Chemurgy: Using Science Innovatively to Save American Agriculture from Overproduction

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Senior Division Historical Paper, National History Day 2010 Competition

After all, it really is all of humanity that is under threat during a pandemic.
- Dr. Margaret Chan, Director General of the World Health Organization

"A PROSPEROUS AND PRODUCTIVE AGRICULTURE is necessary to national and world peace and prosperity."[1] This statement by Clinton Anderson, Secretary of Agriculture from 1945-1948, encapsulates the idea of chemurgy, the utilization of scientific research to discover new uses for agricultural surplus. In the late 1920s, chemurgists began looking at farm goods as raw materials for industry, not just as food. A study of the farm crisis of the 1920s and 1930s, the growth of the chemurgy movement, and current advancements in research will show that the chemurgists caused innovative change in agriculture and industry which greatly impacts the world today.

The significance of the chemurgy movement is best understood after a review of the dismal state of American agriculture in the early parts of the twentieth century. Although many factors led to the crisis, surpluses were a major contributor. During WWI, European demand for food supplies encouraged farmers to expand their operations; this expansion, in conjunction with improved farming methods, led to record levels of production.[2] However, when foreign demand dropped after WWI, the market was suddenly flooded with farm goods, depressing prices below the cost of production.[3] According to a report to Congress, "American farmers [had] succeeded so well in the necessary effort to increase their efficiency that they now consistently [outran] the capacity of the economy to consume what they [had produced]."[4]

The brutally low prices led to disastrous results for farmers. Bank loans could not be met as farm mortgage debt rose to nearly $11 billion in 1923, its highest point in national history.[5] After the stock market crash of 1929, already-depressed crop prices plummeted even further.[6] Over the next three years, agricultural revenue dropped another two-thirds;[7] for example, the price of corn fell from 76

cents per bushel in 1929 to 29 cents in 1932.[8] Farmers were recouping less than half of their production costs, but not knowing what else to do, they "continued to pile up a depressing surplus."[9] By 1933, banks were foreclosing on farm loans at a record rate.[10]

As prices spiraled downward, farmers became desperate. Protestors organized, hoping to force change and drive prices up. Some turned violent. In several states, trucks were turned back from market at gunpoint and milk cans overturned. In Wisconsin, cheese factories were blown up.[11] In Iowa, a judge was nearly hanged for allowing farm foreclosures.[12] A Farmers' Holiday was declared with the slogan "Stay at Home—Buy Nothing—Sell Nothing."[13] Protestors planned to withhold produce until their problems were recognized by the government. Edward O'Neal, president of the Farm Bureau Federation, warned Congress that the threat was real: "Unless something is done for the American farmer, we will have revolution in this country within…twelve months."[14] (See Appendix)

In addition, the farm crisis caused widespread disruption to the American economy.[15] In his *Forgotten Man* speech, Franklin Roosevelt stated the urgency of finding a solution to the surplus problem:

> Approximately one-half of our whole population, fifty or sixty million people, earn their living by farming or in small towns whose existence immediately depends on farms. They have today lost their purchasing power.... The result of this loss…is that many other millions of people engaged in industry in the cities cannot sell industrial products to the farming half of the Nation....No Nation can long endure half bankrupt.[16]

It was clear that something must be done to save American agriculture.

Several solutions were considered. Some supported domestic allotment, paying farmers to stop working some of their land. Others promoted cost of production, a government guarantee that farmers would make a profit even if crop prices dropped. Still others endorsed the McNary-Haugen bill from the 1920s which proposed dumping crop surpluses in foreign countries.[17] Each plan had supporters and opponents.

Eventually, Secretary of Agriculture Henry A. Wallace put together the 1933 Agricultural Adjustment Act (AAA). Quickly implemented before another harvest could be brought in, the AAA asked farmers to destroy more than one-quarter of their crops. Southern farmers, for example, plowed up over ten million acres of cotton which had already been planted.[18] Other commodities were also destroyed, including six million piglets in September 1933.[19] Although it brought some relief, the AAA caused bitter resentment.[20]

It was about this time that the chemurgy movement began to make itself known. Turning away from the same old methods of bailing out agriculture, chemurgists innovatively looked at surpluses from a new angle—not as problems, but as building blocks. Rather than trying to get rid of excess crops, chemurgists hoped to change the way they were used by studying their chemical compositions.[21] The term *chemurgy*, which was created by an organic chemist named William Hale, comes from the Egyptian *keme* for *chemistry* and Greek *ergon* for *work.*[22] Stated simply, chemurgy is "chemistry at work on the farm."[23]

The origins of the chemurgic movement can be traced back to the mid 1920s. In 1924 Wheeler McMillen heard a speaker at the American Farm Bureau Federation's annual convention who lamented, "Unfortunately, the human stomach is not elastic."[24] Inspired by the idea that people can only consume so much farm produce, McMillen began researching non-traditional ways to use agricultural goods. In 1926 he wrote an editorial for *Farm and Fireside* promoting his ideas and calling for funding to explore the possibilities.[25] At the same time, Hale wrote an article recommending that industry turn to farm products for its raw materials.[26]

The writings of McMillen and Hale caught the attention of Henry Ford, who became a strong supporter of the chemurgic movement. Ford was also influenced by George Washington Carver, who is known as the world's first chemurgist.[27] Ford and Carver exchanged letters for several years, sharing their passion for innovative uses of agricultural surplus.[28] (See Appendix) In May 1935, Ford brought together over 300 leaders of agriculture, education, industry, and science in Dearborn, Michigan, for the first Dearborn Conference of Agriculture, Industry, and Science.[29] Here the Farm Chemurgic Council was established,[30] with Francis Garvan and the Chemical Foundation (a non-profit group dedicated to advancing the position of industrial chemistry)[31] promising to support the group for the first year.[32]

At that first meeting, the delegates fittingly met at Ford's replica of Independence Hall to sign a *Declaration of Dependence Upon the Soil and of the Right of Self-Maintenance*.[33] The council members determined that turning in a new direction—to science—would help defeat the agricultural depression.[34] These innovators quickly pledged to find new markets for surplus farm products and to change the way industry and agriculture interacted.

Over the next year, the Farm Chemurgic Council raised almost a million dollars to support research.[35] Their goals were simple: find new ways to use crops, create new uses for agricultural waste products, and discover new crops to replace those in surplus.[36] Achieving these goals was not as simple. Because chemurgic ideas were so innovative, many people were reluctant to accept them. However, Wheeler and others were dedicated to spreading their hopes for the country. Henry Ford was especially adamant in his support of chemurgy: "When it comes to sustaining life, we go to the fields. With one foot in agriculture and the other in industry, America is safe."[37]

The chemurgists were opposed to the AAA and the idea of paying farmers NOT to produce. McMillen, who would later become president of the Farm Chemurgic Council, declared, "We want to keep our America....We know the way. The way is to produce. Production built the nation great, and only production can either preserve or advance our country."[38] Unlike other solutions to the agricultural surplus problem, which attempted to give farmers just enough to survive, chemurgy could help farmers earn a lucrative living. In *A Wider Use of Agricultural Products,* J.L. Welsh argues that using chemurgic ideas to create new demand for agricultural surplus would allow farmers to operate at full capacity without fear of overproducing and would lead to prosperity for agriculture, labor, and industry.[39]

Although innovative, the reasoning behind chemurgy was sound. With over six million American farms, agriculture was, as Hale put it, the "greatest source

of wealth this nation can ever have."[40] In *Restoring Self-Sustaining Agriculture*, Secretary Anderson agreed, calling America, with its over one billion acres of arable land, the "richest agricultural empire in the world."[41] In addition, the chemurgists' focus on using farm products in industry created an equal partnership. Farmers were able to sell their surpluses, and industrialists were able to secure raw materials, both for reasonable prices.[42] This relationship made more sense than importing expensive raw materials from around the world.[43] Another advantage was chemurgy's use of renewable resources; fossil fuels will eventually run out, but agricultural products are renewed each harvest. One supporter argued, "In the long run, indeed, the world must learn to supply its major needs from things that can be grown,…not mined."[44]

