



# ARS Bioproducts Research (Non-Fuel)

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**Research Center Administrators Society  
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“The Agricultural Research Service of the USDA has been one of our greatest sources of assistance and has unfailingly and generously answered all sorts of technical questions from food to plastic bowls.”

*Mastering the Art of French Cooking.*  
Julia Child, et.al.

# "Where the best ideas take wing"

"...one of the most wide-ranging and innovative laboratories anywhere on the planet."

"...the genius behind a world of commercially successful products, including permanent-press cotton, Pringles, Lactaid and pretty much most of the frozen-food aisle."

Time Magazine, Oct. 11, 2004

## WHAT'S NEXT

### BUSINESS

genius behind a world of commercially successful products, including permanent-press cotton, Pringles, Lactaid and pretty much the entire frozen-food aisle.

For an old-school laboratory lumped under the sprawling U.S. Department of Agriculture, ARS keeps pumping out high-tech solutions to a broad array of problems, ranging from the urgent (how to eradicate plant and animal diseases) to the less pressing (how to duplicate the tangy taste of San Francisco's sourdough bread outside the Bay Area). Along the way, the agency has won numerous patents for breakthrough mechanisms, like the one pending for turning peanut shells into hydrogen fuel and another for harnessing chicken manure to remove metals from polluted water.

When the agency began in 1953, its primary mandate was to seek methods for increasing food production. Since then, ARS scientists have helped find ways to double per-acre wheat production and triple cows' milk output. But now that we produce far more food than our collective maw can swallow—and more than we can export—ARS is setting its cross hairs on new challenges. One-fifth of the agency's \$1 billion budget goes to "utilization research" to employ unused agricultural products in places other than landfills. That's where the feathers come in: America's appetite for poultry yields about 5 bil-

**FLYWEIGHT** Quill-free feather fibers, it turns out, can be used to make auto parts



The USDA's old-school laboratory is cranking out high-tech solutions

## A HALF-CENTURY OF INVENTION

ARS is the brains behind countless innovations in food and other fields



### 1950s

ARS invents DEET bug repellent and instant potato flakes. It also rescues the frozen-food industry by establishing the basic requirements for preserving taste, color and texture, which are still followed today

### 1960s

ARS develops permanent-press cotton, shrink-proof wool and permanent creases in wool trousers. It finds a way to prevent gelling in evaporated milk and uses sterilization to eradicate the screwworm fly in the U.S.



### 1970s

**SuperSlurper**, an ARS cornstarch compound that can absorb up to 2,000 times its weight in water, gets laced into baby powder, wound dressings and fuel filters. It inspires similar materials used in disposable diapers and maxipads

### 1980s

ARS hits upon the basis for lactose-free dairy products and creates 100% soybean ink in four colors, which is now used in USA Today and other papers. The agency forms a partnership with a private firm to vaccinate unborn chicks through their eggshells



### 1990s

The agency makes a low-calorie fat substitute out of soluble oat fiber that becomes a hit. ARS invents a large-scale process for peeling orange sections and finds that a lack of vitamin E or selenium can make a benign human virus become virulent

### 2000s

ARS clones the first transgenic cow with an added gene to protect against mastitis and co-patents a method of preserving the look and taste of fresh apple slices for weeks, the basis of a new side order at McDonald's



lion pounds of plucked plumage a year.

For many ARS researchers, the future is all about waste, particularly as an alternative to petroleum. The feather project, for example, can replace some of the fossil fuels used in plastics. Likewise, a surplus of soybeans inspired researchers to develop SoyScreen as an alternative to petroleum-based sunscreens. At ARS's flagship facility in Beltsville, Md., biodiesel, derived from vegetable oil, powers fleets of tractors and lawn mowers for the farms and even heats some of the buildings. Indeed, petroleum is prohibited in the carpeting (which is instead held together by soy-based urethane). The only permissible hand soaps and cleaning products are plant based. And in the parking lot, says Justin Barone, one of two ARS researchers devoted to feather-fiber research, "you'll see a lot more bicycles and Toyota Priuses than SUVs."

As ARS pursues a green agenda, workers at the agency's 100 or so labs across the country are demonstrably patriotic in their quest. "We're trying to help American farmers, help our country, make us less dependent on foreign oil," says Greg Glenn, an ARS engineer in Albany, Calif.

The agency gets little public recognition, and that's just fine. It sticks to the science and leaves product development and marketing—and the glory—to others. Glenn invented some nonfood uses for wheat starch, including a biodegradable version of Styrofoam food containers. His work is being incorporated in various products at EarthShell Corp., a disposable-food-packaging company based in Santa Barbara, Calif. But when commercial production of the wheat-based plates and bowls begins next year, consumers will see only EarthShell's name on the label. There will be no reference to ARS. "We don't want the USDA to appear as an endorser," says Ed Knippling, the mild-mannered plant physiologist who runs ARS. "We don't brand our products."

