Biobased Products Toolkit

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Why Buy Biobased Products?

Federal Regulation Requires Preferred Purchasing of Biobased Products

The Presidents Executive Order 13101 in 1998, which mandated that the federal government purchase recycled and environmentally preferred products, was the first federal initiative on biobased products. When this executive order was codified in the Farm Bill **(Farm Security and Rural Investment Act of 2002 (7 U.S.C. 8102)) in Section 9002 - Federal Procurement of Biobased Products** many agencies were already purchasing and using some biobased products. This law requires that agencies establish procurement programs for preferred purchasing of biobased products. Each Federal agency must develop and implement a biobased product procurement program designed to increase the purchase and use of biobased products.

Following this law, many Federal agencies have identified the procurement of biobased products as part of their missions. For example, among the strategic goals of the Department of Energy, protection of "our national and economic security by promoting a diverse supply and delivery of reliable, affordable, and environmentally sound energy" is met through the procurement of biobased products. US dependency on foreign oil can be reduced through the substitution of biobased products for petroleum fuels and chemicals. Using the nationals renewable natural resources to produce ethanol, biodiesel and a variety of biobased plastics diversifies our economy, may be cheaper in the long run and when sustain ably produced will be better for the environment.

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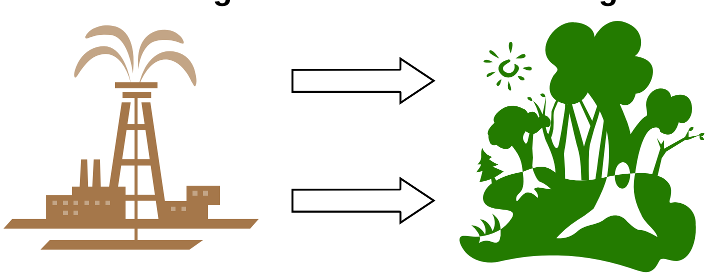


Never Ending Benefits

Besides the fact that there is a Federal law requiring the preferred procurement of biobased products, procurement and use of such products have a variety of benefits including: natural resource, public health, economic, and national security.

Benefit Categories
Natural Resource
Public Health
Economic
National Security

Natural Resource

Wildfire prevention

The removal of excess woody undergrowth in forests for energy production can reduce the likelihood and extent of wildfires.

Reduction of environmental damage associated with spills

Biofuels, unlike petroleum based products, are almost completely biodegradable during their entire life cycle. In 2005 alone there were 21 spills that were 7 to 700 tons along with an additional 3 spills that were over 700 tons. Most spills result from tankers conducting routine operations such as loading, discharging and bunkering which normally occur in ports or at oil terminals.

Protection of biodiversity

The use of biomass resources for fuel, electricity and biobased products can be less harmful to the ecological balance of earth than other fossil fuel-based options.

Why buy biobased products? —Continued

Waste reduction

Many of the biorefinery technologies utilize contemporary waste products as a feedstock to produce energy or products. Resources such as crop residue, animal manure, and urban wood waste can be processed for use as feedstocks, thus reducing the need for other less desirable waste handling methods such as crop burning, lagoons, and landfills.

Soil improvement

By promoting the use of a wider variety of crops, biomass derived products and energy allow for better rotation systems. A 1993 Austrian study found that 98 percent of biodiesel biodegrades within three weeks should there be a spill.

Wildlife habitat enhancement

Through the use of sustainable practices, the production and use of biomass resources has the potential to enhance wildlife habitat, rather than causing the damage that can occur with oil well drilling and petroleum spills.

In 2005 alone there were 3 oil spills that exceeded 700 tons.

Reduction of urban sprawl and of development over sensitive lands

The addition of energy crops to the farmers' portfolio increases the value of agricultural land, thus making the agricultural properties less susceptible to buyout for urban development. Having a biomass fuel resource also reduces the need to explore and drill in environmentally sensitive areas such as the Alaskan Wilderness and the coastal regions of North Carolina or Florida.

Public Health

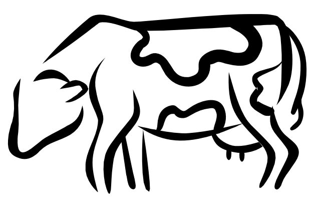
Water quality improvement

Unlike traditional fuels, fuel spills associated with fuel production and consumption will have minimal toxicity impact on the water supply. Biofuels such as ethanol and biodiesel are almost completely biodegradable in a relatively short amount of time. Air quality improvements: Biofuels and most biopower technologies have significantly better emission profiles, including lower levels of: carbon monoxide, ozone, and particulate matter. Also, emissions from fossil fuels have been linked to acid rain and various reoccurring health problems.

Exposure to pollutants from commuting by school bus can increase a child's cancer risk by 4 percent

Reduction of CO2 emissions

Fuels and power that are derived from biomass are carbon neutral, and therefore does not contribute to any net emissions of the CO2 greenhouse gas. In contrast, fossil fuels are high in emissions and can cause dangerous effects. For example, a recent University of California study found that in large urban areas, children riding in school buses with diesel engines collectively inhale more exhaust than everyone else in the city combined. Increased exposures from commuting by school bus are estimated to increase a child's lifetime cancer risk by approximately 4 percent . On average, children spend 90 minutes per day on a school bus.



Reduction of methane emissions

Alternative uses of biomass and organic waste can capture or avoid methane emissions that would otherwise occur by, for example, storing manure in lagoons or open piles, disposing urban biomass waste in landfills, or allowing excessive amounts of crop or forest residues to decompose in site.

Even More Benefits...

Health Care Costs

With the reduction of polluted air, water and land related disease will also be reduced. This related decrease in disease could significantly reduce health care costs. Such as school-age children who are exposed to high amount of air pollution which can cause asthma and exacerbate it. This air quality disease keeps children home from school more than any other ailment.

Economic

Creation of jobs

The increased domestic production of biofuels and energy can spur economic growth, increase local employment opportunities, and is expected to elevate the need for domestic labor. A University of Missouri study found that from the construction of four ethanol biorefineries 154 full time jobs will be created to maintain the facilities.

Reduction of trade deficit

A significant source of the current U.S. trade deficit is the extensive import of foreign oils. Domestically produced fuels would reduce such imports. It is also more economical to produce biofuels over fossil fuels. In Minnesota, the state which has the most ethanol biorefineries, a report done by the Institute for Local-Self Reliance found that, "For every dollar Minnesotans spend on gasoline, some 75 percent leaves the state economy. For every dollar Minnesotans spend on ethanol, some 75 percent stays in the state economy".

Retention of small/family farms

Biomass derived energy and products provide a wider portfolio of crops and more price stability, which could help improve the economics of small family farms.

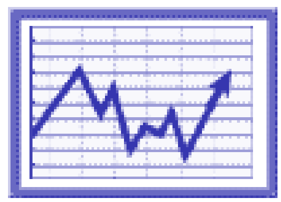
National Security

Reduction of fuel costs and price volatility

Biofuels are viable substitutes for fossil fuels, and can therefore increase the supply of transportation fuel available for use in existing vehicles. As a result, an expanded supply of biofuels can help reduce fuel prices and volatility.

Improved national security

The import of oils from politically unstable regions increases the risk of political conflicts and involvement of the U.S. Reduction of such imports lowers these risks.



Increased energy independence

The reliance of the U.S. on foreign oil subjects our economy to volatility and uncertainty. The increased use of domestic energy sources and products can lower imports and reduce this dependence. In 2004, the U.S. imported 3,692,063,000 barrels of oil, of which 25 percent was from the Persian Gulf alone. Replacing these barrels with U.S. energy sources strengthens the domestic economy and independence.

Promotion of advancements in science and technology

The effort to increase biomass utilization requires multidisciplinary input, and has spurred research in such fields as biotechnology, advanced vehicle development, engineering, economics, and resource management.

> The U.S. imported 3,692,063,000 barrels of oil in 2004, of which 25 percent was from the Persian Gulf

FOR THE END-USER

In order to better understand how the agricultural community can participate in non-food applications for their farm commodities, an overview is needed on the types of renewable products that are available for purchase. This section of the toolkit details the various categories of biobased products that can be included in the portfolio of the governments purchasing programs.

Biobased Adhesives

Description

Biobased adhesives are chemical products used to join or bond two or more other materials together. Their use is broad and includes book bindings, envelopes, stamps, tapes and sutures for medical applications, doors, windows, paper bonds, corrugated paper boxes, lumber, and furniture.

Agricultural Sources

A wide range of agricultural materials can be used to make biobased adhesives, including but not limited to: corn starch, potatoes, wheat, tapioca, casein (from skimmed milk), soy protein, vegetable gums, gelatin, livestock derivatives, and marine animal derivatives.

Vendor Requirements

Vendors should provide data for their biobased adhesives to document biobased content, source of biobased material (i.e. particular crop or livestock), commercial production capacity, total sales of product in previous years and two year sales projections (sales are presented as total weight of product sold so that the amount of biobased materials used can be determined). Vendors should also verify that the product has low or no toxicity to humans, animals, aquatics or plants, and that the product or its processing reduces regulated air and water emissions and solid waste disposal.

To be included in the *biobased adhesives category*, adhesive products must have a minimum biobased content of 80 % by weight. In addition, vendors of other products who certify that at least 90 % of the adhesives used in those products, e.g. furniture, are biobased adhesives can designate those products as biobased products.

Biobased Content is the weight of the biobased material divided by the total weight of the product and expressed as a percentage by weight. Vendors must provide evidence of the biobased material content in the product or system *in addition* to the standards and specs required for the product class.

Biobased Construction Materials and Composites

Description

The applications in the *biobased construction materials and composites* category are broad, and include: wall and roof systems made from compressed wheat straw or other plant fibers; fiber board made from wheat or other cereal straw, sugarcane bagasse, or other plant fiber and chicken feather fiber; composites made from corn oil, cotton oil, linseed oil, soy oil, soybean meal or other plant proteins; molded parts from vegetable fibers; and building or office furnishings – desks, table , cabinets – made from biobased composites. Also included are products and parts made from biobased plastics and/or reinforced with biobased fibers.

The *biobased construction materials and composites* category also includes those products containing biobased adhesives, such as plywood, finger joint lumber, engineered wood building components – laminated beams, trusses, and decorative composites. Plastic lumber, or wood substitutes, can now be made with soy, wheat, and other resins blended with natural fibers, resulting in a very high biobased content product.

Also included in this category are bioplastics, rigid and soft foam, fiber insulation, starch admixtures (such as aqua gels that are added to concrete mixture during setting to reduce the density of concrete), and concrete mold release agents.

Agricultural Sources

Construction materials and composites can be made from agricultural and woody materials or residues, as well as from livestock derivatives. For the purposes of this category, woody materials are those obtained from activities such as forest thinning, fuel reduction in plantation stands, regenerated forest stands, intensively cultivated short rotation woody stands (i.e., less than 10 years old), or wood residue and recovered wood products.

Vendor Requirements

Vendors should provide data for their *biobased construction materials and composites* to document biobased content, source of biobased material (i.e. particular crop or livestock), commercial production capacity, total sales of product in previous years and two year sales projections (sales presented as total weight of product sold so that the amount of biobased materials used can be determined). Vendors should also verify that the product has low or no toxicity to humans, animals, aquatics or plants, and that the product or its processing reduces regulated air and water emissions and solid waste disposal.

Table 1. Biobased Construction Materials and Composites

Guideline for

Minimum Biobased Content (%)

Sub-category	Minimum Biobased Content (%)
Construction Material	90%
Composites	70%

Biobased Content is the weight of the biobased material divided by the total weight of the product and expressed as a percentage by weight. Vendors must provide evidence of the biobased material content in the product or system *in addition* to the standards and specs required for the product class.

Biobased Fibers, Paper and Packaging

Description

Agricultural materials represent an extraordinary source of *biobased fibers.* There is a broad range of agricultural crops and livestock that contribute materials to this category, including: bamboo, corn stover, low grade cotton, flax, kenaf, rice straw, saw dust, sugar cane bagasse (sugarcane residue) , switch grass, wheat and other straws, wood, feathers and wool.

Natural, *biobased fibers* are very ductile and typically do not splinter. Their properties have been compared to carbon and glass fibers for use in fiberglass composites. Products made from natural fiber-based composites weigh about 30 percent less than comparable wood-based products.

A variety of *biobased fibers* can be spun into ropes, textiles and yarns. For example, flax is a traditional textile fiber, used to make linen while other fibers, such as jute, are woven to make burlap for bags and coverings

Biobased fibers can be used for *packaging* in several ways, such in the manufacture boxes, drums and pails for the storage or shipment of food or manufactured products. These packages and packaging materials help protect and sustain the quality of goods during transportation and storage. The interactions between those goods and the package and packaging materials is important since the package provides a barrier to gases, humidity, and light, which can be vital for the quality and shelf life of many retail products, especially foods.

Agricultural Sources

A wide variety of *biobased fibers* can be used to produce tree-free paper, including corn stover (North America's largest source of agricultural residue). Flax fibers and wool can be used in high end paper products and kenaf can be used to make newsprint paper Bagasse, rice straw and wood chips are also good *biobased fibers* for the production of tree free paper.

For packaging, renewable alternative fibers can be derived from other varieties of agricultural materials including, but not limited to: cotton, kenaf, wheat and other straws, chicken feathers and wool. Bulk packaging materials can even include popped corn as a direct replacement of styrene 'peanuts'.

Vendor Requirements

Vendors should provide data for their *biobased fibers, paper, and packaging* to document biobased content, source of biobased material (i.e. particular crop or livestock), commercial production capacity, total sales of product in previous years and two year sales projections (sales presented as total weight of product sold so that the amount of biobased materials used can be determined). Vendors should also verify that the product has low or no toxicity to humans, animals, aquatics or plants, and that the product or its processing reduces regulated air and water emissions and solid waste disposal.

Table 2. Biobased Fibers, Paper and Packaging

Guideline for

Minimum Biobased Content (%)

Sub-category	**Minimum Bio-based Content (%)**
Fibers	90%
Fiber composites	30%
Woven fiber products	75%
Packaging materials	80%
Tree free uncoated printing and writing papers	20%
Tree free coated printing and writing papers	20%
Bristols	50%
Newsprint	20%
Sanitary tissues	30%
Paperboard and packaging products	30%
Other paper products	50%

Biobased Content is the weight of the biobased material divided by the total weight of the product and expressed as a percentage by weight. Vendors must provide evidence of the biobased material content in the product or system *in addition* to the standards and specs required for the product class.

Biobased Fuels and Fuel Additives

Description

A variety of *biobased fuels and fuel additives* can be made from agricultural materials, including liquid, gaseous and solid fuel products. These products can be used to power vehicles, heat buildings, provide heat for industrial steam processes, generate electricity, and run micro-turbines or fuel cells.

Fuel products can be used in in its undiluted (or 'neat') form, mixed with other materials as a formulation, or used as an additive to enhance certain properties of another fuel. For example, ethanol can be burned directly or blended with gasoline, and paper sludge can be burned directly or blended with coal or wood.

Agricultural Sources

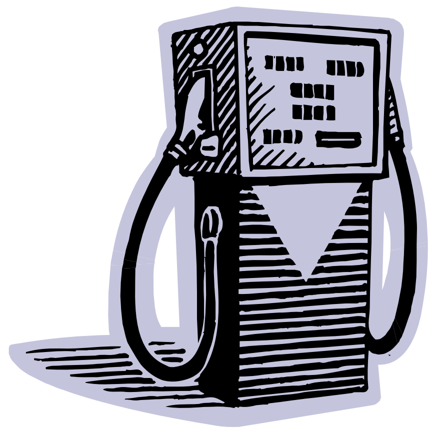
Raw material sources for biobased fuels can include corn, soy bean, rapeseed, animal fat, and wood. Many processing residues can also be used as feedstocks, such as stalks, manure, used cooking oils, used wood, paper and paper sludge, and hulls.

