UPCOMING STORIES

Getting The Most Bang For Your Bark

For private woodlot owners striving to get the most value from their timber, cooperatives may be the answer. They keep the wealth rooted in local communities and encourage sustainable harvesting. Cooperatives just might be a case of seeing the forest for the trees.

Stevia

Some of us flirt with the dangers of synthetic sweeteners to reduce calories. What if you could buy a natural sweetener equally low in calories? Well, you can—or could, until the petro-sweetener companies persuaded the FDA to step in.

Wheat to Pasta to Microwaveable Lunches

With the end of transport subsidies Canadian farmers can no longer afford to ship their raw crops long distances. As a result they're finding ways to increase the local value of agricultural products.

Kenaf: On the Fence

For years kenaf was the USDA's most promising alternative to wood fiber. Just as the crop appeared to be ready for commercialization, the USDA withdrew its support. On the other hand, the private sector is continuing to invest in processing facilities. Does kenaf have a future?

Seeing Red

A hundred years ago natural dyes dominated industry. Today fossil fuel dyes reign supreme but there's a possibility that natural dyes will be back in the picture soon. A progress report.

Correction

In our winter issue we listed the newspaper The Land as a source of more information on Dynaweed, the corn-gluten weed killer produced by Soil Technologies, Corp. A much better source is Steve Nichols at 1-800-221-7645.

ILSR

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The Institute for Local Self-Reliance (ILSR) is a nonprofit research and educational organization that provides technical assistance and information on environmentally sound economic development strategies. Since 1974, ILSR has worked with citizen groups, governments and private businesses in developing policies that extract the maximum value from local resources.

The Carbohydrate Economy

A Publication of the Institute for Local Self-Reliance Volume No. 1 • Issue No. 3 • Summer 1998

Growing Cars

On August 14, 1941, at the 15th Annual Dearborn Michigan Homecoming Day celebration, Henry Ford unveiled his biological car. Seventy percent of the body of the cream-colored automobile consisted of a mat of long and short fibers from field straw, cotton linters, hemp, flax, ramie and slash pine. The other 30 percent consisted of a filler of soymeal and a liquid bioresin.

The vegetable fiber mat also absorbed sound and reportedly kept the car interior warmer in the winter and cooler in the summer. Ford proudly demonstrated the strength of the car body to the gathered reporters by swinging an ax at the trunk, only to have it bounce off.

The timing gears, horn buttons, gearshift knobs, door handles and accelerator pedals were derived from soybeans. The tires were made from goldenrods bred by Ford's close friend Thomas Edison. The gas tank contained a blend: about 85 percent gasoline and about 15 percent corn-derived ethanol.

To Henry Ford, the vegetable car was the perfect vehicle for driving the American farmer out of a 20-year economic depression. But after World War II, the maturation of the petrochemical industry and the export-driven revival of American agriculture seemed to relegate the idea of a biological car to the dustbins of history.

Fifty years later, at the twilight of the twentieth century, Ford's dreams are again attracting attention. Working independently, scientists, engineers and entrepreneurs are finding more and more ways to incorporate vegetable-derived products into your standard car. If these products captured a significant share of the market, it could transform the material basis of our economies, for the automotive industry is the nation's largest consumer of raw materials. Over 60 percent of the oil, 50 percent of the rubber, 65 percent of the iron, 50 percent of carpeting and 20 percent of all electronics and aluminum produced in the U.S. each year ends up in our cars and trucks.

continued on page 4

Ford's idea of a car made entirely of plants was plowed under when he originally proposed it, but recently the auto industry has shown renewed interest in making a biological car, from side panels to seat belts.

The 30 Percent Standard

In his first 18 months in office, President Clinton issued two executive orders and one regulatory ruling that began to lay the groundwork for a truly sustainable economy.

• On March 8, 1994, Executive Order 12902 directed each federal agency and the Postal Service to reduce energy use in their buildings by 30 percent by 2005.

• On October 20, 1993, Executive Order 12873 required virtually all paper purchased by government agencies to contain 30 percent recycled fiber, beginning December 31, 1998.

• In June 1994 the Environmental Protection Agency issued a Renewable Oxygenate Rule (ROR) that required 30 percent of all oxygen used in transportation fuels under the reformulated gasoline program of the Clean Air Act be derived from renewable resources.

THE 30% STANDARD

The 30 percent standard formally linked together three key elements of a sustainable future—reduction, reuse, renewables. Tragically, the White House never linked them together in its public pronouncements nor in the public's mind. Thus they appeared to the public as a disconnected jumble of federal regulations, each responding to some special interest. Today the executive orders have largely faded from public view, allowing individual departments to lag in their compliance. The EPA regulatory action was halted by a federal court (although to my mind that ruling was largely a result of the remarkably weak case the EPA and Department of Energy made to support their action).

If I were president (sigh!) I'd have extended the 30 percent standard to three other products: electricity, fuels and chemicals. By executive order, I'd have required that at least 30 percent of all vehicles purchased or converted by federal agencies under its congressionally mandated clean fuels program must run primarily on renewable fuels (i.e. electricity from the sun, wind, water or biomass; ethanol or methanol from plant matter; or hydrogen from water or crops). I would have required all federal power authorities to purchase at least 30 percent of

By using its substantial purchasing power, the federal government would channel America's scientific genius and entrepreneurial energies toward building the technological and industrial foundation for a sustainable and competitive future.

Wood wastes and agricultural residues can be converted into ethanol, an oxygenated fuel that is mixed with gasoline to reduce carbon monoxide emissions. Government standards require a 30 percent mixture, but cars have been manufactured that run on pure ethanol.

Wind energy, solar power and biomass incineration would be more heavily utilized if the U.S. government was required to draw 30 percent of its electricity from renewable sources. Such a standard, which would affect only federal energy use, would seem conservative to a country like Denmark, where 7 percent of the entire nation's electricity is wind-generated.

their additional electricity from renewable power plants. And I would have required that 30 percent of all chemical products purchased by federal agencies be derived primarily from plant matter. (As this issue goes to press I'm informed that Executive Order 12873 is being revised by the president to include "biobased products." The new order, to be issued shortly, sets in motion an accelerated process for giving preference in government purchasing to plant matter-derived chemicals and other products. Kudos to the Alternative Agricultural Research and Commercialization Center (AARC) for shepherding this through.)

These six 30 percent standards would tie together the interests of environmentalists, industry, farmers and the general public by reducing pollution, strengthening local and regional economies and protecting national security.

