At this time, ARS lacks sufficient technical capacity to lead equipment R&D focused on harvesting, handling, and storing ligno-cellulosic feedstocks (sometimes termed "feedstock logistics"). However, ARS closely coordinates its feedstock production research with institutions leading R&D for feedstock logistics.

Component 3: Biorefining and Co-Products

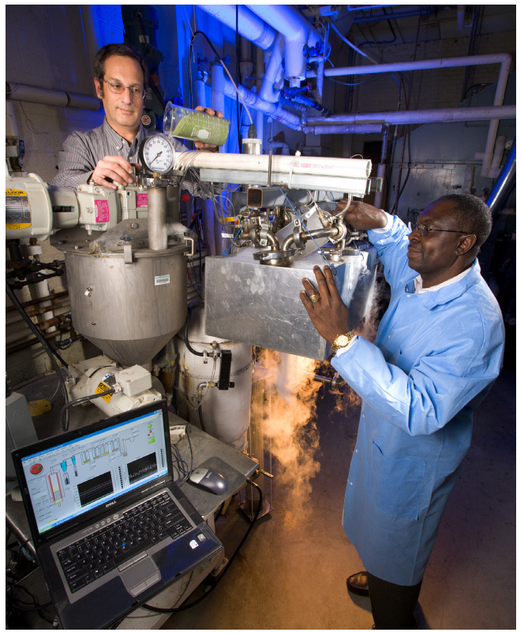
Goal: Enable new, commercially preferred biorefining technologies

Research on biorefining technologies is a critical national need, because the high cost of these processes inhibits the growth of the biobased economy.
In particular, ARS emphasizes research that…

- enables value-added co-products from biorefineries;
- enables processes for full or partial fractionation, pretreatment or biorefining at or near the farm;
- avoids or minimizes disruptions to traditional markets for food or feed as a consequence of biorefining;
- enables the biorefining of agricultural wastes and/or food processing wastes;
- minimizes the resource requirements of, and/or waste generated by, biorefineries;
- enables the recovery and recycling of nutrients from biorefineries to agricultural systems;
- enables innovative, breakthrough, energy-efficient technologies that could have a significant impact on the biorefining of agricultural materials;
- supports ARS research in feedstock development (Component 1) and feedstock production (Component 2);
- supports biorefiners' needs for technical support not otherwise available; and
- supports programs led by other Federal agencies and the private sector for the development of biorefining technologies.

Except for research that could enable cutting-edge, innovative or potentially disruptive technologies, ARS research in biorefining involves (to the extent possible) partnerships with all stakeholders associated with the entire value-added chain (production, harvesting, collection, transportation, storage, fractionation, preprocessing, and final-product marketing) so that the resulting technologies are commercially deployed as widely as possible and in the shortest possible timeframe. ARS coordinates its research with other research institutions tackling the technical barriers associated with biorefining. Federal agencies, universities, and private companies can utilize excess ARS capacity in biorefining research through grants and cooperative agreements.

ARS research in thermochemical conversion focuses on the deployment of such technologies at or near the farm.



Engineers Neil Goldberg (left) and Akwasi Boateng operate a fluidized-bed pyrolysis reactor they designed and built for converting crop residues into renewable bio-oils and biochar.

June 2010

USDA is an equal opportunity provider and employer.

www.ars.usda.gov/bioenergy

United States Department of Agriculture

Agricultural Research Service

ARS Bioenergy Research Strategy

Mission

ARS bioenergy research...

1. **Feedstock Development**
   Enables new varieties and hybrids of bioenergy feedstocks with optimal traits.
2. **Sustainable Feedstock Production Systems**
   Enables new optimal practices and systems that maximize the sustainable yield of high-quality bioenergy feedstocks.
3. **Biorefining and Co-Products**
   Enables new, commercially preferred biorefining technologies.

Vision

ARS bioenergy research both exploits opportunities and overcomes problems associated with bioenergy production, and does so in a manner that maximizes the net impact from ARS research.

Chemical engineer John Nghiem (left) and research leader Kevin Hicks monitor a new process for converting barley into fuel ethanol.

Long-Term Outcomes

ARS bioenergy research...

- Integrates bioenergy feedstock production into existing agricultural systems as quickly as possible and while ensuring the environmental, social, and economic sustainability of these systems.
- Improves national security and the U.S. trade balance by reducing America's dependence on imported petroleum.
- Enables America's transition to renewable sources of energy and biobased products.
- Enables significant new economic opportunities for rural America, while minimizing disruptions to agriculture's traditional markets for food, feed, and fiber.
- Enables farmers to maximize their economic returns from the Nation's use of bioenergy and biobased products.
- Enables important environmental benefits such as...
  - –reduced greenhouse gas emissions
  - –increased carbon sequestration
  - –creating safe value-added products from wastes
  - –maintaining the long-term productivity of agriculturally relevant natural resources such as soil and water
  - –reclaiming unproductive land
  - –rehabilitating unhealthy lands
- Allows rural America to become more self-sufficient in energy, thereby minimizing energy cost volatility (and maximizing local control over energy costs) in rural communities.

