 1,400,000	$ 600,000
13	FY03	Biopolymers and Other Value-Added Products from Distillers' Dried Grains	Iowa State University, Ames, IA	$1,000,000	*$ 250,757*
33	FY05	Implementation of a Scale-Up Pilot Plant Demonstration Facility toward the Commercialization of Florida Biomass Feedstocks for Ethanol Production	The Tampa Bay Area Ethanol Consortium, Bartow, FL	$ 1,920,000	*$ 480,000*
38	FY05	Environmental Enhancement through Corn Stover Utilization	Iowa State University, Ames, IA	$ 1,853,996	*$ 500,349*
				$ 10,637,156	$ 4,657,662
		Forest Biorefineries			
24	FY04	Hayfork Biomass Utilization and Value Added Model for Rural Development	Watershed Research and Training Center, Hayfork, CA	$ 503,400	*$ 152,000*
25	FY04	Development of a Wood Preservative System from Wood BioOil Fractions	Mississippi State University, Forest Products Department, Starkville, MS	$ 1,409,011	*$ 353,000*
37	FY05	Carbon Fiber from Biomass Lignins	Oak Ridge National Laboratory, Oak Ridge, TN	$ 1,083,770	*$ 450,000*
				$ 2,996,181	$ 955,000

Thermochemical, Integrated Biorefinery Systems, and Training

#	FY	Title	Submitter	Funding	Cost Share
17	FY03	Biomass Cogeneration Demonstration Plant at Central Minnesota Ethanol Cooperative	Sebesta, Blomberg & Associates, Inc., Roseville, MN	$2,000,000	$ 13,000,000
5	FY03	Animal Waste Management-Chicken Litter to Energy	Earth Resources, Inc., Carnesville, GA	$ 1,136,936	$ 800,000
14	FY03	Biomass-Fired District Energy: A Source of Economic Development and Energy Security	Local Energy, Tesuque, NM	$1,286,768	$ 455,500
18	FY03	Feasibility of an Integral System for Improving the Economic and Environmental Performance of Poultry and Ethanol Production in North Alabama	T.R. Miles, Technical Consultants, Inc., Portland, OR	$ 254,274	$ 64,449
30	FY04	Small-scale, Biomass Fired Gas Turbine Plants Suitable for Distributed and Mobile Power Generation	Electric Power Research Institute, Palo Alto, CA	$ 241,933	*$ 80,645*
35	FY05	Biomass Gasification: A Comprehensive Demonstration of a Community-Scale Biomass Energy System	University of Minnesota, Morris, MN	$ 1,896,493	*$ 2,345,597*
39	FY05	Biopower Demonstration and Educational Outreach	University of Montana, College of Technology, Missoula, MT	$ 990,500	*$ 443,500*
				$7,806,904	$ 14,319,949

Anaerobic Digestion & Related Research

#	FY	Title	Submitter	Funding	Cost Share
4	FY03	R&D of Anaerobic System on a Large Dairy Farm	Utah State University, Logan, UT	$ 761,385	$ 400,000
15	FY03	Steps Towards a Biorefinery Industry in Vermont	Vermont's Alternative Energy Corporation, Williston, VT	$746,912	$ 224,074
8	FY03	Design and Demonstration of a Commercial Prototype for Onsite Production of High Purity Hydrogen from Farm Animal Wastes - Phase I - proof of concept	New Energy Solutions, Inc., Pittsfield, MA	$ 204,603	*$ 111,888*
9	FY04	Design and Demonstration of a Commercial Prototype for Onsite Production of High Purity Hydrogen from Farm Animal Wastes - Phase II and III	New Energy Solutions, Inc., Pittsfield, MA (small business)	$ 1,456,931	*$ 438,112*
34	FY05	Environmental and Economic Performance of an Integrated, Digester-Cogeneration-Value-Added Process	Clarkson University, Potsdam, NY	$ 805,938	*$ 960,315*
				$ 3,975,769	$ 1,174,074