By using its substantial purchasing power, the federal government would channel America's scientific genius and entrepreneurial energies toward building the technological and industrial foundation for a sustainable and competitive future. These easy-to-understand and readily measurable performance standards could easily be adopted by state and local governments and private businesses. Over time we could raise the sustainability standard from 30 percent to 50 percent and on upward until reduction, reuse and renewables become the key design elements in the economy.

Now we are in the middle of another congressional election year and just a few months from the start of a long presidential campaign. I hope our readers will ask their favorite candidates this simple question: what is your position on the 30 percent sustainability standard?

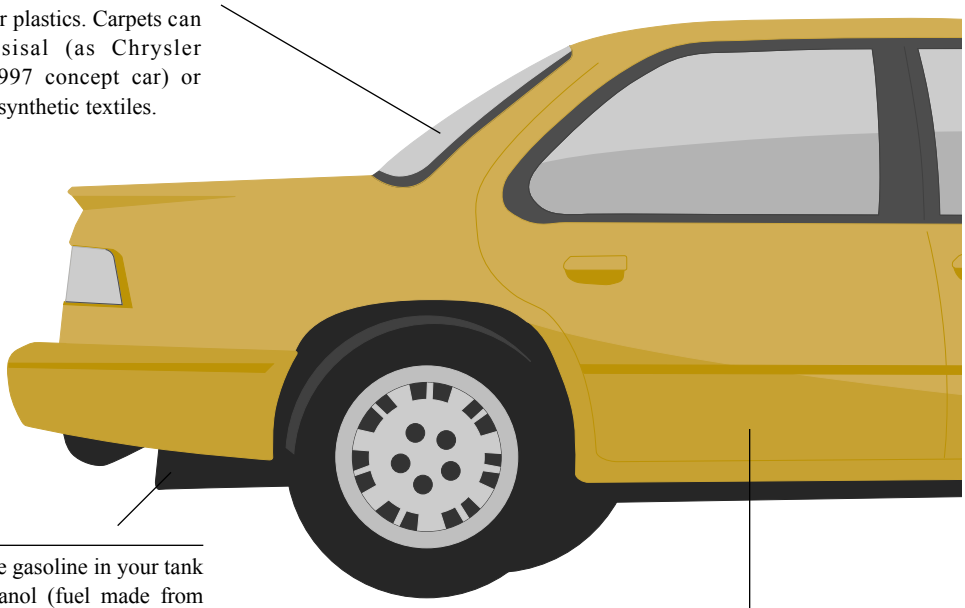
Today the executive orders have largely faded from public view, allowing individual departments to lag in their compliance.

A 30 percent recycling standard for paper skims the surface of available alternatives. Papers made with nonwood fibers, chlorine-free processing and 100 percent recycled content are now on the market.

David Morris
Vice President, Institute for Local Self-Reliance

Interior

Composite materials made with natural fibers such as flax, hemp, jute and ramie can be used to replace fiberglass and other plastics. Carpets can be made entirely of sisal (as Chrysler demonstrated in their 1997 concept car) or hemp, which outperforms synthetic textiles.



Fuels

One hundred percent of the gasoline in your tank can be replaced with ethanol (fuel made from corn, agricultural residues or wood waste). Currently 20,000 flexible-fueled vehicles (capable of running on 85 percent ethanol) are on the road in the U.S.

Exterior

A soybean oil resin is being developed for use in impact-resistant car parts. This material may eventually replace plastic and steel in car frames and bodies.

The New Biological Car

Over 60 percent of the oil, 50 percent of the rubber, 65 percent of the iron, 50 percent of carpeting and 20 percent of all electronics and aluminum produced in the U.S. each year ends up in our cars and trucks.

So how are we doing? This article offers a status report on the biological car and concludes that, although we have a long way to go, recent progress is remarkable.

Fluids

Most of our readers might suspect that the most significant car component, by weight, would be the body or engine or frame. But that's not so. It's the gasoline. The average car consumes almost its own weight in gasoline each year and several times its weight over its lifetime. Half a dozen other automotive fluids add to the importance of this section of a car.

When it comes to fuel, we've surpassed Ford's 1941 car. In Brazil, hundreds of thousands of cars run on pure ethanol. More than 20,000 flexible-fueled vehicles, capable of running on more than 85 percent ethanol, are on the road in the U.S. In the future, plant matter might continue to be converted into liquid fuels like ethanol or methanol, for use in internal combustion engines, or it might be converted into gaseous fuels like hydrogen or methane, for use in fuel cell-driven cars.

Although a plant-based substitute has yet to be found for the 10-13 quarts of transmission fluid found in the average car, 100 percent of the additives used to extend the life of the fluid can be made from plants like crambe or rapeseed. These additives can displace 50 percent of the transmission fluid. Companies like International Lubricants sell such products for cars, and Agri Industry sells tractor transmission fluid that consists of 60 percent soy oil.

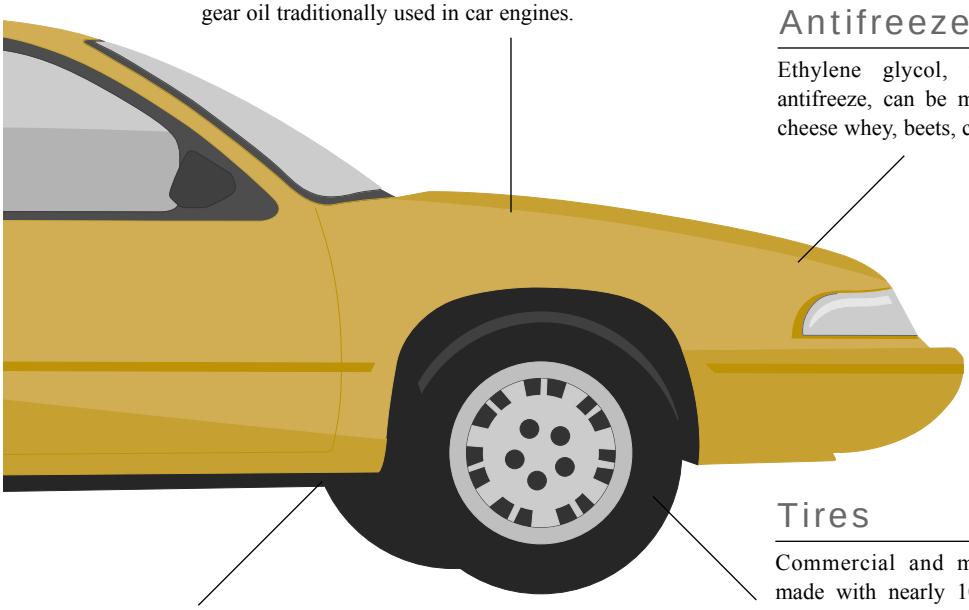
Typically the one to three gallons of fluid used for hydraulic fluid and gear oil are made from petroleum. However, blends of up to 95 percent canola oil can be used. Currently canola oil hydraulic fluids and gear oils, developed by Greenland Corporation, are being used in heavy

Engine Oil

A blend with up to 95 percent canola oil can replace the petroleum-based hydraulic fluid and gear oil traditionally used in car engines.

