



USDA Research **Bioenergy Technologies**

Created from extension of programs serving other pre-existing industries:

- **Utilization of ag- and forest-based materials**
- **Silviculture for wood products**
- **Forages (*breeding & production*)**
- **Soil fertility**
- **Crop improvement (*genomics, genetics & breeding*)**
- **Pollution abatement (*manures*)**
- **Integrated ag systems**





Biobased Industry Outlook Conference
Ames, IA; November 6, 2007

Competitive & Sustainable Bioenergy

ARS Bioenergy Program

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ARS Bioenergy Program

Three Components

1. Feedstock Development
2. Feedstock Production
3. Conversion & Co-Products





ARS

Feedstock Development

1. *Breeding and evaluation of new germplasm*

- Improved breeding methods
- Evaluate for specific adaptation zones
- Identify & incorporate plant traits that enhance energy production
- Rapid & reliable methods for measuring desirable traits
- Risk analyses (*gene flow*)
- Improved germplasm & varieties for energy crops



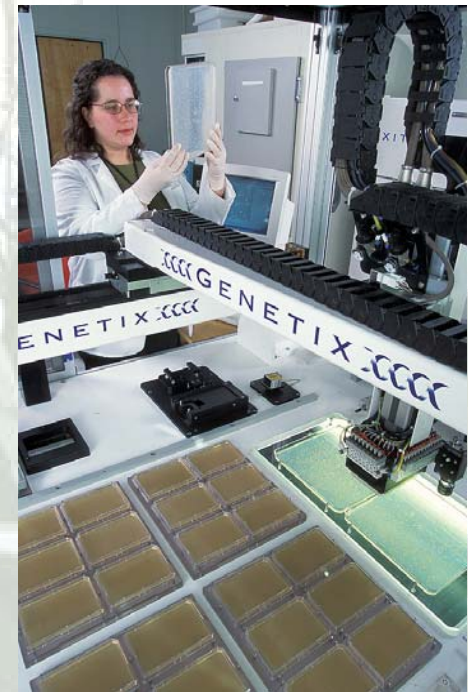


ARS

Feedstock Development

2. *Biological and molecular basis of plant traits*

- DNA markers & genetic maps for bioenergy
- Synteny among model and energy plants
- Identify and validate candidate genes that improve key bioenergy traits
- Understand inheritance mechanisms in complex polyploid perennials
- Mutant, tilling and recombinant populations to test hypotheses for control of traits
- Understand molecular basis for key traits (*cell-wall structure, growth biomass yield, conversion potential*)





ARS

Feedstock Production

1. Region-specific, sustainable practices to maximize feedstock harvest

- Whole-farm optimization tools incorporating bioenergy production from crop residues, dedicated energy crops & post-harvest processing by-products
- Cover crops that increase annual biomass yield and enhance soil carbon & nitrogen
- Rotation configurations that incorporate bioenergy production into food, feed & fiber systems
- Production systems for perennial grasses, energy cane

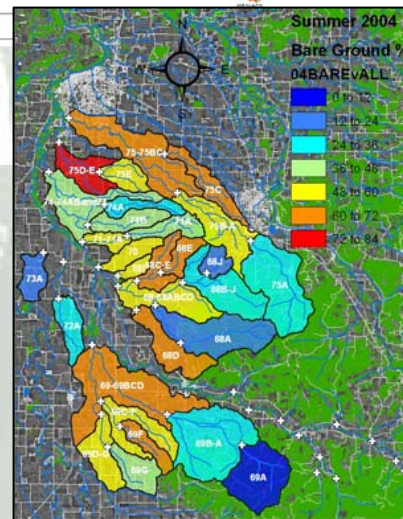
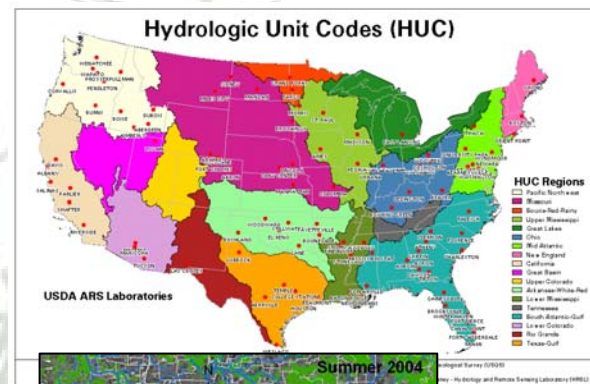




