



An Analysis of Federal Efforts in Ensuring a Successful Future for Rural and Agricultural Communities Through New Uses for Soybeans

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About the Author

John Hillert is a 5th year student in chemical engineering at the Colorado School of Mines. This paper was written under the sponsorship of the American Institute of Chemical Engineers (AIChE) as part of the Washington Internships for Students of Engineering (WISE) program.

The WISE Program

The WISE program began in the summer of 1980. It is designed to give engineering students experience in the public policy making process through a series of meetings and presentations with various offices and organizations throughout the United States government, and through the completion of a public policy paper on a current engineering or science related topic. Papers are written for each student's sponsoring society, which is typically an engineering professional society or science related government organization, and they are presented in early August.

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Executive Summary

The economic wellbeing of rural agricultural communities has long been a concern of the United States government. Commodity prices of major crops are constantly challenged by increases in productivity and competition from foreign governments, and overproduction has led to a number of crop surpluses, which has resulted in decades of subsidies to growers. A creative (but not new) way to solve these problems is in the form of biobased products. Value-added chemicals and materials can be made from crops, forest residues, municipal wastes, and other continually replenishing organic sources. The idea is that a proliferation of these products could create higher demand for major crops, raising their price and increasing agricultural revenue.

This report looks at whether the United States government is going in the best direction to benefit members of rural agricultural communities that grow soybeans. Soy is the second largest crop, and has major potential as a feedstock for new uses. The report examines the infrastructure of soybean research efforts, legislation that will affect new uses, and various opinions and arguments about how the federal government can best improve rural agricultural communities through new uses.

Findings of this report are as follows. There is general agreement that increasing the market for a crop does not necessarily lead to higher prices or profits. Productivity is increasing faster than demand, and the price of soy is near a record low. Some suggest that tailoring federal programs to help farmers participate in biobased production is a way of allowing them to capture the higher prices associated with value-added products. This viewpoint is supported by several examples of successful farming cooperatives that produce value-added products. Others feel that this approach is not appropriate. The USDA's Rural Business and Cooperative Development administered loans to farmers for thirty years as a way of establishing ethanol stills. Nearly half of these loans were defaulted on, and many other new uses cooperatives remain heavily in debt.

Regarding federal research, there are numerous areas where it seems that research dollars should be reallocated or investigated to determine if reallocation is necessary. Soybeans are fourth in funding among major crops, but second in US production. Most research on soy is dedicated to increasing productivity, but it would seem that with a surplus of soy oil, and a commodity price sensitive to overproduction, research should be more focused on increasing demand, such as creating and expanding the availability of value-added products. Genetic engineering is a large part of new uses research. There is question whether genetically modifying crops should receive as much money when genetic engineering of process enhancing microorganisms has been more successful and carries less political consequences. Overall funding for the federal government's latest "Biomass Initiative" does not seem to be enough considering that proposals submitted under the FY 2003 solicitation totaled \$350 million.

The newest piece of federal legislation for new uses is Title IX of the Farm Security and Rural Investment Act of 2002. This legislation provides funding for the previously mentioned Initiative and requires government procurement of biobased products

whenever they are reasonable in cost, readily available, and perform satisfactorily. The underlying importance of this legislation is that it will serve as a medium through which biobased products can be demonstrated, prove their performance, and benefit from a federally enhanced market pull.

Since process engineering is essential to the commercialization of new uses it would seem that federal agencies researching soy should have a higher number of engineers on staff. However, the USDA has difficulty retaining process engineers because they are unable to provide the same benefits and salaries as private industry.

Finally, there does not seem to be a centralized public/private information consortium where researchers can check for overlap. However, most organizations researching soy take special care to ensure the relevance of potential projects.

Conclusions are that the government has several modifications in funding and strategy that it needs to make in order to improve the condition of rural soybean growers. They should find a way to incorporate USDA departments experienced with rural farmers into the Initiative and investigate ways to better allow farmers to bring research technology into the market, possibly by finding ways to encourage joint ventures between farmers and more experienced chemical companies. They should investigate and modify the funding in the areas previously mentioned, and possibly work towards a more centralized research information sharing system.

Issue Definition

The research, development, and commercialization of value-added products for soybeans is a potential avenue for increasing the economic wellbeing of rural soybean farmers. New concerns over global sustainability, dependence on foreign oil, and greenhouse gases have brought a surge of interest in sustainable and environmentally friendly biobased commercial products. Merging these concerns with the federal government's longstanding desire for stimulation of rural economies has resulted in a federal biomass initiative dedicated to developing economically viable biobased fuels and products.

This report looks at the beginning steps of this initiative in regards to its potential impact on the soybean farmer, specifically in the context of nonfood, non-energy, biobased products. The infrastructure and comprehensiveness of biobased product research and development is explored in both the public and the private sectors. Legislation such as the Biomass Research and Development Act of 2000 and the Farm Security and Rural Investment Act of 2002 will be discussed and evaluated. Finally, approving and dissenting viewpoints of federal efforts will be contrasted. All of these areas will be discussed with the hopes of answering the following question:

Are federal programs for biobased soy derivatives heading in the best possible direction to benefit rural agricultural soy communities?

How Does This Concern AIChE?

There are a host of reasons why this topic should concern the chemical engineering professional society. First, the creation of value-added products is a particularly process engineering intensive endeavor. Any corporation, farming cooperative, research group, or federal agency that wishes to increase the availability of value-added products or make profits from them will need the assistance of chemical engineers. This involvement could no doubt lead to changes in process engineering education, improve job opportunities of chemical engineers, and affect the type of work that chemical engineers do. This is particularly true if the federal government has a sincere desire to help rural agricultural communities. Many of their needs are untypical of the chemical and petroleum industries that dominate the organic products market today.

That being said, this report also discusses several funding issues associated with new uses. In their 2003 Public Policy Priorities "AIChE supports federal funding of key chemical engineering research and endorses a doubling of federal funding for science and engineering research over ten years, provided that the increased funds are targeted to address critical needs."¹ New uses research not only addresses critical needs of farming communities, but also concern over greenhouse gases, sustainability, and foreign dependence on oil. Considering the importance of these issues, and the potential for biomass to alleviate some of their consequences, it is reasonable to say that proliferation of new uses will open up new responsibilities and opportunities for chemical engineers.

Finally, recent federal legislation is going beyond the boundaries of funding basic value-added research, and into the realm of providing market stimuli for and assessment of biobased products, both important biomass issues, and therefore important to AIChE.

Introduction

What is Biomass?

The Biomass Research and Development Act of 2000 defines biomass as “any organic matter that is available on a renewable or recurring basis, including agricultural crops and trees, wood and wood wastes and residues, plants (including aquatic plants), grasses, residues, fibers, and animal wastes, municipal wastes, and other waste materials.”² For the last century there has been interest in using biomass, such as commercial crops, as feedstock for fuels and biobased products. In World War II the United States Department of Agriculture devised a process that conquered the obstacles standing in the way of synthetic rubber production.³ George Washington Carver is famous for finding dozens of uses for the peanut,⁴ and legislation in 1938 started four research laboratories dedicated to finding new uses for biomass.⁵ However, this early interest was overshadowed by an abundance of petroleum, which, starting at the end of the Second World War, served as the primary feedstock for most nonfood organic needs.⁶

Within the last ten years many pressing needs have initiated a new surge of federally funded research for biomass projects. Our dependence on foreign oil has revealed a substantial weakness in national security, and declining reserves of petroleum is an ever-present challenge to sustainability. Ethanol and biodiesel derived from energy crops are potential biomass replacements for our fossil fuel economy. Mechanization and productivity gains in agriculture have kept many rural communities in a perpetual cycle of economic stagnation. New uses for agricultural products could help stimulate depressed communities. The agricultural community has historically been under the costly protection of government subsidies. Economically viable biomass products could increase the market for many crops such as corn, soy, switchgrass, and wheat.

This new surge of interest in biomass was heralded by President Bill Clinton’s Executive order 13134, which created the institutional entities required to triple biomass usage by 2010,⁷ and augmented later with the passage of H. 2559, the Agricultural Risk and Protection Act of 2000, which codified those entities into law.⁸ Title III of this act was the Biomass Research and Development Act, which required the integration of the biomass research efforts of all federal agencies.⁹ As “Agricultural Risk Protection” implies, a great deal of attention in this movement has centered on the economic wellbeing of rural communities. This report focuses on one particular member of the rural farm community, the soybean grower, who cultivates and exports the second largest crop in the United States.