One of the early chemurgic successes was soybeans. Taking their cue from George Washington Carver, scientists studied the chemical composition of the soybean, creating numerous new uses, including glue, ink, insecticides, linoleum, paint, soap, and varnish.[45] In the 1930s, Henry Ford even had a car built completely from the legumes.[46] (See Appendix) Due to these developments and others, the number of American acres planted with soybeans skyrocketed from one million to twelve million acres between 1934 and 1944.[47]

Scientists found industrial uses for many other farm products as well. According to McMillen, the chemurgists were constantly looking for "new markets, new buyers."[48] In his support of chemurgy, Henry Ford instructed his development staff to include in the making of Ford vehicles as many farm products as possible.[49] Other successes included using agricultural surpluses to create anesthetics, anti-freeze, cleaners, dyes, dry ice, fuel, medicines, plastics, and powder.[50]

The impressive advancements of chemurgic research began to be noticed. In a pamphlet put out by the Mississippi Industrial Commission, chemurgy's impact is described as "a 'chemical revolution' every bit as epochal as the last century's 'industrial revolution.'"[51] Encouraging manufacturers to change their methods by replacing imported raw materials with farm goods, chemurgists were moving both agriculture and industry forward and securing a place for chemurgy in the world: "Certain as science and sure as the sun, chemurgy is advancing to kingly stature."[52]

Eventually, chemurgy's significance was acknowledged by leaders in government. When a new Agricultural Adjustment Act was passed in 1938, Secretary Wallace called it "a new charter of economic freedom for farmers."[53] The law provided $4 million to fund four laboratories where researchers would develop new markets for farm commodities that were often found in surplus.[54] According to the Department of Agriculture's Agricultural Research Service, "The laboratories might not have been authorized at all were it not for the influence of the chemurgy movement."[55]

Chemurgic research made numerous contributions to America, but perhaps none as important as those made during WWII. McMillen was one of the first to point out the connection between chemurgy and victory, stating that the military needed to be "armed with the best and most of everything. We must out-produce to overwhelm."[56] McMillen believed chemurgy was good for the country. In a

speech entitled *The American Way*, McMillen argued, "The safety and welfare of the US can best be served by fully utilizing the capacity of American farms to meet nearly every essential need of the people."[57]

Soon, scientists were focused on providing goods that were in short supply due to the war. One such substance was rubber. During much of the war, 70% of the synthetic rubber needed to keep American military vehicles moving was created from grain alcohol.[58] Chemurgists were also responsible for guaranteeing a sufficient supply of penicillin and dehydrated foods for soldiers.[59]

It is clear that chemurgic research had a positive and significant impact on America's agriculture, industry, and military. However, when WWII ended, the chemurgy movement lost momentum due to the attention demanded by oil-based goods. After the war, petroleum was inexpensive, and petroleum companies rushed to create new products, hoping to regain ground lost to agricultural products. For decades, it was easier for people to depend upon petroleum-based goods.[60] However, the innovative ideas of the chemurgists did not die.

Today, "chemurgy is back with a vengeance,"[61] but now it is known as industrial biotechnology.[62] The purpose of this new research is to use renewable farm resources to produce chemicals and materials for industry in a way that is eco-friendly and economical.[63] With improved research, concerns about taking care of the earth, and the rising cost of oil, it is easy to understand why chemurgy is regaining favor.

The economic impact of chemurgic ideas is staggering. In the past ten years, the production of biochemicals and other biobased products has increased exponentially,[64] with over 20,000 patents granted annually. Chemical companies like Dow and DuPont are embracing the idea of biotechnology. Global sales of biotechnology products such as paint and plastics are predicted to reach $100 billion in sales by 2011.[65]

The impact on farm income is just as impressive, both locally and internationally. Iowa farmer John Ahlers has seen his crop yields grow 25-30% over the past twenty-five years. However, this increase has not led to fear of surplus and depression as it would have in the 1920s because chemurgic research continues to provide new markets for his harvests, ensuring financial stability.[66] Globally, farm income has increased $28 billion since 1996.[67] The total value of biotech crops has surpassed $210 billion and shows little sign of slowing.[68]

The creation of biofuels is another benefit of chemurgy. The advantages of biofuels are many: they make America less dependent on foreign oil, reduce its debt to oil countries, create more jobs in rural areas, and help protect the environment by reducing carbon dioxide emissions.[69] In 2006 alone, greenhouse emissions worldwide were reduced by fifteen million metric tons due to biotechnology.[70] Because global energy demands continue to increase, creating non-petroleum sources from agricultural products will benefit everyone.

Petroleum companies now view biotechnology as less of a threat than they did in the 1930s and 1940s when ethanol and petroleum were competing for the same market. Instead they see biofuels as "useful tools for blending into, and possibly extending, remaining oil reserves."[71] Partly for this reason, experts believe biotech products will still have a market even if oil prices drop back to $40 per barrel.[72] It

is clear that biotechnology, today's chemurgy, will continue to play a major role in the agricultural economy of the future.

The chemurgists caused innovative changes in agriculture and industry which continue to have significant impact today, as can be seen by examining the farm crisis of the 1930s, the growth of the chemurgy movement, and current advancements in chemurgic research. According to Charles Brannon, Secretary of Agriculture from 1948-1953, the chemurgists' "accomplishments sprang from vision and dedication to the public welfare….They have shown ways to make wiser use of our abundance and to utilize what once was wasted. They have contributed to national well-being to an extent that cannot be measured in money."[73]

Notes

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Books

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Written by one of the founding fathers of the chemurgy movement, this book was interesting to read. However, like several of Hale's other works, it is written in a style a little too "flowery" for my tastes. For example, he writes, "Thus nature herself is proffering man a vast storehouse of chemicals that can be suited to his every want.... Only the dumb and otherwise hamstrung individual can fail to comprehend this glorious outlook given by nature and the spirit of research of man." Despite the writing style, it is clear that Hale believed strongly in the goals of the chemurgists and was probably a good salesman for their ideas. For example, he explains in depth why other fuel sources such as coal, petroleum, and atomic energy have fewer benefits and more disadvantages than do sources created through chemurgy.

———. *The Farm Chemurgic: Farmward the Star of Destiny Lights Our Way*. Boston: Stratford Company, 1934.

This was Hale's first major publication about chemurgy. In it he describes the methods used by chemists, the "tearing asunder of composite matter," to reach the chemical components of some material. I used the book to get the meaning of the term "chemurgy," which originated with Hale, and to help set the timeline for when the movement started.

———. *Farmer Victorious: Money, Mart, and Mother Earth*. New York: Coward-McCann, Inc., 1949.

This book was one of several I found in the library at Iowa State University, originally Iowa State College of Agriculture. I found references to the professors at Iowa State in a few other sources, which explains why the ISU library had primary sources related to chemurgy. One chapter in this book, "Birth of Chemurgy," describes the timeline of how the important people in the chemurgy movement came together. In contrast, a chapter with the exact same title in Hale's *Farmward March* describes the development of organic chemistry.

Hale, William J. *Farmward March: Chemurgy Takes Command*. New York: Coward-McCann, Inc., 1939.

Like Hale's other works, this book shows the author's faith in the ability of chemurgy to change the world. By increasing the industrial use of farm products, Hale explains, "the curse of unemployment [will be] blotted out forever." In turn, those who find new jobs in agriculture will discover a "renewal of health and vigor." Reading Hale's writing makes me smile because his words are so lofty.

McMillen, Wheeler. *The Green Frontier: Stories of Chemurgy*. New York: G.P. Putnam's Sons, 1969.

Wheeler McMillen, president of the Farm Chemurgic Council and long-time advocate of chemurgy, seems to have written *The Green Frontier* to explain his ideas to the common person. The writing style is interesting and easy to comprehend, especially in comparison with Hale's. McMillen clearly tells the history, goals, and benefits of the chemurgy movement, emphasizing that although minerals are not renewable, vegetation (agricultural produce) is. This source, which I discovered at the National Agricultural Library in Maryland, helped me to understand how innovative the idea of chemurgy was at its origin, and it allowed me to compare two major figures in its history.

