Benefits Analysis
USDA Section 9008 Program

A Metrics Study

Requested by William F. Hagy III
USDA Rural Development

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Presented to the
Biomass R&D Technical Advisory Committee Meeting
Washington, DC
September 10, 2008
Outline

• Purpose
• Metrics
• 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.
  • Data collection from June 2006-May 2007
  • Perspective of 2002 and 2005 amendments of the Biomass R&D Act 2000

• To provide a general assessment of performance measures that could lend themselves to tracking of current and future benefits of the program
Steps Used to Construct Metrics for Section 9008 Program

This study

1. What we want to achieve: Measure progress; Guide future activities
2. What we want to measure: Performance of USDA Section 9008 Program
3. What are available measures (for example, # articles, peer reviews, patents)
4. “Mix and Match” create combinations such as integrated measures and indices and validate

Future study

5. Select architecture for data collection and analysis
6. Assess validity and reliability with FY05 Projects
7. Establish a tracking tool for Program and validate

To Achieve Program Goals

**Inputs**
- Tangible quantities put into a process

**Processes**
- Courses of action

**Outputs**
- Products & services delivered by RD&D performers

**Outcomes**
- Transformation of RD&D outputs by economic and other entities over time

**Benefits**
- Long-term societal, economic, and environmental benefits of the outcomes
Input and Process Metrics

Investments in a variety of categories

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

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

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

Legislative

USDA
Strategic Goals
Outcomes

DOE

OMB
GPRA and PART

Executive

Funding Implementation

Oversight/Approval
Strategic Plan Goals

GPRA and PART

Legislative
<table>
<thead>
<tr>
<th>Solicitation FY, Manager</th>
<th>Awards Announced</th>
<th>#</th>
<th>Grants Started</th>
</tr>
</thead>
<tbody>
<tr>
<td>190 pre-prop.</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>23 proposals</td>
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<td></td>
<td></td>
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<tr>
<td>400 proposals</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>400 pre-prop.</td>
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<tr>
<td>93 proposals</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>670 proposals</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

20 projects analyzed for outcomes
41 projects analyzed for overall processes
Funding Proportion by Stage of Development

Total: $46 Mi

- R&D: 36%
- Demo: 46%
- Public Policy & Analyses: 5%
- Education & Training: 13%

Demo Areas Funding in M $, Total $20.9 M

- Initial Prototypes/Systems: $4.82
- Feasibility Studies: $1.78
- Commercial Prototypes: $2.85
- Refined Prototypes: $8.19
- Commercial Plants: $3.26

2005 Act Amendments
Future Targets

- 50% Demonstration: 46%
- 35% Innovation: 35-40%
- 15% Applied Fundamentals: 17%

* Categories are not mutually exclusive
Qualitative and 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
## Technical Area Distribution

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

USDA Technical Area Distribution is consistent with the legislation
Integrated Feedstock Supply System for Corn Stover Biomass (#21)
Iowa State Univ.
Reviewers classified this as a Stage A research project. The involvement on industrial entities on the harvesting side was seen as positive, but overall the broad scope of the effort (plant breeding, harvesting, storage) was seen as a potential problem. The efforts should be coordinated with other storage projects and with conversion research to identify desirable properties in the harvested/stored stover. Further assessment of the project is premature due to it just getting underway.

Recommendation:
Project needs to coordinate with NREL to continue analysis of samples from ensilage at various treatment stages. In addition, providing and coordination with IBSAL is crucial to success. Although breeding is seen as a long-term effort, project should continue to analyze different corn varieties for appropriate stover qualities, and should continue to include and interact with industrial partner(s). Finally, coordination with other projects is critical, even though some of the other projects are not performing necessarily parallel tasks.

Biomass Opportunity for Imperial, Nebraska Region: What’s the Value? (#20)
Jim Hettenhaus
The reviewers felt the project was in Stage 3 or perhaps 4. Though the project is just getting underway, it was felt that it should provide good information on transportation and storage.

Recommendation: Assure coordination with other storage projects (INL, Cargill/MAT), and provide data to IBSAL for validation. Continue to interact with NREL regarding analysis of feedstock qualities with respect to the pile.

Industry led – Assess stage placement, program fit, quality, interactions with other program participants

Academia led
Summing Up Projects with Outputs as of May 2007

USDA Section 9008

R&D
- CSREES
- ARS
- DOE/EERE
- DOE/OS
- NSF
- ...