Antifreeze

Ethylene glycol, the main ingredient in antifreeze, can be made from sugars found in cheese whey, beets, corn and wood pulp.



Tires

Commercial and military aircraft tires are made with nearly 100 percent natural rubber, which is stronger and more resilient than synthetic rubber. The 66 percent of synthetic rubber in a typical car tire could be replaced with natural rubber.

Transmission Fluid

Up to 50 percent of transmission fluid can be displaced with additives made entirely from crambe, rapeseed or soybean oils.

equipment such as garbage trucks. Passenger cars will be targeted in the near future. Agri Industry sells tractor hydraulic fluid made of 70 percent soy oil.

Ethylene glycol, the primary ingredient in the two gallons of antifreeze carried in a typical car's radiator, is derived from fossil fuels. International Polyol Chemicals, Inc. is about to make ethylene glycol from sugars extracted from a wide variety of feedstocks, including cheese whey, cane or beet sugar, corn starch and wood pulp liquor.

A vegetable oil-based engine oil made from canola can entirely replace the four to five quarts of motor oil in a typical engine. The product, developed by Agro Management Group, is currently used in four-cycle engines (such as those in lawn mowers, generators and pumps) but automotive tests indicate it would work well on car engines.

The gallon of windshield washer fluid in cars is mainly natural gas-derived methanol, but Aquinas Technologies sells a product that is 50 percent ethanol.

Only a few ounces of lubricants are used in a typical car. Petroleum-based greases dominate, but lubricants comprised of 95-99 percent canola oil are available from Greenland Corporation. These vegetable-based lubricants have performed well in industrial applications and in large trucks. They may be used next in passenger cars.

The remaining three gallons or so of automotive fluids (shock absorber oil, refrigerant oil, brake fluid and power steering oil), to our knowledge, do not yet have plant-derived substitutes.

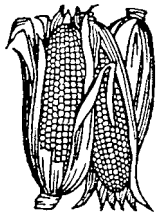
Our verdict? More than 90 percent of automotive fluids can be replaced now or in the near future with vegetable-derived products.

continued on page 6

Soy resin is now being tested by John Deere in tractor door panels and fan shrouding.

Tires

Natural rubber has made a comeback in car tires in the last ten years due to the increased popularity of the radial tire, which now accounts for more than 90 percent of U.S. tire sales. Only natural rubber has the strength and adhesive qualities required for the sidewalls and steel belt of radial tires.



More than 90 percent of automotive fluids can be replaced now or in the near future with vegetable-derived products.

About 33 percent of a typical automobile tire is made from natural rubber. The amount of natural rubber incorporated into a tire goes up as demand on the tire increases. A pickup truck tire, for instance, is approximately 50 percent natural rubber; tires for industrial machines and large trucks are nearly 90 percent natural rubber; and every commercial and military aircraft, including the space shuttle, lands on tires made almost entirely of natural rubber.

The reason that such high-demand applications rely on natural rubber is that no synthetic rubber can replicate natural rubber's resilience, tensile strength and resistance to abrasion, impact and rapid temperature change. The U.S. tire industry annually consumes 826,000 tons of natural rubber and roughly 1.3 million tons of synthetic rubber.

Excluding tires, the average car contains another 45 pounds of rubber in such components as door seals, engine hoses and decorative moldings. About 15 percent of these products consist of natural rubber.

The Interior

The interior of a car contains hundreds of components, from seat covers and door panels to carpeting and consoles and dashboards. Virtually all of these are now made from petroleum but plant matter is threatening to make serious inroads.

Much of the push for biobased parts is a result of environmental regulations in Europe, where car producers are looking to make an entire car out of recyclable or degradable materials. Replacing the two square yards of polypropylene or nylon fibers typically woven into automotive carpeting should be relatively simple. Work is progressing nicely in this area. Chrysler's 1997 concept car, the Pronto Spyder, contained carpeting made entirely of sisal. Ray Berard, senior vice president for technology at Interface Research Corporation, tells us that hemp-based carpets perform better and could be cost-competitive with synthetic textiles if hemp were domestically produced.

Many automotive companies are experimenting with natural fibers as a way to substitute for nondegradable and non-recyclable fiberglass, a material that may also cause health problems for workers.
A key target is the more than 100 pounds of fiberglass-reinforced plastics used in the interior of the car. Today a car contains many kinds of plastics. The instrument panel alone typically contains 15 different types. This variation makes recycling interior components very difficult, encouraging automakers to seek alternatives.

Natural fibers like flax, hemp, jute, sisal and ramie can replace fiberglass. The new composite materials often are composed of 50 percent natural fiber and 50 percent plastic. Natural fibers are good humidity regulators, insulate well against heat and noise and reduce component weight (thus reducing fuel consumption), all facts that Henry Ford discovered and today's auto engineers have rediscovered.

A brief look at some of the cars on the road today reveals that natural fibers are making inroads. The 1996 and 1997 models of Chevrolet's CK Pickup, 4-door Blazer and Suburban contain door paneling and interior trim made from jute fibers. General Motors, BMW and Opel autos contain headliners, package shelves, consoles and seat backs made from flax fiber. The latest VW Passat Variant station wagon boasts several panels of polypropylene reinforced with 50 percent flax. Ford is looking at a hemp fiber composite for the underbody shield for the Mondeo. Chysler is even experimenting with recycled wood fiber-based composites that can be injected molded into automotive parts, such as chime boxes, speaker brackets and bracing for seats.

U.S. companies currently making natural fiber-based composites include Findlay Industries and Cambridge Industries. Other companies, such as Natural Fiber Composites, are using waste wood to make automotive composites.

Our verdict? Little of the car's interior currently comes from plants but many products are about to enter the market. There are few technical or economic obstacles to building the vast

majority of a car's interior from plant-derived materials.