Soy Derivatives

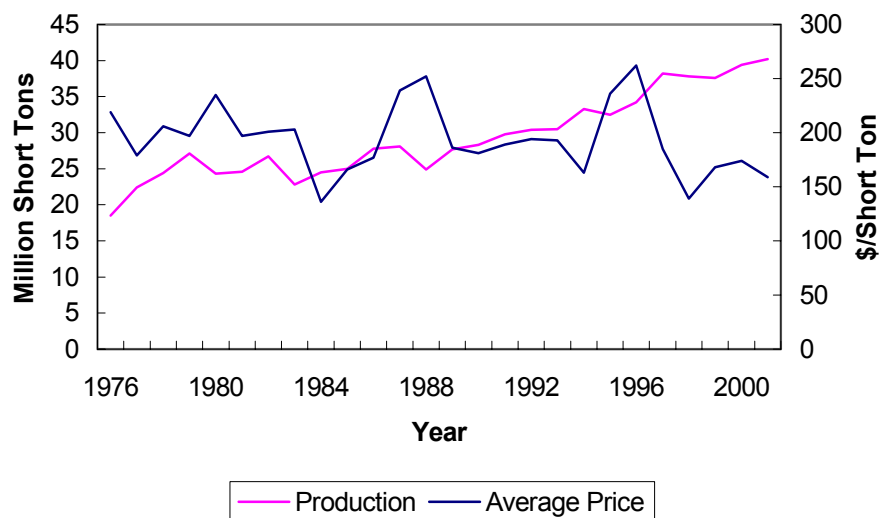
One of the most versatile biomass crops to date has been the soybean. While the primary market for soy is in the purchase of soy meal, there are literally hundreds of value-added products¹⁰ that can be made from various parts of the bean including, but not exclusive

to, inks, plastics, lubricants, coatings, and adhesives.¹¹ The soybean also happens to be the second most produced food crop in the US. In 2001 soy was exported to a tune of \$7.2 billion.¹² In 2002, 2.73 billion bushels were harvested¹³, amounting to approximately 40% of the world market share.¹⁴

Despite these massive sales, rural farming communities are still considered economically depressed. While production for soybean meal and soybean oil have been increasing steadily over the last 25 years, average prices per bushel of meal and pound of oil have either been falling or remaining stagnant (figures 1 & 2).¹⁵ Starting with the creation of a soy check-off program and the creation of the United Soybean Board in 1990 there have been mounting efforts to expand the market for soy in the direction of new uses. There is a large government infrastructure supporting the development and marketing of new uses for soy consisting of universities, government research facilities, executive departments such as the Department of Energy and the United States Department of Agriculture, as well as legislation designed to streamline government efforts, fund research projects, and provide a market for new uses. While these efforts are no small feat there is some question as to the end result. There is evidence that expanding and diversifying product chains of a commodity crop does not necessarily raise its price. It has been suggested that in order to benefit rural communities, new uses policy and efforts must make sure to find ways to tie the higher values of biobased products to the farmer.

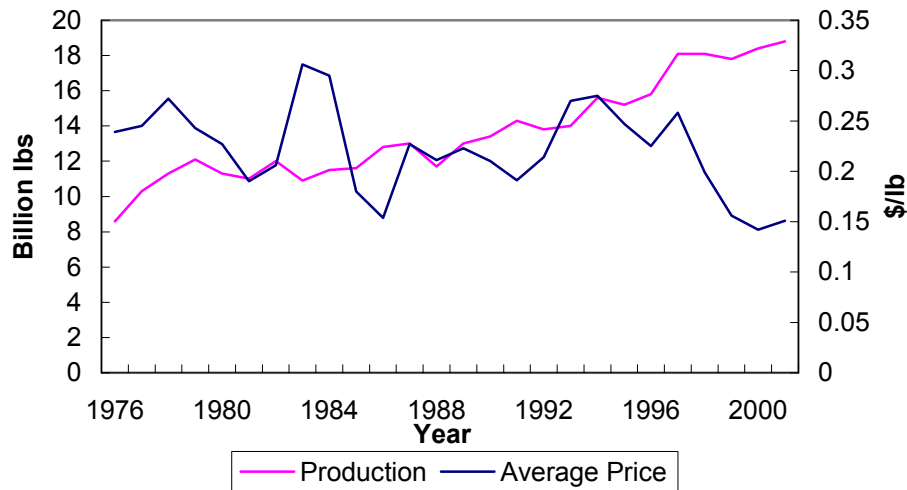
This report is intended to look at the combined biobased product movement for soybeans, and to see if it is headed in the right direction in regards to the stimulation of rural farming communities. Infrastructure, funding, and legislation of the public and private soybean community will be examined in the context of their benefit or detriment to such stimulation, and a range of viewpoints will be presented for objectivity.

Figure 1 - US Soybean Meal Production and Average Price 1976-2001



Data Courtesy of “Soy Stats 2002: A Reference Guide To Important Soybean Facts & Figures”, prepared by American Soybean Association

Figure –2 U.S. Soybean Oil Production and Average Price 1976-2001



Data Courtesy of “Soy Stats 2002: A Reference Guide To Important Soybean Facts & Figures”, prepared by American Soybean Association

Soy Research Infrastructure

United Soybean Board

Arguably the most important organization for soy biobased products is the United Soybean Board or USB. Created by the 1990 farm bill under the auspices of the Soybean Promotion, Research and Consumer Information Act [7 U.S.C. 6301-6311], the USB is a check-off program¹⁶ run by a council of 62 farmers chosen by the secretary of agriculture.¹⁷ A check-off program is where a specified percentage of revenue from a specific crop goes toward improvement and marketing for that crop. In the case of soy 0.5 % of the net market price of all soy sold in the US is given towards the marketing and R&D of soy.¹⁸ Half of this check-off goes to state and local level marketing and research while the other half goes to the USB.¹⁹

Under the oversight of the USDA the USB spends check-off dollars on five primary areas

- International Marketing
- Domestic Marketing
- New Uses
- Production
- Communication²⁰

In FY2002 the soybean checkoff spent \$4,610,500 on new uses development, approximately 13% of their total expenditures, and has been approved to spend \$3,265,167 for FY2003, which is approximately 9% of their total budget.^{21,22} To market soybeans (soybeans in general, not just new uses) the USB spent \$10,627,951 internationally and \$6,718,297 domestically and for FY2003 those dollars have been adjusted to \$10,890,207 and \$5,234,912 respectively.²³

The major areas of research for new uses that USB funds include plastics, adhesives, coatings, lubricants, inks, and specialty chemicals. These categories all have counterparts in the petrochemical industry.

United States Department of Agriculture

Heading new uses research in the federal government is the USDA. In their mission statement the USDA clearly states that two of its responsibilities are “supporting sound development of rural communities” and “providing economic opportunities for farm and rural residents.”²⁴ While the Department of Energy (DOE) and the United States Department of Agriculture (USDA) both do extensive research on biomass, the majority of new uses research and development is done through two agencies of the USDA, primarily because of those two responsibilities. The first is the Agricultural Research Service (ARS), which is the USDA’s in-house research arm. The second agency is the Cooperative State Research, Education, and Extension Service, or CSREES, and its two primary functions are to provide, “Program leadership to identify, develop, and manage programs to support university-based and other institutional research, education, and extension,” and to have, “Fair, effective, and efficient administration of Federal assistance implementing research, education, and extension awards and agreements”.²⁵

Agricultural Research Service

The ARS is the in-house research arm of the USDA, and has been doing new uses research since the early 1940’s. Much of this research is done in GOGOs, or government-owned government-operated research laboratories. The four main laboratories that do this research include the Southern Regional Research Center in New Orleans, Louisiana, the Eastern Regional Research Center in Wyndmoor, Pennsylvania, the National Center for Agricultural Utilization Research in Peoria, Illinois, and the Western Regional Research Center in Albany California.

For FY2003 the ARS spent \$33,226,200 on soy research,²⁶ \$4,975,352 of which was spent on new uses for soy through 15 different research projects.²⁷ Of that five million a little more than \$3,000,000 was spent in the five areas that the USB lists as their five primary areas of new uses research (8 projects).²⁸

Cooperative State Research, Education, and Extension Service

CSREES is the other major contributor of federal soy biobased product research. It provides grants and funding to universities and institutions to carry out research consistent with the USDA’s mission.²⁹ For FY2001 CSREES spent approximately \$14 million on research of soy, most of which was dedicated to improving agricultural

production, reducing costs, and reducing environmental impacts rather than funding new uses projects.³⁰

Biobased Legislation

Federal funding of new uses research (bioproduct development) is no new thing. The Farm Adjustment Act of 1938 initiated the creation of the ARS's four research centers.³¹ These labs began operation in 1941,³² and reasons for this initial research are actually similar to those of today, increasing economic health of rural communities and finding uses for farm surpluses.³³ Since this time there have been many other pieces of legislation assisting biobased product development.

