



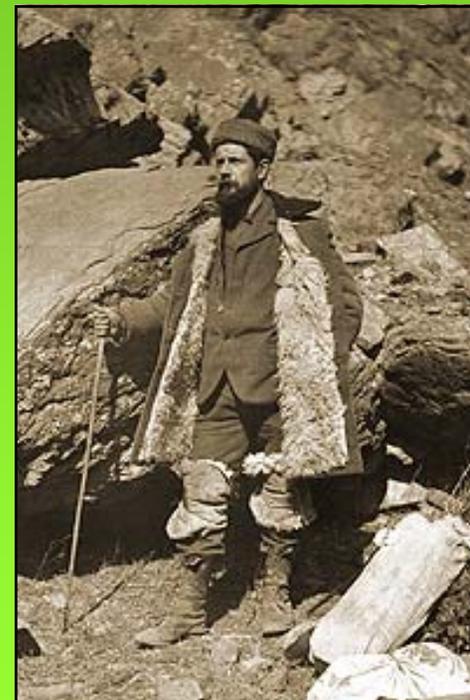
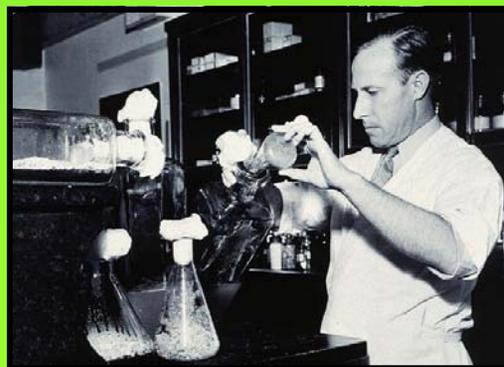
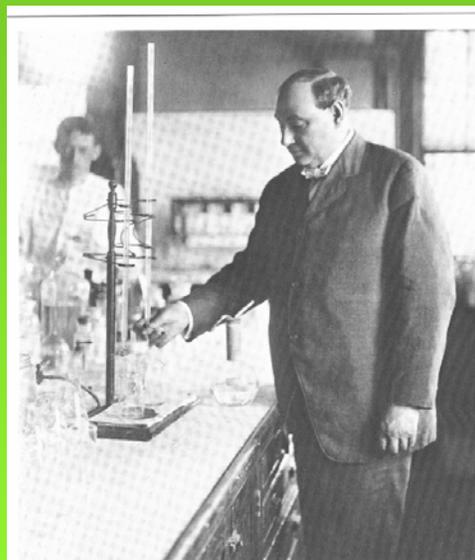
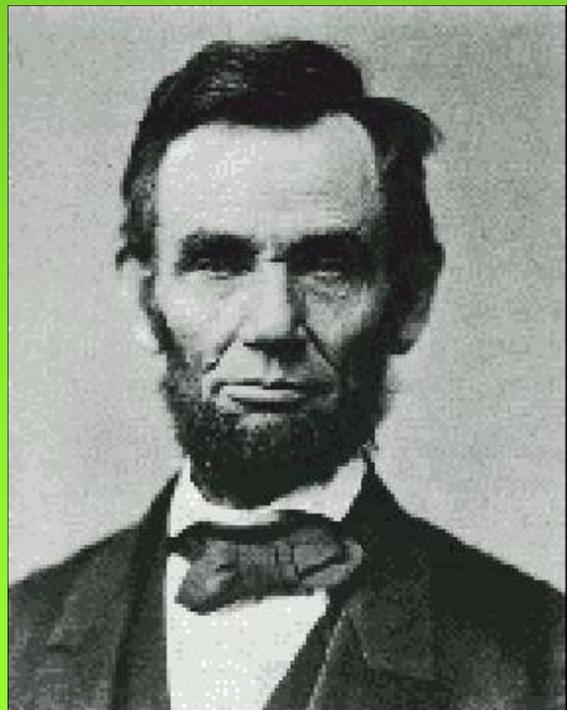
Agricultural Research Service