The Exterior and Frame

In the 1950s Corvette boasted a plastic body. Today a growing proportion of cars are being made with plastics. The performance characteristics of plastics are such that some concept cars even have a frame made from plastics. Companies making wood-plastic composites and natural fiber-reinforced plastics are looking to making car doors.

One of the more intriguing developments may be the creation of a soy oil-based resin for high performance plastics. University of Delaware researchers under the leadership of Dr. Richard Wool have created a soy oil substitute for polyester and vinyl ester in fiberglass reinforced plastics (FRPs). Vinyl ester-based FRPs are costly, high performance plastics that can be used for impact-resistant parts of the car. Soy oil represents about 40 percent of the weight of this plastic.

The soy resin is now being tested by John Deere in tractor door panels and fan shrouding. Wool expects that in the future soy-based high performance plastics could replace not only the plastic in current car bodies, but the steel in car bodies and frames as well.

The Engine

Even Henry Ford didn't make his car engine or axles from vegetable matter. But as plastics creep under the hood for such things as gas tanks and fuel lines, the potential for bioplastics in the engine increases. In the future, if fuel cells or small motors are used to power the family electric vehicle, automotive propulsion systems will be simpler and smaller. This would minimize the amount of materials used in the propulsion system, although they would probably still be made from minerals, not vegetables.

Our verdict? We have a long way to go before the car's propulsion systems will be made from plant matter.

In the future an assembly plant like this might be working with car parts that have their origin in farmers' fields rather than oil fields, utilizing crops such as corn, soybeans, beets and hemp.

How Close Are We to Achieving Ford's Dream?

A biological car is not just around the corner, but the concept is most definitely on the road again. Natural products are competing with petroleum products in a small part of the automotive market, and dozens if not hundreds of new products may soon be entering the market. And this time we are not talking about a single demonstration car constructed by one visionary but about a number of commercially viable companies producing biobased parts for use in millions of cars. Ford's dream may yet see the light of day, although by way of a path he probably never imagined.

General Motors, BMW and Opel autos contain headliners, package shelves, consoles and seat backs made from flax fiber. The latest VW Passat Variant station wagon boasts several panels of polypropylene reinforced with 50 percent flax.

Across the Border, Worlds Apart

In May of this year, a few miles north of Buffalo, New York, 50 Canadian farmers began planting 2,000 acres of industrial hemp, the first commercial hemp crop in that country in 60 years. South of the border that same month, the U.S. Drug Enforcement Administration (DEA) held hearings on its proposal to spray the countryside with lethal chemicals to eradicate any hemp plants growing wild in this country.

Two countries, two radically different attitudes toward the world's most interesting and controversial crop. Why such a difference? Maybe because Canada's hemp policy is overseen by Health Canada, an agency with no vested interest in keeping hemp illegal. In the U.S. hemp falls under the jurisdiction of the DEA, which receives over $16 billion to fight drugs and finds it in its self-interest to demonize hemp, a cousin of marijuana. Indeed, the DEA receives a reported $500 million a year simply to wipe out wild hemp plants. In the U.S. the policy toward cannabis is rigid and absolute. In Canada the government's approach has been much more flexible and sophisticated.

For decades both Health Canada and the DEA have had the authority to issue permits for the growing of hemp for research purposes. But while the DEA has made it impossible for farmers to receive such permits, in 1994 Health Canada's Bureau of Dangerous Drugs granted to mechanical engineer Geof Kime and his business partner, tobacco farmer and retired teacher Joe Strobel, the first federal license to grow industrial hemp. Kime and Strobel raised ten acres near Tillsonburg, Ontario.

The small plot immediately gained widespread public attention. To respond to the sudden public interest, Canada's ministry of agriculture issued a remarkable four-page bulletin on hemp, to this day perhaps the single most concise agronomic overview of hemp. (Gordon Reichert, "Hemp (Cannabis sativa)," Bi Weekly Bulletin, 7:23.)

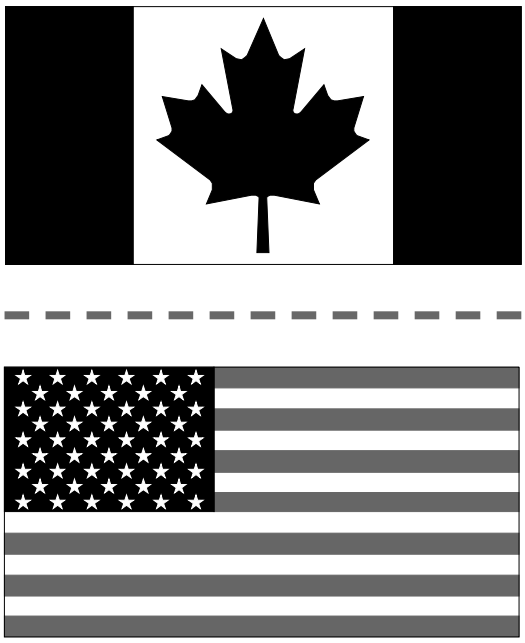
In 1995 the Canadian government issued permits for more than 100 acres of test plots in five provinces. These plots allowed local police authorities to become comfortable with hemp and gave farmers the opportunity to test hemp in different soils and climatic zones. They also generated sufficient raw material for industries to conduct substantial product testing.

In 1996, based on the information gathered, Canada's Parliament modified the Controlled Substance and Abuse Act to allow for the com-

The Canadian process allowed time for farmers, law enforcement officials, industry and government agencies to become familiar with the plant and its properties without getting bogged down in red tape.

mercial planting of hemp. In 1997, when it appeared that Health Canada was not moving fast enough to issue regulations for a 1998 planting, the Parliament made clear its disapproval.

To find out how to handle the crop, researchers visited some of the more than two dozen countries that have gone through the hemp learning curve. In early 1998, Health Canada called together representatives from affected agencies and parties. These included the ministry of agriculture, the Canadian Food Inspection Agency, Revenue Canada (customs), provincial and federal police organizations, farmers, scientists and business persons. After two and a half days the 70 participants had hammered out regulations that allowed Canadian farmers and entrepreneurs to begin developing a domestic hemp industry while taking into account law enforcement officials' concerns about marijuana cultivation.



Health Canada's regulations are more onerous than the hemp industry would like, and the permitting process this first year has been so slow that many farmers were unable to plant any hemp at all. Nevertheless, all parties expect the process to be streamlined in future years.