As a result, the agency's 2,500 scientists tend to live in anonymity, despite their contribution to popular commercial culture. "I'm constantly amazed how few people know we exist," says Glenn. "When I told someone recently that I work for the USDA, she said, 'Oh, so you're a meat inspector, are you?'"

ARS is eager to raise its profile in the business community, however, by passing out information-packed CD-ROMs at trade shows and signing up thousands of executives to receive e-mail updates on new technologies available for licensing. But the



# A Vision of Agricultural Research

**“Food and fiber remain core products, but agriculture has an increasingly important role in the delivery of pharmaceutical, nutritional, and other biobased products; the sound stewardship of biologic, land, water, and atmospheric resources; the well being of food animals; and in continuing to sustain the social and economic health of rural communities.”**

**Frontiers in Agricultural Research. National Research Council, National Academies, 2003**



# Great Lakes Region



- 35% of all NIH research grants
- 33 % of all U.S. R&D dollars
- Has several key prerequisites for successful VC investing
- Only 13.8 % of all U.S. venture capital invested
- Struggles to convert research prowess into innovative, high value firms required to transition its economy
- Opportunities in agriculturally based health, energy and bioproducts including lubricants, polymer feedstocks and fuel additives

**“Turning up the Heat: How Venture Capital Can Help Fuel the Economic Transformation of the Great Lakes Region.”**

**Brookings Institution Metropolitan Policy Program.**

**January, 2010**



**Biobased product means a product determined by the Secretary to be a commercial or industrial product (other than food or feed) that is composed, in whole or in significant part, of biological products, including renewable domestic agricultural materials, and forestry materials, or an intermediate ingredient or feedstock.**

**Title IX, Sec. 9001, 2008 Farm Bill**



## **Market Drivers for Biobased Products**

- **New uses & expanded markets for agriculture commodities and byproducts**
- **Economic development**
- **Reduced dependence on imports**
- **Environmental advantages**
- **Policy incentives**





# Market Potential for U.S. Biobased Products (2008-2025)



- Global chemical industry growth projected at 3-6% per year through 2025, with biobased chemicals market share expected to grow from 2-22%; biobased polymers expected to increase from 0.1% to 10-20% market share
- Shift toward greater use of biobased products linked to the development of fuel biorefineries
- For the next 10 years, grains will be primary feedstock for biobased products

<http://www.usda.gov/occ/reports/energy/index.htm>





## Use of Bioproducts

- **Lessen our national dependence on foreign oil**
- **Promote economic development by creating new jobs**
- **Provide new markets for farm commodities**
- **Expected the Nation's increasing use of biofuels will generate more biobased materials from biorefineries**



# Commercialization Challenges for BioProducts



- **Cost**
- **Performance**
- **Availability**
- **Sustainability**
- **Environmental benefits**



# Policy Challenges

- **Entrenched petroleum infrastructure**
- **Incentives for procurement and use**
- **Sustainability/Environment (carbon credits)**
- **Biotechnology/GMOs (tolerance, IP, traceability)**
- **Trade**
- **Education (policymakers, educators, procurement agents, general public)**
- **Food vs. fuel debate**



## Government Actions

- **Executive Orders (13101 and 13134)**
- **Biomass Research and Development Act of 2000**
- **Energy Policy Act of 2005**
- **Food Conservation and Energy Act of 2008**
- **USDA administers the BioPreferred Program for designating bioproducts for procurement by government agencies**



# USDA Biobased Programs

- **Rural Development – Business and Cooperative Programs**
- **BioPreferred Program ( Biobased Markets)**
- **National Institute of Food and Agriculture (NIFA), formerly Cooperative State Research, Education and Extension (CSREES)**
- **Agricultural Research Service (ARS)**



## Research Challenges

- **Improve understanding of functionality of components of agricultural and forestry materials**
- **Genetically engineer feedstocks for bioproducts**
- **Genetically engineer microbes for conversion**
- **Develop environmentally-friendly and cost effective conversion technologies**
- **Need to document sustainability of bioproducts and their feedstocks**