Federal Technology Act of 1986 [PL 99-502]

Before 1986 there was a need to find an effective way for government agencies and private industry to combine their efforts and bring biobased product technologies to market. The Federal Technology Act of 1986 allowed for the creation of CRADA's, Cooperative Research and Development Agreements, a type of contract specifically designed for this purpose. In order to augment the effectiveness of these agreements the act enables directors of government-owned government-operated (GOGO) laboratories to 1) enter into CRADAs, 2) license inventions that come from CRADAs, 3) "exchange laboratory personnel, services and equipment with research partners", and 4) "waive rights to lab inventions and intellectual property under CRADAs."³⁴

In addition to formalizing public-private ventures the act also created incentives for practical and profitable research. GOGO scientists must "receive a minimum of a 15% share of any royalties generated through patenting or licensing," and, "Scientists and engineers are now responsible for, and evaluated for their abilities to get technology transferred out of the laboratory."³⁵

Executive Order 13134

Executive order 13134 was released on August 12, 1999, initiating the most recent surge of interest in biomass.³⁶ In order to facilitate a goal by President Clinton to triple US biomass usage by 2010³⁷ the order established three bodies, 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, all of which would help, "stimulate the creation and early adoption of technologies needed to make biobased products and bioenergy cost-competitive in large national and international markets."³⁸ The Interagency Council was essentially an advisory committee to the president consisting of top officials, or "designees" to top officials, in various science related government organizations, particularly the Department of Energy (DOE) and the USDA.³⁹ The group was charged with providing a strategic plan on biomass (to the president), outlining how the national goals, among which was "rural economic interests", could best be met through the, "development and use of biobased products and bioenergy in an environmentally sound manner."⁴⁰ The Advisory Committee was charged with providing assessment, and advice, of government goals, distribution of

resources (funding, equipment, etc), effectiveness of biobased product procurement programs, and consequences of usage of biobased products.⁴¹ The Coordination Office was designed as the full-time support of the interagency board, charged with coordinating federal biomass efforts, and disseminating information to involved parties about biobased product and bioenergy issues.⁴²

Biomass Research and Development Act of 2000 [PL 106-224]

Title III of the Agricultural Risk and Protection Act of 2000 was the Biomass Research and Development Act, legislation that required coordination between the USDA and the DOE on biomass research and development.⁴³ This legislation adopted and modified many of the institutions and ideas of executive order 13134. BRDA replaced the Interagency Council with the Biomass Research and Development Board⁴⁴ and the Advisory Committee on Biobased Products and Bioenergy with the Biomass Research and Development Technical Advisory Committee.^{45,46} The new board was no longer asked to provide the president with a plan, but instead was to coordinate research and development activities between various government bodies.⁴⁷ The Advisory Committee retained its identity and was still charged with providing the board with assessment, especially with regards to the consistency of research with initiative goals, merit of chosen projects, and consistency of activities in regards to BRDA legislation.⁴⁸ One distinction to be made about the Board is that it is not an actual agency, but a median through which the various government agencies, namely the USDA and DOE, can consult with each other for a more comprehensive biomass research and development effort.⁴⁹

Biomass Research and Development Initiative

Section 307 of BRDA instructs the Secretaries of Energy and Agriculture, with the assistance of the Board to, “establish and carry out a Biomass Research and Development Initiative under which competitively awarded grants, contracts, and financial assistance are provided to, or entered into with, eligible entities to carry out research on biobased industrial products.”⁵⁰ Among research priorities the Initiative includes “advances in biomass processing,” and stimulation of rural economies. The last part of section 302 authorizes \$49 million annually for biobased industrial products through the initiative.⁵¹ This authorization applies strictly to new uses and does not include funding for bioenergy or biofuel research.

Being in its third year of existence, and only in its second year of funding, results from this Initiative are still in their infancy.⁵² The vast majority of soybean research being done right now is done through the ARS, CSREES, and the United Soybean Board.⁵³ The impact of this act will be seen down the road as projects funded begin to produce results. The ramifications of this act are not irrelevant however, since the coordination efforts of the Board, influenced by advice from the Advisory Committee, could strongly influence the policies and procedures surrounding new uses for years to come.

Farm Security and Rural Investment Act 2002

Farm Security and Rural Investment Act of 2002, or commonly called the Farm Bill, is the most relevant piece of legislation for the Biomass Initiative today. The two sections of particular importance are sections 9002 and 9008 of Title IX.

Section 9002 outlines a plan where “each federal agency shall develop a procurement program which will assure that items composed of biobased products will be purchased to the maximum extent practicable.” Government procurements over \$10,000 must favor biobased products whenever they can be purchased within a reasonable amount of time, meet performance standards, and are not excessive in cost.⁵⁴ This section sets “forth recommended practices with respect to the procurement of biobased products and items . . . and with respect to certification by vendors of the percentage of biobased products used,” and provides “information as to the availability, relative price, performance, and environmental and public health benefits of such materials and items.”⁵⁵ It also establishes, “a voluntary program under which the Secretary authorizes producers of biobased products to use the label ‘U.S.D.A Certified Biobased Product.’”⁵⁶ Finally, section 9002 provides \$1 million annually from a government funding entity, called the Commodity Credit Corporation (CCC), as support for testing biobased products through 2002-2007.⁵⁷

Section 9008 of the farm bill provides \$5 million for FY2002, and \$14 million per year for biobased product research for fiscal years 2003 through 2007.⁵⁸ This money is funded through the CCC, can be carried over from one year to the next, and is different than the funding that sponsors projects in the ARS and CSREES.⁵⁹

Funding in 2002 did not meet the \$5 million appropriated and it was carried into the next year.⁶⁰ 2003 funding under the initiative actually amounted to \$21 million, with the additional seven million coming from \$2 million in carryover and \$5 million from discretionary dollars from the DOE.⁶¹

One additional point to be made about the spending of Initiative research dollars is that 20% of the value of grants made from these funds must be leveraged dollar for dollar by the recipient.⁶² This means that government institutions will not be the ones doing the research from Initiative dollars since government funding cannot be leveraged with government funding.⁶³ Instead private institutions and other alternatively funded institutions will be doing the research.

The Rural Mandate: Why Help Rural Agricultural Communities?

Before analyzing various sides of this issue it is important to discuss why the biomass initiative is meant to help rural communities such as soy farmers. Put simply, it is because the legislation says so. Executive order 13134 clearly states intent for providing opportunities for rural communities through new uses.

Current biobased product and bioenergy technology has the potential to make renewable farm and forestry resources major sources of affordable electricity, fuel, chemicals, pharmaceuticals and other materials. Technical advances in these areas can create an expanding array of exciting new business and employment opportunities for farmers, foresters, ranchers, and other businesses in rural America. These technologies can create new markets for farm and forest waste products, new economic opportunities for underused land, and new value-added business opportunities.⁶⁴

The Biomass Research and Development Act of 2000 declares three times that an underlying principle of a biomass initiative is to, “promote rural economic development.”⁶⁵ Additionally, the wellbeing of agricultural communities is part of our nations heritage. The initial efforts of the 1938 act that established the four research centers resulted from Congress being, “desperate to find ways to dispose of surplus crops and end a chronic farm depression.”⁶⁶ These are both problems that still exist today more than sixty years later.⁶⁷

Discussion of Issues

Tying Profits to Farmers

The Institute for Local Self-Reliance (ILSR) is a nonprofit organization committed to environmentally friendly rural economic development.⁶⁸ Currently, this organization has several objections to the direction of the biomass initiative. They feel that for a successful “carbohydrate economy” there needs to be both a shift from a petroleum feedstock to a renewable feedstock and a rewards system where the farmer benefits from the higher prices brought about by value-added products.⁶⁹ While they feel that the initiative is correctly attempting to switch to a renewable feedstock, they also feel that it is failing in regards to rural economic stimulation.⁷⁰ They maintain that significant evidence exists supporting the idea that increasing the market for a commodity crop does not necessarily increase the wellbeing of the farming community.⁷¹ Soybeans and other major crops are selling at prices near record lows, rapid productivity gains are contributing to unemployment in rural communities, and a small number of buyers serving a large number of sellers is producing too much supply for too little demand.⁷²

As a solution to this David Morris, Vice President of the ILSR and member of the Biomass Technical Advisory Committee, suggests several things the federal government can do to strengthen agricultural communities. For one, government should look for ways of encouraging “dispersed ownership” among farmers, because, “A proliferation of modestly scaled production enterprises will encourage competition, innovation, and cost reduction, while promoting healthy communities and strong local economies.”⁷³ This strategy has the advantage of naturally hedging changes in the price of a commodity crop like soy. A farmer who owns shares in a new uses cooperative proportionate to the amount of feedstock they sell to that cooperative will gain everything there is to lose if a drop in the commodity price occurs. This is because dividends from value-added products would reflect savings the cooperative made in purchasing the feedstock.⁷⁴

Second, Morris suggests requiring higher private-side leveraging for billion dollar corporations than for smaller or farmer-based companies for public/private ventures.⁷⁵ This means that large corporations should have to put up a higher match, corporate-dollar-for-federal-dollar, than a smaller enterprise when it wishes to engage in research projects with the federal government. This would increase the incentive for farmers to take an active role in industrializing biobased products themselves.