Vendor Requirements

Vendors should provide data for their *biobased fuels and fuel additives* to document percent biobased content, source of the biobased material (i.e. particular crop or livestock), commercial production capacity, total sales of product in previous years and two year sales projections (sales presented as total weight of product sold so that the amount of biobased materials used can be determined). Vendors should also verify that the product has low or no toxicity to humans, animals, aquatics or plants, and that the product or its processing reduces regulated air and water emissions and solid waste disposal.

Table 3. Biobased Fuels and Fuel Additives - Guideline for Minimum Biobased Content (%)

Sub-category	Minimum Biobased Content (%)
'Neat' products	90%
Formulated products	15%
Fuel additives	80%



Biofuels Subcategories

Liquid Fuels

The product subcategory of *biobased fuels and fuel additives* includes liquid fuels such as ethanol, methanol, biodiesel, and Fisher-Tropsch diesel. These biobased products can be used as vehicle fuel, heating and lighting products, or as fuels to generate steam or electricity. The liquid fuels can be used as a 'neat' product or as a formulated product. For example, ethanol is the most widely used *biobased fuel and fuel additive*. It is typically made by fermentation of an agricultural product or residue. Ethanol can be used directly as a fuel or can be used as an oxygenated additive and a source of octane in a formulation with other fuels. Another liquid biobased fuel is biodiesel. Biodiesel is defined as a mono-alkyl ester of vegetable oils or animal fats and has been accepted under EPACT as an alternative fuel for regulated fleets at levels as low as 20% blends with petroleum diesel. Biodiesel can be used as a 'neat' fuel, i.e. 100% biodiesel, or blended, for example 20% biodiesel, as a formulation with conventional diesel fuel.

Biobased Content is the weight of the biobased material divided by the total weight of the product and expressed as a percentage by weight. Vendors must provide evidence of the biobased material content in the product or system *in addition* to the standards and specs required for the product class.

Biobased Fuels and Fuel Additives

Gaseous Fuels

The product subcategory of *biobased fuels and fuel additives* includes gaseous fuels derived from biological sources such as hydrogen and methane. These biobased products can be burned as fuels or used for chemical conversion to generate electricity. Gaseous fuels can be used as a 'neat' product or as a formulated product. For example, synthesis gas can be made from biomass, and is composed primarily of hydrogen and carbon monoxide. Hydrogen can be recovered from the synthesis gas or it can be converted to methanol. Synthesis gas can also be pressurized into a liquid fuel for use as a motor fuel. Another example of a gaseous fuel is methane. Methane can be produced from agricultural products or residues using anaerobic digestion or pyrollysis. These fuels can be blended with natural gas or used directly.

Solid Fuels

This product subcategory of *biobased fuels and fuel additives* includes solid fuels containing agricultural residues or products. These biobased products can be used as fuels for stoves, furnaces, and boilers to produce direct light, heat, steam and electricity. The solid fuels can be used as a 'neat' product or as a formulated product where the biobased component can serve either as the binder or the main fuel source.

Solid fuels can be made from agricultural materials such as wood and wood processing residues, formed wood residue; papers, paper sludge and other paper processing residues; grains and grain processing by-products and residues; by-products or residues from soy, cotton and sugar processing; and pelletized residues from livestock production and processing, including manures.

Biobased solid fuels are typically 'formed' for ease of handling into a wide variety of shapes and sizes, including pellets, rolls, and briquettes. Combustible binders, which may be used as neat fuels and/or blended with other primary fuels, allow the solid to be formed into various shapes and sizes. Biobased binders, such as resins and propellants, are also used to facilitate ignition and combustion. Formed coal fines are one example of a solid fuel. Recovered coal fines can be formed into a variety of shapes and sizes, e.g. pellets and briquettes, by using a biobased binder or a combination binder composed of biobased materials and other chemicals. The total biobased content is usually about 5% by weight of the final product. Biobased binders typically comprise only a small part of the total solid fuel and can be derived from dairy by-products and other agricultural sources. The binder would be considered a *biobased fuel additive.*

Biobased Content is the weight of the biobased material divided by the total weight of the product and expressed as a percentage by weight. Vendors must provide evidence of the biobased material content in the product or system *in addition* to the standards and specs required for the product class.

Inks

Description

Inks, derived from biobased materials, have been successfully demonstrated and are increasingly being accepted as viable alternatives to traditional formulations.

These inks can be used to print a broad range of documents, including newspapers, magazines, brochures, business cards, and reports. The inks can also be used with a variety of specialty applications, including stencils, textiles, labeling, as well as pens and other writing instruments.

In 1994, the U.S. Congress enacted the "Vegetable Ink Printing Act", mandating that all Federal lithographic printing be performed using ink made from vegetable oil and materials derived from defined renewable resources.

Newspaper Printing with Soy Ink is one example of the use of biobased inks. Over 90% of all U.S. daily newspapers use soy ink that is made by blending soybean oil with pigments, resins and waxes to make either black or color ink. Unlike petroleum inks, soy ink does not release volatile organic compounds (VOCs) into the atmosphere upon drying. Newspapers printed with soy ink are also easier to recycle.

Agricultural Sources

The majority of biobased inks are made from soy oil or other types of vegetable oils.

Vendor Requirements

Vendors should provide data for their biobased *inks* to document biobased content, source of biobased material (i.e. particular crop or livestock), commercial production capacity, total sales of product in previous years and two year sales projections (sales presented as total weight of product sold so that the amount of biobased materials used can be determined). Vendors should also verify that the product has low or no toxicity to humans, animals, aquatics or plants, and that the product or its processing reduces regulated air and water emissions and solid waste disposal.

To be included in the *Inks* category, the minimum biobased content must be:

Table 4. Inks -

Guideline for

Minimum Biobased Content (%)

Sub-category	Minimum Biobased Content (%)
News inks – black	40%
News inks - color	30%
Sheet-fed inks	20%
Forms inks	20%
Heat-set inks	10%
Specialty inks	20%

Biobased Content is the weight of the biobased material divided by the total weight of the product and expressed as a percentage by weight. Vendors must provide evidence of the biobased material content in the product or system *in addition* to the standards and specs required for the product class.

Landscaping Materials and Composted Livestock and Crop Residue

Description

Landscaping materials include bark, chips, mulch, and pine needles that serve aesthetic and functional purposes. Many biobased products, such as construction materials, coatings, paper, fibers and sorbents are compostable and reusable as landscaping materials. *Compost* is derived from a managed process that decomposes and transforms organic material into a soil-like substance called humus. Food scraps, leaves, paper, wood, livestock manures, and agricultural residues are excellent organic materials that can be composted. *Composting* reduces the amount of waste that may go to a landfill and it produces a valuable soil amendment that can improve the texture and fertility of the soil.

The *composting* process uses microorganisms such as bacteria and fungi to break down organic materials. For the process to work best, it is important that these microorganisms have an adequate supply of organic material, water and oxygen. Managing the temperature of the *composting* material is also important to make the process work. When the *composting* process is complete, the finished product is a valuable soil amendment that is rich in organic matter.

Compost can be blended with nutrient-poor soil to enhance its characteristics and quality. Compost can also be used to control soil erosion when uniformly applied at thicknesses of 2 to 4 inches on slopes of up to 2:1. Slopes with problem soils and more runoffs typically require greater application rates. On highly unstable soils, compost can be used in conjunction with appropriate structural measures.

Agricultural Sources

Various agricultural crops and residues, including straws and short rotation woody crops cab be good sources of compost materials. For the purposes of this category, woody materials are those obtained from: forest thinning, fuel reduction in plantation stands, regenerated forest stands, intensively cultivated short rotation woody stands, woody residue and recovered wood products.

Vendor Requirements

Vendors should provide data for their biobased *landscaping materials and composted livestock and crop residue* to document biobased content, source of biobased material (i.e., particular crop or livestock), commercial production capacity, total sales of product in previous years and two year sales projections (sales presented as total weight of product sold so that the amount of biobased materials used can be determined). Vendors should also verify that the product has low or no toxicity to humans, animals, aquatics or plants, and that the product or its processing reduces regulated air and water emissions and solid waste disposal.

Table 5. Landscaping and Composted Material - Guideline for Minimum Biobased Content (%)

Sub-category	Minimum Biobased Content (%)
Landscaping materials	100%
Composted residues	100%

Biobased Content is the weight of the biobased material divided by the total weight of the product and expressed as a percentage by weight. Vendors must provide evidence of the biobased material content in the product or system *in addition* to the standards and specs required for the product class.

Biobased Lubricants and Functional Fluids

Description

Biobased lubricants and functional fluids are important materials used to reduce friction between moving surfaces or between moving and stationary surfaces in engines and other machinery. Lubricants also help to dissipate the heat on those surfaces and provide other benefits such as corrosion protection. *Biobased functional fluids* are used to transfer heat and/or pressure to or from surfaces, reduce friction in machining operations, and provide electrical insulation.

There is a broad range of *biobased lubricant and functional fluid* products*,* each of which must be carefully designed and developed to meet particular performance needs and applications. These materials often need to be replaced on a routine schedule to maintain their expected performance.

Vehicles, heavy machinery and mobile equipment use lubricants such as crankcase oils and greases, and functional fluids such as transmission fluids, coolants, power steering fluids, and brake fluids. Industrial equipment uses for lubricants include metal working fluids (cutting and drilling oils and lubricants and stamping and forming lubricants), hydraulic fluids and process fluids (heat transfer and dielectric fluids). Total loss lubricants are released directly into the environment when applied as rail and flange, wire rope, and chain saw lubricants; concrete and asphalt form release fluids; and two- cycle engine oils.

Agricultural Sources

Biobased lubricants and functional fluids are typically made from multiple components including one or more base stocks, plus additives that enhance performance or extend the life of the product. A variety of agricultural-based oils can be used as *biobased lubricants and functional fluids*, including but not limited to: canola, corn, rapeseed, soybean, sunflower, and animal fats. The base oil used must have sufficient natural or enhanced stability to be used as base stock for biobased lubricants. Biobased products in this category can be base stock (the starting material into which additives and other materials are blended to make the final formulated product), lubricant or functional fluid additive (materials that are used for specific performance benefits such as lower pour point, increase flash point, greater extreme pressure properties, creating a desired viscosity or reduced foam), or formulated lubricant or functional fluid (the final product including base stock and all additives).

Vendor Requirements

Vendors should provide data for their biobased *landscaping materials and composted livestock and crop residue* to document biobased content, source of biobased material (i.e., particular crop or livestock), commercial production capacity, total sales of product in previous years and two year sales projections (sales presented as total weight of product sold so that the amount of biobased materials used can be determined). Vendors should also verify that the product has low or no toxicity to humans, animals, aquatics or plants, and that the product or its processing reduces regulated air and water emissions and solid waste disposal.

Table 6. Biobased Lubricants and Functional Fluids

Guideline for

Minimum Biobased Content (%)

Sub-category	**Minimum Biobased Content (%)**
Base stock	90%
Additive	70%
Formulated product	15%

Biobased Content is the weight of the biobased material divided by the total weight of the product and expressed as a percentage by weight. Vendors must provide evidence of the biobased material content in the product or system *in addition* to the standards and specs required for the product class.

Biobased Lubricants and Functional Fluids –Continued

Lubricants

Biobased lubricants can be added to fuels used in 2-cycle engines, such as those found in lawnmowers, chainsaws, string trimmers, and other small machinery. *Biobased lubricants* can include bar, chain and sprocket oils or general purpose lubricants used for cleaning.

Hydraulic Fluids

Biobased hydraulic fluids can be used in construction equipment, industrial pumps, as well as in specialty uses where incidental food contact may occur. These specialty fluids can also be used in transmission systems of vehicles and other transportation equipment.

Metalworking Fluids

Biobased functional fluids can be used to lubricate and cool metals and non-metal parts during cutting, fabrication, and drilling operations.

Other Fluids

Biobased functional fluids can serve as mold release agents that are applied to wood, metal or plastic forms prior to pouring concrete or metals. This helps to facilitate the removal of the forms after the concrete or metal has solidified. These biobased products can also be used as dielectric fluids in electric transformers to provide electric insulation and to dissipate heat generated by the transmission of electric current.

Biobased Content is the weight of the biobased material divided by the total weight of the product and expressed as a percentage by weight. Vendors must provide evidence of the biobased material content in the product or system *in addition* to the standards and specs required for the product class.

Biobased Paints and Coatings

Description

Paints and other types of coatings, such as stains, varnishes and sealants can be derived from agricultural materials. These coatings serve the critical function of enhancing the appearance and protecting the materials onto which they are applied. The protective functions include reducing corrosion, preventing water infiltration, and minimizing weathering from sun and wind exposure. *Biobased paints and coatings* have been demonstrated to have similar durability, gloss, and flow characteristics as synthetic or petroleum based paints. *Biobased Paints and Coatings* have a wide range of uses that also include protection of seeds to enhance germination, marine coatings, concrete and wood sealers, stains, corrosion inhibitors, and polishes.

Agricultural Sources

A wide variety of agricultural materials can be used in *biobased paint and coatings* applications, including: (1) xanthan gum, which helps to thicken latex paints and coatings, and uniformly suspend zinc, copper, and other metal additives in corrosion control coatings; (2) cellulose esters and ethers, which can be used to make lacquers and paints; (3) guayule derived epoxy-amine can be used to make coatings for metal panels that help protect the metal from corrosion during exposure to fog and salt; (4) corn, soy, wheat and other proteins can be used to make coatings for paper and cardboard; (5) epoxidized soybean oil can be used as an intermediate chemical in the manufacture of paints.

Vendor Requirements

Vendors should provide data for their *biobased paints and coatings* to document biobased content, source of biobased material (i.e. particular crop or livestock) commercial production capacity, total sales of product in previous years and two year sales projections (sales presented as total weight of product sold so that the amount of biobased materials used can be determined). Vendors should also verify that the product has low or no toxicity to humans, animals, aquatics or plants, and that the product or its processing reduces regulated air and water emissions and solid waste disposal.

The minimum biobased content for Biobased Paints and Coatings is 20%.

Biobased Content is the weight of the biobased material divided by the total weight of the product and expressed as a percentage by weight. Vendors must provide evidence of the biobased material content in the product or system *in addition* to the standards and specs required for the product class.

Biobased Plastics – Monomers and Polymers

Description

The majority of plastics used today are made from petroleum sources, e.g. oil-based, monomers and polymers. Plastics can, however, be derived from a wide variety of agricultural materials such as starch, cellulose, and natural oils.

The plastic materials made from biobased monomers (such as plant oils, propane diol and lactic acid) can be fabricated to closely resemble the molecular structures of petroleum based plastics and provide particular performance and application benefits, e.g. thermoplastic or thermoset characteristics, pressure sensitivity, and elastomer characteristics. Products made from *bioplastics and biopolymers* can be extruded or molded as formed products or rolled as films. Formed products include cutlery, plates, bowls and packaging 'peanuts' while films can include wrapping materials, shopping and trash bags, capsules, pressure sensitive adhesives, and casings. In addition, chemically modified biopolymers can be used as specialty chemicals in such applications as surfactants, plasticizers, lubricants, and in the manufacture of vinyl plastics, paints, and polyurethane for cushions and pads.