———. *New Riches from the Soil: The Progress of Chemurgy*. New York: D. Van Nostrand Company, Inc., 1946.

This book covers the progress of chemurgy up until 1945. I used it to learn about the origin of McMillen's interest in chemurgic research and about the goals of the chemurgists. It includes some humorous stories. For example, in 1938 when the Agricultural Adjustment Act was making its way through Congress, someone questioned an amendment which allowed $4 million earmarked for regional research laboratories: it seemed like a "lot of money to throw blindly into a new kind of research." Instead, the conference committee in charge reduced the amount to $100,000, suggesting the scientists find out how the $4 million would be spent. This proves how innovative chemurgic research was at the time. However, through a clerical error, the conference report contained not only the $100,000 but also the $4 million! Senator Theodore Bilbo of Mississippi, who had introduced the research laboratory bill in the first place, noticed the error and quickly called for a vote before opponents would notice it. The bill became law, and chemurgic research in the Department of Agriculture was underway.

Government Documents/Publications

Agricultural Adjustment Act of 1933. codified at *U.S. Code* 48, § 31, http://www.nationalaglawcenter .org// (accessed April 10, 2010).

As Secretary of Agriculture, Iowan Henry A. Wallace passed the Agricultural Adjustment Act of 1933 to provide relief to desperate farmers. I used this source to establish the severity of the problem and why the chemurgists pushed for change. The beginning of the act shows the urgency of the situation, calling it an "acute economic emergency" caused by a "severe and increasing disparity between the prices of agricultural and other commodities."

Agricultural Adjustment Act of 1938. codified at *U.S. Code* 7, § 35, http://www.law.cornell.edu/ uscode/7/usc_sup_01_7_10_35.html (accessed January 25, 2010).

The influence of the chemurgy movement is shown in the Agricultural Adjustment Act of 1938. The act provided funding for four research laboratories, one in each agri-

cultural area of the United States: the South, the West, the East, and the Midwest. The labs were directed by Congress to find new ways of using surplus farm commodities.

McMillen, Wheeler. "How Far Can We Go in Chemurgy?" In *Crops in Peace and War: The Yearbook of Agriculture 1950-1951*, 10-13. USDA, Washington D.C.: GPO, 1950.

Written by Wheeler McMillen, editor-in-chief of the Farm Journal and president of the National Farm Chemurgic Council, this article is a valuable source. McMillen defends chemurgy on several points, explaining the many contributions made by scientific research. First, he argues that chemurgy would not lead to a food shortage, as some opponents had stated. One goal of chemurgy was to find new industrial uses for agricultural waste products, such as stalks, cobs, and pits. Being able to sell these items might actually encourage farmers to grow more food, not less. Second, he notes the importance of chemurgy in defending America: "No warship is now built, or plane flown, or munition made without drawing upon agricultural materials." According to McMillen, chemurgic research during WWII was responsible for making penicillin plentiful in military hospitals and dehydrated food available to soldiers.

Subcommittee of the Committee on Agriculture and Forestry. United States Senate. *Investigation of Expanded Utilization of Farm Crops*. Document 240. Washington, D.C.: GPO, 1944.

The use of industrial alcohol is discussed in this report to the Senate. According to Dr. Buchannan, director of the Agricultural Experiment Station at Iowa State, America would be stronger if it produced more grain alcohol. He compared using farm products with spending the interest on money in the bank. On the other hand, using fossil fuels is like spending the principle. The document also reports that chemurgic research was helping to keep the country moving during WWII: it was predicted over 600 million gallons of grain alcohol would be required by the military. The chemurgic movement had great impact on the American war effort.

U.S. Bureau of Agricultural Chemistry and Engineering. Department of Agriculture. *Farm Products and By Products For Industrial Use*. Washington, D.C.: GPO, 1940.

This USDA report updates several other reports from the 1930s regarding the use of farm products in industry. For example, it states that the use of soybean oil had increased by ten times in only nine years. The document reports similar growth for corn, cottonseed, and oats. These statistics show the impact of chemurgic research.

U.S. Congress. Senate. *Report to the Congress from the Commission on Increased Industrial Use of Agricultural Products*. 85th Cong., 1st sess., 1957. S. Doc. 45.

The significance of the chemurgy movement's influence is shown in this report to Congress. First, the fact that the Senate had a Commission on Increased Industrial Use of Agricultural Products indicates that Congress believed in the chemurgists' goals. Secondly, the report reviews other alternatives that were tried to reduce surplus and to "prop" up agriculture, calling these methods expensive and unsuccessful. The report suggests more funding for chemurgy as well as for educating students in the science/research areas.

U.S. Department of Agriculture. *Motor Fuels from Farm Products*, by P. Burke Jacobs and Harry P. Newton. Miscellaneous Publication 327. Washington, D.C.: GPO, 1938.

Written by two chemists, this report details the uses of agricultural products for motor fuels. The authors review the importance of motor fuels in modern society, especially

in preparing for war. Due to the shortage of petroleum products during WWI, chemists turned to grain alcohol to supplement the petroleum supply. Noting crop surpluses, Jacobs and Newton suggest turning the crops into alcohol, which could then be stored until the next shortage. This source is important because it shows that chemurgy was not a small movement, but one that was considered at many levels, including at the USDA. In fact, I found this source at the National Agricultural Library.

U.S. Senate. 73rd Cong. 1st Sess. *Use of Alcohol from Farm Products in Motor Fuel*, by U.S. Department of Agriculture. Senate Document 57. Washington, D.C.: GPO, 1933.

The Department of Agriculture created this report at the request of the Senate to "investigate...the practicability and advantages to agriculture of using alcohol manufactured from corn and other farm products." One reason alternate uses for corn were needed was that work animals had been replaced by tractors. Because of this, 35 million fewer acres of corn were needed to feed the work animals. The document states that using corn to produce fuel would have a positive domino effect not only on agriculture but also on the economy of the country as a whole, since the buying power of farmers would be greatly increased. The report recommends developing a long-term, corn-alcohol fuel program.

Van Arsdel, W. B. "Diversification of Another Kind." In *Crops in Peace and War: The Yearbook of Agriculture 1950-1951*, 14-17. USDA, Washington D.C.: GPO, 1950.

The author of this essay, W. B. Van Arsdel, was the assistant director of the Western Regional Research Laboratory, one of four research facilities established by the Agricultural Adjustment Act of 1938. Arguing about the importance of diversification in farming, Van Arsdel explains that industry and agriculture are dependent upon one another for raw materials and markets. In addition, he stresses the importance of researching new uses for agricultural materials rather than using fossil fuels: "In the long run, indeed, the world must learn to supply its major needs from things that can be grown, quarried, or recovered from the sea, not mined."

Von Loesecke, Henry W. "The Chemist Seeks One of Three Goals." In *Crops in Peace and War: The Yearbook of Agriculture 1950-1951*, 21-24. USDA, Washington D.C.: GPO, 1950.

Von Loesecke, a technical adviser in the Bureau of Agricultural and Industrial Chemistry, praises chemistry in this essay, calling it "the farmer's helpmate, no less than the industrialist's." He predicted that the influence of chemistry would continue to grow, finding more uses for agricultural products. Obviously, his prediction was accurate, considering all the ways biotechnology is used today.

Interview

Ahlers, John. Interview by author, LeMars, Iowa, May 9, 2010.

John Ahlers is a farmer outside my hometown. He has farmed over 1200 acres of land for nearly twenty-five years. Interviewing John helped me to see the impact chemurgic ideas still have on farming: he has seen corn yields increase 25-30%, due in large part to agricultural research done by scientists to find new uses for crops and to grow them as efficiently as possible. These increased yields also help provide raw materials for non-food industries, such as ethanol production, without threatening the world's food supply. Because of the increased industrial demand for crops such as soybeans and corn, farmers are paid higher prices per bushel even though they are

producing more. This proves how important chemurgy is because farmers no longer fear surplus as they once did.

Journals/Magazines

"Agricultural Research: A New Approach to the Farm Problem." *Time* (May 27, 1957): 92.