Third, the USDA's rural development and cooperative development divisions should be integrated into the Biomass Research and Development Initiative. They may have suggestions on whether there are, "R&D strategies that foster more dispersed processing," and if there are "licensing issues that might foster more farmer ownership."⁷⁶

Finally, Morris suggests returning to the pre-CRADA commercialization strategy since it was, "based on the acreage impacted," instead of the "patents awarded, licenses negotiated and royalties earned," the latter being a result of the incentives created by CRADA's.⁷⁷

Many of ILSR's ideas were reflected a year earlier in the minority report, also written by David Morris, of the 2001 Technical Advisory Committee Recommendations submitted to secretaries of agriculture and energy, Ann Veneman and Spencer Abraham, and to the public comment solicitation following passage of the farm bill.⁷⁸ Because of the newness of the initiative it remains to be seen whether these recommendations will be adopted. However, recognition of a problem can be seen in the Technical Advisory Committee's Roadmap published in December 2002 where they write that, "Expanding the use of biomass for non-food and feed purposes will benefit farms and rural areas only indirectly and modestly. A more significant development would occur if farmers were able to produce the biofuels or bioproducts themselves, either on the farm or as owners in a local production plant." Later in the report, they go further saying,

"Special consideration should be given to agriculture and forestry-based cooperatives in licensing technologies developed with government support. Efforts should be made to identify existing facilities that can be converted into or enhanced as biorefineries. Finally, an emphasis should be put on rural-based biorefineries."⁷⁹

Indeed, some of ILSR's concerns are being addressed or have been addressed to certain extents. 40% of CRADAs created through the USDA's Office of Technology Transfer are done with small businesses, a portion of which are located rurally, and the USDA's Department of Rural Development gives grants for value-added cooperatives.⁸⁰ Regarding the suggestions to include the departments of Rural Development and Cooperative services, Tom Dorr, undersecretary for Rural Development, is waiting for confirmation from the senate for the job as point of contact for Secretary Veneman in the Biomass R&D board.⁸¹ Giving this job to the senior official in Rural Development, somebody who is a direct representative of rural agricultural interests, is a good way of

protecting the interests of rural agricultural communities.⁸² However, there is question over whether Senate confirmation will ever take place, being that over two years have passed and it has yet to happen.⁸³ Currently, there is an official memorandum signed by Secretary Veneman in January of 2002, stating that Mark Rey, Undersecretary for Natural Resources and Environment, who is Senate confirmed, will hold the position as point of contact on the Board until the confirmation of Undersecretary Dor.⁸⁴

Evidence supporting farmer owned processing is found in examples where farming cooperatives have been involved with new uses. In west Iowa a farming cooperative makes lubricants,⁸⁵ and throughout Minnesota there are strings of cooperatives producing ethanol.⁸⁶ In another example South Dakota Soybean Processors, a soybean oil producer, purchased the rights to SoyOyl, a polyol used in making flexible and rigid foams.⁸⁷ It currently has the capacity to put five million pounds per month of soybean oil into SoyOyl, which itself is a 12 billion pound per year market.⁸⁸

Opponents of government support for agriculturally controlled processing of new uses say that while farmers may have enough resources and expertise to start a biodiesel refinery, they do not have enough industry experience to bring a more advanced product such as a plastic or adhesive to market.⁸⁹ Others go further in questioning the commercial abilities of farmers, recalling a remarkably unsuccessful string of government loans given to farmers in order to establish local ethanol stills.⁹⁰ Of the 23 loans administered by the USDA's Rural Business and Cooperative Services department since the 1970's, 11 debtors have defaulted.⁹¹ Indeed, many of the farmer operated ethanol stills established in Minnesota working today, which are often cited by the ILSR as success stories, are still heavily in debt.⁹²

Increasing Awareness of New Uses for Soy

As seen by the research focuses of the USB and the ARS, many soybean products have competitive counterparts in the petroleum industry. The inertia, large infrastructure, and name brand recognition that the petroleum industry has in the United States creates a great difficulty for the adoption of soybean products.⁹³ Because of this there is a need to get emerging new-uses technologies into the hands of people who can commercialize them, and, once those technologies start producing products, increase the awareness of their existence among potential markets.

CRADAs are the primary way that technology is transferred out of the CSREES and ARS and into industry.⁹⁴ The exclusive licensing that can be granted to individual corporations by government researchers and their directors gives those companies the incentive to adopt these technologies, whereas before 1986 their competitors had access to the same inventions, nullifying the benefits of intellectual property.⁹⁵ The royalties earned and performance requirements that government scientists are exposed to through the Technology Transfer Act encourages them to seek partners in industry.

As for product awareness, the USB's international and domestic marketing helps disseminate information about biobased products, and, as mentioned earlier, section 9002 provides a means by which potential customers can compare soy products to name brand

competitors. However, the USB's role in advertising new uses is still in its infancy.⁹⁶ A small percentage of their marketing budget is spent on advertising specific products to potential customers because the number of readily purchasable soy products has not yet matured⁹⁷. Two exceptions to this include a few minor cleaning solvents, and soy inks, the latter of which being extensively advertised in Europe and Japan⁹⁸. The proportion of advertising for new uses is expected to increase as more and more new uses companies make competitive products that are readily available for purchase⁹⁹. Mike Erker, the BioProducts Development Director at USB, does not feel this time is too far off, saying that there was more interest in these products last year than all previous years combined.¹⁰⁰

The Farm Bill – Section 9002

Federal procurement of biobased products could be a significant step towards the proliferation of renewable commercial products. Procurement by the government, which spends approximately 2.2 trillion tax dollars every year,¹⁰¹ has the potential to provide a market pull for biobased products,¹⁰² and possibly create enough demand to allow some companies to increase their production-of-scale, which would drive costs down and further increase their attractiveness to government procurement, and possibly industry.¹⁰³

One important function that the farm bill does is to provide standards and information about biobased products on the "item level," which will provide procurement agents with the information they need to make informed purchases.¹⁰⁴ This information will include such things as the ecological footprint of individual products and the qualifying amount of biobased content these products must have to be considered biobased purchases.¹⁰⁵ Currently, Iowa State University, "under a cooperative agreement with the Office of Energy Policy and New Uses, is developing the infrastructure to establish a biobased product testing program."¹⁰⁶ Part of this infrastructure includes an electronic forum that "will be open to manufacturers/vendors to post information about their biobased products that qualify for preferred procurement under the statute."¹⁰⁷

Already there are indicators that government procurement could be an engaging customer for biobased products. *Some* products are reasonably close in price to their competitors, and still others tend to be less expensive if you take into account whole lifecycle costs.¹⁰⁸ Oftentimes biobased products, while initially more expensive than their petroleum-based counterparts, are more environmentally friendly, which reduces time-consuming paperwork and costly disposals.¹⁰⁹ The Departments of Defense and Interior as well as ARS facilities in Beltsville, Maryland have already shown a willingness to pay premium prices for biobased materials.¹¹⁰ Beltsville already uses biobased products including cleaners,¹¹¹ hand soaps made from soybean oil and walnuts, 90-weight gear oil, and high-pressure grease,¹¹² while the US Post office has used a soy-based substance called BEAN-e-doo[®] to save money removing mastic from aging facilities.¹¹³ From a historical perspective, 1980's industry regarded recycled paper as an unprofitable investment.¹¹⁴ Passage of the Resource Conservation and Recovery Act (PL 94-580¹¹⁵) led to several years of government support and procurement, which allowed economic factors and technological advances to make recycled paper a success.¹¹⁶

While enthusiasm runs high for the potential of federal procurement, some caution that success in this area will be slow in coming. They say demand generated by government purchases through this legislation will be gradual, and that only a moderate amount of performance testing will occur.¹¹⁷ The real value of this legislation comes not just from its potential to increase the availability of biobased products, but the real-world medium it provides to demonstrate, as opposed to testing, the usefulness and performance of individual biobased products.¹¹⁸

Funding: Yield & Crop Representation

Two other concerns that have been voiced about funding for soy biobased products regards yield and crop representation. The first concern is that a disproportionate amount of money goes towards advances in productivity, with productivity being “the agronomic traits including yield, disease, and pest resistance.”¹¹⁹ As mentioned earlier, a large amount of the \$14 million that CSREES spends annually goes towards increasing the productivity of soybeans. Since there is a surplus of soybeans why not decrease productivity research, and put more dollars into new uses, which could consume the surplus and capture higher prices through value-added biobased products?¹²⁰

In order to answer this question, it should be noted that there are two fundamental products that come from the soybean:¹²¹ soybean meal, which is the main food part of the soybean, and soybean oil, which has great potential for new uses, and is typically more valuable than other parts of the soybean, including meal.^{122,123} Currently, there is not a surplus of meal, but there is a surplus of oil, which for 2003 is estimated to be 1.36 billion pounds.¹²⁴ Because only part of the soybean is overproduced there is an economic tradeoff to be considered. Does the higher-values that can be captured by either finding a market for the oil surplus or allowing farmers to participate in the manufacture of new uses for soy outweigh the benefits that can be received from selling more meal?¹²⁵

The second point is an inconsistency in crop representation. Soy is the second major US crop, behind corn and ahead of cotton and wheat. However, soy receives the least amount of funding from the federal government (figure 3).¹²⁶ One possible explanation for this is that some lobbies of individual crops, such as cotton, are more effective than others at getting funding appropriated for their part of the agricultural community.¹²⁷

Figure 3 - Commodity FY 2003 ARS funding

Corn	\$53,893,800
Cotton	\$48,478,600
Wheat	\$43,365,100
Soybean	\$33,226,200

Table courtesy of American Soybean Association

Funding: Genetic Engineering

The majority report of the 2001 Technical Advisory Committee Recommendations includes genetically modified crops as a priority research area saying that, “research is needed at the genetic level to produce crops with desirable traits for both edible and industrial uses,” and that, “Longer-term genetic research could change the chemical composition of plants to produce crops with new chemical compositions that are much closer to the final industrial product.”¹²⁸ Indeed, this priority is high on the list considering that genetic engineering accounts for \$33-\$53 million of the federal biomass R&D budget.¹²⁹

Support for plant genetic engineering is in contrast to the minority report included with the Technical Advisory Recommendations, which describes such research as having considerably less benefits than other types of genetic research.¹³⁰ The report draws a distinction between “outside” genomics, which is genetic enhancement of actual crops, and “inside” genomics, which is the genetic engineering of, “microorganisms to improve productivity inside the manufacturing plant.” The report says that inside genomics has had considerable success improving the efficiencies of biomass industrial processes, often by 40 to 90%,¹³¹ while outside genomics has had limited success and carries more risk of harmful consequences.¹³²