Agricultural Sources

Agriculturally derived *bioplastics and polymers* are typically more biodegradable and significantly less toxic to use or produce than their petroleum counterparts. *Bioplastic polymers* include: (1)cellulose - the most plentiful carbohydrate, which comprises 40 percent of all organic matter in the world; (2) starch - found in corn, potatoes, wheat, tapioca, and other plants, which can be used for non-food purposes such as paper, cardboard, textile sizing, and adhesives; collagen - the most abundant protein found in mammals, which can be used to make sausage casings, medication capsules, and photographic films; casein – a commercial product derived mainly from skimmed milk that can be used in adhesives, binders, protective coatings, and other products; corn, soy and wheat proteins are abundant and can be used to make adhesives and coatings for paper and cardboard; polyesters are produced by bacteria through fermentation processes and are used in biomedical applications.

Vendor Requirements

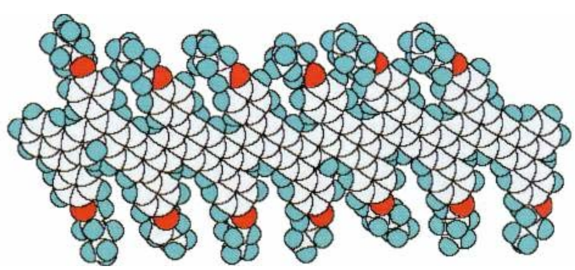
Vendors should provide data for their biobased *bioplastics and biopolymers* to document biobased content, source of biobased material (i.e. particular crop or livestock), commercial production capacity, total sales of product in previous years and two year sales projections (sales presented as total weight of product sold so that the amount of biobased materials used can be determined). Vendors should also verify that the product has low or no toxicity to humans, animals, aquatics or plants, and that the product or its processing reduces regulated air and water emissions and solid waste disposal.

Table 7. Biobased Plastics – Monomers and Polymers

Guideline for

Minimum Biobased Content (%)

Sub-category	**Minimum Biobased Content (%)**
Base stock	70%
Additive	90%



Biobased Content is the weight of the biobased material divided by the total weight of the product and expressed as a percentage by weight. Vendors must provide evidence of the biobased material content in the product or system *in addition* to the standards and specs required for the product class.

Biobased Solvents and Cleaners

Description

Biobased solvents and cleaners are widely used in manufacturing and as product ingredients in adhesives, paints, and coatings. Biobased solvents and cleaners tend to be less volatile than petroleum-based products, are typically non-reactive with other chemicals, are non-corrosive, and are rapidly assimilated by the environment. Solvent and cleaner applications for this product category are broad, and include alternatives to such petroleum chemicals as trichlorethylene, xylene, toluene, and methylene chloride, Other common uses for this product category include fabric and textile cleaning, fruit and vegetable cleaning, removal of tar, oil, stains, and paints from concrete and metal surfaces, paint stripper for metals and wood, carpet and upholstery cleaner, solvent for inks, paints and other materials, graffiti remover, and industrial parts cleaning.

Agricultural Sources

Biobased solvents and cleaners are made from renewable agricultural materials, including corn, soy, and livestock.

Vendor Requirements

Vendors should provide data for their biobased *solvents and cleaners* to document biobased content, source of biobased material (i.e. particular crop or livestock), commercial production capacity, total sales of product in previous years and two year sales projections (sales presented as total weight of product sold so that the amount of biobased materials used can be determined). Vendors should also verify that the product has low or no toxicity to humans, animals, aquatics or plants, and that the product or its processing reduces regulated air and water emissions and solid waste disposal.

Table 8. Biobased Solvents and Cleaners

Guideline for

Minimum Biobased Content (%)

Sub-category	Minimum Biobased Content (%)
Neat or Concentrate Product	90%
Formulated Product	50%

Biobased products in this category can be 'neat' or concentrated products that are used directly or blended with other materials prior to use, or formulated products.

Industrial Cleaners and Degreasers

Parts Cleaning Compounds are products containing one or more *biobased solvent* that are formulated with other performance additives such as surfactants, biocides, and rheology agents. These products are used in manufacturing and fabrication operations for cleaning parts prior to assembly or in repair operations such as automotive shops. They may be combined with other technologies such as supercritical fluid cleaning, media blasting, ultra-sonics, vibratory cleaning, and vapor degreasing.

Metal Cleaners can be neat or formulated products used for cleaning large metal surfaces such as the interior of storage tanks and ship holds.

Printing Ink Removers are formulated products used for the removal of ink from printing presses and other printing equipment such as blanket washes and screen cleaners.

Adhesive/mastic removers are generally formulated products designed to remove adhesives or mastics from machinery used in gluing applications or from surfaces where an adhesive or mastic has been applied (such as in tile removal).

Paint Strippers are generally formulated products designed to remove paints from wood or metal surfaces.

Asphalt Removal and Release materials are formulated or neat solvent products used to remove built up asphalt from machinery, or it can be used as a pre-spray for dump trucks to prevent sticking of asphalt to truck beds.

Biobased Content is the weight of the biobased material divided by the total weight of the product and expressed as a percentage by weight. Vendors must provide evidence of the biobased material content in the product or system *in addition* to the standards and specs required for the product class.

Biobased Solvents and Cleaners—Continued

Institutional Cleaners and Degreasers

Hard Surface Cleaners include general-purpose formulated products for the removal of greases and other dirt from metal, tile, glass, plastics and hard surfaces.

Glass cleaners are generally formulated products for the removal of dirt from glass surfaces with minimal or no film residues.

Food Machinery Cleaners are formulated products used to remove accumulated greases and soils from metal and non-metal parts of food machinery such as meat saws and slicers, vent fans, ovens, cooking vats, etc. These should be approved for incidental food contact and certified by the manufacturer as safe for such uses.

Textile cleaners are formulated products for the removal of heavy stains from textiles prior to institutional cleaning (dry cleaning or laundry).

Graffiti Removers are formulated products for the removal of graffiti (spray paint, markers, crayons, etc.) from metal and or wood surfaces.

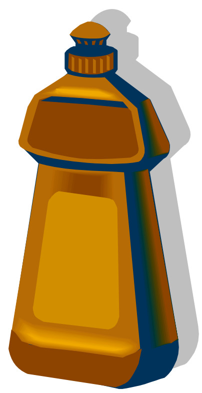
Concrete, Stone and Masonry Cleaners are formulated products that remove oil, grease, soot and other soils from concrete driveways/sidewalks, stone and masonry.

Household Cleaners and Other Products

Hand cleaners and Soaps are formulated products for the removal of heavy greases and dirt from skin.

Laundry Aids include stain removers and pre-wash agents for the treatment of stains on fabrics.

Wood Cleaners and Polishes are formulated products for cleaning and polishing wood surfaces and furniture.



Biobased Content is the weight of the biobased material divided by the total weight of the product and expressed as a percentage by weight. Vendors must provide evidence of the biobased material content in the product or system *in addition* to the standards and specs required for the product class.

Biobased Sorbents

Description

Biobased sorbents are materials that are used to take up and hold liquids. Their use is broad and includes collection of oil and other environmental spills, collection of blood and fluids in medicinal and surgical applications, collection of urine in diapers and incontinence products, and animal bedding.

There are three mechanisms by which liquids are collected by the sorbent: *absorption, adsorption*, or both. *Absorbents* allow the liquid to penetrate into pore spaces in the sorbent material they are made of, while *adsorbents* attract the liquid to the sorbent surface but do not allow the liquid to penetrate into the sorbent.

Agricultural Sources

A wide range of agricultural materials can be used as *biobased sorbents*, including but not limited to wool, cotton and cotton linters, vegetable starch, kenaf, and agricultural residues such as corn stover and peanut hulls. Biobased products in this category must address the function of the entire product, e.g., the sorbent itself as well as the casing or framework holding or enclosing the sorbent.

Vendor Requirements

Vendors should provide data for their *biobased sorbents* to document biobased content, source of biobased material (i.e. particular crop or livestock), commercial production capacity, total sales of product in previous years and two year sales projections (sales presented as total weight of product sold so that the amount of biobased materials used can be determined). Vendors should also verify that the product has low or no toxicity to humans, animals, aquatics or plants, and that the product or its processing reduces regulated air and water emissions and solid waste disposal.

Table 9. Biobased Sorbents

Guideline for

Minimum Biobased Content (%)

Sub-category	Minimum Biobased Content (%)
Sorbents	90%
Sorbent Systems	75%

The *biobased sorbents* product category is organized as two broad groups of products: sorbents and sorbent systems

Sorbents

The product category of *biobased sorbents* includes those products derived from plant or animal matter. Excluded from this category are sorbents such as clay or peat that are extracted from the earth. It is USDA's intent that the active sorbent be a biobased product. For example, cotton fibers can be used to make pads or booms and cotton lint can be used as a dry absorbent that can be spread onto the liquids. Low value wool can also also be used to make absorbent pads.

Kenaf, a fast-growing, drought-resistant, non-wood fiber plant, is related to okra and cotton. The dried stalks of the kenaf plant can be sized to produce a variety of products including industrial sorbents that are lightweight, ultra-absorbent, and 100% biodegradable. Corn stover, corncobs, peanut hulls, and other crop residues are used to absorb liquid spills.

Sorbent Systems

Sorbents can be placed in containers, packages, gauzes, or other carriers to create a sorbent system. This aids in handling of the sorbent and better application of the sorbent at a location to achieve greatest benefit. The sorbent carrier may be of a material other than a biobased product – although use of biobased products as carriers is encouraged. For the purposes of this category, the biobased material is the 'active' part of the sorbent system.

Plant starch contained within a cotton bag is an illustration of a sorbent system. While the plant starch is not the end product, it is the "active" ingredient in these sorbent systems. For example, USDA 's Agricultural Research Service developed a patented sorbent gel that can be considered a sorbent system. The gel is capable of absorbing hundreds of times its own weight in water and has been applied as seed coatings, wound dressings, automobile fuel filters, plastic barriers used at construction sites, and most notably disposable diapers.

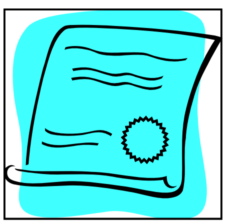
Biobased Content is the weight of the biobased material divided by the total weight of the product and expressed as a percentage by weight. Vendors must provide evidence of the biobased material content in the product or system *in addition* to the standards and specs required for the product class.

Federal Biobased Legislation & Federal Agency Collaboration

Introduction

Although many individuals believe that the Federal Biobased Procurement program originated with the 2002 Farm Bill many actions were taken before this to bring about the creation of such program. Biobased companies are popping up around the country and this program is being developed in a way to enable the federal government to procure these products. Procurement programs have already been established in some agencies and six products have been identified as preferred products. It is now up to the US Agriculture Department (USDA) to analyze the rest of the identified products for their biobased content and to add them to the preferred procurement listed.

Early Actions that Encouraged Federal Procurement of Biobased Products



In September of 1998 the President issued Executive Order 13101, which mandated federal purchases of recycled and environmentally preferred products (EPPs). Then in August 1999, the Interagency Council on Biobased Products and Bioenergy, the Advisory Committee on Biobased Products and Bioenergy, and the National Biobased Products and Bioenergy Coordination Office, were created by a second Presidential Executive Order, 13134. Additional research support for biobased products came from the passage of the Biomass Research and Development Act of 2002.

Historical Overview: Section 9002 Federal Procurement of Biobased Products

Passage

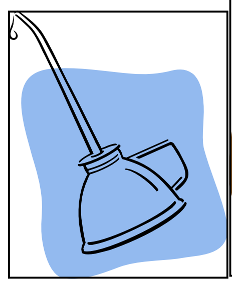
In May of 2002 the Farm Security and Rural Investment Act of 2002 (FSRIA) which included the first Energy Title contained Section 9002 Federal Procurement of Biobased Products. This section requires Federal agencies to purchase biobased products that meet price, availability, and performance standards; provides for a voluntary labeling program of certified “biobased products”; and provides financial assistance for testing of biobased products by manufacturers.

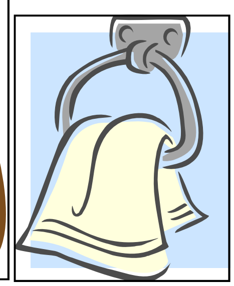
Implementation

As with all federal programs the Federal Procurement of Biobased Products program went through a long process of rule making, comment periods and then final rule making. This process took close to three years and was spurred along in 2004 by a GAO report called *Biobased Products: Improved USDA Management Would Help Agencies Comply with Farm Bill Purchasing Requirements*, was released. The final rule on the first six products was just released in March of 2006.

The items are:

- Mobile equipment hydraulic fluids
- Biobased roof coatings
- Water tank coatings
- Diesel fuel additives
- Penetrating lubricants
- Bedding, bed linens and towels





Federal agencies will not have to give water tank coatings and bedding, bed linens, and towels preferred procurement status until there are two or more suppliers. USDA will issue a Federal Register notice when at least two suppliers are making these items available.

Current Status and Application

USDA is working on a second proposed rule for the next ten products and is drafting a third proposed rule with another ten items. Finally, information on the products to be found in the fourth proposed rule is being gathered.

Success Stories in the Federal Government

Many Federal agencies have begun procuring biobased products because of the earlier Executive Orders and memorandums from agency Secretaries, in addition to the fact that some agencies have found that biobased products have superior characteristics compared to the conventional products. Agencies including the Department of Energy, Interior, Agriculture and Defense have seen great success from using biobased products and should be seen as leaders in the progress towards implement the Federal Procurement Program. For more information, see the **Successful use of Biobased Products in Federal Agencies and Departments Fact sheet.**

Federal Agencies Procuring Biobased Products

All of the Federal agencies listed below have policies or memorandums encouraging the use and procurement of Biobased Products:

- Department of Agriculture
- Department of Energy
- Department of Interior
- Department of the Navy

These agencies have established award programs for offices who submit stories or relevant experiences about their use of biobased products. Some products that have been used by these federal offices include: biodiesel and ethanol, soy-backed carpet, biobased cycle oil, lubricant, hydraulic fluids and solvents.

The Following Links Provide helpful information on the Federal Biobased Preferred Procurement Program:

Federal Biobased Preferred Procurement Program

http://www.biobased.oce.usda.gov/public/index.cfm

Office of the Federal Environmental Executive

http://www.ofee.gov/

Biobased Products and Bioenergy Coordination Council

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

DOE Biobased Products Website

http://www.eh.doe.gov/p2/epp/biobased.html

DOD & USDA Biomass R&D Initiative

http://www.bioproducts-bioenergy.gov/default.asp

For more information on the Federal Biobased Procurement Program contact:

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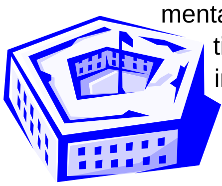
Successful use of Biobased Products in Federal Agencies and Departments

With the President leading the way with his Executive Order 13101, which mandated that the federal government purchase recycled and environmentally preferred products, some agencies began procuring biobased products. When this executive order was codified in Farm Bill Farm Security and Rural Investment Act of 2002 (FSRIA) (7 U.S.C. 8102) in Section 9002 - Federal Procurement of Biobased Products many agencies were already purchasing and using some biobased products.

Awards and Recognition

White House Closing the Circle Awards: Established 12 years ago, totaling nearly 300 projects, to recognize outstanding achievements of Federal employees and their facilities for efforts which resulted in significant contributions to or have made a significant impact on promoting environmental stewardship. There are six different award categories Waste/Pollution Prevention; Recycling; Green Purchasing; Environmental Management Systems; Sustainable Design/Green Buildings and; Alternative Fuel and Fuel Conservation in Transportation. The green purchasing guidelines fall under E.O. 13101, environmental management under E.O. 13148, green/sustainable buildings under both executive orders, and reduced fuel usage under E.O. 13149. The inclusion of biobased products in the 'Green Purchasing' category give these products access to the federal governments huge purchasing appetite.