This article reports that, because of the problem of farm surpluses, increased research was needed so that agriculture could move forward. Innovative uses of farm products, such as using tomatoes to create antibiotics and hay to manufacture hormones, are also discussed.

"Agriculture: 100 Percent Failure." *Time* (November 13, 1933): http://www.time.com/// article/,9171,746291-1,00.html (accessed February 15, 2010).

According to this article, five governors met with Secretary of Agriculture Wallace and President Roosevelt to discuss the farm crisis in November of 1933. Details about farm protests, such as dumping milk and blocking trucks on the way to market, helped me to understand the urgency of the situation and why an innovative approach was needed.

Barnard, H. E. "Prospects for Industrial Uses for Farm Products." *Journal of Farm Economics* 20, no. 1 (February 1938): 119-133. http://www.jstor.org// (accessed October 11, 2009).

The focal point of Barnard's essay is profit. He explains that many chemurgic processes are initially expensive and therefore not very practical. However, he argues that through research, they can become more efficient and eventually turn a profit. Therefore, he urges the continued research and development of new uses for farm products.

Benson, H. K. "A Chemurgic Program for the Pacific Northwest." *Northwest Science* 12, no. 3 (1938): 68-71. http://www.vetmed.wsu.edu/_NWS/%20journal%20articles/-1939/%20vol%2012/-3/-02-06/%20p68%20Benson.PDF (accessed May 8, 2010).

Published in the Pacific Northwest in 1938, this journal article gave me new insight into the chemurgy movement. Since I am from the Midwest, most of my research has focused on new uses for corn and soybeans. However, this article describes new uses for other agricultural products such as apples, potatoes, wheat, and wood. It even discusses using science to harness energy from the sun and from water. This helped me realize why the four research labs were placed around the country.

"Besides Food, Products of Farm Used 400 Ways." *Science News Letter* 35 (June 1939): 381.

Hundreds of new non-food products that were compiled in the government publication "Industrial and Engineering Chemistry" by the U.S. Department of Agriculture are reported in this journal article. The significance of the chemurgic movement is shown in that its influence resulted in 400 new uses for surplus materials which were given special attention by the USDA, the largest agricultural organization in America.

Burlingame, Roger. "Chemurgy—A Strong New Weapon." *Popular Science* 139, no. 2 (August 1941): 105-107, 220. http://books.google.com (accessed December 29, 2009).

In this issue of *Popular Science*, most of the articles describe the country's preparation for war. In his piece, Burlingame explains that chemurgy was helping this ef-

fort by providing substitutes for materials normally imported. He states that in the movement's history, "almost every chemurgic step...has been a help toward defense economy." Scientists had found replacements for fuel, rubber, steel, wood, and wool, among other things.

Burlingame, Roger. "Rainbow Over the Farm." *Harper's Magazine* 180 (December 1939): 50-59.

After Burlingame summarizes the history of agriculture and industrialization, he reports details about Henry Ford's dedication to chemurgy. Ford was determined to use as many agricultural products as possible in each vehicle his company produced. Burlingame also sees hope for farming from chemurgy as long as farmers are willing to try new crops and methods.

"Byproduct Alcohol: New Process Effects Big Economy by Eliminating Malt and Yields Abundant Protein for Both Human and Animal Diets." *Business Week* (June 12, 1943): 72.

In 1943, a new process was developed which would make it much cheaper to use alcohol as a fuel. The method would remove protein from grain, leaving alcohol as an inexpensive byproduct that was predicted to save the government $1 million in fuel costs for the army. In addition, the removed protein would be worth five cents per pound as feed for livestock. This process is a perfect example of the focus of chemurgy, using research to more efficiently use agricultural products.

"Chemistry to the Farm." *Christian Science Monitor* (November 9, 1940): 8-9.

Lamenting the vicious cycle of overproduction on farm prices, this article encourages increased spending on chemurgic research, especially through the USDA's four regional laboratories. Because it describes the work being done at each lab, this story helped me to understand the wide influence chemurgy had on American living.

"Chemurgy: A New and More Bountiful Era Emerges From Our Farms and Laboratories." *Newsweek* (November 3, 1951): 82-83.

This article was helpful because it reports new chemurgic uses for products previously considered to be worthless, such as corn cobs and peanut shells. It also explains the rise and fall of income in the National Farm Chemurgic Council. At the time this article was written in 1951, the Council had 5000 members, showing that chemurgy's influence was growing. The goal of these members was to be prepared for a shortage in any resource: "We're Getting Ready" was one of their mottos.

"Chemurgy Arrives: U.S. Research Labs and Countless Private Projects Now Testify to Agriculture's New Role in Industrial Economy." *Business Week* (December 28, 1940): 36-37.

This article provides specific examples of the chemurgic research being done in the four laboratories funded by the Agricultural Adjustment Act of 1938. In addition, several private companies in different parts of America were working on projects inspired by chemurgy. This article emphasizes the influence of chemurgy on American industry: "Chemurgy has arrived" it states.

"Chemurgy: Second Dearborn Meeting Fosters Back-To-Farm Movement by Hitching Plow to Industry." *Newsweek* (May 16, 1936): 32-33.

This article is unique because it details the creation of the Farm Chemurgic Council

and describes its first two meetings in great depth. While there were only 300 people in attendance at the first meeting, the second meeting boasted over 1500 members who discussed matters such as fuels, oils, plastics, and poor farmers. The increase in attendance shows that the significance of chemurgy was growing.

"Citadel of Chemurgy." *Newsweek* (March 17, 1941): 40.

According to this article, a celebration was held in Laurel, Mississippi (nicknamed the Chemurgic City) on April 6, 1941, when thousands of people visited the city to "inspect its accomplishments in developing new industrial uses for products of the soil." This town was unique because it was home to the only sweet potato starch factory in the country, showing how innovative the chemurgic research was.

Corey, Lewis. "Problems of the Peace: II. The Farmers." *Antioch Review* 4, no. 2 (Summer 1944): 257-268.

In this article of the *Antioch Review*, Corey predicts that surpluses would be a major problem for farmers after WWII. However he also says that chemurgy would help relieve this problem by utilizing waste and surpluses, greatly aiding farmers.

"Democracy: Its Essentials and its Problems." *Scholastic* (May 13, 1940): 14-15.

I found this article interesting because it states simply one of the reasons for surpluses: people just were not as hungry because machines were doing much of the labor previously done by people. Since people did not burn as many calories working, they could not consume as many either. One of the solutions discussed in this article was to seek the help of the Farm Chemurgic Council and the federal government to create new uses for surpluses.

Gale, Ralph E. "Potato Plastics: Offer Possibility of Using Agricultural Wastes." *Scientific American* (March 1944): 124.

Gale discusses different ways chemurgic research was helping to recycle and reuse waste products such as potato pulp. Scientists developed methods to turn these surpluses into plastics which aided the war effort and had an impact on the survival of America.

"Gasoline and Coal Made from Farm Crops." *Popular Mechanics* (February 1941): 166-167.

The author of this article describes the situation of oil and fuels in America. Although many more years of oil use remain, he encourages the use of more renewable fuel sources to ease economic concerns in the future. This article is unique because it describes the history of how fuels and oils are created in the Earth.

"Growing a New World." *Popular Mechanics* (June 1944): 28-31.

Because the U.S. was cut off from many of its resources during WWII, chemurgy had new opportunities to show how beneficial its research could be. This source explains that the missing products needed to be replaced so that America could successfully wage war. In addition, it states the chemurgists' creed: "Nothing that grows is useless; we simply [have not] yet found out how to use everything."

Haystead, Ladd. "Chemurgy: Cure or Cause of Surpluses?" *Fortune* (June 1944): 182-184.

Reading this article helped me to understand the state of farming surpluses after

WWII. Haystead describes not only the many advances made in chemurgic research during this time but also the potential loss of demand once regular trade routes were reopened. For example, natural rubber was cheaper to import than synthetic rubber was to make. However, this cost did not take into consideration the effects that would be felt by the entire economy when farmers built up surpluses again. This proves that chemurgic ideas were needed even after the war, even though much of the progress that had been made was temporarily lost.