U.S. officials could learn from Canada's experience. Under the final regulations, approved in late March, industrial hemp is defined as a cannabis plant whose leaves and flowering heads do not contain more than 0.3 percent THC (the psychoactive component). To prevent higher levels of THC, importers and exporters of hemp seed must be licensed. Shipments of live seeds must be accompanied by foreign certification and from countries that do not allow plants containing more than 0.3 percent THC. Health Canada will publish a list of approved countries.

Only approved varieties of industrial hemp seeds (as specified in Health Canada's List of Approved Cultivars) may be planted. However, Canadian officials understand that breeders need a wide selection of germ plasm to develop breeds optimal for Canadian growing conditions. Thus plant breeders will not be restricted to approved cultivars.

Products derived from seed, such as oil and seed cake, must contain no more than l0 milligrams of THC per gram, a figure considerably below the 50 mg/g level set by the Swiss Academy of Sciences.

To obtain a license for importing, exporting, production or sale of industrial hemp, applicants must provide information from a Canadian police force listing any arrests or convictions with respect to drugs over the previous ten years.

The Canadian process for legalizing industrial hemp has been cautious but not paranoid, incremental but not glacial. It allowed time for farmers, law enforcement officials, industry and government agencies to become familiar with the plant and its properties without getting bogged down in red tape. South of the border, the process is stalled—perhaps even stumbling backwards—as long as the federal government lets drug agencies make agricultural policy.

Two countries, two radically different attitudes toward the world's most interesting and controversial crop.

For more information contact Jean Peart, Manager, Hemp Project, Bureau of Drug Surveillance, Therapeutic Products Directorate, Address Locator 4103A, 122 Bank Street, 3rd Floor, Ottawa, Ontario, Canada K1A 1B9 (613-654-6524).

(See Book Shelf/Web Shelf for additional sources.)

BioComp®: Composite Lumber is Finding Fans

Composed of 40 percent biomass and 60 percent recycled plastic, BioComp can be produced using wheat straw, grasses, cotton gin waste or kenaf. The resulting composite has the strength and durability of hardwoods and can be cut, shaped, drilled and nailed. It is resistant to insects and waterproof and will not rust or rot.

Getting a new technology off the ground is never easy. It's taken George Tyson of Xylan-XyMax, Inc. (Henderson, Nevada) 12 years to finally hit his stride. The technology to produce BioComp®, Tyson's patented composite lumber material made from plant fiber and recycled plastic, is being licensed to five companies who plan to manufacture a range of products, from pallets to particleboard.

Composed of 40 percent biomass and 60 percent recycled plastic, BioComp can be produced using wheat straw, grasses, cotton gin waste or kenaf. The process involves extruding the plant fibers and causing a chemical reaction that leads to steam explosion of the biomass. With more surface area exposed the fiber forms a strong bond with the melting polypropylene plastic.

The resulting composite has the strength and durability of hardwoods and can be cut, shaped, drilled and nailed. It is resistant to insects and waterproof and will not rust or rot. Unlike wood, BioComp does not warp or split. BioComp can withstand temperatures of 600°F, and fireproof coating can be applied for added safety. The finished product holds paint, or color can be incorporated during processing.

Xylan-XyMax was founded in 1986 as Xylan, Inc. and later developed an international marketing arm under the name XyMax 2000. Both were combined under the name Xylan-XyMax in 1995.

The company developed BioComp with private funding and loans and grant money from the U.S. Department of Agriculture's Alternative Agricultural Research and Commercialization (AARC) program, the Department of Energy's National Renewable Energy Laboratory and the Kansas Technology Enterprise Corporation.

Xylan-XyMax manufactured BioComp at a pilot plant in Mankato, Kansas, but lacked the capital necessary to expand to full production and is now offering its technology on a joint venture basis.

According to the company, an average BioComp plant requires 9,600 tons of recyclable plastic and 6,300 tons of agricultural fiber to yield a typical output from a plant of this size: about 16,000 tons of product per year, in both pellets (used in injection molding) and flat sheets. This amount of product generates approximately $7 million in revenue. Machinery costs from $1.5 to $3.5 million, depending upon the complexity of the final product.

N-Tech (Colorado Springs, Colorado) is among those planning to produce BioComp. The company is constructing a $10 million plant in Burlington, Kansas, which will be finished by the end of the year. The plant will produce about one ton of pallets per hour. Though more expensive than standard wood pallets ($8.50 compared to $3-7 per pallet), the BioComp pallets are light and reusable and compete very well against other reusable plastic pallets, which can cost $25 or more.

Additional BioComp plants are expected to come online in the next 18 months. A plant in northern Montana will use straw to produce pellets for injection molding applications such as interior trim and door parts.
A plant in Buckeye, Arizona, will use cotton waste to manufacture flat sheets for interior paneling for buildings and cattle cars, as well as particleboard. In Mankato, Kansas, an investor has purchased the equipment from the pilot plant and is seeking additional funding to begin production using wheat straw.

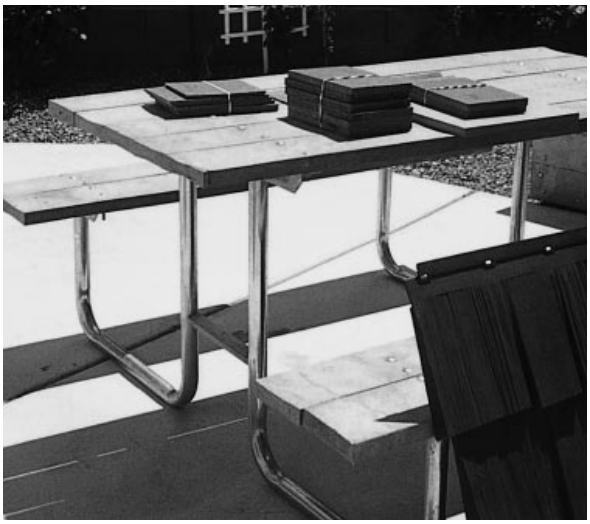


Photo courtesy of Xylan-XyMax, Inc.

Picnic tables in national parks may soon be made from agricultural wastes and recycled plastic.

Interest in BioComp has also developed in parts of Asia, where wood is scarce and demand for building materials, at least until the recent economic crisis, has been strong. Mithra Group Ltd. (Seoul, Korea), a large construction company, has licensed the BioComp technology and plans to build a manufacturing facility in Korea. The company will produce particleboard, cabinets, panels and cement-type building forms. Studies by Ishida Corporation (Nagoya, Japan) indicate a large market potential in Japan, and the corporation is seeking exclusive marketing rights for BioComp products in that country.