Department of Defense (DOD) Secretary's Environmental Award: Each year the Secretary of Defense honors installations, teams, and individuals for outstanding work in DOD environmental programs. On February 10, 2000, the Environment, Safety and Occupational Health Policy Board (ESOHPB) approved 17 environmental awards within six categories, including: Natural Resources Conservation; Cultural Resources Management; Environmental Quality; Pollution Prevention; Environmental Restoration and; Environmental Excellence in Weapon System Acquisition. The Pollution Prevention category includes a 'Green Procurement' section which includes the procurement of biobased products.



Department of Interior Environmental Achievement Awards (EAA): DOI employees and teams as well as DOI cooperators (contractors or outside partners) who have attained exceptional environmental achievements are awarded for their achievements based on the White House Closing the Circle Awards criteria. Each year the Secretary of the Interior awards teams and individuals for their outstanding leadership, including in the 'green purchasing' category, then winners of the DOI award are then entered in the Closing the Circle Awards.

Department of Energy's Buy Bio Project and GreenPurchasing award: The Bio Buy Project is a voluntary project that encourages the purchase of commercial or industrial products composed, in whole or in significant part, of biological products or renewable domestic agricultural or forestry materials. The procurement of biobased products directly aligns purchasing habits with DOE's mission of energy security, and the displace petroleum by renewable products.

Success Stories

Closing The Circle Award

Beltsville Agricultural Research Center (BARC)

The Beltsville Agricultural Research Center (BARC) has been constantly expanding the use of **biobased products** since 1999. The Center has worked closely with the Defense Energy Supply Center, to purchase large quantities of **pre-blended B20**, which reduced costs and made it easier for Defense and civilian agencies to purchase the fuel.

In addition to **biodiesel**, the Center utilizes a variety of biobased products on a regular basis. Specific examples include **soy-backed carpet; biobased 2-cycle oil; gear lubricant; hydraulic fluids; lithium grease; anti-wear hydraulic oil; chainsaw bar and chain lubricant; oil cutter; penetrating fluid; power steering fluid; and engine oil**. **All shops utilize biobased hand cleaners, parts cleaners, and metal cleaners.**

Successes—Continued

When it was time to negotiate a new janitorial contract, BARC included in the statement of work a requirement that the contractor utilize biobased and/or environmentally preferable cleaning materials, restroom hand soaps, and other products. The contract was successfully awarded, and these products are being used on a daily basis in all buildings.

DOD Secretary's Environmental Award

Waste Pollution/Prevention-Civilian

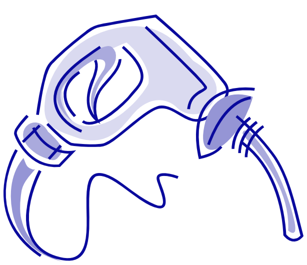
Department of Homeland Security

Over the past four years, USCG Air Station Borinquen, Puerto Rico, has changed from a focus almost entirely on hazardous waste disposal activities to a unit-wide waste prevention effort led by a full-time environmental protection specialist with cross departmental and community support. These pollution prevention efforts have led to increased usage of energy efficient products, replacement of solvent-based cleaners with a self-recycling solvent system and a **biobased aqueous parts cleaner**, and an aggressive recycling program.

Energy Efficiency in Transportation-Civilian

National Aeronautics and Space Administration

The Energy Policy Act and Executive Order 13149, Greening the Government Through Federal Fleet and Transportation Efficiency, require Federal agencies to acquire alternative fuel vehicles as 75 percent of their new acquisitions of light-duty vehicles. **Alternative fuels include ethanol**, compressed and liquefied natural gas, propane, and **biodiesel**. Agencies also are required to increase the fuel economy of their vehicles and reduce their petroleum fuel consumption. The National Aeronautics and Space Administration (NASA) exceeded the 75 percent alternative fuel vehicle acquisition requirement for 125 vehicles by acquiring 330 total credits in FY 2004. NASA acquired 308 light-duty vehicles in 2004, 167 of which were EPAct-covered, and gained 61 credits for using **biodiesel**. The agency also used **alternative fuels** for 27 percent of its operation of AFVs, an increase of 18 percent over FY 2003.



Energy Efficiency in Transportation-Military

Department of Defense

The Marine Corps has exceeded the Energy Policy Act (EPAct) requirements for the past five years, led Department of Defense and other Federal agencies in the adoption of **biodiesel**, introduced and expanded the use of neighborhood electric vehicles, and met the 2005 requirements for Executive Order 13149 in 2003, two years ahead of schedule. During FY 2004 the Marine Corps had a 27.5 percent fuel reduction and a 243 percent compliance with EPAct, while using more than 1.2 million gallons of **biodiesel**. In addition to the 28 neighborhood electric vehicles purchased last year, the Marine Corps is seeking to procure 48 hybrid vehicles for use by its recruiting force and is taking an active step for the future of hydrogen-powered fuel cell vehicles.

DOI Environmental Achievement Awards

Pictured Rocks National Lakeshore, National Park Service (NPS), Michigan

Mr. Chris Case, Facility Manager at the NPS Pictured Rocks National Lakeshore, is recognized on his ground-breaking work institutionalizing the Pictured Rocks comprehensive **Bio-Fluids/Lubricants Program**. This program created and managed by him, showcases the effectiveness and benefits of **bio-based fuels and lubricants** use at DOI facilities. For example, his program demonstrated that **biodiesel** works effectively even in Michigan's cold winter temperatures, which had been a barrier to **biodiesel** use at some DOI facilities. His most noteworthy accomplishment's is that he shares his knowledge and experiences with other facility managers in DOI and across the Government. Through his far-reaching education efforts, he has presented his lessons learned to nearly 1,000 Government employees and officials who can duplicate his success.

Grand Teton Lodge Company, National Park Service

Grand Teton Lodge Company (GTLC) continues to demonstrate their commitment to environmental stewardship at Grand Teton National Park and the surrounding community through a company-wide, ISO 14001 certified Environmental Management System. GTLC remains one of Jackson County's largest recyclers and supports Jackson Community Recycling by sponsoring electronics recycling, fluorescent lamp recycling, and serving on the recycling board. In order to advance renewable energy use and conservation, GTLC partnered with Lower Valley Energy to champion the commercial availability of wind-generated power in Wyoming. In cooperation with Grand Teton National Park, GTLC uses **biodiesel** in all trucks and buses.

Parker River National Wildlife Refuge, Fish and Wildlife Service

Parker River National Wildlife Refuge built a 15,945 square-foot sustainable design visitor center and headquarters that has features in all of the Leadership in Energy and Environmental Design (LEED) categories. Sustainable elements include a heating and cooling system that uses the ambient temperature of ground water to regulate the building's temperature; natural ventilation systems; **recycled-content wood columns, roof trusses, carpet, linoleum flooring, and drywall**; low or no Volatile Organic Compounds and hydro-chlorofluorocarbons materials; and no cremated copper arsenate preservatives in exterior wood. The Commonwealth of Massachusetts' Department of Parks and Recreation contributed $1,000,000 toward design and construction of the facility. Interpretive exhibits provide education on the benefits of sustainable buildings, wise resource management, and environmental stewardship.

Procurement Objectives

The procurement of biobased products follows the same fundamental principles and organizational objectives as that of general procurement. These principles and objectives include:

- Provide an uninterrupted flow of supplies and materials to maintain operations.
- Keep inventory investment and loss at a minimum.
- Maintain product quality and performance standards.
- Improve the organization's overall function and competitiveness.
- Accomplish all procurement activities at the lowest possible level of product and administrative costs.

Source: Erridge, Lammings, Cousins, Bowen, Faruk

Possible Biobased Supplier Initiatives

As an organization, there are some activities that can be initiated as part of the process to achieve greater biobased products utilization. The following is a list of such activities.

- Supplier audits and assessments
- Development of biobased criteria on approved supplier list
- Mandated certification or accreditation by independent party
- Jointly developed biobased products technology with supplier
- Engagement of supplier in design for biobased product innovation
- Conducting life cycle analyses with cooperation from suppliers
- Influence legislation in cooperation with suppliers
- Creation of a supply club to collaborate on biobased products issues
- Matching of biobased purchasing policy with organizational objectives

Source: Lambert and Stock

A General Outline for the Development of a Biobased Product Procurement Process

1. Identify major types of procurement that could easily utilize biobased products, such as:

   1) Facilities Operations Support Services, 2) Construction, 3) Landscaping and Grounds Keeping, 4) Maintenance and Repair of Vehicles and Trailers, 5) Maintenance, Repair and Alterations, 6) Custodial and Janitorial Services, and 7) Food Services/Cafeteria)

2. Develop clear language of what constitutes a biobased product.

3. Clarify objectives in the purchasing policy that reflects the company's overall corporate social responsibility policies.

4. Characterize supply base and set criteria for prioritizing suppliers.

5. Develop best methods for collecting information from priority suppliers, e.g. direct surveys, accreditations, background checks, interviews of other buyers.

6. Set minimum standards for biobased product characteristics, e.g. component mix, component percentage, purity, and production process.

7. Life cycle analysis of major input materials.

8. Develop database or protocol to track technological changes and emerging biobased products.

9. Develop database or protocol to track biobased procurement performance and success.

Source: Various

Procurement Guide –Continued

Biobased Management System

For managers, there are several things to keep in mind in the context of achieving greater biobased products utilization. A successful biobased products procurement initiative should embody the following management practices:

- Communication of the biobased policy throughout entire organization, not just purchasing.
- Compliance records for adherence to biobased policy.
- Well defined roles and responsibilities at all management levels for increased usage of biobased products.

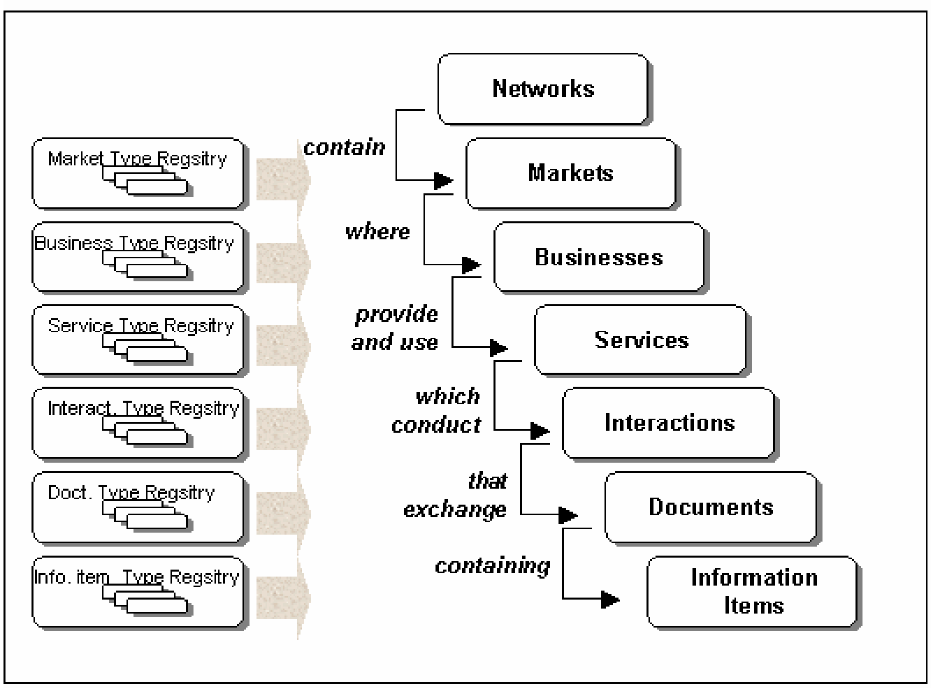
Source: Lammings and Hampson

Getting to Know the Supplier

One of the most important components of a successful biobased procurement program is the building of a relationship with the supplier. A vendor assessment program can be developed or modified to accompany some specific criteria that have a focused relevance to biobased products procurement, including:

- Attitude to biobased products
- Willingness to cooperate with the customer's original motivation for using biobased products, i.e. economic development, national security, environment, public health.
- Willingness to actively participate in learning more about the customer or buyer.
- Willingness and ability to implement a biobased product line or policy.

Source: Lammings and Hampson



Digitizing the Biobased Procurement Process– Some E-Models to Consider.

Buyer-centric e-procurement model

In this purchasing model, it is the buyer who implements the software to support its own procurement processes. The buyer obtains catalogue data from its contracted suppliers and creates a single internal catalogue for the use by its purchasing officers.

Source:htttp://www.agimo.gov.au/publications/2000/04/checklist/appendix_c

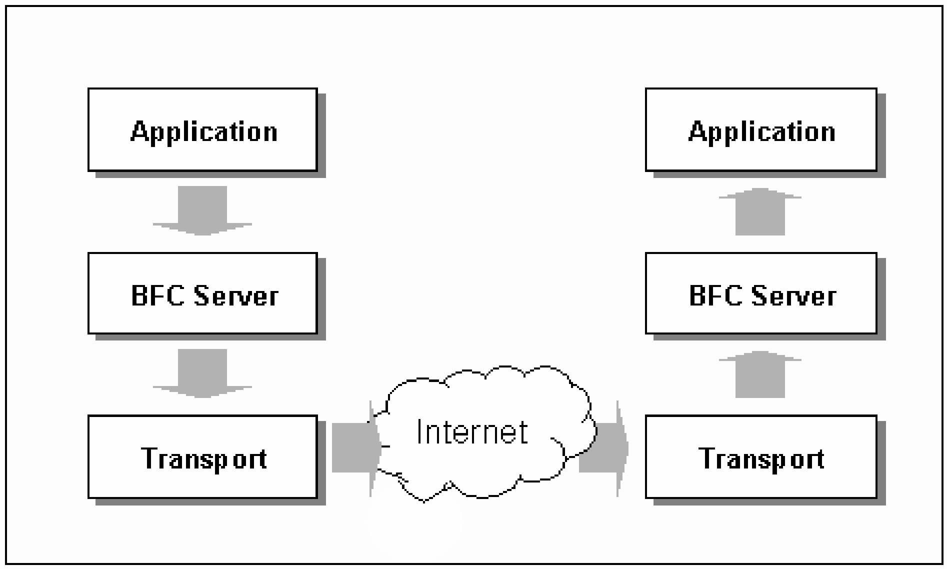
Procurement Guide –Continued

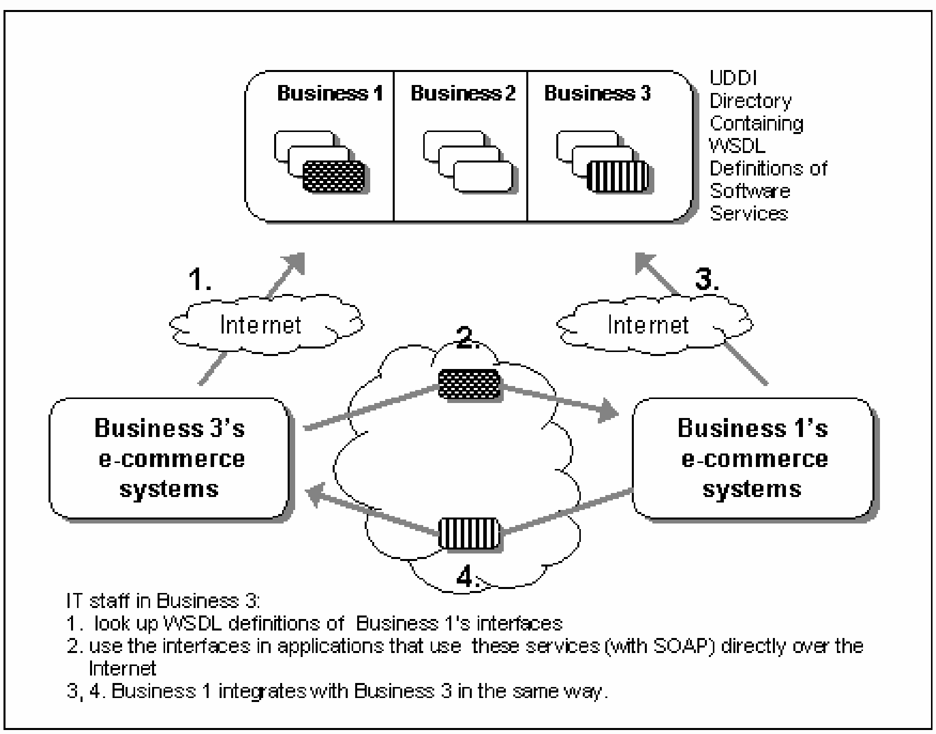
Digitizing the Biobased Procurement Process– Some E-Models to Consider.