Holman, Ross L. "A Chemurgic Fantasy." *Yale Review* 34, no. 2: 282-291.

Holman fantasizes at the beginning of this article about the future of farm commodities, such as selling a cow for how many "hats or coats you can milk from her." The rest of the article describes the many unknown uses for agricultural products such as soybeans, corn, cotton, and skim milk. One comment he made really caught my attention: "It would be hard to find a product in the manufacture of which corn is not or could not be used." I found this interesting since today corn does seem to be everywhere, especially in corn syrup form. I have even seen commercials discussing the benefits of corn syrup.

"Industrial Corncobs: Main Uses to Date are Based on Physical Properties." *Scientific American* (November 1943): 224-225.

This article deals mainly with new uses created for the millions of discarded corn cobs. The cobs could be used as fillers for some plastics and other materials. This is a classic example of chemurgy; by changing the way people thought about waste, the chemurgists created extra income for struggling farmers.

"Magic of Chemurgy: Duplicated in the Home Laboratory." *Popular Science* (February 1942): 199-201. http://books.google.com/?id=pScDAAAAMBAJ&pg=PA199&dq=chemurgy&cd=3#v=onepage&q=chemurgy&f=false (accessed May 11, 2010).

Published while the chemurgy movement was gaining popularity, this article gives directions for making glue from milk, rayon material from wood pulp, and ethyl alcohol from potatoes. The intent of the experiments was to show what chemists were doing to replace scarce raw materials used in industry. The article describes the chemurgists' work as "magical transformations...[which] turn food product waste and surplus into industrial plenty." This description points out the innovative nature of the chemurgy movement.

"Millions from Waste." *Popular Mechanics* (December 1940): 834-837.

Sawdust, cornhusks, peanut hulls, pine tree needles, and wood trimmings are only a few of the many wastes listed in this article that could be converted into millions of dollars. Crop surpluses were also being converted to serve a greater purpose. However, the cost of these conversions was too expensive at the time to be practical.

"New Wonders of Agriculture." *Popular Mechanics* (June 1940): 801-803.

Written in a simple style, this article explains clearly how several different surplus farm products—such as sugar cane, corn cobs, casein from skim milk, soybeans, and grape oil—were being used in industry. However, whenever scientists found these new ways to use agricultural surpluses, farmers were able to increase production due to improvements in insect control or plant breeding. The author explains that the USDA's four new laboratories would help keep the scientists ahead of the surplus. These labs might not have been built without the work of the chemurgists.

"Oil on the Bush: Castor Bean a Favorite of Farm Chemurgic Council." *Business Week* (April 4, 1942): 30-31.

One important contribution of the chemurgists was the replacement of necessary goods that were in short supply (due to World War II) with agricultural substitutes. For example, a severe shortage of oils used in industry was alleviated by castor oil from castor beans grown by American farmers. Rapeseed oil—produced in Minnesota, Wisconsin, and Michigan—was used to create synthetic rubber, plastics, cements, and insulation. Innovative uses such as these helped America survive during WWII.

"Oil-Producing Crops Recommended in South." *Science News Letter* (June 1944): 354.

According to this article, the federal government and university professors were persuading farmers in the South to plant crops such as okra that could produce oil. This is just another innovative use of agricultural products.

"Production: Industry Looks to the Soil." *Business Week* (April 26, 1947): 80-82.

The impact of chemurgic research on agriculture and industry is proven in this article, which describes the need to decentralize industrial areas so that factories could move closer to their supply of raw materials—farms. The issue was so significant that a National Decentralization Conference was being held in Oklahoma City to discuss the changes.

"Science and the Beanstalk." *Women's Home Companion* 69 (September 1942): 14-15.

Unlike many other articles that I studied, this one describes how farm products can be used in industry on a molecular level. Scientists discovered that the protein molecule in the soybean is unusually large which makes it useful in many different processes.

"War Spurs Chemurgy: Curtailment of European Supplies Promotes Production of Substitutes from Farm Products." *Business Week* (April 6, 1940): 34-35.

This article describes how the war in Europe and Europe's need for food and supplies had created openings for chemurgists all over the country. Many of the products that were in demand in Europe could be created in America using chemurgic processes. Interestingly, one of the advances praised in this article was the ability of Minnesota and California farmers to grow flax in order to supply the country's cigarette paper needs. Normally, cigarette companies got their papers from France and Italy, supplies that were cut off with World War II. Getting enough cigarette papers probably would not be the focus of a national magazine today, but it was an important topic in 1940.

Letters

Bowling, Joseph H. Joseph H. Bowling to George Washington Carver, July 7, 1934 George Washington Carver Papers at Tuskegee Institute. Iowa State University Library Microfilm Collection, Ames.

Carver received hundreds of letters like this one from people wanting more information about one of his discoveries. Bowling was especially interested in Carver's development of cement blocks made from cotton for paving streets and highways. Chemurgic research was used in a variety of ways, as this letter shows.

Carver, George Washington. George Washington Carver to Carter, March 4, 1935 George Washington Carver Papers at Tuskegee Institute. Iowa State University Library Microfilm Collection, Ames.

In this letter to a "Mr. Carter," Carver predicts what the chemists of the future will find in their work, "an absolute mystic maze of endless possibilities." Carver's visions have come true, with scientists finding a multitude of new uses for farm produce.

———. George Washington Carver to Henry Ford, June 30, 1931 George Washington Carver Papers at Tuskegee Institute. Iowa State University Library Microfilm Collection, Ames.

Written in 1931, this was one of the first of many letters between Henry Ford and George Washington Carver. The two shared an intense interest in chemurgy. In this letter, Carver congratulates Ford for recognizing the "far seeing possibilities of our native products." Carver also invites Ford to Tuskegee Institute to see for himself the progress being made in Carver's lab.

Carver, George Washington. George Washington Carver to M. L. Ross, August 26, 1930 George Washington Carver Papers at Tuskegee Institute. Iowa State University Library Microfilm Collection, Ames.

In this letter to his friend, Dr. Carver congratulates him on his work in chemistry, writing, "You will not be able to exhaust the wonders of any element, saying nothing of the marvels of compounds." These words emphasize Carver's passion for chemurgy, which makes sense since Carver is known as the world's first chemurgist. He dedicated his life to finding practical everyday uses for all sorts of agricultural produce. For example, later in the letter he discusses surplus piles of straw that were lying around. He suggested to Ross that they be turned into building boards or paper.

Hanger, J. W. J. W. Hanger to George Washington Carver, June 18, 1935 George Washington Carver Papers at Tuskegee Institute. Iowa State University Library Microfilm Collection, Ames.

Written by a Methodist minister, this letter asks Carver to send information concerning the ability of peanut oil to treat victims of infantile paralysis. Hanger was hoping to help members of his congregation stricken with the disease. This remedy, which showed considerable success, is just one of many useful applications developed by scientists for common crops.

Petty, C. A. C. A. Petty to George Washington Carver, June 2, 1934 George Washington Carver Papers at Tuskegee Institute. Iowa State University Library Microfilm Collection, Ames.

Petty wrote this letter to Carver expressing a similar interest in the many uses of peanuts. Petty also discusses Carver's "reputation as a pioneering chemist." Many people spoke highly of Carver's chemurgic research because it helped farmers find new markets for their goods.

Puffer, F. A. F. A. Puffer to George Washington Carver, June 6, 1935 George Washington Carver Papers at Tuskegee Institute. Iowa State University Library Microfilm Collection, Ames.

This letter is significant because it was sent by F.A. Puffer, a missionary in India, to George Washington Carver. When Puffer returned to the United States for a visit, Mahatma Gandhi asked him to meet Carver to get ideas about turning waste and surplus into "profitable uses." The far-reaching impact of chemurgy is proven by this request.

Newspapers

Blair, William M. "Eat Crop Surplus, Farm Leader Asks." *New York Times*, August 17, 1949.

At a meeting of the Ohio State Grange, Wheeler McMillen encouraged farmers to turn to science to find answers for crop surpluses. According to this *New York Times* article, he "predicted a solid future for agriculture through scientific developments" and warned farmers not to depend upon the government for a bail out.