USDA Research and Development and Emerging Bioeconomy: Challenges and Opportunities

**Ghassem R. Asrar, Deputy Administrator
Agricultural Research Service
U.S. Department of Agriculture**

1862-2007 145 Years of Agricultural Research



USDA Bioenergy/Biofuels R&D

- USDA has a long history of research, development, and deployment in:
 - Biomass, biobased products, and bioenergy
 - Renewable energy for farms and ranches
 - Energy management and efficiency

VISION -

Agriculture and forestry as major providers of the Nation's energy/fuel and industrial products and an agricultural sector less dependent on fossil fuels.



Energy Production through Agriculture -
*Capture carbon dioxide and convert solar energy
to fuels and products*

BIOMASS

FUELS

VALUABLE
COPRODUCTS &
BIOPRODUCTS

CHEMICAL
FEEDSTOCK

Tremendous opportunities for agriculture

Biofuels Legislation – *National Directions*

Energy Title-2002 Farm Bill

- Established new programs and grants
- Reauthorized and broadened the bioenergy program



Accompanied by Congress members, President George W. Bush signs the Farm Security and Rural Investment Act of 2002 in the Dwight D. Eisenhower Executive Office Building May 13.

Research & Energy Titles-2007 Farm Bill

Administration Proposed Title

Establish an Agricultural Bioenergy and Biobased Products Research Initiative with \$500 million over 10 years to advance fundamental scientific knowledge for the improved production of renewable fuels and biobased products.

Other energy proposals are contained within the Energy, Conservation, and Rural Development titles.

USDA Bioenergy/Biofuels R&D

- Supports the President's 20 in 10 initiative and goal.
- Develops and deliver feedstock production systems that are sustainable and competitive.
- Enables and improve commercial deployment of biomass conversion technologies.
- Supports infrastructure development through assistance to communities and businesses.
- Improve efficiency in agricultural and forestry operations.
- Supports education and outreach.
- Develops policy in support of bio-fuels and bio-products production and use.

Desired Outcomes and Impact

- **Improve national security and the U.S. balance of trade by reducing America's dependence on imported petroleum.**
- **Help America transition to renewable sources of energy and other goods.**
- **Realize important environmental benefits such as reducing greenhouse gas emissions, increasing carbon sequestration, reclaiming unproductive lands, and rehabilitating unhealthy lands.**
- **Realize significant, new, sustainable (environmentally, economically and socially) economic opportunities for rural America.**
- **Realize secure sources of energy for rural America.**

R&D Challenges/Opportunities

- Can we produce enough feedstocks?

- Enhance productivity
- Not disrupt markets
- Avoid land-use competition

- Can we produce feedstocks sustainably?

- Maintain ecological integrity
- Enhance environmental values

- Can we make biofuels competitive?

- Optimize agronomic and silvicultural systems
- Innovative conversion and delivery technology deployment
- Bioproducts and coproducts

- Can we enable a “Rural Renaissance?”

- Transition to a bioeconomy – education, training, and outreach
- Provide economic opportunities
- Provide assistance