Biodiesel Catalytic Synthesis & Glycerol Catalytic Upgrading

#	FY	Title	Submitter	Funding	Cost Share
7	FY03	Heterogeneous Catalyst Development for Biodiesel Synthesis	Clemson University, Clemson, SC	$894,203	*$ 230,836*
6	FY03	New Technologies for the Production of Methyl Esters	West Central Cooperative, Ralston, IA	$1,826,648	$ 550,000
36	FY05	Conversion of BioDiesel Derived Glycerol to Glycidol, Glycerol Carbonate and C-3 Oxygenates by Catalytic and Biocatalytic Pathways	North Carolina State University Department of Chemical & Biomolecular Engineering, Raleigh, NC	$ 1,606,265	*$ 411,795*
				$ 4,327,116	$ 1,192,631

#	FY	Title	Submitter	Funding	Cost Share
Specific Process Component Research					
12	FY03	Coupled Processes for Bioenergy Production: Biological Hydrogen Production Links with Microbial Fuel Cells	Pennsylvania State University, University Park, PA	$ 614,913	*$ 175,965*
23	FY04	BioSep: A New Ethanol Recovery Technology for Small-Scale Rural Production of Ethanol from Biomass	Membrane Technology and Research, Inc., Menlo Park, CA	$ 1,032,045	*$ 600,000*
22	FY04	Fuel Cell Systems Operating on 100% Bio-Liquid Fuels	Technology Management Inc., Cleveland, OH	$ 965,161	*$ 241,290*
				$ 2,612,119	$ 1,017,255

Public Policy Measures to Support Biomass Deployment - Outreach

16	FY03	Biomass for Tomorrow's Energy and Greenhouse Gas Management Needs: An Economic, Engineering and Environmental Appraisal of Opportunities & Policies	Texas Agricultural Experiment Station, Texas A&M, College Station, TX	$716,338	*$ 182,050*
29	FY04	Development of Workable Incentive Systems for Biobased Products, Biofuels and Biopower	North Carolina State University, Raleigh, NC	$ 450,000	*$ 115,333*
40	FY05	Incentives for Biomass Commercialization: Pioneering Markets for Biomass Using Renewable Energy Certificates, Emission Reduction Credits and Incentive Programs for Ammonia, PM10 and PM2.5 Reductions	Environmental Resources Trust, Washington, DC	$ 449,993	*$ 191,078*
41	FY05	Bioenergy: Optimum Incentives and Sustainability of Non-Industrial Private Forests in the U.S. South	University of Florida, Gainesville, FL	$ 656,525	*$ 164,494*