Which side is correct on this issue is up for debate, especially with regards to soybeans. While it is true that inside genomics has been more successful than outside genomics, it is also true that there has been a reasonably larger proportion of effort put into modifying microorganisms than into crops.¹³³ It is quite possible that genetic crop modification for new uses is not yet a mature science, and with some work has discoveries yet to come. In the case of soybeans, DuPont successfully improved the oleic acid concentration of soybean oil from 22.8% to 80%,¹³⁴ making “an oil which is naturally more heat stable and contains less saturated fat than regular soybean oil.”¹³⁵ This oil has much utility in the new uses industry, but was driven out of the fast food market for which it was originally intended because of the stigma attached to GM foods.¹³⁶

The case of Dupont illustrates a distinction to be made about outside genomics; GM crops used for biobased products carries less political consequences than GM foods. However, those consequences are still higher than inside genomics, which is uncontroversial so long as genetically engineered microorganisms are used in an enclosed environment.¹³⁷

A Need for More Funding

A last point to be made about federal funding for biomass research is that the consensus among the public and private research sectors and the USDA and DOE administrations is that funding for the biomass Initiative needs to be increased. After passage of the farm bill in 2002 appropriated funding for the Initiative, the Biomass Coordination Office began accepting solicitations for biomass research.¹³⁸ The Office received some 400 project solicitations amounting to \$350 million dollars worth of money requested, but had only \$21 million, about 6%, to fund projects with.¹³⁹ Considering that new uses for soy is only a small fraction of the interests this money has to serve it would seem that the

initiative needs more funding in order to be considered comprehensive. Additionally, the farm bill gives biomass research \$14 million per year, but the Biomass Research and Development Initiative (and the Farm Bill) authorized \$49 million, more than three times this amount.¹⁴⁰ This large difference between the original amount intended and the money actually appropriated has led some to question how much initiative there is behind the initiative.¹⁴¹

Retaining Chemical Engineers in USDA Biobased Programs

A National Research Council (NRC) publication entitled *Biobased Industrial Products* writes,

Many technically feasible techniques for processing renewable materials have been developed in the laboratory but have little chance of commercial viability. Providing explicit mechanisms for cooperation between laboratory scientists and process engineers would help avoid this problem and help ensure adoption of effective and economical approaches.¹⁴²

This report goes on to say that there is a widening gap between “federally funded basic research and industry-funded applied research and development.” This gap is referred to as the “Valley of Death.”¹⁴³ The intention behind these statements seems to be that successful commercialization of new uses technologies is dependent on successful integration of process engineers with federal efforts.

With that being said, there seems to be some difficulty in keeping engineers involved in the federal side of new uses research. For several decades the ARS has had a shortage of engineers.¹⁴⁴ They have been unable to retain chemical engineers both because they cannot afford to provide benefits and salaries that are competitive with industry, and because ARS scientists cannot enjoy the type of independent consulting available in academia.¹⁴⁵ The median salary of chemical engineers in the United States in 2000 was \$65,960.¹⁴⁶ The middle 50% of those chemical engineers earned between \$53,440 and \$80,840.¹⁴⁷ This retention issue does not seem to be limited to the ARS considering that CSREES currently staffs four engineers, only one being a chemical engineer.^{148,149} However, it should be noted that “state partners [of CSREES] in the land grant system include hundreds of engineers that serve as a source of expertise for numerous technology and processing issues.”

Research Overlap

One general concern over biomass research that also applies to new uses for soy is that there “is no one agency clearinghouse for who’s doing what.” Dan Manternach, Executive director of the New Uses Council, feels there could be a significant amount of overlap, some needless, in new uses research between the public and private sector and within each of those sectors themselves. Indeed, it seems that the only comprehensive in-house method of tracking new uses research in the USDA is to initiate a search through their Current Research Information System (CRIS).¹⁵⁰ While CRIS was started specifically for the purpose of allowing CSREES to keep track of its own research, and

while it is a very comprehensive database, it does not include research from private industry, nor does it allow industry to request comprehensive searches done by CRIS employees directly.¹⁵¹ Internet searches on their database are open to everybody, but comprehensive searches by staff are restricted to other federal employees and university partners.¹⁵² Some research databases exist in the private sector, but these services must be paid for.¹⁵³

Mr. Manternach's concern is echoed in the previously mentioned Biobased Industrial Products, which suggests, "Readily accessible databases could help promote the development of biobased products."¹⁵⁴ Among the information it offers as "needed information resources" is a "bibliography covering the literature of this field as background to guide future research," "data on ongoing demonstration and precommercialization projects," and "electronic 'bulletin boards' for people working in the area."¹⁵⁵

Mr. Manternach offers that a potential solution for this problem could come through the Biobased Manufacturer's Association (BMA), an offshoot of the New Uses Council, which intends to "solicit the research community, both public and private, to contact [BMA] and 'lay claim' to identified objectives they are working on so that the research community. . . [can] see which research objectives already have multiple teams and entities working on them, and which ones have few or even nobody working on them."¹⁵⁶

On the other hand of the spectrum, members of CRIS, ARS and the USB question the effectiveness of a centralized research solicitation for several reasons. First, there are numerous safeguards already in place meant to prevent research overlap. Not only does CSREES do a CRIS search when considering a project, they have an extensive panel review staffed by experts in the field, and projects must be approved by national program leaders who have a good deal of experience with those topics also.¹⁵⁷ The ARS has national program leaders who are responsible for avoiding research overlap. Each proposal submitted to the ARS "must describe the uniqueness of the research approach or how it differs/complements other research in ARS or elsewhere," and the ARS, "interacts with stakeholder groups to ensure the relevance of research."¹⁵⁸ Similar efforts are done at the USB, which has people continually looking into what's going on with soy research and holds annual forums where representatives from universities and industry talk about what they are working on.¹⁵⁹ It has also been noted that university researchers are hesitant to share information about their work until they are near publication, nor is industry willing to share until they have a patent.¹⁶⁰ A comprehensive research clearinghouse would need to be continually staffed with people actively investigating current research, would have to show that it is capable of staying current and thorough, and would need to show longevity in order to be an effective research tool.¹⁶¹

Conclusions

Federal biomass efforts require several adjustments in order to provide rural agricultural communities the best chance of economic improvement through new uses for soy. Regarding research, appropriated dollars should reflect the soybean's position as the

second most produced crop, instead of being fourth in funding. Concerning the biomass initiative as a whole, there is definitely a need to increase funding towards the \$49 million authorization, especially considering the raw number of solicitation's the USDA is receiving for new uses. In terms of where the money is spent, further investigation needs to be done in order to compare inside vs. outside genomics. However, in the absence of such investigation it seems that arguments on the side of the ILSR are more compelling, both because inside genomics is a more proven science and because outside genomics carries with it aggressive political ramifications. Finally, cost-benefit analysis and risk-assessment should be performed to determine whether shifting money away from productivity research and towards new uses is a better long-term strategy for farming communities.

As for a comprehensive research clearinghouse, it would seem that both public and private organizations doing soy research already have effective and thorough methods of preventing overlap. However, since the Biomass Research and Development Initiative is meant to be a joint coordination effort between the USDA, DOE, and other federal agencies, it might make sense to expand CRIS's scope to include new uses research done by all of the departments, and possibly solicit the private sector for non-proprietary information on their projects. Doing this would require more funding and more manpower, but a more powerful information system might make checking for overlap more efficient, and reduce the amount of effort each individual organization must go through to produce a balanced research program.

Regarding increasing the role of process engineers in federal new uses research and development, it would seem that greater incentives must be offered to attract chemical engineers into USDA departments such as the ARS. Appropriate incentives include offering higher salaries and better benefits, or by incorporating the opportunity for lucrative consulting into the duties of researchers.

While the above changes will hasten the discovery of a greater array of economically feasible soy biobased products, there is still the reality that improving the market for a commodity does not guarantee that the price of the commodity will improve. Despite loans being made for value-added cooperatives, there lacks a distinct federal coordination effort that could assist farmers in capturing higher values for biobased products. The USDA's departments of Rural Development and Rural Business and Cooperative Services are not currently integrated with departments doing new uses research, nor do they have representation on the Board or Advisory Committee. Appointing Undersecretary Dorr to the Board would be a major step in the right direction, but the Senate's long delay leaves doubt that this will ever happen in the current administration. Many CRADAs are with large corporations, and among the 40% of small business CRADAs, only a portion of these are with farming cooperatives. While evidence suggests that farmers themselves are inefficient at maintaining processing facilities either individually or in coops, it is not to say that there aren't solutions out there that could merge the expertise of larger corporations with the investment of farmers, or that programs couldn't be designed to help farmers start facilities with a higher rate of success. It also seems sensible that a certain portion of soy research be dedicated to

investigating how to strengthen the success of farming cooperatives, and to investigate new uses production processes that are easier to adapt to such cooperatives.

