



ARS Overview

- **USDA in-house research**
- **100+ laboratories**
- **1,200+ projects**
- **9,000+ employees**
- **2,500+ scientists**
- **\$1.1 billion annual budget (FY2009)**
- **Farm-to-table research scope**
- **22 National Programs**
- **Information and technology transfer**
- **Industry, university, federal and international collaborations**



USDA **Strategic Energy Science Plan**

USDA biorefining research focus...

- **On-or-near farm conversion**
- **Biorefinery co-products**
- **Manure-to-energy**
- **Integrating bioenergy production into existing farming operations**
- **Integrated research programs in biorefining, feedstock production, logistics and feedstock development**

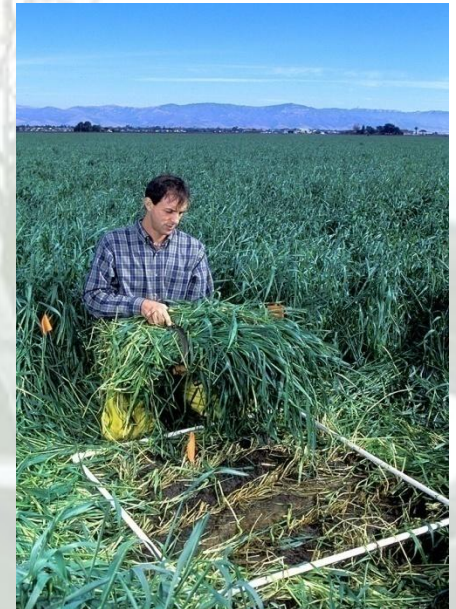


ARS Bioenergy Research

Involves multiple national programs...

➤ **Bioenergy (307) – biorefining focus**

- **Agricultural quality & utilization (306)**
 - ❖ bioenergy is a biobased product
- **Forages (205)**
 - ❖ ruminant livestock – original biorefinery
- **Soil sustainability (202)**
 - ❖ crop residue retention
- **Integrated ag systems (207)**
- **Crop improvement & protection (301, 302, 304)**
- **Manure utilization (206)**





ARS Bioenergy Research

www.ars.usda.gov/biofuels

Strategy

- Enable new varieties and hybrids of bioenergy feedstocks with optimal traits (Feedstock Development)
- Enable new optimal practices and systems that maximize the sustainable yield of high-quality bioenergy feedstocks (Feedstock Production)
- Enable new commercially-preferred biorefining technologies (Biorefining)

Cross-component Coordination Teams

- Cellulosics to EtOH/BuOH
- Lipids to fuels
- Starches/sugars to EtOH/BuOH
- Thermochemical & catalytic processing



ARS Feedstock Development

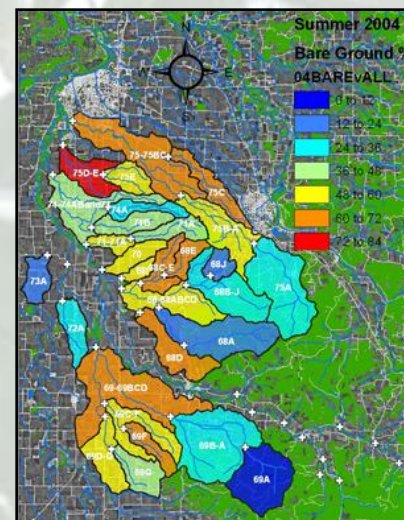
- **Biological and molecular basis for plant traits**
 - **Understand molecular basis for key traits** (*cell-wall structure, growth biomass yield, conversion potential*)
- **Breeding and evaluation of new germplasm**
 - **Improved germplasm & varieties for energy crops**





ARS Feedstock Production

- **Region-specific, sustainable practices to maximize feedstock harvest**
 - **Whole-farm optimization tools to incorporate bioenergy feedstock production into farm operations**
- **Analytical tools to estimate potential feedstock amounts and the implications of harvest on natural resource base**
 - **Decision tools for farmers and biorefinery operators**
- **On-farm utilization of biorefinery coproducts**
 - **Physical, chemical and biological value of byproducts as soil amendments and nutrients**