ARS Feedstock Production

2. Analytical tools to estimate potential feedstock amounts and the implications of harvest

- Operations mgmt. tools for feedstock production that consider climactic and soil conditions
- Biophysical models to predict effects of feedstock production on natural resources processes and quality
- Decision tools for farmers and biorefinery operators





REAP: *Renewable Energy Assessment Project*



REAP Team Locations

- **Nation-wide network of coordinated research teams.**
- **Historic watersheds, long-term experiments, and databases.**
- **Interdisciplinary approach including bio-physical sciences, modeling, and economics.**
- **Excellent collaborations with universities, industry, and other Agencies.**



REAP: *Products*

- **Guidelines for crop and soil management to ensure sustainable harvest**
- **Predictive tools for crop biomass harvest**
- **Tools to assess short and long-term trade-offs (environmental and economic)**

Outcome

Biomass energy industry based on sustainable management practices.



ARS Feedstock Production

3. *On-farm utilization of biorefinery co-products*

Physical, chemical and biological value of co-products as soil amendments

- ❖ ethanol by-products
- ❖ gasification ash
- ❖ bio-char
 - NSTL – Ames, IA
 - glomalin – Mandan, ND;
Beltsville, MD
 - pyrolysis – Wyndmoor, PA
 - peanut hull char – Florence, SC
 - tested Eprida product –
Morris, MN

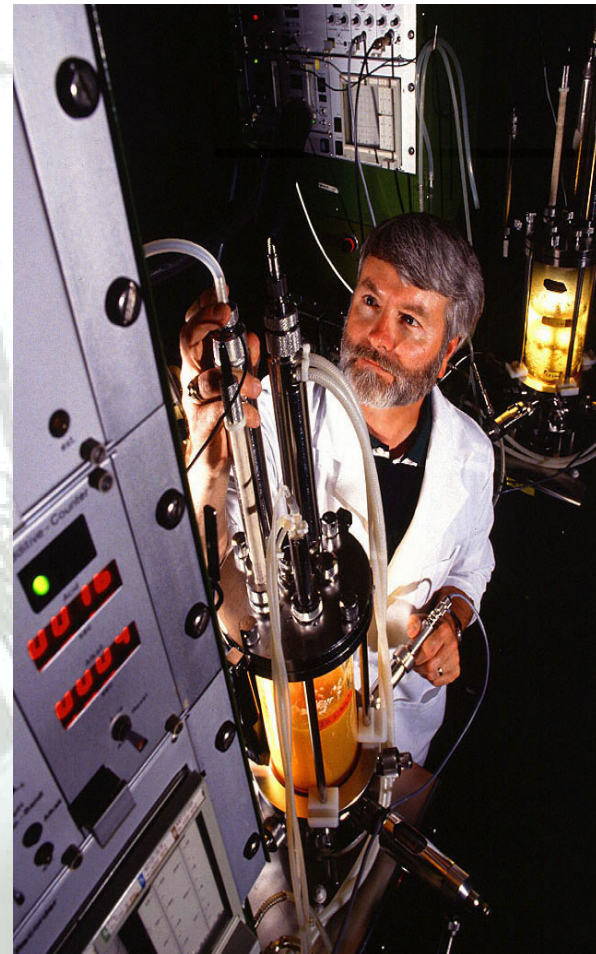




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Conversion & Co-Products

- ***Biodiesel***
 - fuel quality (*cold flow, oxidative stability, etc.*)
- ***Biochemical*** (to EtOH & BuOH)
 - starches & sugars (*1st gen.*)
 - cellulose (*2nd gen.*)
- ***Thermochemical***
 - farm-scale
- ***Process economics; market & life cycle analyses***
 - determine R&D goals & priorities
- ***Biorefinery co-products***





U.S. Cellulosic Energy Crops **What We Could Do Today**

Traditional cellulosic biorefineries:
ruminant livestock

- **U.S. hay: ~61 million acres¹**
 - alfalfa: 21.5 million acres
 - other: 39.5 million acres
- **Ave. yield: ~2.5 tons/acre¹**
 - alfalfa: 3.35 tons/acre
 - other: 1.78 tons/acre
- **Ave. price: ~\$110/ton¹**

1. 2006 data

barrier: Water