Despite such challenges, many features of the soy infrastructure are already in place that facilitate and will continue facilitating adoption and commercialization of soy products. The check-off program has the desire and capability to fulfill the needs of an emerging industry. It promotes research, and disseminates information about available products both domestically and abroad. The large proportion of their budget that the check-off program has available to market emerging products is a good way of dealing with the reality that, if potential buyers are unaware of the existence of green alternatives, then soybean products will not be purchased. The demonstrative medium and information about individual biobased items that will result from the farm bill will provide benchmarks by which consumers can evaluate biobased products, as well as create a market pull that will assist soy biobased products in achieving production-of-scale and market maturity. Finally, the ARS and CSREES, along with research and commercialization activities funded through the USB, provide a steady foundation of research, and a pipeline for commercialization, that will continue to provide the advances and development needed for new and affordable soybean products.

Policy Recommendations

Funding: USDA funding should be proportioned to reflect a commodity crop's production ranking, meaning that soy biobased products should get the second-most amount of funding in the USDA for new uses, instead of fourth. Research dollars for genetic engineering should reflect the effectiveness and political consequences associated with the type of genetic research, meaning that there should be a shift in the proportion of funding that outside genomics receives in favor of inside genomics. The amount by which this should be shifted warrants study. On the same token, cost-benefit analysis and risk-assessment should be performed to determine whether shifting money away from productivity research and towards new uses is a better long-term strategy for farming communities. Finally, overall funding for the Biomass Research and Development Initiative should be increased to meet a larger portion of the vast number of solicitations from private industry for new uses research.

Research Overlap: The current means of assessing possible research overlap seems effective and thorough in every major organization researching soy. However, funding CRIS to cover new uses research in all departments and the private sector might produce a valuable increase in efficiency when investigating overlap. CRIS should also be allowed to increase access to its staff assisted searches by members of industry.

Incorporating Process Engineering: The role of process engineers in federal research institutions investigating new uses for soybeans seems to be limited. Greater effort must be made to attract chemical engineers into federal laboratories and institutions, namely by offering competitive pay and benefits, or by facilitating something similar to the lucrative consulting practiced in academia.

Tying Profits To Farmers: More efforts should be placed on integrating departments in the USDA that are experienced with rural agricultural communities. In particular, Senate confirmation of Undersecretary Dorr would put rural interests on the Biomass Research & Development Board. Perhaps most importantly, the Biomass Initiative needs to pursue better ways of helping farmers capture higher values for their crops. A USDA program sponsoring joint commercialization ventures between corporations and farming communities would be a good way of allowing farmers to get a hedged return on their investments, utilizing the technical expertise and experience of larger chemical companies, and reducing the risk of both sides by dividing costs. Favoring these ventures when there are multiple bidders for CRADA's involving valuable federally researched technologies, granting them leveraging preferences, and favoring them for licenses are possible ways of doing this. Another strategy would be to improve the processes already in place in the Department of Rural Development that gives grants for value-added cooperatives, and to integrate them into the Biomass Research and Development Initiative because existing value-added cooperatives, such as ethanol stills, have a poor track record. Along the same lines, the USDA should dedicate a certain portion of their research budget to investigating how to strengthen the success of farming cooperatives, bridge the research/commercialization gap known as the Valley of Death, and to investigate new uses production processes that are easier to adapt to such cooperatives.

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- ¹ Public Policy Priorities – AIChE <http://www.aiche.org/government/prioritystatements>
- ² PL 106-224 Title III of “The Agricultural Risk Protection Act” is “The Biomass Research and Development Act”. Signed into law June 20, 2000
- ³ “Biobased Industrial Products – Not a New Idea for the ARS”. *Agricultural Research*; April, 2002. Pg. 16
- ⁴ “Biobased Products: America’s Second Green Revolution”. *Agricultural Research*; April, 2002. Pg. 2
- ⁵ Personal interview with Dr. Frank Flora, National Program Leader of Product Quality & Utilization of the Agricultural Research Service, USDA; June 25, 2003
- ⁶ “From Petro to Agro: Seeds of a New Economy”, Dr. Robert E. Armstrong. A publication of the Center for Technology and National Security Policy, National Defense University. October 2002
- ⁷ “Accelerating the Shift to a Carbohydrate Economy: The Federal Role”. Executive Summary of the Minority Report of the Biomass Research and Development Technical Advisory Committee: January 10, 2002
http://www.carbohydrateeconomy.org/library/admin/uploadedfiles/Accelerating_the_Shift_to_A_Carbohydrate_Econo.htm
- ⁸ PL 106-224 Title III of “The Agricultural Risk Protection Act” is “The Biomass Research and Development Act”. Signed into law June 20, 2000
- ⁹ PL 106-224 Title III of “The Agricultural Risk Protection Act” is “The Biomass Research and Development Act”. Signed into law June 20, 2000
- ¹⁰ The phrase “value-added product” in this report means a nonfood, nonenergy product derived from a biomass feedstock. Synonymous with this are the phrases “new uses”, “biobased product”, and “bioproduct”
- ¹¹ www.unitedsoybean.org is the checkoff program for soybean farmers. Under its target research areas it lists adhesives, coatings and printing inks, lubricants, plastics, and specialty products as its main areas of research. These are also the primary areas of soy research that experience competition from petroleum products.
- ¹² www.unitedsoybean.org United Soybean Board website: overview, USDA Soybean Promotion and Research Program, background information
- ¹³ <http://www.usda.gov/nass/aggraphs/soyprod.htm> National Agricultural Statistics Service, United States Department of Agriculture
- ¹⁴ www.unitedsoybean.org United Soybean Board website: overview, USDA Soybean Promotion and Research Program, background information
- ¹⁵ “Soy Stats 2002: A Reference Guide To Important Soybean Facts & Figures”, prepared by American Soybean Association
- ¹⁶ www.unitedsoybean.org United Soybean Board website: overview, USDA soybean Promotion and Research Program, Background Information
- ¹⁷ www.unitedsoybean.org United Soybean Board website: what we do, overview
- ¹⁸ Phone Interview with Michael Erker, Bioproducts Development Director at United Soybean Board. June 30, 2003
- ¹⁹ Phone Interview with Michael Erker, Bioproducts Development Director at United Soybean Board. June 30, 2003
- ²⁰ www.unitedsoybean.org United Soybean Board website: what we do, overview
- ²¹ www.unitedsoybean.org United Soybean Board website: the library, annual reports, fiscal year 2002.
- ²² According to Mike Erker of the USB, the decrease in funding was representative of the change in check-off dollars, which reflects soybean revenue for that year.
- ²³ www.unitedsoybean.org United Soybean Board website: the library, annual reports, fiscal year 2002
- ²⁴ Mission of the United States Department of Agriculture <http://www.usda.gov/mission/miss-toc.htm>
- ²⁵ www.reeusda.gov/1700/about/about_csrees.htm
- ²⁶ www.soygrowers.com/membership/longterm03.htm American Soybean Association “Long Term Competitiveness Issues”
- ²⁷ Numbers are from an Agricultural Research Service Agricultural Research Information System Project Listing performed under Frank Flora.
- ²⁸ Information provided by Dr. Frank Flora, National Program Leader of Product Quality & Utilization

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- ²⁹ Phone interview with Carmela Bailey, National Program Leader, Agricultural Materials, CSREES
- ³⁰ Email correspondence with Carmela Bailey, National Program Leader, Agricultural Materials, CSREES. Dollar figure is a result of an online CRIS search done by Bailey.
- ³¹ <http://www.ars.usda.gov/is/timeline/centers.htm>
- ³² Personal interview with Dr. Frank Flora, National Program Leader of Product Quality & Utilization, ARS, USDA; June 25, 2003
- ³³ <http://www.ars.usda.gov/is/timeline/centers.htm>
- ³⁴ <http://intramural.nimh.nih.gov/techtran/legislation.htm#ftta>
- ³⁵ <http://intramural.nimh.nih.gov/techtran/legislation.htm#ftta>
- ³⁶ “Executive Order 13134: Developing and Promoting Biobased Products and Bioenergy” Retrieved from <https://www.denix.osd.mil/denix/Public/Legislation/EO/note52.html>
- ³⁷ “Biomass Feedstock Availability in the United States: 1999 State Level Analysis,” retrieved from <http://bioenergy.ornl.gov/resourcedata/> Accessed 6/10/2003
- ³⁸ “Executive Order 13134: Developing and Promoting Biobased Products and Bioenergy” Retrieved from <https://www.denix.osd.mil/denix/Public/Legislation/EO/note52.html>
- ³⁹ “Executive Order 13134: Developing and Promoting Biobased Products and Bioenergy” Section 2 Retrieved from <https://www.denix.osd.mil/denix/Public/Legislation/EO/note52.html>
- ⁴⁰ “Executive Order 13134: Developing and Promoting Biobased Products and Bioenergy” Section 2 Retrieved from <https://www.denix.osd.mil/denix/Public/Legislation/EO/note52.html>
- ⁴¹ “Executive Order 13134: Developing and Promoting Biobased Products and Bioenergy” Section 3 & 4 Retrieved from <https://www.denix.osd.mil/denix/Public/Legislation/EO/note52.html>
- ⁴² “Executive Order 13134: Developing and Promoting Biobased Products and Bioenergy” Section 6 Retrieved from <https://www.denix.osd.mil/denix/Public/Legislation/EO/note52.html>
- ⁴³ Email correspondence with Dr. Frank Flora, National Program Leader of Product Quality & Utilization; June 25, 2003
- ⁴⁴ From this point on the Biomass Research and Development Board will be referred to as “the Board.”
- ⁴⁵ PL 106-224 “The Biomass Research and Development Act,” Sections 305 & 306; Signed into law June 20, 2000
- ⁴⁶ From this point on the Biomass Research and Development Technical Advisory Committee will be known as the “Advisory Committee.”
- ⁴⁷ PL 106-224 “The Biomass Research and Development Act,” Sections 305; Signed into law June 20, 2000
- ⁴⁸ PL 106-224 “The Biomass Research and Development Act,” Sections 306; Signed into law June 20, 2000
- ⁴⁹ Personal Interview with John Ferrell, Co-director of Biomass Research and Development Coordination Office
- ⁵⁰ PL 106-224 “The Biomass Research and Development Act,” Sections 307; Signed into law June 20, 2000
- ⁵¹ PL 106-224 “The Biomass Research and Development Act,” Sections 307; Signed into law June 20, 2000
- ⁵² Personal interview with Merlin Bartz, Special Assistant to the Undersecretary for Natural Resources and Environment; July 18, 2003
- ⁵³ Based on comments from David Morris, Vice President for the Institute for Local Self-Reliance and member of Biomass Research and Development Technical Advisory Committee, Dr. Frank Flora, National Program Leader of Product Quality & Utilization of the Agricultural Research Service
- ⁵⁴ PL 107-171 Farm Security and Rural Investment Act of 2002
- ⁵⁵ PL 107-171 Farm Security and Rural Investment Act of 2002
- ⁵⁶ PL 107-171 Farm Security and Rural Investment Act of 2002
- ⁵⁷ “Current Status on Implementing Title IX of the Farm Security and Rural Investment Act of 2002” <http://www.usda.gov/energy/title%209%20implement%20status%20041809.html> Written April 18, 2003, accessed June 26, 2003
- ⁵⁸ “Current Status on Implementing Title IX of the Farm Security and Rural Investment Act of 2002” <http://www.usda.gov/energy/title%209%20implement%20status%20041809.html> Written April 18, 2003, accessed June 26, 2003