ARS Biorefining Research Priorities

- **Biocatalysis (EtOH & BuOH)**
 - **cellulosic (*2nd gen.*)**
 - **starches & sugars (*1st gen.*)**
- **Thermochemical**
 - **crop and animal wastes**
 - **farm-scale**
- **Biodiesel**
 - **fuel quality (*cold flow, oxidative stability, etc.*)**
- **Biorefinery co-products**
 - **For all biorefining platforms (*biodiesel, biocat, thermo*)**
- **Process economics, market & life cycle analyses**
 - **identify R&D goals & priorities**
- **Upfront tech transfer plans & partners**
 - **pilot facilities (*ARS regional research centers*)**





USDA **Biorefining Research**

Ongoing projects...

2nd gen. Biocatalytic

- *Inhibitor-tolerant and pentose-utilizing ethanologenic and butanologenic biocatalysts*
- *Novel, robust pretreatment processes*
- *Identifying saccharification and fermentation inhibitors and develop abatement strategies*
- *On-farm pretreatment*
- *Analytical methods for assessing quality of harvested biomass for biocatalytic conversion*
- *Novel, high-productivity enzyme/protein systems for biomass saccharification*



USDA **Biorefining Research**

Ongoing projects...

2nd gen. Biocatalytic *(cont.)*

- *Simultaneous saccharification-and-fermentation (SSF) processes*
- *Novel, high-throughput screening techniques for biomass deconstruction enzymes*
- *Fuels from cellulosic biomass via volatile fatty acid intermediates*
- *Consolidated bioprocessing (CBP) for cellulosic ethanol and adhesive coproducts*
- *Bio-butanol*
- *Ethanol-utilizing fuel cells [Phase I SBIR]*



USDA Biorefining Research

Ongoing projects...

Thermochemical and Catalytic

- ***Catalytic and non-catalytic processes for farm-scale production of stable and transportable pyrolysis oils***
- ***Slow pyrolysis- or torrefaction-based processes for converting agricultural feedstocks (e.g., crop residues, manures, processing wastes, biorefinery byproducts) into solid fuels and soil amendments which improve soil productivity, improve water quality, and sequester carbon***
- **Glycerol to liquid fuels via gasification [Phase I SBIR]**



USDA **Biorefining Research**

Ongoing projects...

1st gen. (biocatalytic)

- *Prevent, detect, control and/or correct microbial contamination in ethanol production facilities*
- ***New separation technologies for biofuel and/or co-product recovery from dilute fermentation broths***
- ***Reduce biorefinery water usage in conversion of winter barley (cellulose and starch) to ethanol and co-products from barley-based biorefineries***



USDA **Biorefining Research**

Ongoing projects...

Biodiesel

- ***In-situ transesterification from low-cost feedstocks***
- ***Removing performance-degrading contaminants (e.g., catalysts, sterol-glucosides, sulfur)***
- *Improving cold flow performance*
- *Improving oxidative and storage stability*
- *Microwave-assisted trans-esterification [LSU]*
- *Enhancing biodiesel engine performance*
- ***QA methods***



USDA **Biorefining Research**

Ongoing projects...

CoProducts

- ***Cellulose-based bioproducts via fractionation, enzymatic and/or chemical processing***
- *Xylitol from cellulosic biomass*
- ***Ethanol fermentation co-products via biocatalysis***
- ***High-value coproducts from corn ethanol biorefineries***
- *Improving storability and flowability behavior of distillers dried grains with solubles (DDGS) and distillers wet grains (DWG)*
- *DDGS-based foods*
- ***Polymers and high-value industrial products from glycerol***



ARS Bioenergy Research Budgets

thousands of dollars

2007	2008	2009	2010 (proposed)
\$20,829	\$21,339	\$31,359	\$41,329
Feedstock Development		20%	19%
Feedstock Production		26%	42%
Biorefining		53%	38%