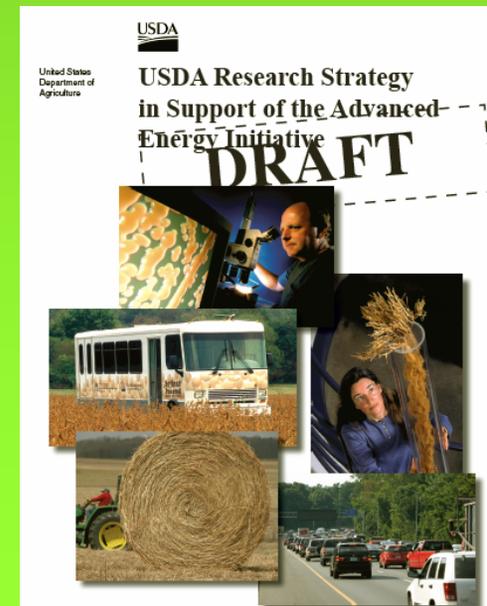
USDA Contributing Agencies/Programs

- **Agricultural Marketing Service**
- **Farm Service Agency**
- **Foreign Agricultural Service**
- **Forest Service**
- **Global Change Program Office**
- **Natural Resources Conservation Service**
- **Office of Budget and Program Analysis**
- **Office of Communications**
- **Office of Energy Policy and New Uses**
- **Risk Management Agency**
- **Rural Development**
- **Office of the Under Secretary Research, Education and Economics**
- **Agriculture Research Service**
- **Cooperative State Research, Education and Extension Service**
- **Economic Research Service**
- **National Agricultural Statistics Service**



USDA's Energy Council

- **Purposes:**
 - Oversight of implementation of President's National Energy Plan including EAct of 2005.
 - Coordination of USDA Energy Related Programs.
 - Review and evaluation of key policy and program decisions on energy matters.
 - Development of Initiatives to transform and generate alternative energy sources.
 - Assist and oversee continued implementation of Title IX of 2002 Farm Bill.
- **Chair: Tom Dorr, RD**
- **Co-Vice Chairs: Keith Collins, OCE; Mark Rey, NRE**
- **Ex-Officio Members: DOE, EPA, DOC, DOI, DOT**
- **Methods:**
- **Coordinate Secretary's bi-weekly energy briefings**
 - Established four standing oversight committees
 - Research and Development
 - Commercialization
 - Communication & Outreach
 - International Cooperation



Biobased Products and Bioenergy Coordination Council (BBCC)

Chair – Gale Buchanan, Under Secretary REE

Vice Chair – Rodger Conway, Director, OEPNU

Working Chair: Bob Fireovid (ARS), Working Vice Chair: Bill Goldner (CSREES), Secretary Marion Buford (FS)

<http://www.ars.usda.gov/bbcc/>

- Agricultural Marketing Service
- Agricultural Research Service
- Cooperative State Research, Education and Extension Service
- Farm Service Agency
- Foreign Agricultural Service
- Forest Service
- Global Change Program Office
- Natural Resources Conservation Service
- Office of Budget and Program Analysis
- Office of Energy Policy and New Uses
- Office of the Assistant Secretary for Administration Office of the Under Secretary for Research, Education and Economics
- Rural Business-Cooperative Service
- Rural Utilities Service

***Growing Energy and Opportunity in America
– Linking Land Conservation, Innovation,
and Value***



Biofuels Legislation – *National Directions*

Biomass Research and Development Act 2000



Biomass Research and Development Initiative

The Biomass R&D Act directed the Departments of Energy and Agriculture to:

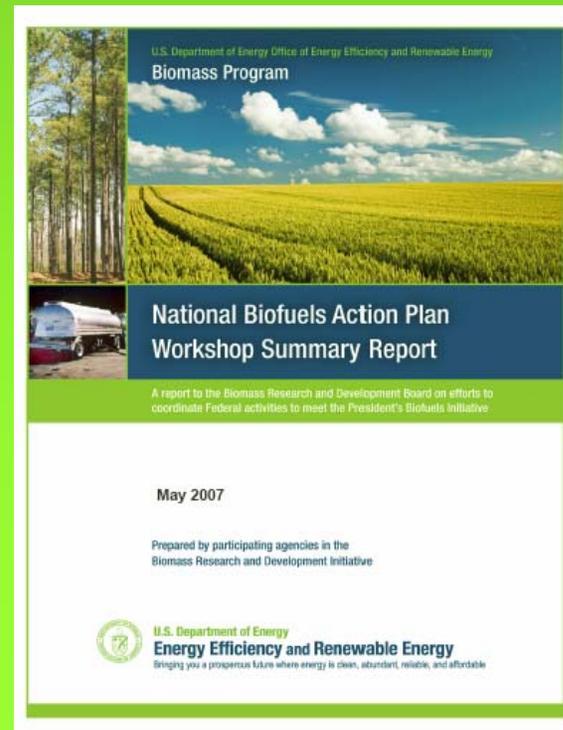
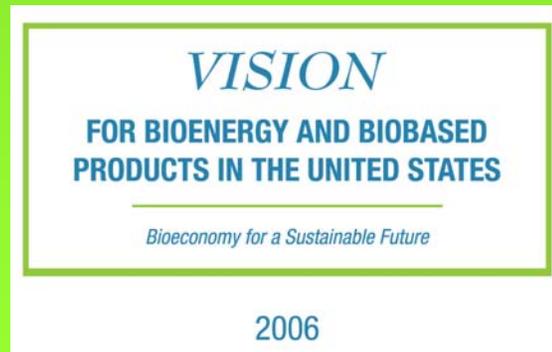
- **Integrate their biomass R&D**
- **Create the Biomass Research and Development Board**
- **Establish the Biomass Research and Development Technical Advisory Committee (BTAC)**