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- ⁶⁰ Personal interview with Merlin Bartz, Special Assistant to the Undersecretary for Natural Resources and Environment; July 18, 2003
- ⁶¹ Personal interview with Merlin Bartz, Special Assistant to the Undersecretary for Natural Resources and Environment; July 18, 2003
- ⁶² Personal interview with Merlin Bartz, Special Assistant to the Undersecretary for Natural Resources and Environment; July 18, 2003. Note that the author is not sure if this is formalized policy or informal practice.
- ⁶³ Personal interview with Merlin Bartz, Special Assistant to the Undersecretary for Natural Resources and Environment; July 18, 2003
- ⁶⁴ “Executive Order 13134: Developing and Promoting Biobased Products and Bioenergy” Section 1 Retrieved from <https://www.denix.osd.mil/denix/Public/Legislation/EO/note52.html>
- ⁶⁵ The point that the Biomass Research and Development Act mentions rural interests several times is made here: www.carbohydrateconomy.org, “Comments to the United States Department of Agriculture On the Use of Resources under Section 9008 of the 2002 Farm Bill,” David Morris Vice President, Institute for Local Self-Reliance. The number of times it is mentioned was found by reading the Act itself.
- ⁶⁶ <http://www.ars.usda.gov/is/timeline/centers.htm> “History of Research at the U.S. Department of Agriculture and Agricultural Research Service: Finding New Uses for Surplus Products”
- ⁶⁷ Personal interview with Dr. Frank Flora, National Program Leader of Product Quality & Utilization; June 25, 2003
- ⁶⁸ www.ilsr.org
- ⁶⁹ “News from the Field: In a Carbohydrate Economy, Ownership Matters” written by David Morris, Vice President of Institute for Local Self-Reliance. October 16, 2000 <http://www.carbohydrateconomy.org/>
- ⁷⁰ “News from the Field: In a Carbohydrate Economy, Ownership Matters” written by David Morris, Vice President of Institute for Local Self-Reliance. October 16, 2000 <http://www.carbohydrateconomy.org/>
- ⁷¹ “News from the Field: In a Carbohydrate Economy, Ownership Matters” written by David Morris, Vice President of Institute for Local Self-Reliance. October 16, 2000 <http://www.carbohydrateconomy.org/>
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- ⁷³ “Accelerating the Shift to a Carbohydrate Economy: The Federal Role, Executive Summary of the Minority Report of the Biomass Research and Development Technical Advisory Committee, Jan 10,2002
- ⁷⁴ Personal interview with Merlin Bartz, Special Assistant to the Undersecretary for Natural Resources and Environment; July 18, 2003
- ⁷⁵ “Comments to the United States Department of Agriculture On the Use of Resources under Section 9008 of the 2002 Farm Bill” by David Morris, Vice President of the Insitute for Local Self-Reliance. December 3, 2002
- ⁷⁶ “Comments to the United States Department of Agriculture On the Use of Resources under Section 9008 of the 2002 Farm Bill” by David Morris, Vice President of the Insitute for Local Self-Reliance. December 3, 2002
- ⁷⁷ “Comments to the United States Department of Agriculture On the Use of Resources under Section 9008 of the 2002 Farm Bill” by David Morris, Vice President of the Insitute for Local Self-Reliance. December 3, 2002
- ⁷⁸ www.carbohydrateconomy.org, “Comments to the United States Department of Agriculture On the Use of Resources under Section 9008 of the 2002 Farm Bill,” David Morris Vice President, Institute for Local Self-Reliance. After the first draft of the farm bill regulations passed the OMB they were passed along to the public for comment for sixty days. After this period the comments were considered, adjustments to the bill were made were it was seen fit, and the next phase of regulatory drafting commenced
- ⁷⁹ Quote is from page 16 of the December 2002 Roadmap written by the Biomass Technical Advisory Committee. The concept of a biorefinery is gaining much momentum in the biomass community. Just like a petroleum refinery, a biorefinery would allow multiple high-end products to be spun off of the same feedstock, and residuals could be used for heat and electricity (page 23 of Biomass Roadmap 2002). Such

a concept would probably be suitable for soy since there are many examples of biodiesel refineries throughout the country.

⁸⁰ Phone interview with Ron Buckhalt, Technology Transfer Marketing Technician, Office of Technology Transfer, July 25, 2003

⁸¹ Phone interview with Ron Buckhalt, Technology Transfer Marketing Technician, Office of Technology Transfer, July 25, 2003

⁸² Phone interview with Ron Buckhalt, Technology Transfer Marketing Technician, Office of Technology Transfer, July 25, 2003

⁸³ Phone interview with Merlin Bartz, Special Assistant to the Undersecretary for Natural Resources and Environment. July 25, 2003

⁸⁴ Phone interview with Merlin Bartz, Special Assistant to the Undersecretary for Natural Resources and Environment. July 25, 2003

⁸⁵ Phone interview with Ron Buckhalt, Technology Transfer Marketing Technician, Office of Technology Transfer; July 25, 2003

⁸⁶ “News from the Field: In a Carbohydrate Economy, Ownership Matters” written by David Morris, Vice President of Institute for Local Self-Reliance. October 16, 2000 <http://www.carbohydrateeconomy.org/>

⁸⁷ <http://www.agmrc.org/business/cs/ksusdsoy.pdf> “South Dakota Soybean Processors: Joint Ventures and Strategy” Department of Agricultural Economics, Kansas State University; January 2003

⁸⁸ <http://www.agmrc.org/business/cs/ksusdsoy.pdf> “South Dakota Soybean Processors: Joint Ventures and Strategy” Department of Agricultural Economics, Kansas State University; January 2003

⁸⁹ Personal interview with Krysta Harden, American Soybean Association Washington Representative; July 7, 2003

⁹⁰ Phone interview with Marvin Duncan, Agricultural Economist, Office of Energy Policy and New Uses in Office of Chief Economy, USDA.

⁹¹ Information provided by the USDA’s Department of Rural Business and Cooperative Services. Talked to secretary for William Hagy.

⁹² Personal Interview with John Ferrell, Co-director of Biomass Coordination Office; July 23, 2003

⁹³ 1) Personal interview with Krysta Harden, American Soybean Association Washington Representative; July 7, 2003 2) Personal interview with Dr. Frank Flora, National Program Leader of Product Quality & Utilization; June 25, 2003

⁹⁴ Personal interview with Dr. Frank Flora, National Program Leader of Product Quality & Utilization, ARS, USDA; June 25, 2003

⁹⁵ Personal interview with Dr. Frank Flora, National Program Leader of Product Quality & Utilization, ARS, USDA; June 25, 2003

⁹⁶ Phone Interview with Michael Erker, Bioproducts Development Director at United Soybean Board. June 24

⁹⁷ Phone Interview with Michael Erker, Bioproducts Development Director at United Soybean Board. June 30, 2003

⁹⁸ Phone Interview with Michael Erker, Bioproducts Development Director at United Soybean Board. June 30, 2003

⁹⁹ Phone Interview with Michael Erker, Bioproducts Development Director at United Soybean Board. June 30, 2003

¹⁰⁰ Phone Interview with Michael Erker, Bioproducts Development Director at United Soybean Board. June 30, 2003

¹⁰¹ Presentation by Kei Koizumi, American Association for the Advancement of Science (AAAS); June 24, 2003

¹⁰² Phone interview with Carmela Bailey, National Program Leader, Agricultural Materials, CSREES; July 3, 2003

¹⁰³ Phone interview with Carmela Bailey, National Program Leader, Agricultural Materials, CSREES; July 3, 2003

¹⁰⁴ Phone interview with Marvin Duncan, Agricultural Economist, Office of Energy Policy and New Uses in Office of the Chief Economist; August 1, 2003.