Tests conducted by the Wood Materials and Engineering Laboratory at Washington State University found that BioComp particleboard exhibited superior strength properties over standard particleboard and had the added advantage of being formaldehyde-free. BioComp is also cheaper than standard particleboard due to lower resin requirements (2 percent compared to 4.5-6 percent). Resin is the most expensive component in particleboard manufacturing. Savings of over 60 percent can be realized from the resin alone, resulting in an overall cost reduction of 5-10 percent for producing BioComp compared to traditional particleboard.

Curious about this new material? You may be able to experience BioComp up close and personal the next time you're on vacation. The government has expressed an interest in using the composite material to replace the warped panels on picnic tables in national parks.

Contact George Tyson, Xylan-XyMax, 259 Finestra Dr., Henderson, NV 89014 (702-260-4464).

Gemtek® Products: Cleaning with Fruits and Grains

Gemtek® Products is a line of grain- and fruit-derived cleaners and degreasers produced by Salesco Manufacturing, an Arizona-based corporation. Salesco was cutting-edge long before a market for "green" products existed. It began making 100 percent biobased cleaners in Hawaii 25 years ago. Demand for Gemtek's products has grown dramatically in recent years. Annual production currently exceeds 24 million gallons and generates nearly $10 million in sales.

Gemtek's products are formulated for a variety of cleaning applications, from heavy-duty industrial cleaners to household glass cleaners and automotive care products. Gemtek's products do not contain any chlorinated solvents or petroleum-based derivatives and do not contribute to volatile organic compounds. As a result, the components in its products aren't listed on the EPA's Toxic Release Inventory nor are they considered hazardous air pollutants. This gives them a clear advantage over the heavily regulated petroleum-based cleaners.

At first glance, Gemtek's products appear more expensive than those of its competitors. But as the biochemical industry is fast discovering, it is not price but cost that matters. The challenge is to convince the buyer that the cost per application, including avoided regulatory and cleanup costs, is lower even if the price per pound is higher.

Consider one of Gemtek's products, SC-1000®, which is widely used in the automotive industry for degreasing engine blocks and parts, cleaning exterior and interior components, removing soils from glass and vinyl and even cleaning hands. SC-1000® sells for approximately $1.43 per pound. Petroleum-based degreasers and cleaners, such as methyl ethyl ketone (MEK), xylene and 1,1,1-trichloroethane sell for $0.46, $0.76 and $1.07 per pound respectively.

Thus SC-1000® appears too costly compared to the petroleum-based products. On the contrary, the biobased cleaner is actually cheaper to use. SC-1000® is typically diluted to a 1:10 solvent to water ratio for effective cleaning and degreasing. Petrochemical cleaners are used undiluted. This reduces the "use-cost" of the biobased product to $0.14/lb. Cost can be reduced even further. For example, in dip tank applications, a 2-5 percent solution is typical, making the cost of SC-1000® approximately $0.04/lb.

But wait, there's more. In addition to being cheaper to use, the product is also fully filterable, reusable and recyclable. This is very important for companies seeking to reduce downstream pollution and decrease overall disposal volumes. A California company that fabricates a line of metallic auto parts estimates savings in excess of $100,000 per year in disposal fees by switching to SC-1000®, a 50 percent

Photo courtesy of Gemtek Products.

At first glance, Gemtek's products appear more expensive than those of its competitors. But as the biochemical industry is fast discovering, it is not price but cost that matters. The cost per application, including avoided regulatory and cleanup costs, is lower even if the price per pound is higher.

reduction from using petroleum-based cleaners.

Gemtek has a variety of clients, including Mercedes Benz, GM, Coca Cola Bottling Company, Del Monte, United Airlines, Hilton Hotels, McDonalds, Jiffy Lube, AT&T and the U.S. Navy.

Contact Bruce Bateman, Gemtek Products, 4747 N. 12th St., Phoenix, AZ 85014 (800-331-7022).

Soyshield and Soyguard: The Premium Diesel Market

Premium diesel fuel has become substantially more popular in the last few years: it now accounts for about 25 percent of the 35 billion gallons of diesel consumed nationwide. Premium diesel contains additives designed to enhance performance and extend engine life. Until now these additives were made from petroleum, but two new products derived from soybeans have recently entered the market.

Advanced Fuel Solutions (Lynnfield, Massachusetts), a two-year-old fuel marketing consulting company, developed and patented these two new fuel additives with funding from the Minnesota Soybean Research & Promotion Council. After successful test results from independent labs, Advanced Fuel Solutions licensed its technologies to two well-established companies. SoyShield is currently being produced by Schaeffer Manufacturing Company (St. Louis, Missouri), and SoyGuard should be released by a Nebraska-based company this summer.

Until now these additives were made from petroleum, but two new products derived from soybeans have recently entered the market.

While both products contain detergents and a lubricity component derived from soybeans, each is formulated somewhat differently. SoyShield offers the added advantage of a cetane enhancer. The advantages of using these additives include keeping the fuel system clean, creating a protective coating for greater lubricity, improving cold weather performance, reducing hesitation and misfiring, optimizing combustion efficiency and reducing emissions. What this adds up to is better performance and longer engine life. Both manufacturers also claim improved fuel efficiency.

It is recommended that these products be added at a rate of one gallon of SoyShield for every 500 gallons of diesel fuel and one gallon of SoyGuard for every 300 gallons of diesel fuel, the difference being attributed to higher levels of soy-derived components in the SoyGuard product. At a cost of $14-15 per gallon, SoyShield increases the average cost for diesel fuel by 2-3 cents per gallon. Pricing for SoyGuard has yet to be determined.

Comparing SoyShield and SoyGuard with other petroleum-derived additives is difficult because currently there are no standards a fuel must meet in order to be labeled premium. As a result, some fuels sold as premium actually do little to enhance performance, so pricing for diesel additives varies greatly. SoyShield and SoyGuard are generally cost-competitive with other performance-enhancing additives.

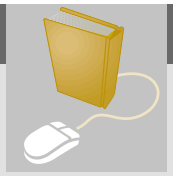
Photo courtesy of United Soybean Board.

These soy-derived additives will be marketed in ten midwestern states, primarily to the agricultural sector. Farmers operate expensive diesel machinery and appreciate the benefits of a fuel additive that reduces down time and extends engine life. Approximately 650 million gallons of diesel are used for agricultural purposes in the Midwest. One-quarter of this, or 160 million gallons, is sold as premium diesel.