Relevance of ARS Bioenergy Research

The growth and long-term viability of bioenergy production in the Nation are impeded by a number of technical and commercial barriers. ARS leverages its strengths and unique capabilities to address technical barriers that can be overcome by ARS resources.

The ARS Bioenergy Research Strategy supports the following high-level plans:

- National Action Plan of the United States Biomass Research and Development Board
- Energy Strategic Plan of USDA's Research, Education and Economics mission area
- ARS Strategic Plan for FY 2006–2011 – specifically, Performance Measure 2.1.1

Technician Sarah Batt uses a robot to pick yeast colonies and transfer them onto starch plates, where they'll be screened for desirable enzyme production.

Goals of ARS Bioenergy Research

ARS has adequate research capabilities to pursue three major Components associated with the ARS Bioenergy Program:

- Feedstock Development
- Sustainable Feedstock Production Systems
- Biorefining and Co-Products

Action plans describing the research to be performed under each Component are laid out in the ARS Bioenergy Research Action Plan for the ARS Bioenergy National Program (NP-213). In addition to the research managed under National Program 213, some of the research performed under the following National Programs also contribute to the bioenergy research goals:

- Soil Resource Management (NP-202)
- Climate Change (NP-212)
- Manure and Byproduct Utilization (NP-206)
- Water Availability and Watershed Management (NP-211)
- Rangeland, Pasture and Forage Systems (NP-215)
- Agricultural System Competitiveness and Sustainability (NP-216)
- Plant Genetic Resources, Genomics, and Genetic Improvement (NP-301)
- Plant Biological and Molecular Processes (NP-302)
- Plant Diseases (NP-303)
- Crop Protection and Quarantine (NP-304)
- Crop Production (NP-305)
- Quality and Utilization of Agricultural Products (NP-306).

Strategies for transferring the technologies that arise from ARS bioenergy research are summarized in the Technology Transfer Action Plan.

ARS bioenergy research in the three Components is integrated through five USDA Regional Biomass Research Centers. The Centers are networks of ARS and Forest Service research facilities and are designed to accelerate the establishment of sustainable biomass supply for the commercial production of biofuels, biopower, and other bio-based products. The Centers leverage the collective efforts of USDA research, USDA action agencies, and partners in universities, industry and commercial ventures, other Federal and state agencies, non-government organizations, tribal nations, and international entities.

Geneticist Michael Casler harvests switchgrass seed as part of a breeding program to develop new cultivars with improved biomass conversion to bioenergy, broad adaptation, and high biomass yields.

Program Priorities

Based on input from ARS stakeholders, research priorities for each Component were developed and are described in this section.

Component 1: Feedstock Development

Goal: Enable new varieties and hybrids of bioenergy feedstocks with optimal traits

ARS researchers will develop new germplasm, hybrids, and varieties with value-added traits to enhance the yield of usable energy per acre. New scientific knowledge and innovative technologies will result from fundamental research conducted on the molecular, biochemical, and genetic control of key plant traits impacting energy and co-product value. Improved understanding of the plant cell wall as a biofuel source will lead to efficient conversion of biomass into bioenergy and co-products.

ARS researchers involved in plant genomics, genetics, molecular biology, and breeding from several National Programs will coordinate existing projects to support this strategic plan. Optimizing feedstock development will require cooperative research activities with ARS projects in feedstock development, production, and biorefining. ARS research for feedstock development will be coordinated with feedstock production and biorefining research within ARS and with relevant research at other government agencies, universities, and research institutions.

Component 2: Sustainable Feedstock Production Systems

Goal: Enable new optimal practices and systems that maximize the sustainable yield of high-quality bioenergy feedstocks

Research to maximize sustainable production of bioenergy feedstocks is a critical national need because more than half of the total production cost for bioenergy is tied up in the cost of feedstocks. Further, crop residues such as corn stover and cereal straws hold much promise as large-scale biorefinery feedstocks, but understanding of the long-term impact of residue removal on soil productivity is lacking.

ARS has unique competencies for research impacting…

- sustainable agricultural production
- soil, water, and air resources
- biophysical-economic modeling

Consequently, ARS is expected to assume a lead role in Federal-wide research for feedstock production. In particular, ARS leadership and strategic focus on sustainable agronomic systems are based on the following capabilities:

- optimizing sustainable feedstock production systems in cooperation with feedstock development activities
- development and application of biophysical-economic models
- on-farm utilization of biorefinery co-products such as distillers grains and biochar
- proven abilities to perform interdisciplinary and multi-location agricultural research.