"Dr. Hale Says Chemurgy Can Solve Jobless Problem, in Talk at Connecticut College." *Day* (New London, Connecticut), October 28, 1936. http://news.google.com/?nid=1915dat=19361028&id=daktAAAAIBAJ&sjid=Z3EFAAAAIBAJ&pg=2976,5069109 (accessed May 11, 2010).

William Hale spoke to students at Connecticut College about unemployment and the chemurgy movement. Hale argued that if industry would use more agricultural products rather than importing raw materials from other countries, millions of jobs could be created in the United States. Hale was a visiting professor of chemurgy at Connecticut College when he gave this speech about the impact of chemurgic research.

"Laboratory Notes." *New York Times*, May 1, 1938.

Reporting on the Fourth Annual Chemurgic Conference, this article describes the reaction of farmers being introduced to sorbitol, a chemically complex alcohol. They were especially interested in it because it could be made inexpensively from corn sugar and used to make book glue, clothing, and shoes. The chemurgists were always on the lookout for innovative ways to use farm products.

Laurence, William L. "Scientists Promise More Food for All." *New York Times*, December 28, 1949.

According to Laurence, Dr. Elvin C. Stakman, the president of the American Association for the Advancement of Science, predicted an increased use of scientific knowledge to stretch the earth's resources. He said, "We are in the midst of an agricultural revolution...[which will] make possible a more abundant life for an increased population." This statement shows that even scientists believed that chemurgy was an innovative way to enhance agriculture.

"Martial Law Reigns in County." *LeMars Semi-Weekly Sentinel* (LeMars, Iowa), May 2, 1933.

I used this article to verify my facts about the threatened hanging of Judge Bradley. I had learned about the incident in school, since it happened in my hometown, but I wanted to check my memory. Frustrated because Bradley would not declare a moratorium on farm foreclosures, a crowd dragged him from the courthouse, slapped and kicked him, threw him into the back of a truck, drove him out into the country, choked him, smeared him with axle grease, and threatened to hang him. The attack on Judge Bradley shows how desperate the destitute farmers were and how important it was to find a solution to the farm crisis.

Popham, John. N. "New Plant Hunt Urged By Expert." *New York Times*, March 31, 1949.

Speaking at the National Farm Chemurgic Council's Fourteenth Annual Conference,

Council President Wheeler McMillen urged his audience to "explore the mysteries of the plant kingdom to provide an ever-renewing source of abundance," according to this *New York Times* article. He warned that the people of the world would starve if science was not trusted to provide new uses for plants.

"President Invites World to Share Benefits of US Farm Revolution." *New York Times*, November 23, 1949.

President Truman, speaking to the Food and Agriculture Organization of the United Nations, called advances made in farming "an agricultural revolution" and offered to share America's expertise with other countries in the world, according to this article. Many other nations were suffering because of surpluses just like America had years earlier, before chemurgic ideas increased industrial demands.

Quackenbush, Amanda. "Report Of Progress: Gardeners Reap Benefit of Research by Agricultural Experiment Stations." *New York Times*, August 21, 1949.

A Connecticut agricultural experiment station's field day is reported in this article. The theme for the day was "Science Pays Dividends." The popularity of chemurgic ideas is evident in this story, which predicts that the slogan of all agricultural experiment stations would soon be "Put Science to Work for Agriculture."

"Strange Clothes." *New York Times*, April 27, 1949.

The versatility of farm goods is indicated in this article about innovative uses of agriculture products. At the 7th Annual Chemurgic Conference, one man wore a suit made from milk products; another had a soybean tie; and yet another wore a hat made from milk fiber.

Pamphlets

Atlas Powder Company: Industrial Chemicals Department. *Chemicals from Farm Products*. Wilmington, DE: 1950.

This pamphlet describes an industrial plant that had "become a new kind of 'farmers market'—converting farm raw materials into new products which enrich American living standards." This industrial plant was essential in the implementation of chemurgy. I found this unique source at the National Agricultural Library.

Du Pont. *Du Pont's Partnership with the Farmer*. Wilmington, DE: Du Pont, 1944.

Du Pont was one of chemurgy's early industrial sponsors. This pamphlet documents the multitude of non-traditional ways corn, cotton, pine rosin, turpentine, and wood pulp were being used in Du Pont factories. Each page is divided into two columns, one for "What Du Pont Makes from Farm Products," and the other called, "How They Serve the Public." This source shows the wide impact of chemurgy.

Martz, Charles E. *New Uses for Farm Products*. Columbus, OH: Educational Printing House, Inc, 1939.

This pamphlet, which was originally purchased by the Iowa State College of Agriculture and Mechanic Arts Library, states simply and clearly how chemurgy began and why it was an innovative undertaking, different than what had come before. The movement was so different that Martz calls it magical: "We are in an age of magic, when scientists are turning some of the things with which we are so familiar into substances that look and feel very different." He even compares the magic of chem-

urgy with Cinderella, when the Fairy Godmother turns the pumpkin into a carriage. Reading this pamphlet made me smile because the author seems so excited about the potential of chemurgy.

Mississippi Industrial Commission. *The Realm of King Chemurgy*. n.d.

According to the Mississippi Industrial Commission, the state of Mississippi was a great location for new chemurgic research because of its "goods-hungry people" and the many factories being built. In this pamphlet, the Commission describes the many traits of Mississippi that make it perfect for chemurgy.

Speeches

Anderson, Clinton P. "Restoring Self-Sustaining Agriculture." In *Agricultural Prosperity: How Maintained?* 3-14. U.S. Department of Agriculture, Washington, D.C.: GPO, 1946.

Self-sufficiency is the focus of this speech. Anderson, who was the Secretary of Agriculture from 1945-1948, calls America the "greatest, richest agricultural empire in the world" which, unfortunately, often out produced demand. He explains the need for finding new markets for agriculture's surplus and waste products to make farming more profitable. According to Anderson, agricultural self-sufficiency would lead to "national and world peace and prosperity."

Buffum, William W. "Origin and Purposes of Farm Chemurgic." In *Midwestern Conference of Agriculture, Industry, and Science*, 2-7. Dearborn, MI: Farm Chemurgic Council, 1937.

Buffum explains the origins of the Farm Chemurgic Council in this speech, which he presented at the Midwestern Conference on the Problems of the Industrial Utilization of Agricultural Products. In addition, he emphasizes that chemurgy is not an "overnight cure-all for the farm problem." He seems to realize that aligning agriculture and industry would take long-term efforts.

Dorr, Thomas C. Speech, American Oil Chemists Society, Quebec, May 15, 2007. http://www.rurdev.usda.gov///TCD-05-15-07-Quebec-Amer-Oil-Chemists-Soc.pdf (accessed November 17, 2009).

Dorr was a USDA undersecretary when he presented this speech to the American Oil Chemists Society. In it, he encourages continued research into industrial biotechnology, which he said holds "the potential to transform American agriculture and our nation's research base." Biotechnology is the modern-day version of chemurgy, showing that although the movement was innovative in the 1920s, it is still influential today. Dorr calls chemurgy/biotechnology "an extraordinary opportunity," adding, "The pace of innovation is incredible." This source is especially interesting to me because before Dorr went to work for the USDA, he spent 29 years farming near Marcus, Iowa, which is only 21 miles away from where I live.

Gammons, Charles C. "Agriculture and Industry: Partners in Food Progress." Address, National Farm Chemurgic Council, 17th Annual Conference, St. Louis, March 11, 1952.

Charles Gammons was Vice-President and General Counsel of Atlas Powder Company when he gave this speech to the Farm Chemurgic Council's annual meeting. He states that Atlas was proud of its long association with the council because "chemurgy is

synonymous with progress." He then describes several of the developments by Atlas due to chemurgic research. This speech emphasizes the innovative nature of chemurgy.

Hope, Clifford. "Agricultural Parity in Relation to Production." In *Agricultural Prosperity: How Maintained?* 15-26. U.S. Department of Agriculture, Washington, D.C.: GPO, 1946.