Biofuels Legislation – *National directions*

Biomass Research and Development Act 2000



BR&Di and BTAC coordinate efforts across all federal Agencies to develop:



Complimentary Capabilities of A Nationwide Network

- ***Agricultural Research Service (ARS)*** the in house research are of the USDA focuses on the development, production and logistics associated with existing and new biomass feedstocks, and on their efficient and economic conversion to energy, fuel and other bioproducts.
- ***Cooperative State Research, Education and Extension Service (CSREES)***, mobilizes the research resources of both small businesses and the nation's higher-education community, especially the land-grant universities, to address the technical barriers associated with producing biomass feedstocks and converting them to biofuels and other bioproducts.
- ***Forest Service (FS)*** focuses on the production of woody biomass and its efficient conversion to bioenergy and bioproducts.
- ***Rural Development (RD)*** finances technologies needed to convert biomass into biobased products and bioenergy in a manner which is cost-competitive in large national and international markets.
- ***Economic Research Service (ERS)*** develops and monitors key indicators of the agricultural system and rural communities, providing market analysis, developing projections of commodity supply, demand and retail food prices.



USDA CSREES R&D Activities

The Road to Cellulosic Ethanol

- **Feedstocks:** Understand Critical Functions in Plant Growth and Maintenance
- **Deconstruction:** Improved, inexpensive and robust enzymes with higher activity and longer lifetimes for breakdown of cellulose microfibrils to sugars
- **Fermentation:** Improved biological organisms and enzymes capable of metabolizing both C-5 and C-6 sugars
- **Co-Product Development:** Value-added uses for residual streams

USDA Forest Service R&D Activities

- **Forest biomass assessment, planning, and decision tools**
- **Biomass management and utilization guidelines – sustainability, site productivity, and conservation practices**
- **Improved economics – biomass production, harvesting and transportation, and processing/conversion**
- **New uses for wood and advance technology– biobased products, forest biorefinery, and wood-based ethanol**
- **Forest production systems and improved genetic material for short-rotation forestry**