¹⁰⁵ Phone interview with Marvin Duncan, Agricultural Economist, Office of Energy Policy and New Uses in Office of the Chief Economist; August 1, 2003.

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- ¹⁰⁶ “Current Status on Implementing Title IX of the Farm Security and Rural Investment Act of 2002” <http://www.usda.gov/energy/title%209%20implement%20status%20041809.html> Written April 18, 2003, accessed June 26, 2003
- ¹⁰⁷ “Current Status on Implementing Title IX of the Farm Security and Rural Investment Act of 2002” <http://www.usda.gov/energy/title%209%20implement%20status%20041809.html> Written April 18, 2003, accessed June 26, 2003
- ¹⁰⁸ Phone interview with Carmela Bailey, National Program Leader, Agricultural Materials, CSREES; July 3, 2003
- ¹⁰⁹ Phone interview with Marvin Duncan, Agricultural Economist, Office of Energy Policy and New Uses in Office of the Chief Economist, USDA
- ¹¹⁰ Phone interview with Carmela Bailey, National Program Leader, Agricultural Materials, CSREES; July 3, 2003
- ¹¹¹ Phone interview with Carmela Bailey, National Program Leader, Agricultural Materials, CSREES; July 3, 2003
- ¹¹² “A Profile in Biobased Success, USDA Facility Uses Biobased Products to Combine Mission, Policy and Research with Everyday Operations” United Soybean Board publication provided by Michael Erker
- ¹¹³ “United Soybean Board “BEAN-e-doo[®] Does It All for U.S. Postal Service Including Saving Big Dollars” United Soybean Board publication provided by Michael Erker
- ¹¹⁴ Phone interview with Ron Buckhalt, Technology Transfer Marketing Technician, Office of Technology Transfer, July 25, 2003
- ¹¹⁵ <http://www.setonresourcecenter.com/40CFR/Docs/wcd00055/wcd05588.asp> Compliance Resource Center
- ¹¹⁶ Phone interview with Ron Buckhalt, Technology Transfer Marketing Technician, Office of Technology Transfer, July 25, 2003
- ¹¹⁷ Phone interview with Marvin Duncan, Agricultural Economist, Office of Energy Policy and New Uses in Office of Chief Economy, USDA.
- ¹¹⁸ Phone interview with Marvin Duncan, Agricultural Economist, Office of Energy Policy and New Uses in Office of Chief Economy, USDA.
- ¹¹⁹ Email correspondence with Dr. Frank Flora, National Program Leader of Product Quality & Utilization; June 25, 2003
- ¹²⁰ Phone interview with Carmela Bailey, National Program Leader, Agricultural Materials, CSREES; July 3, 2003
- ¹²¹ Actually, there is a third, the soybean hull, but potential as food or new uses for this product is currently limited.
- ¹²² Personal interview with Krysta Harden, Washington Representative of the American Soybean Association; July 7, 2003
- ¹²³ <http://www.agmrc.org/business/cs/ksusdsoy.pdf> “South Dakota Soybean Processors: Joint Ventures and Strategy” Department of Agricultural Economics, Kansas State University; January 2003
- ¹²⁴ Phone Interview with Michael Erker, Bioproducts Development Director at United Soybean Board. June 30, 2003
- ¹²⁵ Note that this last point is not from a specific source. In interviewing, the author was unable to find a person who could comment on this paradox, leading to the question of whether it has actually been addressed.
- ¹²⁶ Personal interview Krysta Harden; July 3, 2003. <http://www.soygrowers.com/membership/longterm03.htm> Also, note that data is just for ARS. In the July 3, 2003 phone interview Carmella Bailey of CSREES said she believes this order of funding is true for her institution as well.
- ¹²⁷ Phone interview with Dr. Frank Flora, National Program Leader of Product Quality & Utilization, ARS USDA; July 11, 2003.
- ¹²⁸ 2001 Technical Advisory Committee Recommendations of the Biomass Research and Development Technical Advisory Committee submitted to Secretaries of Agriculture and Energy, Ann Veneman and Spencer Abraham. December 2001.
- ¹²⁹ “Accelerating the Shift to a Carbohydrate Economy: The Federal Role: Executive Summary of the Minority Report of the Biomass Research and Development Technical Advisory Committee” David Morris, Vice President of the Institute for Local Self-Reliance

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- ¹³⁰ 2001 Technical Advisory Committee Recommendations of the Biomass Research and Development Technical Advisory Committee submitted to Secretaries of Agriculture and Energy, Ann Veneman and Spencer Abraham. December 2001.
- ¹³¹ “Accelerating the Shift to a Carbohydrate Economy: The Federal Role: Executive Summary of the Minority Report of the Biomass Research and Development Technical Advisory Committee” David Morris, Vice President of the Institute for Local Self-Reliance
- ¹³² Phone interview with Carmela Bailey, National Program Leader, Agricultural Materials, CSREES
- ¹³³ Phone interview with Carmela Bailey, National Program Leader, Agricultural Materials, CSREES
- ¹³⁴ <http://www.asa-europe.org/pdf/benefits.pdf>, “The Benefits of New Biotechnology Produced Soybeans,” K. Nill
- ¹³⁵ “DuPont Develops High Oleic Soybean,” 3/31/97 DuPont Press Releases
- ¹³⁶ Phone interview with Carmela Bailey, National Program Leader, Agricultural Materials, CSREES
- ¹³⁷ Phone interview with Carmela Bailey, National Program Leader, Agricultural Materials, CSREES
- ¹³⁸ Phone interview with Merlin Bartz, Special Assistant to the Undersecretary for Natural Resources and Environment. July 25, 2003
- ¹³⁹ Phone interview with Merlin Bartz, Special Assistant to the Undersecretary for Natural Resources and Environment. July 25, 2003
- ¹⁴⁰ PL 106-224 “The Biomass Research and Development Act,” Sections 305 & 306; Signed into law June 20, 2000
- ¹⁴¹ David Morris, Vice President of the ILSR, member of Biomass R&D Technical Advisory Committee
- ¹⁴² <http://books.nap.edu/books/0309053927/html/110.html> Biobased Industrial Products: Research and Commercialization Priorities Committee on Biobased Industrial Products, National Research Council, 2000. Pg. 110
- ¹⁴³ <http://books.nap.edu/books/0309053927/html/111.html#pagetop> Biobased Industrial Products: Research and Commercialization Priorities Committee on Biobased Industrial Products, National Research Council, 2000. Pg. 111
- ¹⁴⁴ Personal interview with Dr. Frank Flora, National Program Leader of Product Quality & Utilization, ARS, USDA; June 25, 2003
- ¹⁴⁵ Phone interview with Dr. Frank Flora, National Program Leader of Product Quality & Utilization; August 4, 2003
- ¹⁴⁶ <http://www.bls.gov/oco/ocos029.htm> Occupational Outlook Handbook 2002-03 edition. US Department of Labor, Bureau of Labor Statistics
- ¹⁴⁷ <http://www.bls.gov/oco/ocos029.htm> Occupational Outlook Handbook 2002-03 edition. US Department of Labor, Bureau of Labor Statistics
- ¹⁴⁸ Email correspondence with Carmela Bailey, National Program Leader, Agricultural Materials, CSREES; August 7, 2003
- ¹⁴⁹ The other three consist of two agricultural engineers and one civil engineer. The chemical and two agricultural engineers are national program managers. Information from reference 148.
- ¹⁵⁰ Phone interview with Allen Moore, CRIS staff; July 3, 2003
- ¹⁵¹ Email correspondence with Dennis Unglesbee, Information Systems and Technology Management – Applications, CRIS; July 7, 2003
- ¹⁵² Email correspondence with Dennis Unglesbee, Information Systems and Technology Management – Applications, CRIS; July 7, 2003
- ¹⁵³ Phone interview with Allen Moore, CRIS staff; July 3, 2003
- ¹⁵⁴ <http://books.nap.edu/books/0309053927/html/116.html> Biobased Industrial Products: Research and Commercialization Priorities Committee on Biobased Industrial Products, National Research Council, 2000. Pg. 116
- ¹⁵⁵ <http://books.nap.edu/books/0309053927/html/116.html> Biobased Industrial Products: Research and Commercialization Priorities Committee on Biobased Industrial Products, National Research Council, 2000. Pg. 116
- ¹⁵⁶ Email correspondence with Dan Manternach, Executive Director of the New Uses Council; July 10, 2003
- ¹⁵⁷ Email correspondence with Dennis Unglesbee, Information Systems and Technology Management – Applications, CRIS; July 7, 2003

¹⁵⁸ Email correspondence with Dr. Frank Flora, National Program Leader of Product Quality & Utilization; June 25, 2003

¹⁵⁹ Phone Interview with Michael Erker, Bioproducts Development Director at United Soybean Board. July 24

¹⁶⁰ Phone Interview with Michael Erker, Bioproducts Development Director at United Soybean Board. July 24

¹⁶¹ Phone Interview with Michael Erker, Bioproducts Development Director at United Soybean Board. July 24