* Cost share as submitted for FY05

$ 2,272,856 $ 470,905

Back Up

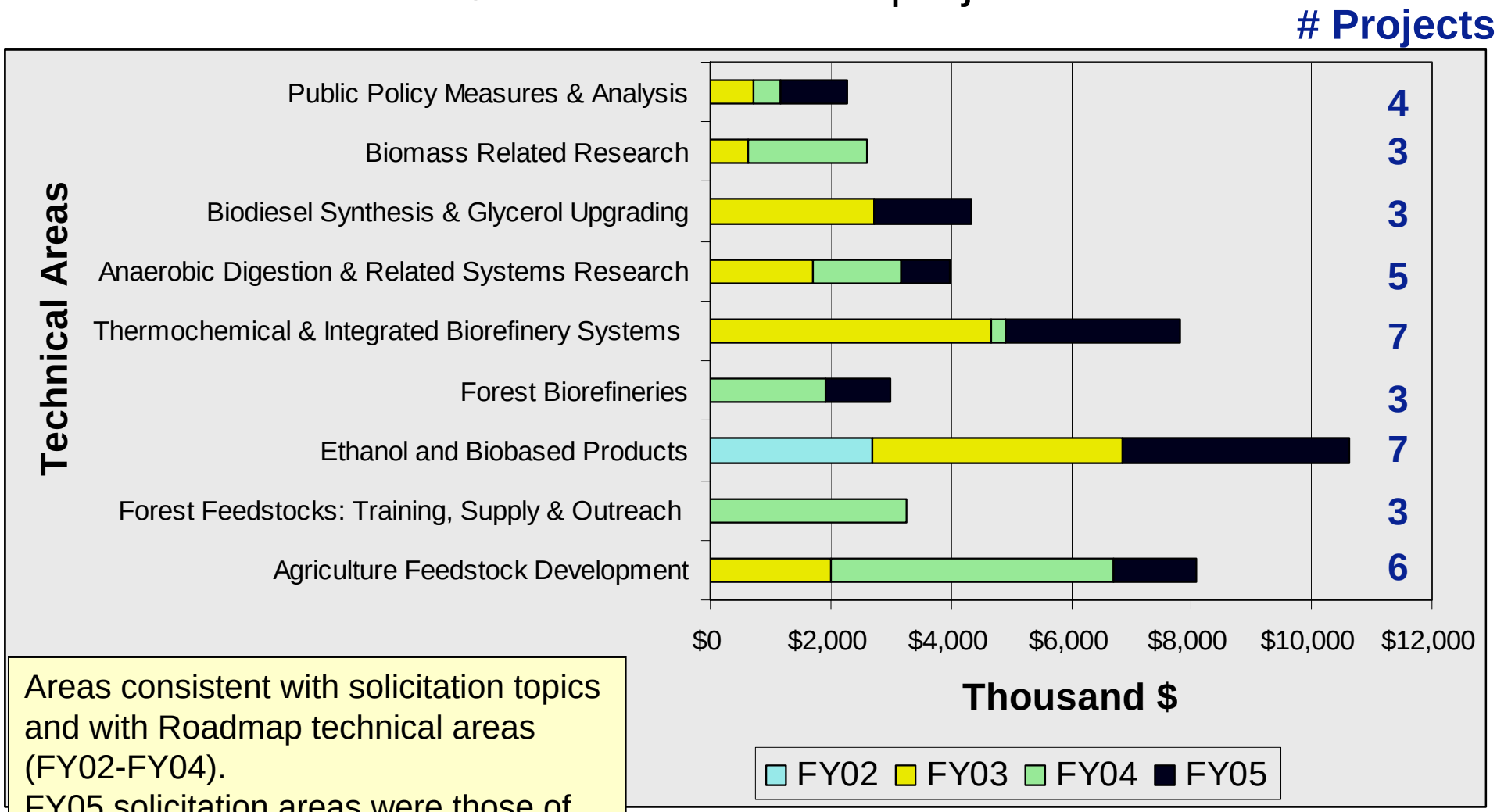
A Benchmark for Technology Development – DOC-NIST's Advanced Technology Program (ATP)

	1990-2000 Cumulative			Average 1999-2002		
Measures	**ATP**	**Target**	**Measure/ Million $**	**ATP**	**Target**	**Measure/ Million $**
DOC/NIST Funding, Million $	$ 1,640			$150		
Cost Share, Million $	$ 1,629		0.99	$150		1.0
Cumulative # pubs generated by ATP funded research	565	680	0.34	150	100	1.0
Cumulative # patents generated by ATP funded research	693	770	0.42	100	100	0.67
Cumulative # technologies under commercialization	166	170	0.10	25	35	0.17

National Institute for Standards and Technology (NIST)