RD&D
- 20 projects
- 6 R&D
- 5 demo & feasibility studies
- 2 first commercial
- 1 analysis
- 4 RD&D & refined prototypes
- 2 outreach & training

Commercialization Grants and Loans
- Section 9006
- B&I
- RUS
- Others
- DOE 932
- USDA and DOE Loan Guarantees
- EQIP
- SBIR
- ...

USDA Section 9008 projects investment in FY03-FY05 was $44 Mi. 5.4% of all USDA and 4% of USDA/DOE investments in the period.
Links with Other Programs

- R&D
- USDA Section 9008 RD&D
- Commercialization Grants and Loans

- 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 RD Loans
- RUS
- Others
- DOE 932
- USDA and DOE Loan Guarantees
- EQIP
- SBIR
- AgStar ...

- Private equity – Cogen Corn Dry Mills
- Pretreated biomass in animal feeds with protein
- Anaerobic Digestion in “Valley of Death”
- 1st Commercial

- Environmental Technology Verification needed for anaerobic digestion
  - EPA, USDA, DOE, NIST, SBIR, etc.

- Dairies and CAFOs

- Learn by Doing
- Commercial replication
- Feed Industry Trials + Increased biofuels production

- Chicken litter to electricity

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

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 without increase of corn area.

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  
PI: Charles Abbas; abbas@admworld.com
## Baseline Measures for Tracking

<table>
<thead>
<tr>
<th>Measures</th>
<th>Measure Amount</th>
<th>Index Measure/ Million $</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>USDA Funding, Million $</td>
<td>$22.4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cost Share, Million $</td>
<td>$22.7</td>
<td>1:1</td>
<td>50 % cost share</td>
</tr>
<tr>
<td># Proj. FY02 (2), FY03 (15), FY04 (4)</td>
<td>20</td>
<td>0.9</td>
<td>One FY03 project continued in FY04. Counted as 1</td>
</tr>
<tr>
<td>Cumulative # Publications</td>
<td>40</td>
<td>1.8</td>
<td>Easy to track but best associated with quality index</td>
</tr>
<tr>
<td>Cumulative # Patents (applied and issued)</td>
<td>20</td>
<td>0.9</td>
<td>Upper limit. Later separate applied and issued patents. Index is 0.04 for issued patent.</td>
</tr>
<tr>
<td>Cumulative # technologies under commercialization</td>
<td>2</td>
<td>0.08</td>
<td>One 1&lt;sup&gt;st&lt;/sup&gt; commercial (Project # 14, FY03) and one commercial prototype (Project # 14 FY03)</td>
</tr>
<tr>
<td>Cumulative # Processes, products, systems under development</td>
<td>36</td>
<td>1.6</td>
<td>Difficult to track. Expert judgment on the overall portfolio.</td>
</tr>
<tr>
<td>Cumulative # Licenses</td>
<td>2</td>
<td>0.08</td>
<td>Easy to track</td>
</tr>
<tr>
<td>Cumulative # Companies involved ith IP generation</td>
<td>40</td>
<td>1.8</td>
<td>Requires detailed analysis of projects</td>
</tr>
<tr>
<td>Cumulative # Projects financed</td>
<td>2</td>
<td>0.08</td>
<td>Easy to track. USDA RUS Loan (Project # 3 FY03). Equity financing (Project # 14 FY03)</td>
</tr>
<tr>
<td>Cumulative # Feasibility studies</td>
<td>5</td>
<td>0.2</td>
<td>Decrease investment risk. Downselection tool</td>
</tr>
<tr>
<td>Cumulative # Outstanding training/ education courses/policy analysis</td>
<td>3</td>
<td>0.12</td>
<td>Not just numbers; counts only if quality is built into it.</td>
</tr>
<tr>
<td>Cumulative # of students to Post-docs</td>
<td>56</td>
<td>2.5</td>
<td>Human resource development dimension of training of professionals. Easy to track</td>
</tr>
<tr>
<td>Cumulative # of project investigators and lead collaborators</td>
<td>81</td>
<td>3.6</td>
<td>Human resource dimension of complexity of projects with multiple investigators at different organizations.</td>
</tr>
<tr>
<td>Comparison with DOC/NIST Advanced Technology Program (ATP)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>----------------------------------------------------------</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ATP Development only 1990-present</td>
<td>RD&amp;D - USDA Section 9008</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cumulative # Publications/Mi$</td>
<td>0.34 mid program 1.0 early 2000</td>
<td>1.8 includes earlier R&amp;D phases</td>
<td></td>
</tr>
<tr>
<td>Cumulative # Patents/Mi$</td>
<td>0.42 mid program 0.67 early 2000</td>
<td>0.04 issued 0.9 applied</td>
<td></td>
</tr>
<tr>
<td>Cumulative # Techn. Under Development/Mi$</td>
<td>0.10 mid program 0.17 early 2000</td>
<td>0.08 0.24 estimated based on 36 tech under development and the ratio 9:1 from prototypes to successful commercialization*</td>
<td></td>
</tr>
</tbody>
</table>