In this speech, Hope explains one of the great difficulties facing farmers, that their prices were tied to the world market. Surpluses in America or around the world could make the prices fluctuate wildly. Finding new markets for surpluses through science (chemurgy), was vitally important to stabilize or increase the profits of farmers. According to Hope, such stabilization would benefit all Americans: "In the long run,...we all go up and down together in this country."

Kuhlmann, Henry E. "Farm Prosperity Beckons: Our Great Surpluses Can Lead to Disaster or into Opportunity." In *Vital Speeches of the Day*, 281-282. New York: Daly, 1960.

Presented to Farm Bureau leaders in Lincoln, Nebraska, in 1959, this speech emphasizes the relationships among agriculture, industry, labor, and the rest of the country. Kuhlman argues that "Great Depressions are not caused from scarcity but from ill or unmanageable surpluses." He repeats this idea later in his speech and then tells his audience that the dangers of surplus can be changed to opportunity by turning to chemurgic research.

McMillen, Wheeler. "The American Way." Address, Ninth Annual Conference of Agriculture, Industry, and Science, 1943.

At the 9th Annual Conference for the National Farm Chemurgic Council, Wheeler McMillen, the President of the NFCC, gave an address which discussed, among other things, the need to develop the production power of American farms and factories to aid the war effort.

———. "New Riches from the Soil: Foundation for World-Wide Hope." In *Vital Speeches of the Day*, 407-410. New York: Daly, 1947.

McMillen gave this speech at the opening of the Twelfth Annual Chemurgic Conference in Oklahoma City on March 26, 1947. It is interesting the way he tweaked the title of one of his books for the speech, adding "Foundation for World-Wide Hope." Hope for a better future was one of the chemurgists' themes, as is evident in some of the statements McMillen made: "We would like to see an America where agriculture, labor and industry march forever forward, hand in hand, to lift even higher the livings of American families and to build ever stronger the bulwarks of the national strength." Another part of his speech that made me think was his reference to the 1500 plants for which people have found uses. According to McMillen, this is only about one-half of one percent of the plant species available to us.

———. "Production and Patriotism: We Want to Keep Our America." In *Vital Speeches of the Day*, 440-444. Vol. 7. New York: Daly, 1941.

Speaking before the Seventh Annual Chemurgic Conference, McMillen emphasizes the need to increase production to keep America strong. The theme of the conference in 1941 was "Chemurgy in Defense—and Beyond." McMillen explains chemurgy's doctrine that "the spiral of prosperity is production." The more that Americans produce, the more they will earn, and the more they can consume. Chemurgy's goal was to make all farmers successful producers by providing more markets.

Phillips, Benjamin. "Chemurgy—For Better Environment and Profits." Address presented at 32nd Annual Conference of the Chemurgic Council, Washington, D.C., October 22-23, 1970.

It was interesting to read this speech because it was written just about in the middle of the time between now and the beginning of the chemurgy movement. Looking back, Phillips explains how the focus of the Chemurgic Council had shifted from "promoting the use of renewable resources...to making use of waste products from any source." Not only were the chemurgists innovative when they began, but they have also continued to change to stay current with the changing times.

Roosevelt, Franklin Delano. "The Forgotten Man." Radio address, April 7, 1932. New Deal Network: Works of Franklin D. Roosevelt. http://newdeal.feri.org/_details.cfm?link=http://newdeal.feri.org//c.htm (accessed February 15, 2010).

Roosevelt states clearly in this speech that finding a solution to the surplus problem was urgent. He reminds his listeners that nearly half of all Americans earned "their living by farming or in small towns whose existence immediately depends on farms." According to Roosevelt, when those fifty to sixty million people lost their buying power due to low prices caused by surpluses, every business in America was affected. He gravely predicts, "No Nation can long endure half bankrupt. Main Street, Broadway, the mills, the mines will close if half the buyers are broke."

Stearns, Stuart G. "Chemurgy: The Idea Whose Time Has Come." In *New Resources from the Sun*, 1-8. Washington D.C.: Roger Williams Technical & Economic Services, Inc., 1973.

Stearns promotes the chemurgic movement in this speech, which was presented at the 34th Annual Conference of the Chemurgic Council in 1973. First, he summarizes its beginnings and then turns to the innovative uses that were being developed for waste products such as cellulose. Stearns says that the time was right for scientific advancements in farming: "The only things which can deter us are a failure of nerve and a failure of imagination."

Wallace, Henry A. "The Cotton Plow-Up." Radio address, August 21, 1933. *New Deal Network: Selected Works of Henry A. Wallace*. http://newdeal.feri.org//.htm (accessed February 15, 2010).

Reading the transcript for this radio address helped me to understand why the chemurgists thought it important to find alternate uses for farm products. The surpluses were so great in the 1920s and 1930s that farmers could not make a living. The Agricultural Adjustment Act of 1933 allowed the government to pay farmers to plow up their crops of corn, cotton, rice, tobacco, and wheat. In this speech, Wallace defends the plan, explaining that farmers would destroy ten and a half million acres of cotton to reduce the surplus. However, according to Cohen in *Nothing to Fear*, Wallace did not like the idea of planting less or reducing production. The chemurgists offered an innovative alternative to which the USDA eventually turned.

Wallace, Henry A. "Pigs and Pig Iron." Radio address, November 12, 1935. *New Deal Network: Selected Works of Henry A. Wallace*. http://newdeal.feri.org//.htm (accessed February 15, 2010).

When Wallace was Secretary of Agriculture, he made a difficult decision to have six million piglets killed in September of 1933, a desperate measure taken to try to reduce farm surpluses. Wallace uses this speech to explain to the American public why

the move was necessary. Although the pork was used to feed the hungry, the action was still controversial.

Welsh, J. L. "A Wider Use of Agricultural Products." In *Agricultural Prosperity: How Maintained?* 39-51. U.S. Department of Agriculture, Washington, D.C.: GPO, 1946.

Welsh presented this address at the 34th annual meeting of the Chamber of Commerce of the United States. In the speech, he emphasizes the critical role the synthetic rubber industry had played in winning WWII. According to Welsh, over 70% of the synthetic rubber used to "[keep] our army on wheels" was made from grain alcohol. He explains that 56 bushels of grain can be turned into one car tire, and that using crops this way is much better for America than building up surpluses like the ones that led to the farm depression after WWI: "The major portion of our national prosperity must come from the farm. When the farmer is not prosperous neither are we in Industry, in Labor, or in the Nation itself." The answer to the surplus problem, according to Welsh, lay in science finding new ways to utilize excess farm products, in other words, chemurgy.

Willis, Paul S. "Grocery Manufacturers—Pioneers in Chemurgy." Address, National Farm Chemurgic Council, Oklahoma City, Oklahoma, March 28, 1947.

As president of the Grocery Manufacturers of American, Willis describes the many applications of chemurgy in the grocery business. One example he gives in this speech is the new uses of a cheese byproduct called casein, which could be made into artificial wool, paint, and plastics. Although Willis predicts tough times ahead, he also shows faith that with "Paul Bunyan Chemurgy leading the way, no one can prophesy how brilliant our future may become." This speech shows how innovative the chemurgy movement was.

Unpublished Document

Western Agricultural Insurance Company. Farm Records for John Ahlers. 2009.

This document lists the corn and soybean yields per acre for the last ten years on the Ahlers farm. John Ahlers farms 600 acres of beans and 600 acres of corn, as well as smaller fields of oats and alfalfa. These records show a steady increase in the yields per acre for his fields. Even with the increases, however, Ahlers says prices have stayed high because scientists continue to find new uses for farm produce. This was not true in the 1980s, when Ahlers' father was paid by the government not to farm some of his land. This practice has ended since chemurgic ideas have regained popularity.

Secondary Sources

Books

Borth, Christy. *Pioneers of Plenty: The Story of Chemurgy*. New York: Bobbs-Merrill Company, 1939.