# A 70-year History of Bioproducts Research



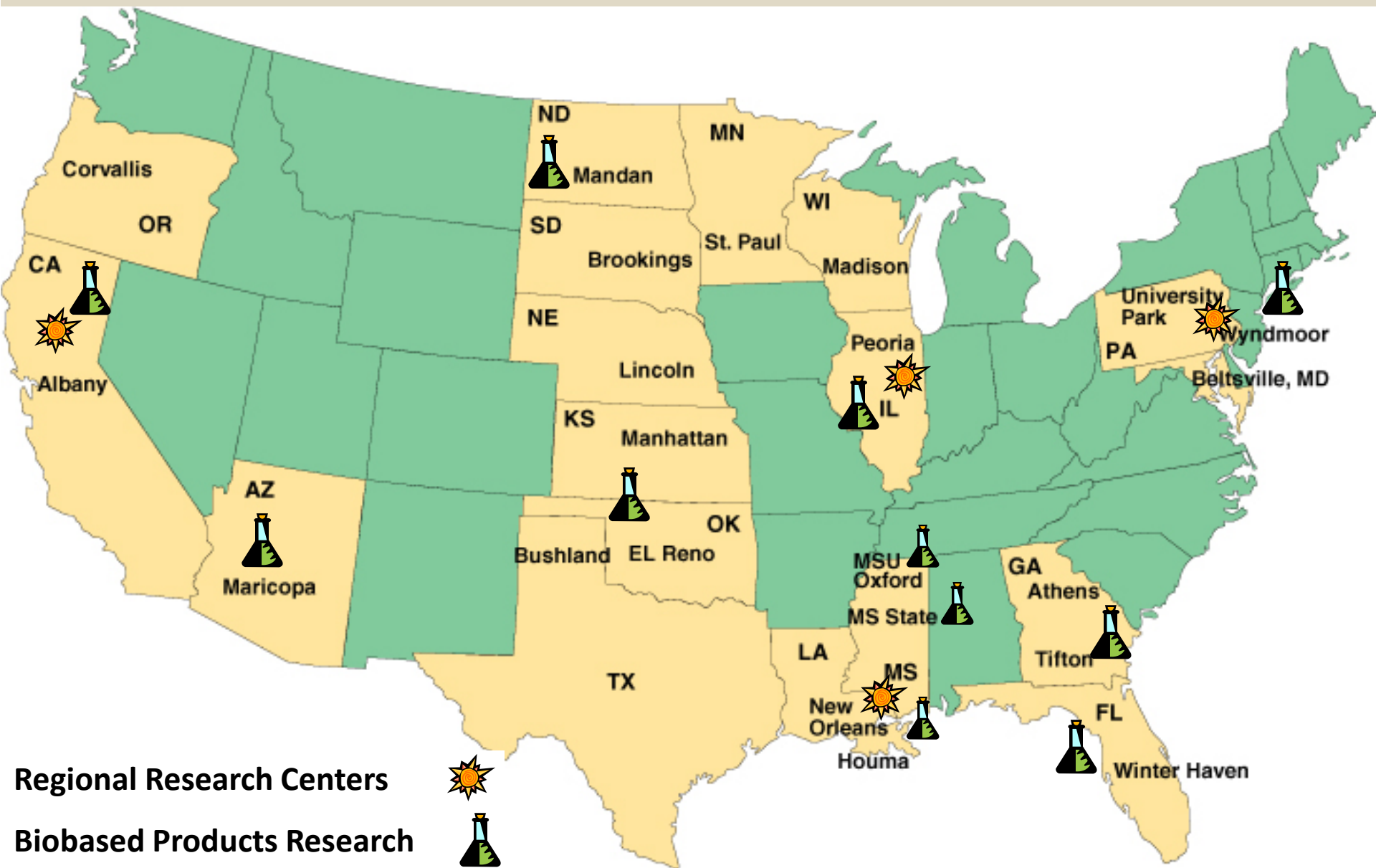
- **1938 Agricultural Adjustment Act Section 202**

**The secretary (of Agriculture) is hereby authorized and directed to establish, equip, and maintain four regional research laboratories, one in each major farm producing area, and at such laboratories conduct researches into and to develop new scientific, chemical and technical uses and new and extended markets and outlets for farm commodities and products and byproducts thereof. Such research and development shall be devoted primarily to those farm commodities in which there are regular or seasonal surpluses, and their products and byproducts.**





# ARS Biobased Products Research Laboratories



Regional Research Centers

Biobased Products Research



Since 1940 the four regional research centers have provided the major portion of ARS's capability for research and development of technology to increase the use of agricultural products and thereby enhance the economic viability and competitiveness of U.S. agriculture.