Seller-centric e-procurement model

In this model, the supplier provides a software system where buyers can browse the supplier's catalogue and place orders.

Source: http://www.agimo.gov.au/publications/2000/04/checklist/appendix_c





Digitizing the Biobased Procurement Process– Some E-Models to Consider.

Third party-managed e-procurement model

In this system, buying and selling organizations trade on an independent platforms. This platform is provided by a third party software and database developer.

For a complete checklist of developing an E-procurement system

http://www.agimo.gov.au/publications/2000/04/checklist

Procurement Guide– Resources for Buying Biobased Products

General Web Resources:

- http://www.bioproducts-bioenergy.gov/
- http://www.biobased.us/index.html
- http://www.carbohydrateeconomy.org/
- http://www.nal.usda.gov/ttic/biofuels/research.htm
- http://www.ofee.gov/gp/bioprod.html
- Biobased Industrial Products: Research and Commercialization Priorities
- http://www.ciras.iastate.edu/usdabio.asp
- http://www.epa.gov/oppt/epp/gentt/textver/topic22.html
- http://p2library.nfesc.navy.mil/Fact_Sheets/DSDATA/sotbysection.html#12
- http://www.epa.gov/cleanenergy/tools.htm
- http://www.biobased.oce.usda.gov
- http://www.nrel.gov
- http://soybiobased.org
- http://www.biomasss@bcs-hq.com
- http://www.greenproducts.net
- http://www.soyoyl.com
- http://www.gemtek.com
- http://www.enduratite.com
- http://www.cleanenvironmentco.com
- http://www.griffinind.com
- http://www.stepan.com
- http://www.snogel@agp.com
- http://www.columbusfoods.com
- http://www.hiperfuels.com
- http://www.soypower.net
- http://www.worldenergy.net
- http://www.techoils.cargill.com
- http://www.hampeloil.com
- http://www.schaefferoil.com
- http://www.admworld.com
- http://www.eh.doe.gov/p2/epp/buybio/index.html
- http://www.bio.org/ind/background/biobasedproducts2.asp
- http://www.biomasscouncil.org/
- http://www.cglg.org/biomass/
- http://www.nrbp.org/index.htm
- http://www,serbep.org/
- http://www.bioenergy.ornl.gov/

Proprietary Databases:

The following directories have proprietary databases that allow searches by specific companies, keywords, industries, and locations. A procurement manager interested in purchasing "biobased" and "environmentally friendly" products can search via these key words to locate the specific companies that emphasize these product lines.

- **Harris Info Space, Harris Industrial Directory.**
- **U.S. Industrial Directory**
- **Regional Industrial Buying Guide**

Procurement managers can access these databases by yearly subscriptions, or by finding a higher educational institution with current subscriptions.

Relevant Books for Discussion of Broader Concepts

Title: Biorenewable resources : engineering new products from agriculture / Robert C. Brown.

Published: Ames, Iowa : Iowa State Press, 2003

Title: The biobased economy of the twenty-first century : agriculture expanding into health, energy, chemicals, and materials / edited by Allan Eaglesham, William F. Brown, and Ralph W.F. Hardy.

Published: Ithaca, N.Y. : National Agricultural Biotechnology Council, c2000

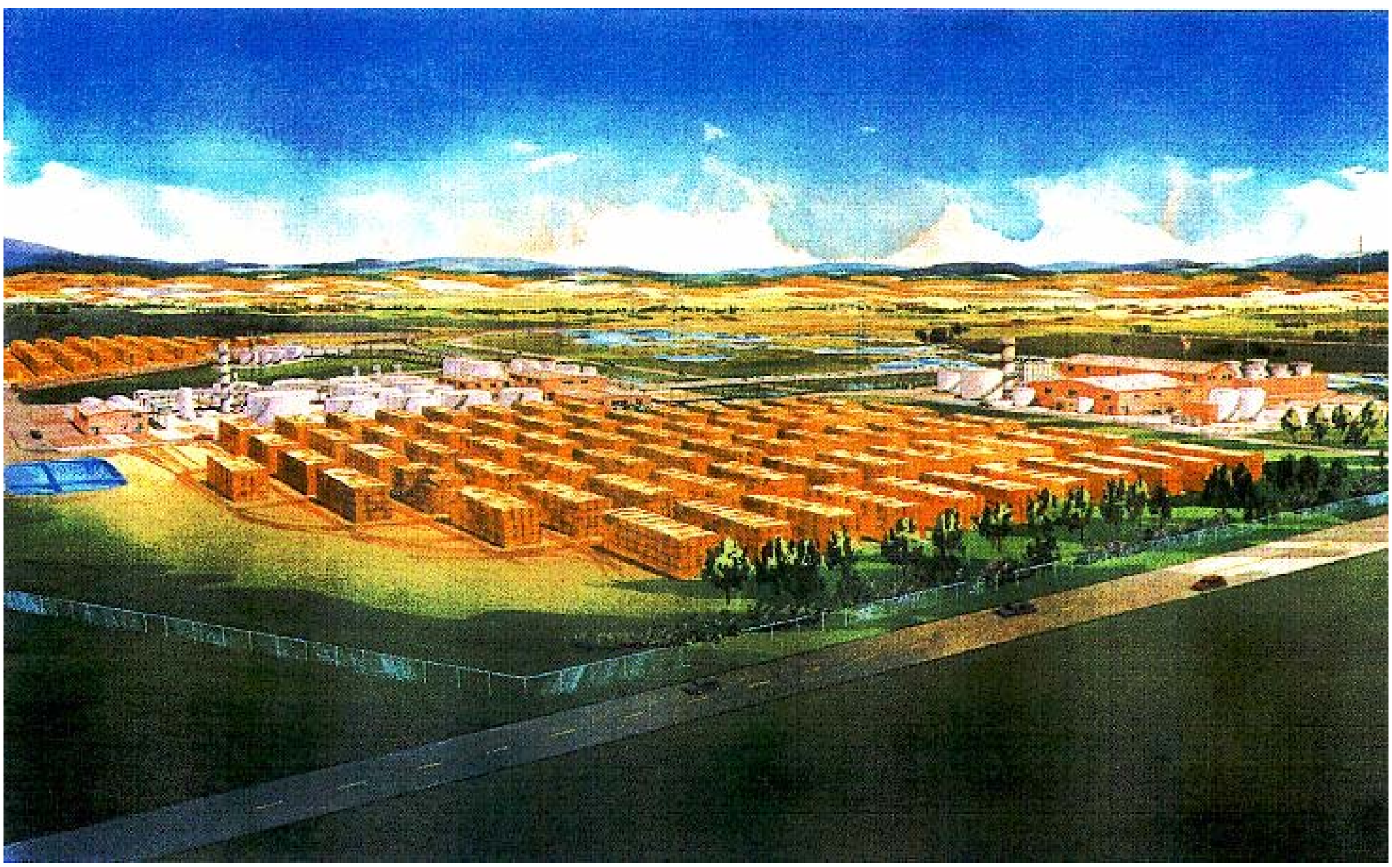
Title: The green multiplier : a study of environmental protection and the supply chain / Lutz Preuss.

Published:Basingstoke, Hampshire ; New York : Palgrave Macmillan, 2005.

The Biorefinery Concept-
An Overview From The National Renewable Energy Laboratory

A biorefinery is a facility that integrates biomass conversion processes and equipment to produce fuels, power, and chemicals from biomass. The biorefinery concept is analogous to today's petroleum refineries, which produce multiple fuels and products from petroleum. Industrial biorefineries have been identified as the most promising route to the creation of a new domestic biobased industry.

By producing multiple products, a biorefinery can take advantage of the differences in biomass components and intermediates and maximize the value derived from the biomass feedstock. A biorefinery might, for example, produce one or several low-volume, but high-value, chemical products and a low-value, but high-volume liquid transportation fuel, while generating electricity and process heat for its own use and perhaps enough for sale of electricity. The high-value products enhance profitability, the high-volume fuel helps meet national energy needs, and the power production reduces costs and avoids greenhouse-gas emissions.



Conceptual Biorefinery

NREL's biorefinery concept is built on two different "platforms" to promote different product slates. The "sugar platform" is based on biochemical conversion processes and focuses on the fermentation of sugars extracted from biomass feedstocks. The "syngas platform" is based on thermochemical conversion processes and focuses on the gasification of biomass feedstocks and by-products from conversion processes.

NREL Biorefinery Development Activities

The NREL Biomass Program is involved with six major biorefinery development projects that are focused on new technologies for integrating the production of biomass-derived fuels and other products in a single facility. The emphasis is on using new or improved processes to derive products such as ethanol, 1,3 propandiol, polylactic acid, isosorbide, and various other chemicals.

Second Generation Dry Mill Refinery (Broin and Associates, Inc.) This project will enhance the economics of existing ethanol dry mills by increasing ethanol yields and creating additional co-products.

Integrated Corn-based Biorefinery (E.I. du Pont de Nemours & Co., Inc.) This project will build a bio-based production facility to convert corn and stover into fermentable sugars for production of value-added chemicals.

Making Industrial Biorefining Happen (Cargill Dow LLC National) This project will develop and validate process technology and sustainable agricultural systems to economically produce sugars and chemicals such as lactic acid and ethanol.

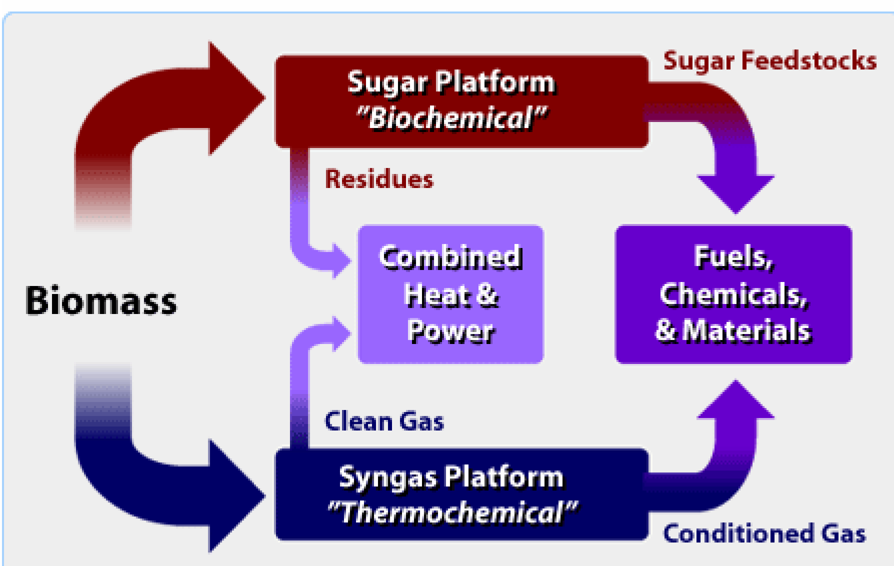
Advanced Biorefining of Distiller's Grain and Corn Stover Blends (High Plains Corp.) This project will develop a novel biomass technology to utilize distiller's grain and corn stover blends to achieve significantly higher ethanol yields while maintaining the protein feed value.

DOE Biorefinery Development Activities

New Biorefinery Platform Intermediate (Cargill, Inc.) This project will develop a biobased technology to produce a wide variety of products based on 3-HP acid, which is produced by fermentation of carbohydrates.

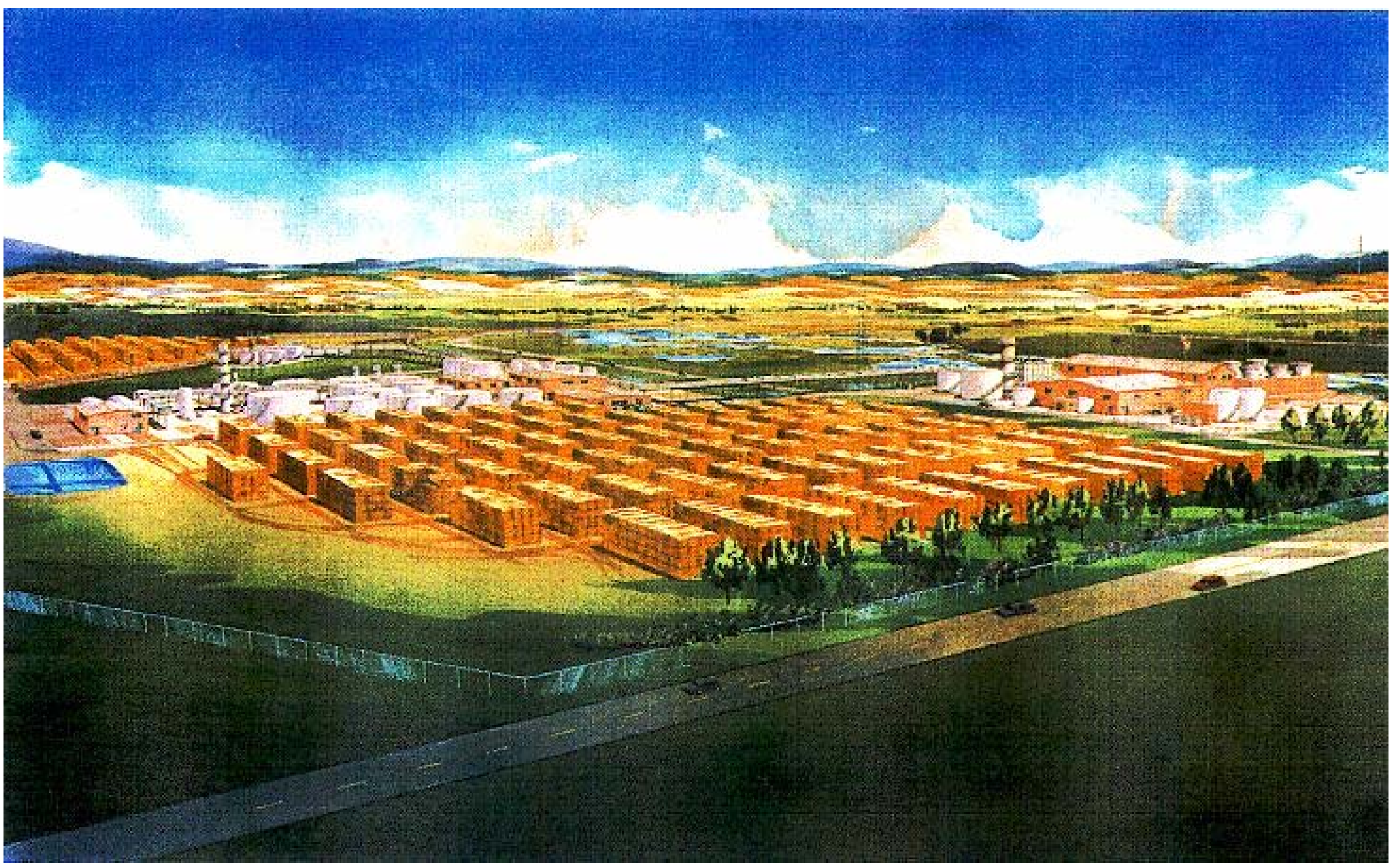
Separation of Corn Fiber and Conversion to Fuels and Chemicals (National Corn Growers Association) This project will develop an integrated process for recovery of the hemicellulose, protein, and oil components from corn fiber for conversion into value-added products.