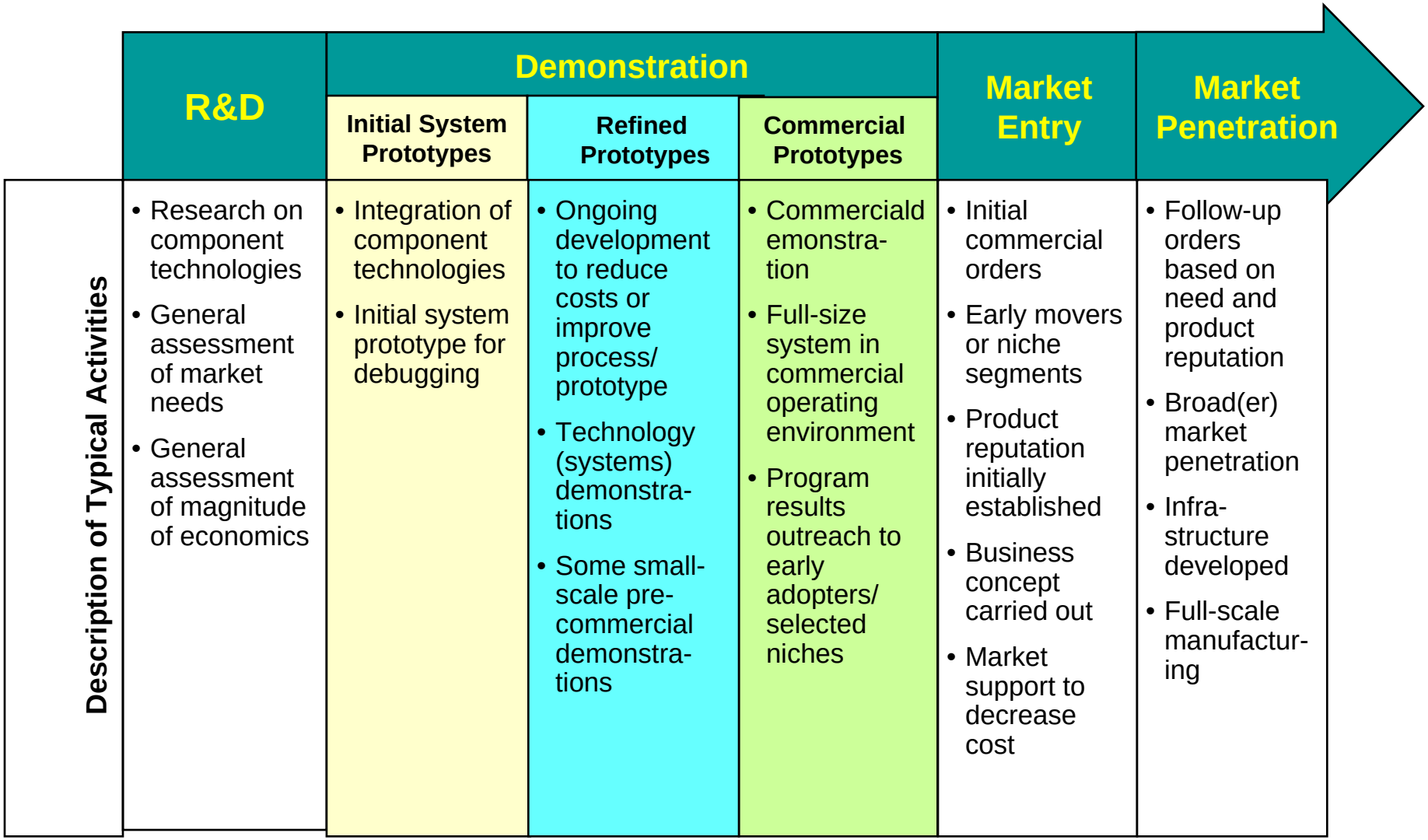
Project Portfolio by Solicitation
Technical Topical Areas

$45.98 M funds 41 projects



Areas consistent with solicitation topics and with Roadmap technical areas (FY02-FY04).
FY05 solicitation areas were those of the 2005 Amended Act .

Stage of Development
USDA Section 9008 Projects



After A.D. Little Report, ref.# 71038, 2001

Sebesta's Cogeneration Assessment and Implementation

USDA Rural Development
Committed to the future of rural communities.