The National Conference on Weights and Measures is reviewing a proposed premium diesel standard, which would set requirements for energy content, cetane, detergency, thermal stability and cold weather operability. A lubricity component is also under consideration, but testing methods have proved inadequate to date. If the standard is adopted, SoyShield and SoyGuard will be well positioned in the additive market because both products meet or exceed all of the requirements.

Contact Paul Nazzaro, Advanced Fuel Solutions, P.O. Box 291, Lynnfield, MA 01940 (978-664-5923) or Jay Shields, Schaeffer Manufacturing Company, 102 Barton St., St. Louis, MO 63104 (800-325-9962).

BOOK SHELF



WEB SHELF

Web Sites

Health Canada

At this site you can find the Canadian regulations on hemp spelled out. http://www.hc-sc.ca/hpb-dgps/therapeut/drht-meng/hemp.html

National Soy Ink Information Center

Established by the Iowa Soybean Association as an information source for soy ink manufacturers and users. http://www.soyink.com

United Soybean Board

Funded with soybean check-off money, this site provides information on new uses for soy-derived products. http://www.unitedsoybean.com

Web Forums

Below are three list-serve/discussion groups that often engage in conversation about biobased products and/or technologies. We encourage you to investigate—and add your input as a reader of The Carbohydrate Economy!

Green Clips

This list serve provides a summary of news on sustainable building design and related government and business issues. It is published every two weeks and distributed via email to subscribers. Current developments with ag-based construction materials are often highlighted. GreenClips@aol.com

Green Building

This is a discussion forum on green design and construction. Sponsored by Iris Communications, Inc., creator of the Oikos web site and REDI database of green building materials, Environmental Building News (EBN), an international newsletter on environmentally responsible design and construction, and the Center for Renewable Energy and Sustainable Technology (CREST). To subscribe, contact greenbuilding@crest.org

AG-RES

A discussion group devoted to promoting the research, development and marketing of pulp, paper and construction materials, AG-RES focuses solely on the utilization of agricultural residues. Open to everyone: farmers, agronomists and soil scientists; pulp and paper producers, experts, consultants and workers; environmentalists, policymakers and educators; transportation sector representatives; potential investors; and other interested parties. To subscribe, contact ag-res@essential.org

Publications

"Hemp and Marijuana: Myths and Realities."

David West (North American Industrial Hemp Council, 1997). An excellent discussion of the biochemical distinction between hemp and marijuana. Contact NAIHC at 608-224-5135 or http://www.naihc.org.

Fiber Wars: The Extinction of Kentucky Hemp.

David West (North American Industrial Hemp Council, 1994). Contact NAIHC (above).

The Cultivation of Hemp: Botany, Varieties, Cultivation and Harvesting.

Iván Bócsa and Michael Karus (Sebastopol, CA: Hemptech, 1998).

Hemp Horizons: The Comeback of the World's Most Promising Plant.

John W. Roulac (White River Junction, VT: Chelsea Green Publishing Company, 1997).

Following are books by two of chemurgy's chief proponents (see page 14).

The Farm Chemurgic.

William Jay Hale (Boston, MA: The Stratford Co., 1934).

Farmward March.

William Jay Hale (New York: Coward-McCann, Inc. 1939).

New Riches from the Soil.

Wheeler McMillen (New York: Van Nostrand, 1950).

Chemurgy: Postwar Plant Matter Prophets

One pile consisted of a package of cottage cheese. Another was a blue and gray knitted winter sports suit composed of a skirt, sweater and cap. The third pile included a can of paint, a tube of grease and a collection of plastic products, including buttons, billiard balls and piano keys. Everything except the cottage cheese had been manufactured in a lab.

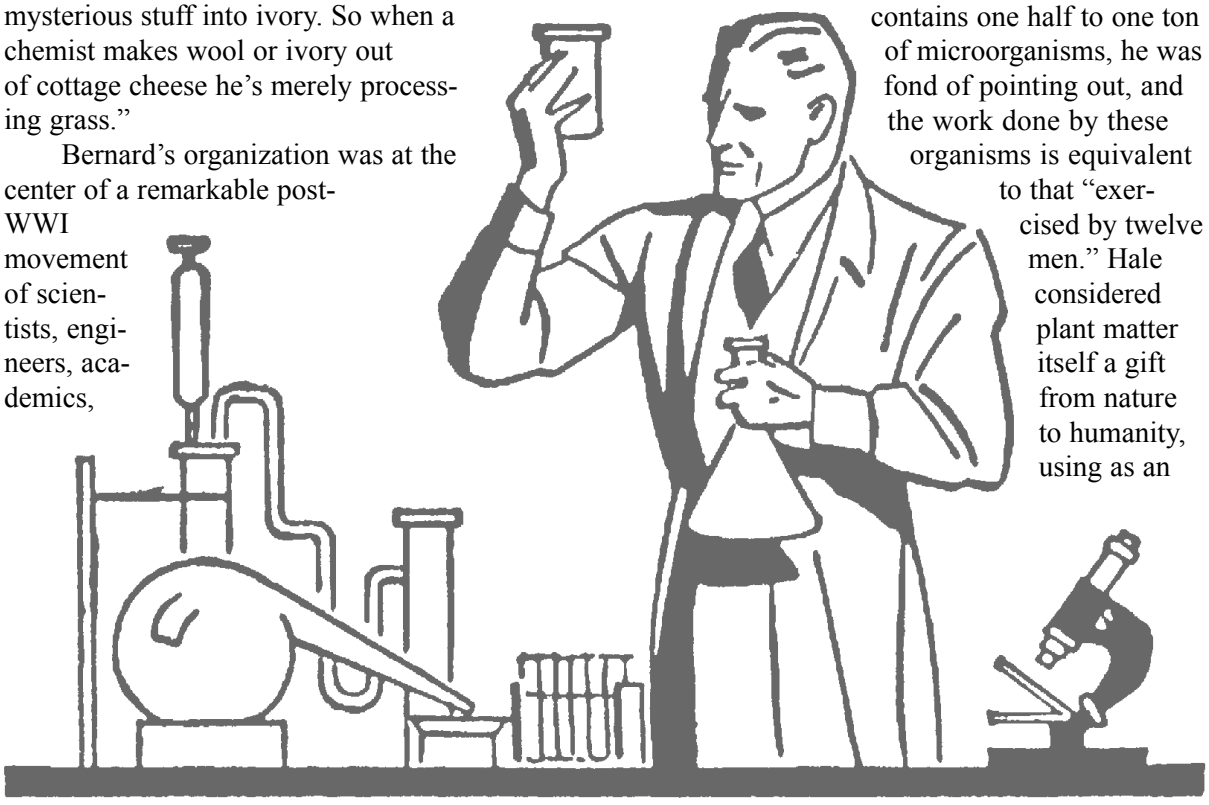
In 1942 a visitor to the office of Dr. Harry Everett Barnard, technical director of the National Farm Chemurgic Council, would have encountered a table with three one-pound heaps of products. One pile consisted of a package of cottage cheese. Another was a blue and gray knitted winter sports suit composed of a skirt, sweater and cap. The third pile included a can of paint, a tube of grease and a collection of plastic products, including buttons, billiard balls and piano keys. Everything except the cottage cheese had been manufactured in a lab.