Biorefinery Concept



The Biorefinery Concept- A Technical Overview for Producers

In order to better understand how the agricultural community can participate in non-food applications for their farm commodities, an overview is needed on the types of renewable products that are feasible for commercialization. This section of the report details various types of raw material compounds that can be processed for a wide range of industrial applications. The types of raw materials are divided into three major classes according to their most basic biochemical makeup: (1) Nitrogenous compounds, which includes amino acids, enzymes, and other complex proteins (2) Fats and oils, and (3) Carbohydrates and other fibrous materials.



Nitrogenous Compounds

Amino Acids

Amino acids are nitrogenous compounds that serve as the building blocks for more complex protein molecules. At the most basic level, amino acids contain an amino group (NH_2) and a carboxylic acid group (COOH). The presence of various side groups differentiate the 20 types of amino acids. In addition to serving as the building block for proteins, amino acids are also vital as molecular messengers, and as intermediates in cellular metabolism. Amino acids can exhibit chirality, which is simply a structural form capable of producing mirror image of differing physical orientation, e.g. the right and left hand.

Market and Applications

It Began with MSG

The commercialization of amino acids date back to 1908 with the discovery of monosodium glutamate (MSG) as a flavor enhancement. Earlier production processes were expensive, as they utilized acid or base hydrolysis to breakup whole protein molecules. In 1956, the Kyowa Hakko corporation found a microbial process that outperformed the economics of hydrolysis, and mass commercialization of MSG at a cheap price became possible. To date, Kyowa Hakko remains one of the world's largest producers of amino acids, and continues to develop and retain innovative microbial processes for production of other amino acid types. The utilization of MSG as a food flavoring is currently the largest segment of the amino acid world market in terms of volume, which amounts to approximately 700,000 metric tons per year on a global basis (Wheeler, 1999).

Nutraceuticals

Nutraceuticals represents a particularly high growth segment within the amino acids markets. Nutritional formulas for the infant and elderly population generates an annual amino acid demand of 5000 metric tons, with an additional 1500 tons distributed to the dietary supplements market (Wheeler, 1999). The growth rates in these amino acid sectors are expected to range between 10 to 15 percent on an annual basis. Common amino-acids produced for human consumption include lysine, arginine, isoleucine, leucine, valine, glutathione and n-acetyl-cysteine.

Animal Feed

Animal feed is the largest and most extensive amino acid application in the United States. Annual sales in the U.S. market are approximately $911 million, and growing at a rate of 2.5% per year. Total global volume of animal feed amino acids is currently estimated to be at 700,000 metric tons on an annual basis. The popularity of amino acid enriched feeds are particularly prominent amongst swine feed producers, who are now substituting crude proteins (such as soybean and corn) with lysine and threonin. These amino acid formulations are deemed to be superior nutrient delivery methods. Lysine, especially, is anticipated to expand at a rate of 7.5%, with emerging markets in Latin America and China. The widespread use of Lysine can be attributed to the discovery of a cheap and efficient fermentation process in the early 1990s that allowed the commodity to aggressively penetrate the animal feed market.

Pharmaceutical

Pharmaceutical applications pose a special requirement for amino acids, whereby the chirality of the molecule must be fully distinguished and separated before use. A molecule with the same composition, but with opposite "mirror" orientations of its active groups, can produce completely different effects as a drug. While one form can function as a treatment, its mirror counterpart may produce fatal results.

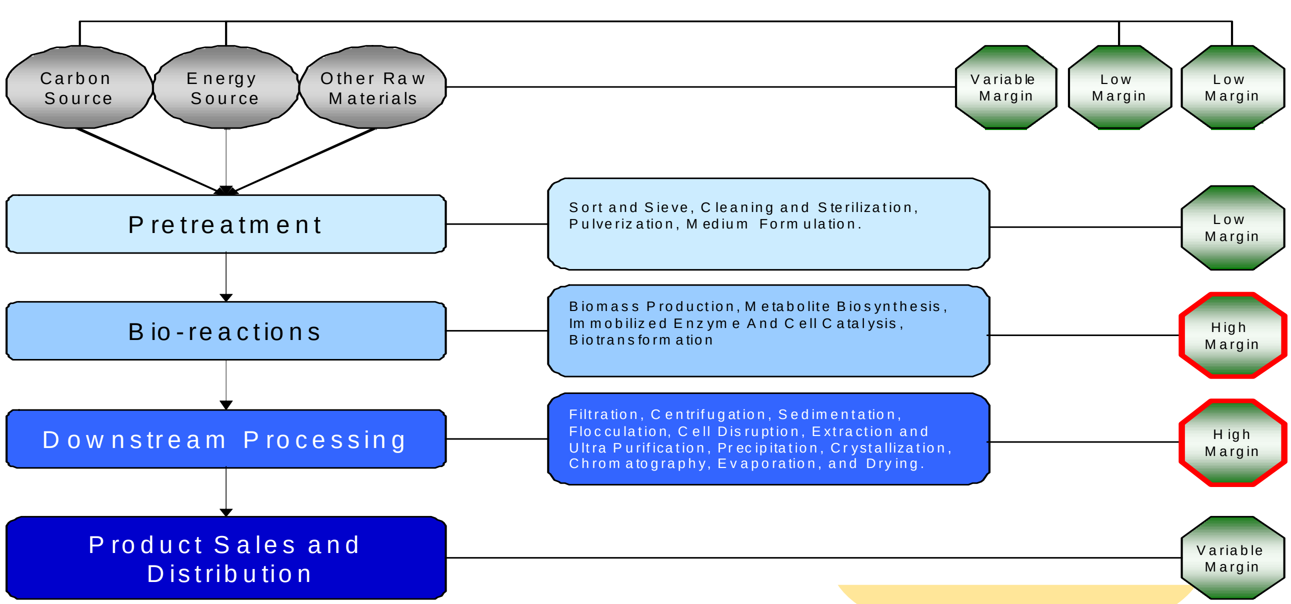
The pharmaceutical industry represents a relatively small segment of the total worldwide amino acid volume. However, this particular market is already showing double digit growth (Wheeler, 1999), and is poised to become one of the largest revenue generators for amino acid producers. In 2002, sales of single-enantiomer drugs topped $159 billion, almost doubling the figure of $87.9 billion just five years before (Lisakka, 2003). The majority of the top selling drugs to date are chiral in nature, including the two leading drugs of Lipitor and Zocor in the 2002 world market (Rouhi, 2003). The ability to produce and refine chiral amino acids is an extremely high value process for any biotechnology or specialty chemical firms.

Amino Acids—Production Process

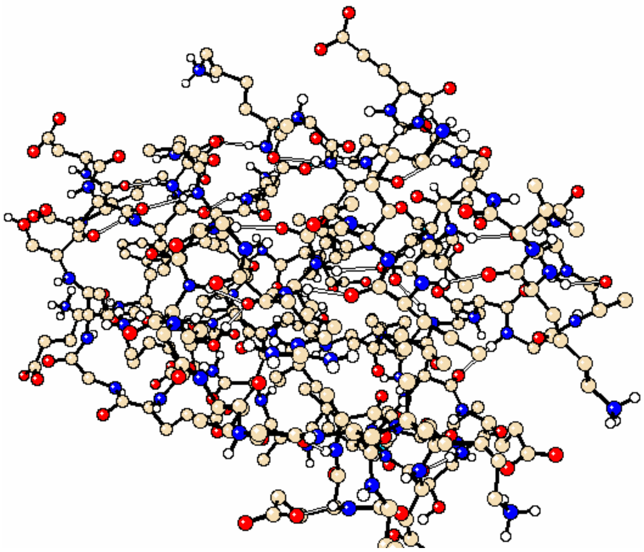
Various production processes have varying combinations of efficiency and profit margins. Table 5 describes the process and yield of various production methods, and Figure 10 demonstrates some of the different margins for the various activities in the fermentation process.

Table 10.	Description	Chiral Specificity	Relative Yield
Fermentation	Manipulation of microorganisms to affect the overproduction of the desired amino acid.	Capable of high specificity and enantiomer differentiation	High
Chemical Synthesis	Multiple sequence of reactions involving a number of starting chemicals to produce the final de-	Mostly Incapable (and costly) in producing specific enantiomers	Low to Medium
Enzymatic Reactions	Combination of enzymes and precursor materials that generates a specific pathway for amino acid	Capable of high specificity and enantiomer differentiation	Varies
Bio-transformation	Unlike fermentation, microorganisms do not internally generate the desired amino acid, but rather manipulate a number of starting materials in a medium to achieve end product.	Capable of high specificity enantiomer differentiation.	Medium
Hydrolysis	A strong solution (such as an acid) is used to break the peptide bonds of a protein molecule into its component amino acids, followed by purification and extraction.	Mostly incapable of producing distinguishable enantiomers	Low

Fermentation Value Chain and Processes



Enzymes



Introduction

Enzymes are complex protein molecules that function as a biological catalyst in chemical reactions. Several abilities of the enzyme molecule account for its prominence, which includes: (1) high specificity (chiral specific differentiation) between the enzyme molecule and the substrate, (2) controllability of reaction rates and inactive states, (3) recoverability of the enzyme, as the molecule itself is not altered in its function as a catalysts, (4) efficiency of reactions in relatively mild conditions, (5) economically more cost effective than lengthy and complex chemical reactions, and in most cases (6) more environmentally friendly, and "greener" in overall perception (Moses, Cape, and Springham, 1991). Despite these winning characteristics, enzymes must face the persistent obstacles of molecular stability and costs.

Perhaps the most notable early use of enzymes was in the production of potable alcohol, whereby the fermenting organisms function as a live enzyme package. Enzymes can also function in a separate medium once secreted by the producing organism. The recognition of this fact led to the next development phase for the molecule, which is to extract and concentrate the enzyme directly from living sources, e.g. the isolation of chymosin from calf stomach for use in cheese making. (Moses, Cape, and Springham, 1991).

The production, use, and recovery of enzymes have grown in complexity, sophistication, and efficiency. For example, many enzymes today can be produced via the genetic modification of specific single or combined organisms. The current day repertoire of isolated enzymes is about 2000. Enzymes are usually classified according to the type of chemical reaction they catalyze. The following table exhibits these six major classes.

- **Hydrolases** catalyze bond breakage with the addition of water. This is the largest group of industrially applied enzymes.
- **Ligases** catalyze the joining of two molecules.
- **Oxidoreductases** catalyze oxidation or reduction of their substrate.
- **Transferases** catalyze group transfer.
- **Lyases** remove groups from their substrates.
- **Isomerases** catalyze intramolecular rearrangements.

Source: Leisola, Jouni, Pastinen, & Turunen

Enzyme Production Process

The majority of today's industrial enzymes are produced by the fermentation process of microorganisms, while a smaller portion is extracted from plant and animal sources. Many of the fermentation derived enzymes utilize microorganisms that have been genetically reengineered to over-express the enzyme producing gene. On occasion, further protein engineering is required to achieve the desired properties such as stability in extreme thermo conditions.

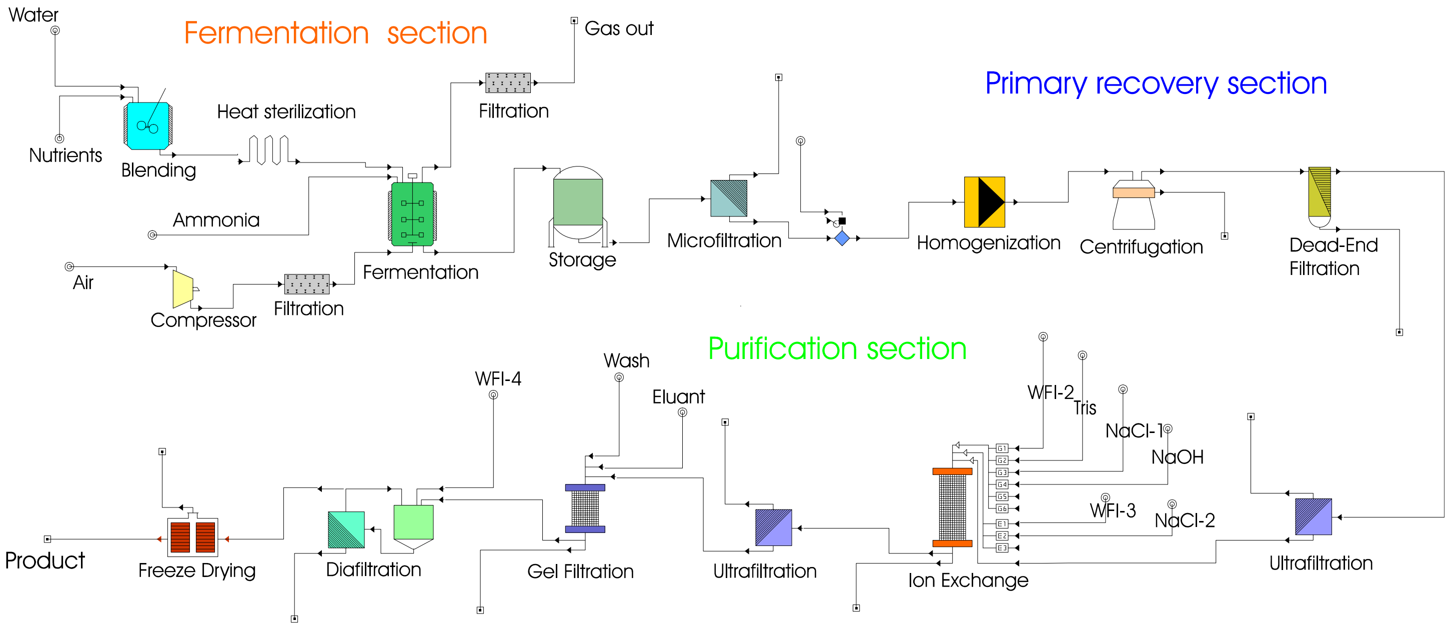
The production of enzymes via fermentation can be divided into six major steps:

- Enzyme selection
- Microorganism selection
- Genetic engineering to over-express the desired product
- Optimization of culture medium and production conditions
- Optimization of recover and purification process
- Protein engineering to achieve thermo stability or other properties.

The following figure diagrams the fermentation production process of enzymes in more detail.

Enzymes—-Continued

ENZYME PRODUCTION FLOW SHEET



Source: Leisola, Jouni, Pastinen, & Turunen

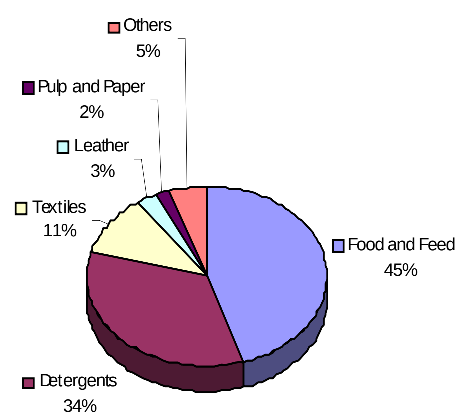
Market Overview

The current global market for enzymes is estimated to be worth $2 billion USD, with a projected annual growth rate of 5% (Guzman, 2005). Optimistic industry experts predict a sales volume of $3 billion by 2008, with an estimated growth rate of 6.5% (Mirasol, 1998). Fig 12. shows worldwide consumption profile of industrial enzymes.