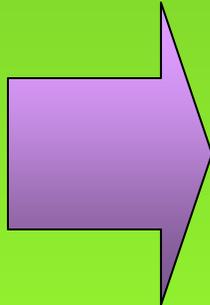
USDA Forest Service R&D Activities



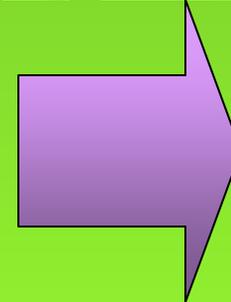
Photo: Jake Eaton, Podtatch Corporation



Forest Biomass Feedstock



Conversion Processes



Uses

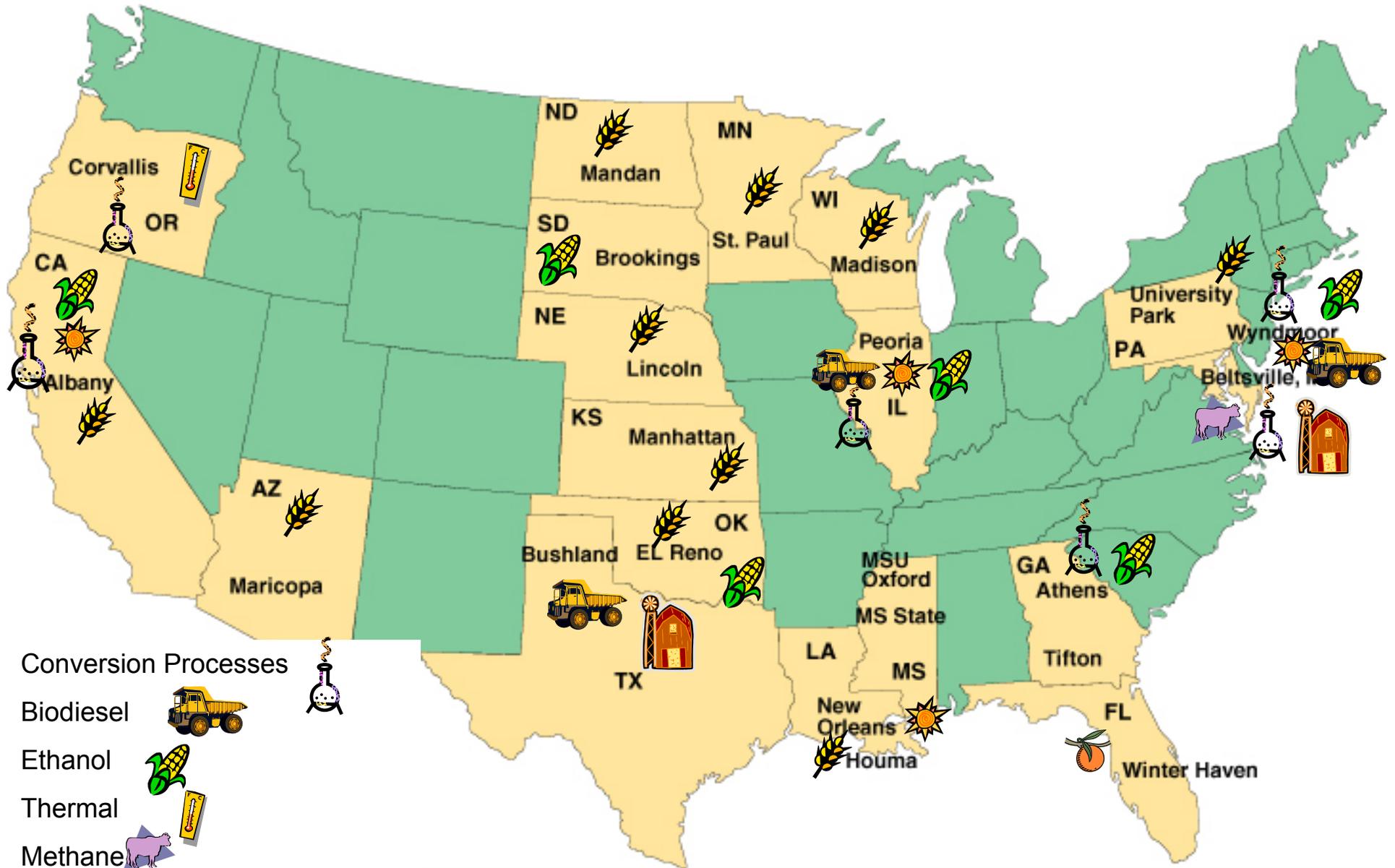
- Forest Residues
- Hazardous Fuel and Restoration Treatments
- Short Rotation Woody Crops
- Wood Waste
- Conventional Forest Production and Thinnings

- Manufacturing
- Co-firing
- Combustion
- Gasification
- Enzymatic Fermentation
- Gas/liquid Fermentation
- Acid Hydrolysis/Fermentation