Outcomes:

1. Public business plan
2. Cogen plant in operation
3. 1 MW Green Power - new product
4. NG independence
5. 20 jobs added in infrastructure with a 10-yr wood residue contract
6. 3 additional business plan projects for 6 dry mill cogen plants

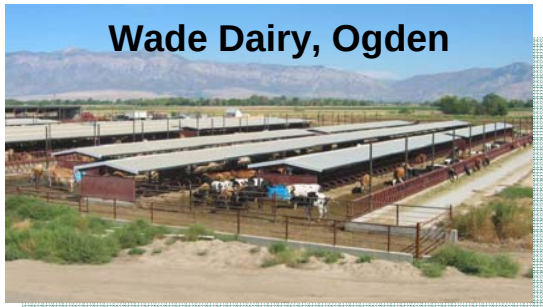
Central Minnesota Ethanol Cooperative (CMEC)

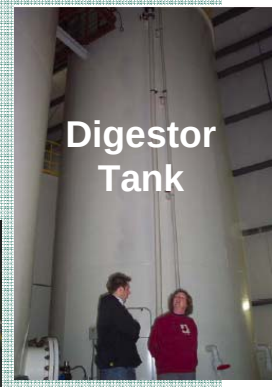
Little Falls, MN

Prime, Location: Sebesta, Blomberg & Associates, Roseville, MN
Participating Orgs: CMEC, Primenergy, PCL, Dahlen
Funding: $2 M USDA, $2 M MN/Xcel, $11 M debt financing CMEC
POP: Sept 03–Aug 06

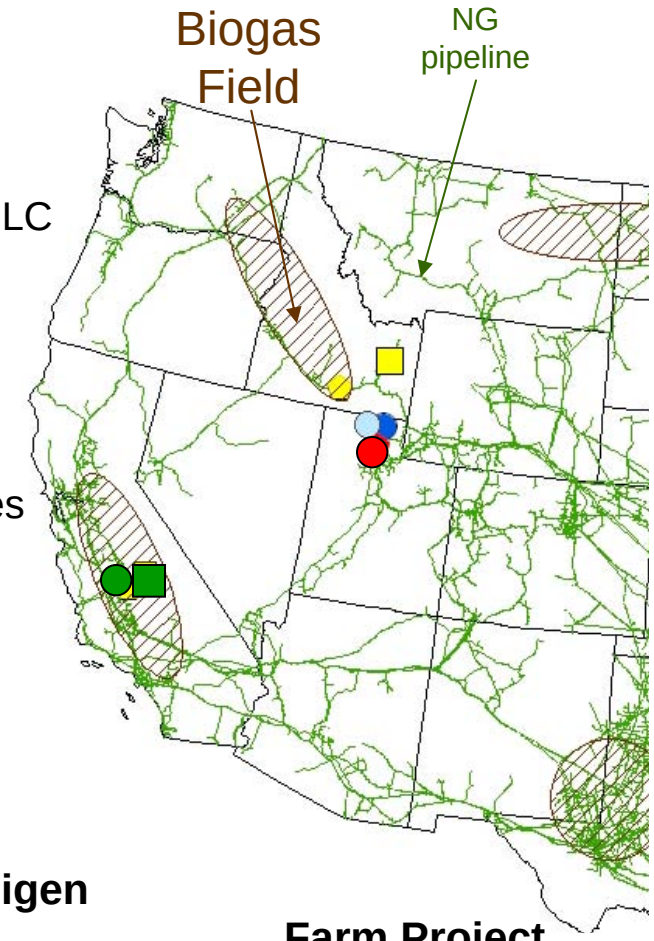
P.I.: *Cecil Massie; cmassie@sebesta.com*

R&D of Anaerobic System on a Large Dairy Farm in Ogden, UT





Designed, built & in operation



Prime: Utah State University, Logan, UT
Participating Orgs: Andigen, LC
Funding: $761,385 USDA; $400,000 UT
POP: Sept 2003–July 2006
P.I.: *Conly Hansen; chansen@cc.usu.edu*

Current Andigen Licensees

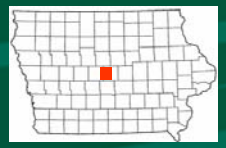
Intrepid Resources and Tech Inc., Idaho Falls, ID

AgriMass Enviro-Energy Inc., Visalia, CA (Central CA)