Industrial Enzymes in the Food Market

The food processing industry represents one of the largest end users of industrial enzymes, which are applied in the preparation of starch, dairy, fruit juice, alcoholic beverages, and baking. Since 1998, industrial enzyme manufacturers have received a boost from the food processing industry as more health conscious consumers demand the displacement of undesired chemicals. Food processors have also provided the drivers for industrial enzymes by elevating their standards in food quality, process savings and higher product yields. (Mirasol, 1998). Perhaps the best example of this “green” trend is the replacement of bromide in the baking process with the enzyme lacase, an enzyme that also helps to produce dough of higher stability, elasticity, and shape retention.

Fig 1. Worldwide Consumption Profile of Enzymes



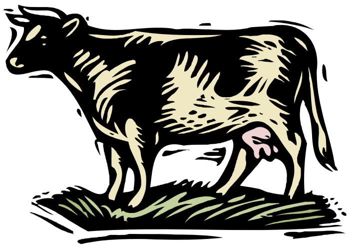
Enzymes—-Continued

Starch and sugar processing is the single largest application for food enzymes, primarily due to consumption by the soft drink industry. Food enzymes are used to make high fructose corn syrup (Jarvis, 2001).

The surge of innovation in food processing enzymes since 1998 can be attributed to the collaboration between food processors and enzyme manufacturers. This has propelled the food enzymes market in the US to a total of $142.4 million in 2003, with projected revenue of $184.5 million in 2010. Among the enzymes used in food application, those used in the bakery industry constitute nearly one third of the market (Guzman, 2005). Bakery applications is considered one of the fastest growing subsectors within the enzyme market. Conventional enzymes, such a amylases are mature and will grow about 3%/year, in line with overall food industry growth. The U.S. food enzyme market is expected to grow at 6.5 % per year, and higher estimates places the total U.S. sales to have already reached $230 million in 2004 (Seewald, 2001).

After decades of slowdown in growth, enzymes are making a comeback in food applications. Advanced discovery and optimization of manufacturing techniques have renewed interest and spurred rapid development. Much of the innovation is coming from collaboration between food processors and enzyme manufacturers. Consolidation among the major producers is likely to open the door to small, specialty producers that can supply low volume niche-markets with high value enzymes. These niche markets can be an effect entry point for the agriculture industry.

Industrial Enzymes in Animal Feed



Enzymes are added to animal feed to increase digestibility of essential vitamins and minerals, increase nutritional value and animal product yield, and reduce harmful materials in waste. In barley and wheat , added enzymes break down some of the glucan to increase the nutritional value of the feed, a practice widely used in Europe and Southeast Asia. A recent development is the use of phytase in swine feed to reduce the need for added phosphates, thus reducing the environmental impact of the animal excretions. The company Diversa, for example, has several products in development, including carbohydrases and proteases which will increase the digestibility of carbohydrates and promote weight gain in livestock (Challenger, C. 2003)

Industrial Enzymes in Pharmaceuticals

Enzymes, like amino acids, can express chiral specificity in its structure. Single enantiomer compounds are of high value in the pharmaceutical industry, since different enantiomers of the same drug compound can mean the difference between a cure and a toxin. Of the 820 drugs that were development in the year 1998, for example, 75% (or 610) were single enantiomer products. The potential of these biocatalysts in drug manufacturing can be a major driver for the enzyme industry, especially those companies that must survive on large margin (Papanikolaw, 1998). Innovations in enzyme production can also directly expand or branch into the development of advanced pharmaceutical proteins (since enzymes are essentially one or groups of complex peptide chains). Companies like Novozymes are pursuing biopharmaceuticals as a means to expand their market presence (Challener, 2003). Since 1998, major pharmaceuticals have also begun to outsource some of their raw material production functions, thus creating new market arenas for enzyme manufacturers (Papanikolaw, 1998).

Industrial Enzymes in Detergents

The highly competitive laundry and dishwasher detergent industries have also driven enzyme research and development initiatives in the last few years. The recent focus has been on lower washing temperatures, shorter washing cycles, and higher detergency (Guzman, 2005). Advanced developments in proteases, amylases, and lipase continue to offer hope for a recently stagnant detergent market. In 2003, demand for detergent enzymes totaled about $140 million for the U.S. market. Increased demand is projected for traditional detergent enzymes in emerging markets such as Eastern Europe and Asia (Van Arnum, 1997).

Complex Industrial Proteins: Gluten and Collagen

Gluten

Gluten is a complex mixture of proteins that is found predominant in wheat. The largest single application for gluten is in baking and cereal production. Recent interest in environmentally renewable products have spawned interest in using gluten as a substitute for some fossil derived chemicals and materials. Besides starch and cellulose, gluten proteins have excellent potential for applications in packaging materials, films, adhesives, and surfactants. The biodegradable properties of gluten make it ideal for disposable (one time use) type of products (R.J. Hamer, 2003).

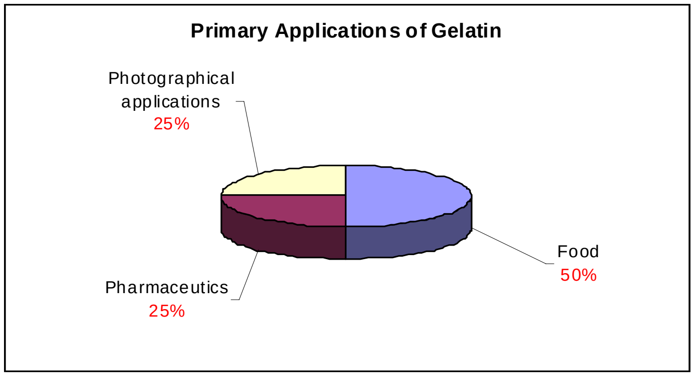
Gluten Properties	Gluten Applications and Products
Naturally insoluble in water. Viscous and elastic properties.	Biodegradable films, adhesives, coatings, and packing material.
Once made soluble, gluten can act as a an adsborbent interface between liquid and other phases: 1. air & liquid (foams) , 2. oil & liquid (emulsions).	Cosmetic and cleaning agents.
Adhesive properties	Substitute for more expensive casein derived proteins.

Non-food applications for gluten.

Table 11.

Collagen and Gelatin

Collagen is an abundant but complex group of proteins found in the bone, tendons, and other connective tissues of animals. Highly specialized collagen has a number of high value (though low volume) surgical and pharmaceutical applications (Table 7). Since most medical grade collagen is derived from bovine hides, the raising of specialized cow stocks can provide an additional layer of potential value for the agricultural community. The most prolific use of collagen is as a feedstock protein for the preparation of gelatin. World wide consumption of gelatin for various applications is in the order of approximately 200 kilo tones per year (Wolf, 2003). Figure 13 shows the percentage breakdown for the three major applications of gelatin. Gelatin has a number of important properties that make it useful for a variety of industrial applications (Fig



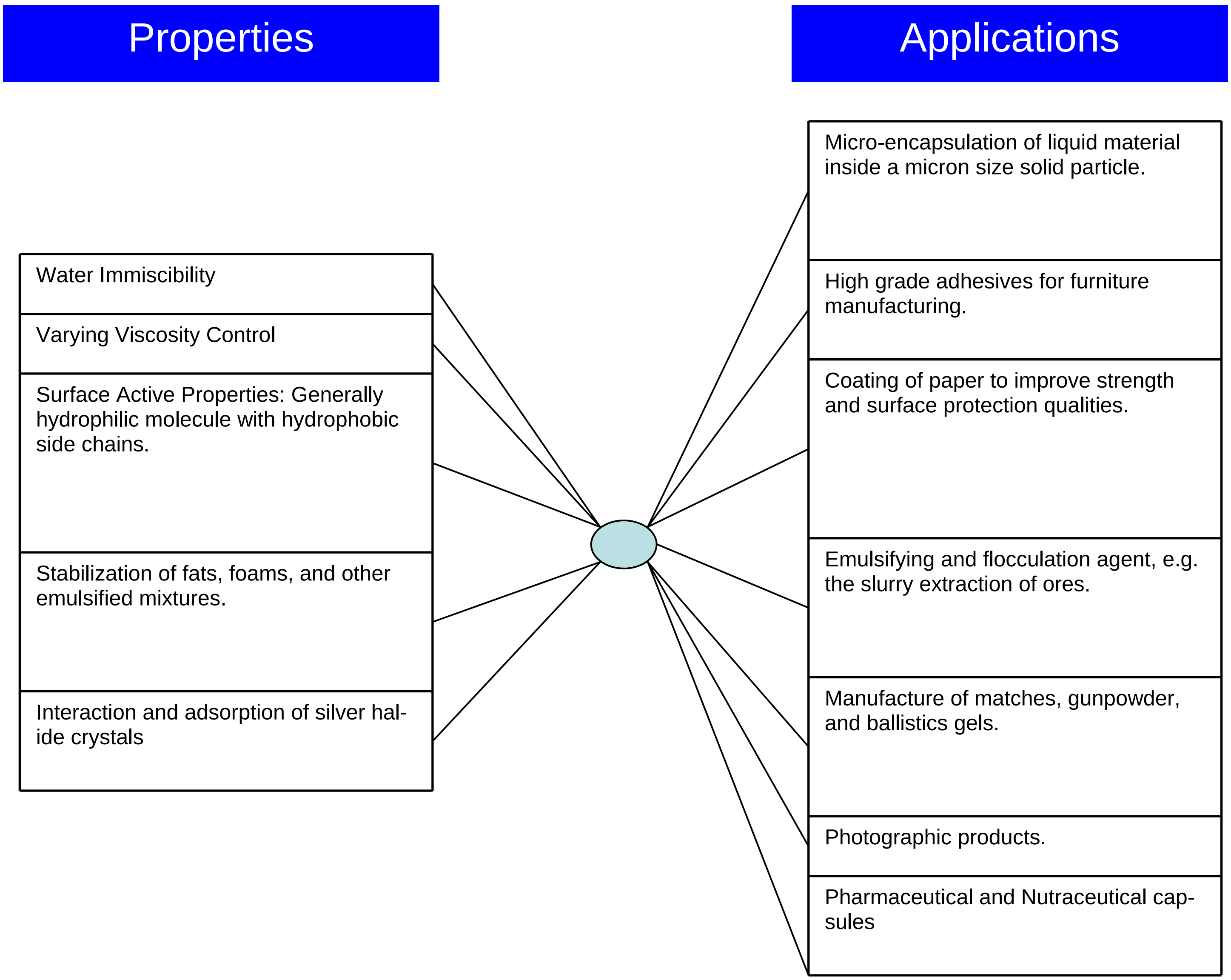
High Value Medical Applications of Collagen	
Formulation	**Application**
Whole tissue substitutes	Porcine heart valves; carotid arteries
Solutions and dispersions	Injectable collagen for cosmetic alterations, bulking agent for constipation, coating for vascular prostheses, culture mediums, and gene delivery systems.
Foam or Sponge	Matrix system for tissue engineering, would dressing, haemostatic material, bone repair, arterial repair.
Microspheres	Drug delivery systems
Fleeces or Non-woven Fibers	Would dressing, haemostatic material, suture dressing.
Gels	Corneal repair, corneal shields
Composite materials	Wound dressing
Air dried films	Wound covering; anti-adhesion coating, periodontal ligament attachment.

Source: (Wolf, Industrial Proteins in Perspective, 2003).

Table 12.

Complex Industrial Proteins: Gluten and Collagen—Continued

Properties and Applications for Gelatin



Fats and Oils

Fats and Oils (lipids) are hydrophobic compounds composed of triglycerides, which can be broken down into free fatty acids and glycerol. Lipids are typically soluble in non-polar molecules like chloroform, methylene, and ethanol. The chemical and physiological properties of fats and oils are determined by the length of the fatty acid chains, by the degree of saturation, and by the type of reactive groups. For example, longer fatty acid chains (12 or more carbons) are used most frequently in detergents, while the shorter varieties are used in plastics manufacturing (Wintsch, 1991).

Glycerol

Glycerol is one of the components of a lipid molecule (usually in the form of an ester). Production of glycerol typically comes about as the byproduct in the hydrolysis of oils to yield free fatty acids. Industrial glycerol can also be derived from propylene, which is a petroleum refined product.

Glycerol Production Process and Applications

Production Process	Applications and Products
Esterfication, hydrolysis of oils and fats. Glycerol is often a byproduct in the production of other compounds.	• Ingredient in cosmetics, personal care products, tobacco, and cough medicines. • Plasticizer for cellophane. • Precursor to solvents, perfume fixatives, explosives, and antifungal agents.

Table 13.

Fatty Acids

Fats and Oils can be hydrolyzed to form various free fatty acids and fatty acid derivatives. Fatty acids are commonly used as chemical intermediates in the production of esters, ethoxylates, and amides, which are then applied in the manufacturing of the following products:

- Pharmaceuticals
- Paper
- Surfactants
- Cosmetics
- Resins
- Nylon-6,
- Plasticizers
- Lubricants

Fatty acids from vegetable and natural oil sources constitute about 40% of total production,in the U.S., with the remaining 60% coming from petrochemical sources. (Biobased Industrial Products, Washington D.C.). Table 9, 10, & 11 show the various forms and derivatives of fatty acids, various production processes, and the corresponding industrial applications.

Free Fatty Acids

Class of Free Fatty Acids	Production Process	Industrial Applications
Saturated	High temperature hydrolysis of fats and oils with or without assistance of catalysts, enzymatic hydrolysis	Internal lubricants in plastics formation, slip and antiblock agents, & mold release agents. Also a crucial component in the formation of: caulking products, crayons, candles, high pressure engine lubricating oils, resins, textile lubricants, cosmetics, soaps, alkyd res-
Monosaturated		
Diunsaturated		
Multiunsaturated		

Table 14.

Fats and Oils

Fatty Acid Salts

Table 15

Types of Fatty Acid Salts	Production Process	Industrial Applications
Salts of Lead, Barium, Strontium, Calcium, Zinc,	Hydrolysis of fats and oils with an alkali & the fatty acids are liberated as their metal salts	Stabilizers for PVC or polyvinyl chloride concrete waterproofing, personal care and cosmetic products, rubber manufacturing, paper and textile coatings.
Salts of Cobalt, Maganese, Calcium, Zirconmium and Lead		Oxidative catalysts that accelerates drying of oil based paints.
Salts of Lithium		Increases viscosity of lubricating oils In the production of industrial grease
Salts of Tin		Catalyst for polyols and and isocyanates flexible foams
Sodium Salts		Various soaps, cosmetics, and personal Care Products

Other Fatty Acid Derivatives

Table 16.