- Biofuels:
 - Diesel & Ethanol
- Electricity and Heat
- Biobased Products
 - Composites
 - Specialty Products
 - Chemicals
- Traditional Products

ARS' Bioenergy Program

- **Energy crop research**
 - Developing new plant varieties for biofuels feedstocks
- **Ethanol**
 - Processing
 - Developing new microbes and enzymes for conversion
 - Developing valuable co-products from ethanol production
- **Biodiesel**
 - Processing
 - Quality and performance
- **Other**
 - Methane from manure
 - Thermo-chemical and biological conversion of biomass to hydrogen
 - On-farm and remote renewable energy systems



Conversion Processes

Biodiesel



Ethanol



Thermal



Methane



Citrus Waste



Regional Research Center



Feedstocks



On-Farm Systems



USDA Bioenergy Research Locations



Can we produce enough feedstocks?

Starch Based Feedstocks



Investigate means to increase grain yield



Investigate opportunities to expand starch feedstock options to include barley, sorghum, millet, and field peas

Can we produce enough feedstocks?

Oil Based Feedstocks

- Investigate methods to increase oil content
- Expand biodiesel feedstocks to include rendered animal fats and byproducts, restaurant waste fats/oils, greases, etc.



Can we produce enough feedstocks?

Cellulose Based Feedstocks



- Determining the economic production cost feasibility of perennial herbaceous energy crops
- Characterization of the switchgrass genome
- Modifying the genetics of switchgrass for enhance energy crop properties



- Developing energy cane for increased biomass yields
- Developed high biomass alfalfa for forage and bioenergy

Can we produce enough feedstocks?

Cell Wall Initiative

- Elucidate plant cell wall molecular biology
 - ❖ “designer” cell walls to dramatically improve ease of hydrolysis
- Germplasm collection screening
 - ❖ **20 gene banks throughout U.S.**
 - 470,000 accessions
 - 11,700 species
 - 13,154 industrial crops accessions



Can we produce feedstocks in a sustainable manner?

Crop residue removal and soil impacts

Renewable Energy Assessment Project (REAP)



- Residue needed to maintain soil function and sustain production
- Trade-off for residue use as bioenergy versus soil carbon feedstock
- Developing an algorithm to guide sustainable harvest of residue for biomass ethanol
- Developing management strategies for sustainable harvest of residue

Crop residues should not be considered wastes, and are necessary to maintain soil carbon levels required for soil sustainability. These studies will enable farmers and producers to calculate the amount of residue that can be safely removed for ethanol processing.

National ARS effort: IA, IN, AL, NE, CO, OR, MN, ND, WA

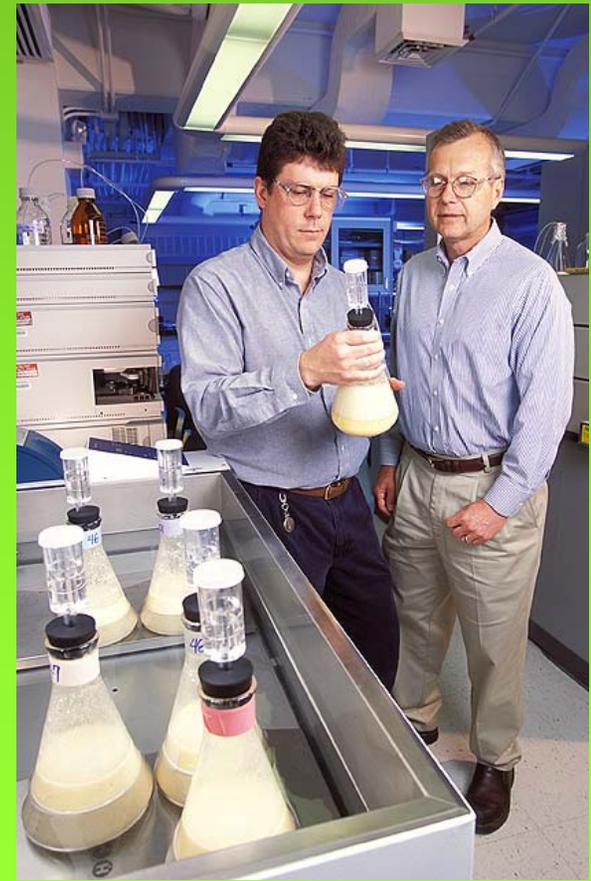
Can we make biofuels competitive?