NIST = National Institute for Standards & Technologies

Quality Metrics for Section 90008

Project Management Metrics

From FY05 on
Projects Objectives Met
• fully (%)
• partially (%)
• Unmet (%)

Specific Scientific/Technical Measures for:
• Feedstock production
• Recalcitrance
• Product diversification
• Strategic guidance

• Solicitation Management Process and Review
• Program Peer Review
• Biomass R&D Board
• Biomass R&D TAC

Metrics Framework

Direct Measure of R&D Quality
• Bibliographic Measures
• Special honors or awards

Cumulative Measures/Million $

# Publications

# Patents (applied and issued)

# Technologies under commercialization

# Processes, products, systems under development

# Licenses

# Companies involved with intellectual property generation

# Projects financed

# Feasibility studies

Quality Education and Information Transfer Products
• Quality and impact
• Special honors or awards

Business Development
• Patents (Pat.) and licenses
• Growth of new and of existing businesses
• Development of Products/Processes/Systems

Resource Development
• Human
• Infrastructure

# Outstanding training and education courses, and policy analysis

# of students to Post-Docs/Human Resources

# of project investigators and lead collaborators
• Section 9008 is consistent with the legislation (2002 and 2005 ahead of schedule)

• Multi-level peer review consistent with legislation and best practices.
  – Feedback loops established
    • Input and feedback from TAC, Biomass R&D Board, USDA, DOE
    • Input to solicitations
    • Guidance to proposal reviewers in selecting projects with measurable goals based on lessons learned from 20 projects
    • PIs praise site reviews; issue of competitiveness with State Gate

• Projects producing scientific and technological outputs and outcomes, five years after the first two awards

• The road to assessing benefits of the program requires tracking of projects over time and periodic analyses of outcomes. Some quantitative measures are possible. The most meaningful require expert judgment of quality.

• Validation of measures and tracking mechanism needed.
Back Up Metrics Information

• Input and Process Metrics
• Output Metrics
• Outcomes and Impact Metrics
Input Metric

- Project partnerships include 150 participating organizations in 36 states, DC, and a few international
- Average 5 partnering organizations/project
- Projects with 60 participants common. Has + and - impacts
- All Act eligible entities participated

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.

<table>
<thead>
<tr>
<th>Other</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>USDA Lab</td>
<td>32</td>
</tr>
<tr>
<td>DOE Lab</td>
<td>32</td>
</tr>
<tr>
<td>State Org.</td>
<td>21</td>
</tr>
<tr>
<td>Indian Tribe</td>
<td>7</td>
</tr>
<tr>
<td>EPA</td>
<td>4</td>
</tr>
<tr>
<td>Public/Private</td>
<td>4</td>
</tr>
</tbody>
</table>
## Peer Review Metrics System

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

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

- 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
• Number of companies and amount of biofuels and bioelectricity produced
• 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 greenhouse 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*
Sebesta’s Cogeneration Assessment and Implementation

**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
Corn Dry Mill Improvement Pathway

Milling → Liquefaction/Cooking → Saccharification → Conventional Ethanol Fermentation → Ethanol Recovery → Ethanol

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 2.6 New Fractionation
- Fractionation
- Recover Oil and Fiber Coproducts

M 2.7 Alternate Sources for Heat and Power
- Natural Gas
- Steam and Power Production

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

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

Sebesta’s Project at CMEC produced 1st example
R&D of Anaerobic System on a Large Dairy Farm in Ogden, UT

Prime: Utah State University, Logan, UT
Participating Orgs: Andigen, LC
Funding: $761,385 USDA; $400,000 UT
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

Biogas Field
NG pipeline

Wade Dairy, Ogden
Designed, built & in operation

Manure Collection

Heat Exchanger

Digestor Tank

3406 Cat Engine
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

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**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

- 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.

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