Fatty Acid Derivative	Production Process	Industrial Applications
Fatty alcohols	hydrogenolysis with various catalysts, hydrogenation of methyl esters	Surfactants with high detergent properties that are less toxic than similar products containing benzene rings.
Esters	transesterfication to produce methyl ester, which then serves as intermediate to more complex esters.	Foam stabilizers, viscosity modifiers, detergent additives, thickeners, suspending agents, cosmetic ingredients.
Fatty nitrogen compounds, amides,amines, nitriles	ammonolysis of fatty acid or methyl esters	Various polishes and blending agents, fuel detergent and anti-corrosion agents, engine oil additives, industrial and personal fabric softener, deicer. Treatment ingredient for textiles, furs, paints, and resins.
Oleic acid derivatives	electrically induced ozone treatment and further oxidation to produce azelaic, pelargonic, and petroselinic acids	Synthetic motor oils and lubricants

Biodiesel

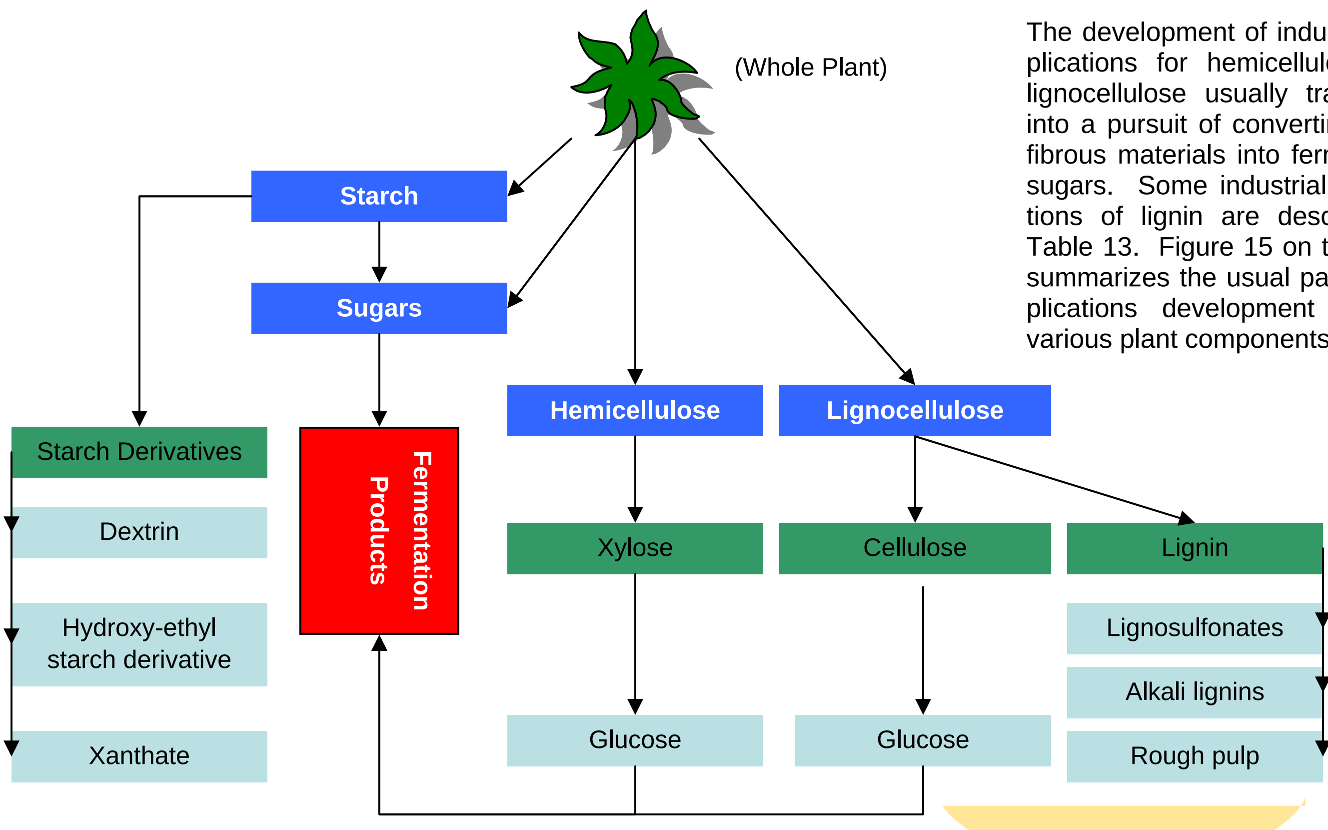
Biodiesel is a clean burning fuel that can be made from crop oils or animal fats. In addition to producing significantly less harmful emissions when combusted, Biodiesel can also be used in a number of industrial applications, including that of a biodegradable solvent or lubricant. The use of Biodiesel in the United States has grown tremendously in the last few years. From just 500,000 gallons in 1999, annual production has increased to an estimated 30 million gallons in 2004. The popularity of this alternative fuel can be attributed to its compatibility with regular diesel fuel and regular diesel engines. In addition to its lowered emissions in almost all categories of pollutants, Biodiesel has the advantage of being domestically produced. Numerous private and public agencies have adopted support and research efforts in the promotion of this versatile fuel, all in the hopes of continuing its growth. North Carolina alone utilized approximately 750,000 Gallons of 100% neat Biodiesel in 2003.

Carbohydrates and Other Fibrous Plant Materials

Different plant and plant parts have varying contents of starches, sugars, cellulose, hemicellulose, and lignin. Starches and sugars account for the majority of the agriculturally derived industrial applications, as they are the most feasible forms of plant material for fermentation processes. Some well known products that are produced via fermentation of starches and sugars include: ethanol, lactic acid, and acetic acid. About 70% of the industrial starch produced in the U.S. is consumed by the pulp and paper industry in the form of sizing agents and adhesive pastes. The remaining 30% is used in food processing and food packaging products (Szmant, 1986). Other polysaccharides, like pullulan and xylans, have structural applications as polymers and fibrous materials. Starches can also form chemical derivatives that have useful properties (Table 12).

Table 17.

Starch Derivative	Properties and Applications
Dextrin	Dextrin is formed by the partial heat degradation of starch. Dextrin is often used in the solvent refining of lubricating oils, butadiene, rosin, and other chemicals. It can also be used (1) as a solvent for nitrocellulose and cellulose acetate; as an intermediate for phenolic and furan resins, which are in turn used in the preparation of nylon; (2) as a component of weed killers and fungicides; (3) as an intermediate in the production of lysine; and (3) as an ingredient for refining rare earth.
Hydroxy-ethyl starch derivatives	Starch can undergo chemical reactions with ethylene to form a chemical used in the production of polyurethane foams.
Xanthate	Starch, via a reaction epichlorohydrin can be converted to a form of cross linking Xanthate. Xanthates can be used as a chelating agent for metal ions in the treatment of waste water, and as a slow release formulation for agrichemicals.



The development of industrial applications for hemicellulose and lignocellulose usually transforms into a pursuit of converting these fibrous materials into fermentable sugars. Some industrial applications of lignin are described in Table 13. Figure 15 on this page summarizes the usual path of applications development for the various plant components .

Carbohydrates and other Fibrous Plant Materials — Continued

Functions and Applications of Lignin

Table 18.

Lignin Functions	Applied Materials
Dispersing Agent	Asphalt emulsions, carbon black-rubber mixtures, stucco slurries, ceramic mixtures, pigment paste formulations
Binding Agent	Gypsum wall boards, metal sand cores, animal feed pellets, charcoal briquets
Leveling Agent	Printing process & ore mining.
Plasticizing Agent	Cement
Humectant	Printing paste
Sequesterant	Calcium and other mineral ions
Stabilizer	Soil and mulch

State Biobased Product Initiatives

Overview

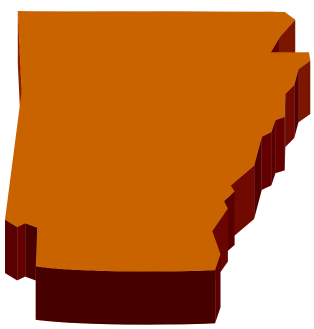
Many states have begun to recognize that biobased products represent an important economic development opportunity for utilizing their existing resources, including their biomass resources, labor resources, and existing industrial capabilities. With rising petroleum prices pushing the cost of petroleum-derived products higher, in combination with continued advancements in biotechnology, and Federal policies that support biobased product commercialization, state governments have a good basis for fostering the production and use of biobased products in their states.

State Actions to Foster Biobased Product Development

The following examples highlight the range of state initiatives that have been undertaken to promote the development and use of biobased products.

Arkansas

The Arkansas Biobased Products Act of 2005 (HB 1543) promotes the economic development of biobased products in Arkansas and requires state agencies to consider purchasing biobased products.

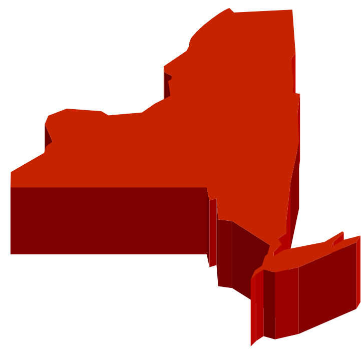


Michigan

In February 2006 it was announced that the Mid-Michigan Innovation Alliance will be receiving a $15 million 3-year grant from the U.S. Dept. of Labor (DOL) to create new jobs in bio-based fuels, chemicals, and materials. Mid-Michigan is a 13-county region that stretches from the state capital in Lansing, eastward to Saginaw. A key focus of the effort will be to refocus automotive supplier firms once tied to the automotive industry to emerging and growing bio-based manufacturing markets. Michigan's Governor Jennifer Granholm spearheaded the effort to bring the federal dollars to Michigan. Michigan State University (MSU) will lead the effort, including outreach assistance through the MSU Extension program.

New York

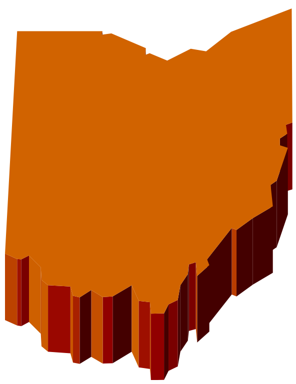
In November 2005, the New York State Energy Research and Development Authority provided $500,000 under a solicitation focused on facilitating the development, demonstration, and commercialization of bioproduct technologies, equipment, and manufacturing plants. Projects were required to partner with the Syracuse Center of Excellence in Environmental and Energy Systems.



State Biobased Product Initiatives

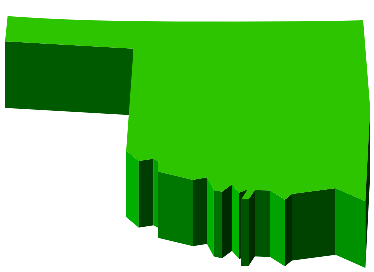
Ohio

The Ohio Bioproducts Innovation Center (OBIC) is a new research initiative that integrates academia and industry toward the development of renewable specialty chemicals, polymers/plastics and advanced materials. The Center was funded in 2005 by the Ohio Department of Development through a $11.5 million award, leveraged with matching funds from external partners. OBIC builds on the strength of Ohio's largest industries — agriculture and the chemicals, plastics and rubber materials sector. In an effort to provide value to industry partners, OBIC operates through a *Cell-to-Sell* approach: a market-pull business model designed to link genetics, biotechnology, chemical conversion and product development for the commercialization of bioproducts. OBIC is headquartered at The Ohio State University.



Oklahoma

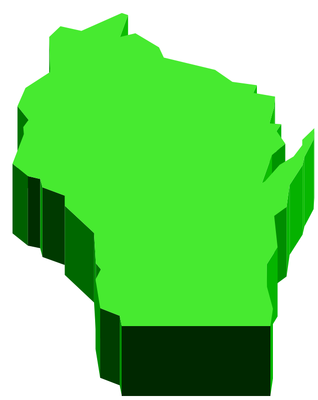
The Oklahoma Biofuels Development Act 2005 (SB 363) provides for the expanded use of Oklahoma agricultural products by encouraging the processing, market development, promotion, distribution and research of various biofuels and their byproducts in the state. The Act establishes an 11-member Oklahoma Biofuels Development Advisory Committee that will address the various market, policy, and development issues specified under the Act.



Wisconsin

Governor Jim Doyle signed "Executive Order 101" in 2005 to establish a Consortium of Biobased Industry to develop short-term and long-term policy and commercialization strategies to promote the development and use of bio-based products and bioenergy. The consortium is composed of stakeholders from the farm and forestry sectors, chemical manufacturing, energy companies, electric utilities, environmental organizations, the research community, and other critical sectors. The goal is to stimulate the creation and early adoption of technologies needed to make biobased products and bioenergy cost-competitive in large national and international markets.

As part of Governor Doyle's initiative to foster Wisconsin's bio-based economy, the Wisconsin Department of Agricultural Trade & Consumer Protection funded a solicitation for proposals in March 2006 titled "Biogrants," which offered $700K in funding. Examples of eligible projects included the development of new ways to generate usable forms of energy or fuels; new biobased products, including new fibers and other biobased materials; new technologies that enhance commercial viability of biobased business; or new systems that transform waste streams into energy or bio-based products.



List of Biomass Coordinators and Information on Biobased Products

Regional Contacts

Pacific Regional Biomass Energy Program

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Western Regional Energy Program

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Western Governor's Association

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Great Lakes Regional Biomass Energy Program

Fred Kuzel

Council of Great Lakes Governors

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Southeast Regional Biomass Energy Program

Kathryn Baskin

Southern States Energy Board

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Northeast Regional Biomass Energy Program

Rick Handley

CONEG Policy Research Center, Inc.

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northeastbio@sso.org

State Contacts

The National Association of State Energy Officials (NASEO) has a listing of the Biomass Coordinator or sometimes referred to as the Renewable Energy Program Manager in the state government energy offices.

Go to: www.naseo.org and click on to States/Territory Offices and then go to the state in the U.S. A. map.

United Soybean Board (USB): Biobased Solutions for Government

The USB has a Soy Products Catalogue that contains updated information on soy-based products and manufacturers.

Go to: www. Soybiobased.org/products catalogue/

USDA Biobased Products and Bioenergy Coordination Council (BBCC)

The BBCC is facilitating and promoting the marketing of biobased products and has current information regarding the federal biobased products program.

Go to: www.ars.usda.gov/bbc/

USDA-Cooperative Extension Service Offices

Each state has a state cooperative extension office and can provide information regarding biobased products.

Go to: www.csrees.usda.gov

BioProducts Canada

BioProducts Canada is an industry-led organization regarding commercialization of biobased products and has a Canadian Bioproducts 2005 Industry Catalogue.

Go to: www.bio-productscanada.org/

Private Organizations

AgroTech Communications, Inc. is working to help expand the use of biobased products.

Go to: www.agrotechcommunications.com/

GEMTEX is providing information on the biobased industry and benefits of biobased products.

Go to: www.gemtek.com

Barriers for Government Employees

- Level of awareness about biobased product
- Nay Sayers
- Lack of funds
- How to find Biobased products.
- Level of Senior Management Support
- Lack of Regulation and Guidance
- What can I Purchase?

Barriers for Biobased Manufacturers and Dealers

Level of awareness on how to market products to the Federal Government

a. Register with CCR

b. Understanding the North American Industry Classification System

How to find what contracts contain biobased products

a. Search Procurement Forecast

b. Search the Federal Business Opportunity (FedBizOps)

Not prepared for competition

Excessive pricing.

Strategies/Outline for Overcoming Barriers

1. Develop Procurement Tools/Templates that guide Requirement Officials on how and when to include biobased products as requirements in an SOW.

2. Identify types of procurements that could easily utilize biobased products.

3. Develop language to be included in the procurement description being placed in FedBizOps that assist vendors in identifying requirements having biobased products. (Example)

"This procurement requires the use of biobased products to the extent that such products are reasonably available, meet agency or relevant industry performance standards, and are reasonably priced. Where available, these products should first be acquired from among qualified products that fall under the umbrella of items designated through the Federal Biobased Products Preferred Procurement Program (FB4P)".

4. Develop internal policy

5. Consider including biobased opportunities in Procurement Forecast.

6. Provide information on where to identify biobased products that have been designated

7. Most importantly "Get Senior Management's support"

Source :

Mike Green

U.S. Department of Agriculture

Departmental Administration

Office of Procurement and Property Management