Bernard delighted in explaining that all the items on the table were ultimately derived from grass. The sports suit, for instance: "It looks like wool, feels like wool, but is actually cottage cheese [put through a chemical process]." The products in the third group had been manufactured with casein, a protein found in milk. Bernard noted, "What you see on this table is not cheese at all, but grass. When a cow eats grass she converts it into beef and leather and cottage cheese. When a sheep eats grass one of the results is wool. An elephant turns the same mysterious stuff into ivory. So when a chemist makes wool or ivory out of cottage cheese he's merely processing grass."

Bernard's organization was at the center of a remarkable post-WWI movement of scientists, engineers, academics, industrialists and government officials. The end of the war severely reduced demand for agricultural products and contributed to a major recession in rural America. On the other hand, the end of the war boosted the standing of the embryonic U.S. chemical industry. The U.S. seized chemical patents held by Germany, the world leader in chemical engineering, and imposed a three-year ban on imported German chemical products. To encourage a homegrown chemical engineering industry, The Chemical Foundation was formed with the royalties from licensing Germany's patents to American firms. During the war significant advances had occurred in both petroleum engineering and industrial fermentation techniques. The crucial question was, what would be the raw materials of the emerging chemical industry?

Enter William Hale, son of a minister, Dow Chemical chemist and co-inventor of the widely used Hale-Britton process used to extract nitrogen from air. Hale was fascinated by the potential for marrying the enormous productivity of natural systems with human genius.

One acre of soil contains one half to one ton of microorganisms, he was fond of pointing out, and the work done by these organisms is equivalent to that "exercised by twelve men." Hale considered plant matter itself a gift from nature to humanity, using as an



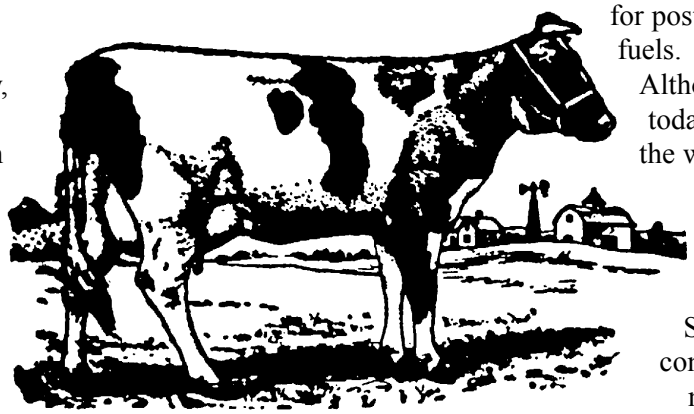
example the corn plant, which increases its weight 3000 times in 100 days, 95 percent of the weight gain from what some chemurgists called "solidified sunlight."

Chemurgy's First Words

On October 2, 1926, Hale's article, "Farming Must Become a Chemical Industry," was published in The Dearborn Independent. Requests for reprints ran so high that The Chemical Foundation took over the task and quickly distributed over 500,000 copies.

The chemurgy movement was born. The term combined chemi, the Egyptian word for black soil, and ergon, the Greek word for work.

The vision of chemurgy galvanized many, including George Washington Carver, Charles Holmes Herty, Thomas Edison and Henry Ford. The Farm Chemurgy Council was established in 1935. Its members included Wheeler McMillen, editor of The Farm Journal; MIT President Karl Compton; Nobel Prize-winning physicist Robert Milliken; General Motors Vice President Charles Kettering; and Sears, Roebuck & Company Board Chairman Robert E. Wood.



The chemurgy movement had several notable successes. Herty demonstrated that southern yellow pine could be used to make paper, and in 1935 the Union Bag company set up shop in Savannah to prove the point. In 1935 Standard Oil of New Jersey and the English Distillery Company produced a 33.5 percent alcohol blend for cars. William Mason, an associate of Thomas Edison, converted tens of thousands of tons of waste wood slabs, bark and sawdust into a construction product that carried the same name as his new company: Masonite.

Other products were more short-lived and exotic. The National Dairy Products Corporation, for example, made fibers out of milk protein and used them as substitutes for rabbit fur in making hats. As one wag observed, "This was a case of actually taking the rabbit out of the hat."

On May 7, 1935, the first national chemurgic conference was held in Dearborn, Michigan. Delegates assembled in a rotunda of the Edison Institute Museum (an exact reproduction of Independence Hall) in Henry Ford's Greenfield Village. On a desk once used by Abraham Lincoln they signed a "Declaration of Independence Upon the Soil and the Right of Self-Maintenance."

Chemurgy's Support Wanes

Just as World War I spawned the chemurgy movement, World War II ended it. American agriculture recovered, in part because of the opening of major export markets to war-devastated Europe. The price of oil dropped below that of water, and petroleum became the basis for postwar chemicals and fuels.

Although few people today have even heard the word chemurgy, we still benefit from its brief reign. The Herty Institute of Savannah, Georgia, continues its work on new papermaking techniques. In California, Louisiana, Pennsylvania and Illinois, the four research laboratories established by Congress in 1938 continue to look for new, often industrial uses for regional crops.

Perhaps more important than the institutional remnants of the chemurgy era is the fact that its principles resonate with an expanding number of industrialists, farmers, environmentalists and policymakers. Fifteen years ago ILSR coined a new term to describe the return to plant matter-based products: the carbohydrate economy. For this generation, the writings of Hale, McMillen and other chemurgists are neither quaint nor archaic but part of the foundation on which we can build a more sustainable economy and society. (See our Book Shelf/Web Shelf for a few of their most influential works.)

During World War I significant advances had occurred in both petroleum engineering and industrial fermentation techniques. The crucial question was, what would be the raw materials of the emerging chemical industry?