Farm Project

Whitesides Dairy, Rupert, ID

Fletcher Dairy, Tulare, CA

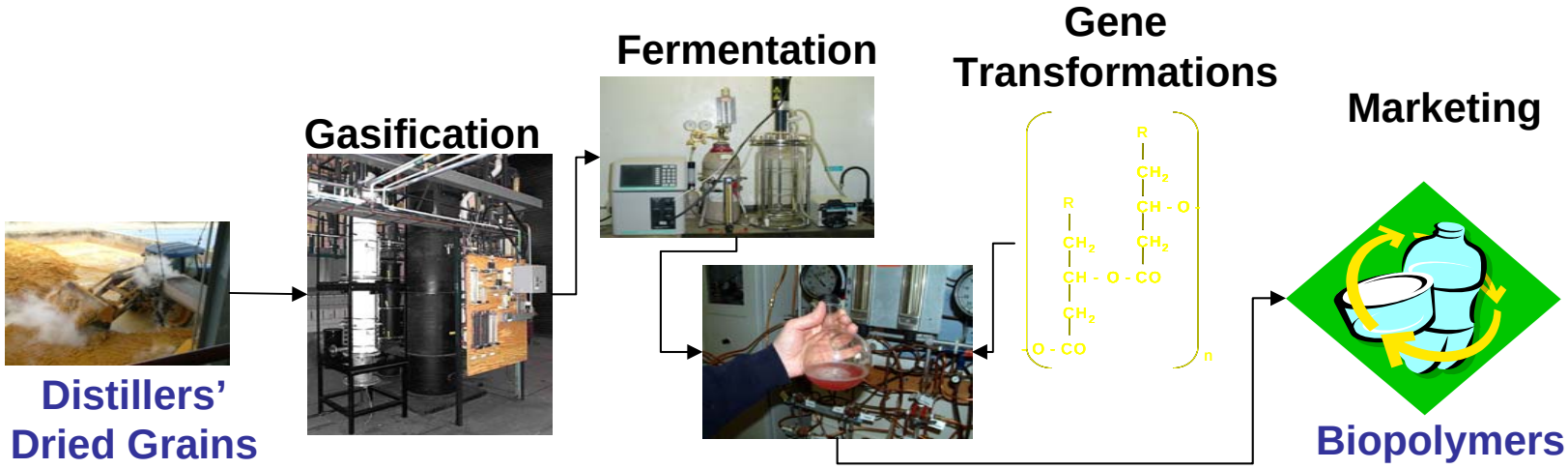


Biopolymers and Other Value-Added Products from Distillers' Dried Grain

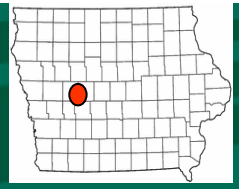
USDA Rural Development
Committed to the future of rural communities.

1. Corn dry milling process changes to extract lipid and protein/zein;
2. Gasification of extracted DDGS and syn gas conditioning; Char to soil amendment
3. Syn gas to biopolymers
   - Fermentation syn gas with *Rhodospyrillum rubrum* for polyhydroxyalkanoates
   - Cloned *R. rubrum* to produce multiple products from syn gas; 4 patent applications
4. Technoeconomic evaluation.

Team: 5 faculty ISU; 10 SDSU; 1 MGP; Multidisciplinary, science, eng., economics, food, marketing, other



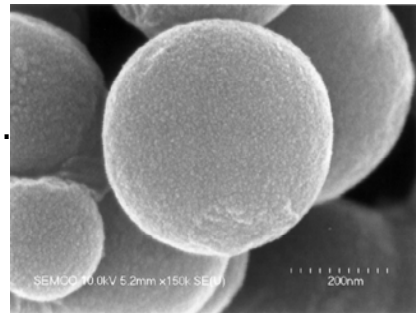
Prime, Location: Iowa State University, Ames, IA
Participating Orgs: South Dakota State University; Midwest Grain Processors Coop.
Funding: $1,000,000
PoP: Oct 03 to Dec 06



New Technologies for the Production of Methyl Esters

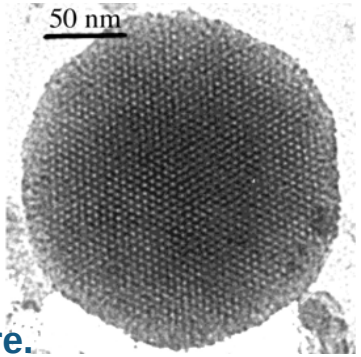
USDA Rural Development
Committed to the future of rural communities.