**WRRRC**



**ERRC**



**SRRRC**

**NCAUR**





# ARS Biobased Successes

- **1941 – Developed submerged liquid fermentation process for penicillin production**
- **1943 - Found that linoleic and linolenic acids were retarding process of making synthetic rubber from butadiene and styrene; solved by partial hydrogenation.**
- **1944 - Developed 'epoxidation' reactions, which enabled the production of flexible vinyl plastics**
- **1950 - Developed commercially-viable process for producing dextrans (from sugar beet pulp and sugar cane). Used to produce synthetic blood plasma for the Korean War**



## ARS Biobased Successes

- **1950 - Developed commercially-viable process for making xanthan gum, an edible food thickener made by fermentation**
- **1976 - Patented SuperSlurper, a co-polymer of starch that absorbs over 100 times its weight in water. Started superabsorbent industry**
- **1994 - Fantesk invented; an inseparable mixture of starch and oil, which has been found to have numerous food and non-food applications.**



**But what have you done  
for us lately?**





# Biodegradable Soy-based Hydraulic Fluid



**Exclusively  
licensed to  
Agrilube/Bunge,  
2006**

**Test with the National Park Service**



# Biobased Metalworking Fluid

In aluminum rolling mill operations like this one, Alcoa, Inc., tested ARS's new biobased metalworking fluid and preferred it to the petroleum-based lubricants. As a result, ARS-developed bio-based fluids are now used routinely at Alcoa's Reno, NV, mill.





**NCAUR scientists developed a way to make printing inks, previously a petroleum-based product, from 100 percent soy oil which have characteristics that either meet or exceed industry standards for product functionality. Two patents were awarded to ARS for news ink and sheetfed and heatset ink technologies, with licensing having been executed or in process for these technologies.**



# Guayule Latex



Guayule is a rubber-producing southwestern desert shrub. ARS scientists in Albany, CA discovered that guayule latex is hypoallergenic and suitable for the manufacture of high-value and life-saving medical products. ARS's commercial partner, Yulex Corporation, built a plant in AZ to produce guayule latex and has signed agreements to provide material for products, including latex balloon catheter products.





# Cotton Gin Hydromulch



**ARS researchers at Lubbock, TX, worked with an industrial partner to convert cotton gin byproducts into a high performance hydromulch for the 'green' industry. The hydromulch minimizes soil erosion while promoting grass seed establishment and returns revenue to cotton producers and ginnerers.**



# Compostable Food Service Products



Starch/fiber composite materials made into compostable food service products. Sold in over 900 retail stores. Market potential is \$8 billion



Rapid (~35 da): Bowls, cups, plates, trays





# SoyScreen



An all-natural sunscreen and antioxidant for skin and hair care applications. Vegetable oil is enzymatically converted with botanical extracts through a “green” manufacturing process with low ecological impact. Licensed to iSoy Technologies.







# Soybean Protein-Based Plywood Adhesive



A soybean protein-based plywood glue designed for foam extrusion. Soybean flour replaced spray-dried animal blood, the industry's protein extender, is cheaper than the industry glue but is just as strong and has Eliminated health concerns about handling animal blood.

Commercially used by Georgia Pacific





# Second Generation Superabsorbent



Based on original superabsorbent technology incorporating new agricultural application and manufacturing methods. Helps growers achieve higher yield and better quality with less water. Absorbent Technologies, Inc. (ATI) has developed its own patents and maintains ongoing relationships with USDA researchers. Zeba products, from ATI, are targeted toward the turf, nursery, and home and garden markets. The technology is also in Scotts products.