Processing and Conversion

- **Developed and demonstrated eco-friendly, enzymatic corn steeping processes for enhanced wet milling**

- reduces need for hazardous reagents
- positively impact both the economic and environmental cost of processing
- produced a value added DDGS with high protein and lower fiber
- patented and licensed

- **Developing enhanced ethanol-water separation technologies**



Can we make biofuels competitive?

Processing and Conversion



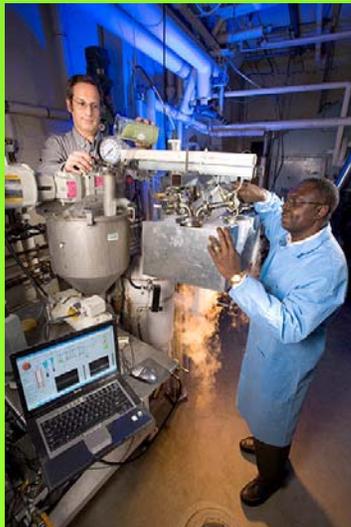
New enzyme discoveries-

- Discovered the most active β -xylosidase enzyme for releasing sugars from biomass
- Discovered and patented two novel microbial enzymes for cellulose processing.
- Isolated and expressed fungal enzymes for biomass processing



Advances in microbiology-

- Creation of glucose resistant ethanolic microorganisms capable of using multiple sugars
- Novel application of *Lactobacillus plantarum* as biocatalyst for ethanol production
- Developed environmentally sensitive pretreatment of lignocellulose biomass



Thermochemical processing-

- Developing small scale gasification and pyrolysis units targeted to 'on farm' energy production

Can we make biofuels competitive?

Value added coproducts

- Developing & improving value-added coproducts - corn zein, corn fiber oil, corn fiber gum
- Processing improvement to add nutritional value to dried distillers grains
- Fermentation products – adhesives



Can we enable a “Rural Renaissance?”

USDA Rural Development Activities

Section 9006 – Renewable Energy Systems and Energy Efficiency Improvements Program

- **Establishes a grant, loan, and loan guarantee program to assist eligible farmers, ranchers, and rural small businesses in purchasing renewable energy systems and making energy efficiency improvements.**

Section 9008 - Research and Development (R&D) Biomass Program

-Support research, development, and demonstration on biobased products, biofuels, and biopower.

- **Eligible Recipients: Institutions of Higher Learning; National Laboratory; Federal Research Agency; State Research Agency; Private Sector Entities; and Nonprofit Organizations or a consortium of two or more of entities described above.**



ARS Office of International Research Programs

Multilateral Cooperative Projects:

Middle East Regional Irrigation Management Information System

Israel Jordan Palestinian Authority
Middle East Visiting Researchers

Bilateral Cooperative Project:

Morocco

Tunisia

U.S.-Israel Binational Agriculture Research and Development Fund (BARD)

Memorandum of Cooperation between USDA/ARS and the Ministry of Agriculture of the State of Israel

EPO-BIO:

Joint program between ARS and EC

Flagship programs: cell walls, oilseeds, biopolymers

Labex:

Joint program between Embrapa (Brazil) and ARS

Growing dialog regarding bioenergy

Exploring new opportunities with other countries



'OIRP enhances the effectiveness and impact of U.S. Agriculture by managing the ARS Overseas laboratories and facilitating International research activities'

Agricultural Research: key to food and energy security and natural resources stewardship