- Base-type catalysts synthesized, mounted on mesoporous solid supports and evaluated for efficiency and recyclability in catalyzing the transesterification of oils with methanol. Acid-type mesoporous solid catalysts synthesized for esterification of various oils and fatty acid feedstocks with methanol.
- Field testing new, recyclable heterogeneous acid and base catalysts for converting various oils and fatty acid oils to methyl esters,
- Fine tuning performance characteristics of the new heterogeneous catalysts,
- Conducting cost analyses using selected heterogeneous catalysts with various oils and fatty acid feedstocks.
- Identified best catalyst; performance held in 7-mo bench scale tests.
  US Patent filed. PCT in filing process.
  Partnerships discussions.
- 8 graduate students trained.



SEM image of the mesoporous silica microsphere.

TEM image of cross-section showing hexagonal lattice units of porous framework.



Prime, Location: West Central Cooperative, Ralston, IA
Participating Orgs: Iowa State University
Funding: $1,826,648; cost share
POP: Oct. 03–Dec. 06

P.I.: *Scott Vernimont; scottw@westcentral.net*
P.I.: *Victor Shang-Yi Lin; vsylin@iastate.edu*

Corn Dry Mill Improvement Pathway

Milling

Liquefaction /Cooking

Saccharification

Conventional Ethanol Fermentation

Ethanol Recovery

Ethanol

M 2.3 Mixed Sugars to Ethanol
- Ethanol Recovery
- C5/C6 Sugar Ethanol Fermentation

M 2.5 New Products from C6 Sugars
- C6 Sugar Conversion to Chemical Intermediates
- C6 Sugar or Intermediate Conversion to Products
- Recover New Coproducts

M 2.1 Residual Starch Conversion
- Residual Starch Conversion to C6 Sugars
- Recover New Feed Product

M 2.2 Fiber Conversion
- DDG Fiber Conversion to C5/6 Sugars
- Recover New Feed Product

M 2.6 New Fractionation
- Fractionation
- Recover Oil and Fiber Coproducts

M 2.5 New Products from C5/C6 Sugars
- C5/C6 Sugar Conversion to Chemical Intermediates
- C5/C6 Sugar or Intermediate Conversion to Products
- Recover New Coproducts

New Oil and Fiber Coproducts

Coproducts from C6 Sugars

Recover DDGS Product

Feed Products

Coproducts from C5/C6 Sugars

Natural Gas

Steam and Power Production

M 2.7 Alternate Sources for Heat and Power
- Biomass Resources
- Steam and Power Production

Heat and Power for Dry Mill

Sebesta's Project at CMEC produced 1st example

Section 9008 USDA Project Numbers 1, 10, 11, 13 support pathway

Qualitative or Quantitative Metrics?

- Discovery and innovation are difficult to measure with quantitative metrics.
- The best approach is to use process and input metrics that ensure the promotion of discovery and innovation.
- As the science matures, more output metrics are appropriate and outcomes will emerge from these activities
- Hybrid qualitative and quantitative measures offer best strategic guidance

Metrics in Research Programs

Peer Review Metric

- The item measured = **scientific outcomes**
- The unit of measurement = **subjective assessment**
- Inherent value = **performance and productivity** of scientists, engineers, and involved organizations.

NRC, 2003, “The Measure of STAR: Review of the U.S. Environmental Protection Agency's Science to Achieve Results (STAR) Research Grants Program , http://books.nap.edu/openbook.php?record_id=10701