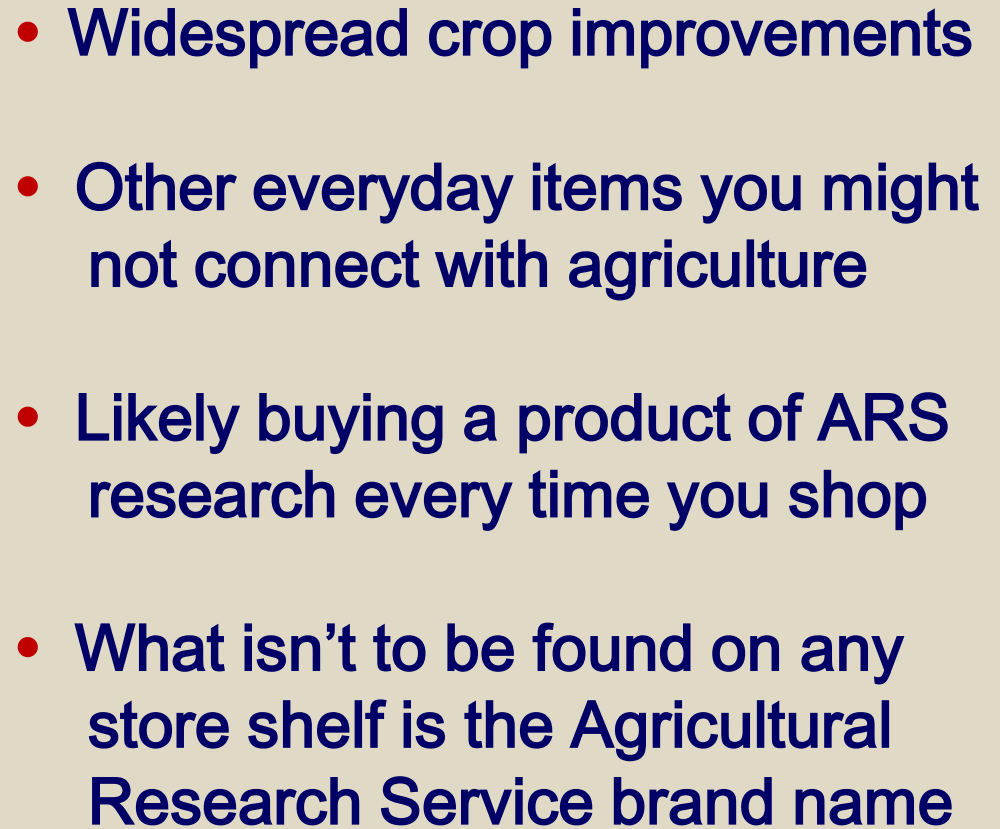




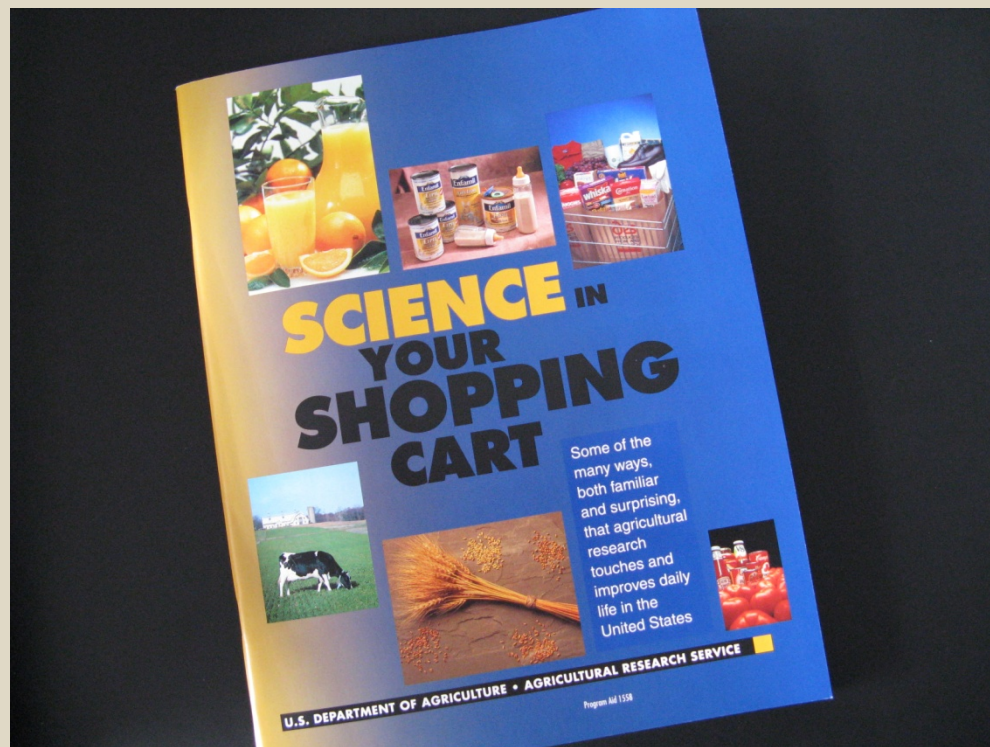
# Future Research



- **Feedstocks**
  - ID properties of crop oils desirable for industrial use
  - ID alternative feedstocks
  - Utilize animal waste and byproducts as feedstocks
- **Conversion and Processing**
  - Basic chemistry research (oils, lignin, carbohydrates)
  - Economical green chemical processes
- **Scalability (large-scale production)**
- **Develop new products with increased functionality & improved environmental properties**



Federally funded agriculture research has been so successful in finding solutions to farmers' problems and providing what consumers need that for every dollar spent, \$1.35 is returned to the taxpayer.







Agricultural Research Service



Leading America towards a better future  
through agricultural research and  
information.



# USDA

United States Department of Agriculture