Written in a conversational manner (It begins, "Although the word that heads this chapter is not yet in your dictionary, it already affects your life far more than you realize."), Borth's work introduces many important people in the story of chemurgy. I especially enjoyed learning more about William Hale's childhood, when his neighbors called him "that terrible Hale boy." They did not understand, according to Borth, Hale's curiosity about the world around him. Studying anatomy, biology, chemistry, entomology, mathematics, physics, and zoology, Hale and his brother "experimented

endlessly." Borth believes it is lucky for the human race that Hale's parents were tolerant of his behavior.

Brinkley, Douglas. *Wheels for the World: Henry Ford, His Company, and a Century of Progress*. New York: Viking Press, 2003.

Henry Ford was an intriguing person, as evidenced by the many interesting stories in this book. The chapter I used was called "Making an Impact." It describes Ford's fascination with ending America's reliance on petroleum products through chemurgy. He insisted that gasoline was a fuel of the past and that ethanol or some other agriculture product was the "wave of the future." Ford wanted farmers to profit from the need for fuel instead of oil companies. He was so outspoken about it that oil lobbyists felt threatened and started calling him "Crazy 'Peace Ship' Henry." Another interesting story describes a program Ford began at one of his factories to reduce the waste of wood chips. His researchers created charcoal briquettes which are still used in household grills.

Cohen, Adam. *Nothing to Fear*. New York: The Penguin Press, 2009.

Cohen focuses on five of Roosevelt's closest advisors in this book. One of them was Iowan Henry A. Wallace, Secretary of Agriculture from 1933-1940, so Cohen supplies background information on agriculture to explain Wallace's role in the New Deal. I used this source to help establish facts about the farming crisis during the late 1920s and 1930s.

Government Documents/Publications

Brannan, Charles F. "Foreword." In *Crops in Peace and War: The Yearbook of Agriculture 1950-1951*. USDA, Washington D.C.: GPO, 1950.

In this foreword, Brannon summarizes the contributions made by chemurgy in 1950-1951, explaining that the "accomplishments sprang from vision and dedication to the public welfare." Brannon praises the advancements made in agricultural research as being especially important for national defense. He explains that during these years, science was used to improve the lives of farmers and consumers alike: "They have contributed to national well-being to an extent that cannot be measured in money." In addition, he describes a bright future in chemurgic research: "What we already have achieved is truly a matter both for pride and thankfulness, but what we may achieve on today's foundations holds even greater promise for tomorrow."

Economic Research Service. *An Illustrated Guide to Research Findings from USDA's Economic Research Service*. Economic Information Bulletin No. (EIB-48) , April 2009. http://www.ers.usda.gov//// (accessed May 5, 2010).

Reading this report helped me get an idea of the many factors influencing decisions made by the United States Department of Agriculture to determine the direction of the future. For example, it uses charts, diagrams, and maps to illustrate how the development of corn ethanol affects the environment (because of increased use of fertilizer and water to grow corn), as well as how it affects world grain and meat prices. For these reasons, the USDA is promoting the use of switchgrass and cellulose ethanol which will have fewer repercussions. I also enjoyed using this source because it is well put together and has outstanding graphics.

"Finding New Uses for Surplus Products." *USDA, Agricultural Research Service*. http://www.ars.usda.gov///.htm?pf=1 (accessed October 4, 2009).

In the 1930s, the federal government was desperate to find relief for farmers suffering from the Depression. Finally, in 1938, Congress passed the Agricultural Adjustment Act, which authorized the building of four laboratories. The purpose of these research facilities was to find new uses for surplus crops. This report, sponsored by the USDA Agricultural Research Service (ARS), chronicles the history of the creation of these labs. According to the ARS, the "laboratories might not have been authorized at all were it not for the influence of the chemurgy movement." Statements such as these helped me to realize how far-reaching the influence of the chemurgic movement is.

Herrick, H. T. "New and Better Uses for Our Crops." In *Crops in Peace and War: The Yearbook of Agriculture 1950-1951*, 6-9. USDA, Washington D.C.: GPO, 1950.

I found this source at the National Agricultural Library in Maryland, and it was one of the first things I read about chemurgy. It gives a good but brief overview of the chemurgists' goals and then describes in greater detail the four regional research laboratories. It also directed me to the Agricultural Adjustment Act of 1938, since that is the legislation that established the research labs.

Kish, Stacy. "The Green Industrial Revolution: Improving Biorefinery Efficiency." *USDA, National Institute of Food and Agriculture* http://www.csrees.usda.gov/////_biorefinery.html (accessed November 17, 2009).

Reading this report helped me to understand the impact of chemurgy in today's world. Although the more preferred term today is "biotechnology," the meaning is the same...using science to find new uses for farm products. Sponsored by the USDA's National Institute of Food and Agriculture, this report describes new methods of producing biofuels in refineries that are more environmentally friendly. Kish argues that biofuels "offer a tremendous opportunity to enhance national security, balance trade, [and] increase rural employment opportunities."

"Our History: Origins of U.S. Agricultural Research." *USDA, Agricultural Research Service*. http://www.ars.usda.gov//site_main.htm?docid=2789&pf=1&cg_id=0 (accessed September 10, 2009).

I used this report to determine the factors leading to the massive surpluses of the late 1920s. It also directed me to the Agricultural Adjustment Acts of 1933 and 1938.

Stefferud, Alfred. "The Editor to the Reader." In *Crops in Peace and War: The Yearbook of Agriculture 1950-1951*. USDA, Washington D.C.: GPO, 1950.

In this letter from the editor, Stefferud helps me to understand the purpose of the USDA agricultural yearbook in which I found several relevant sources. As a report on the accomplishments of the four research laboratories, the yearbook's goal was to "set forth the possibilities of using surplus products in new ways."

Trullinger, R. W. "Science in the Agriculture of Tomorrow." In *Crops in Peace and War: The Yearbook of Agriculture 1950-1951*, 1-5. USDA, Washington D.C.: GPO, 1950.

Trullinger emphasizes the need for scientific research, which he calls "the core of agricultural technology." He explains that farmers cannot rely on old methods, but instead must "have faith in the future of scientific agriculture." This source helped me to realize how hard it was for farmers to turn from old, well-established methods to new, untried ones. This may be one reason why the chemurgy movement faced so much opposition.

U.S. Department of Agriculture. *Biotechnology Facts: Agricultural Biotechnology: Food Security and Poverty Reduction*, by Office of the United States Trade Representative. Washington, D.C.: GPO, 2006. http://www.usda.gov//2006-09-28-biotech-foodsecurityandpoverty.pdf (accessed May 9, 2010).

I used this document to help establish the impact of chemurgic research/in agriculture today. The report includes statistics and links to various organizations such as the World Health Organization, the United Nations Food and Agriculture Organization, and the Consultative Group on International Agricultural Research. Data from these sources shows that over 90% of the world's 8.5 million farmers who grow biotech crops are from poor, developing countries. This fact alone shows that chemurgic ideas have major global impact.

U.S. Department of Agriculture. *Chemurgy and Agriculture: 1934-1940*. Special Reference Briefs, SRB93-07. Washington, D.C.: GPO, 1993.

I used this report to find details about when and how the Farm Chemurgic Council started at the first Chemurgic Conference held in Dearborn, Michigan. The report also led me to other sources, such as those by Barnard, Garvin, Hale, McMillen, and Pursell.

U.S. Department of State. Bureau of International Information Programs. *Food versus Fuel*. Washington D.C.: GPO, 2008. http://www.america.gov//washfile-english///xjsnommis0.1375696.html (accessed April 28, 2010).

Under Secretary of Agriculture for Rural Development Thomas Dorr was the guest speaker for this "Ask America" webchat, discussing the "food versus fuel" debate. Questions came in from around the world, including from Armenia, Bangladesh, India, and Russia, probably because these countries face widespread hunger. Dorr reassured the respondents that the U.S. is not diverting the corn it exports for food to supply ethanol production. Instead, farmers are producing more to keep up with demand. In addition, according to the U.S. Renewable Fuels Standard, over half of U.S. ethanol will be produced from non-food agricultural sources, such as grass and the by-products of harvest, by 2022. This shows that chemurgic ideas have changed the way people think about agriculture and still impact thinking today.

Interviews

Brookes, Graham. "Advantages of Biotechnology in Agriculture Affect Economics and Environment." Interview by Monsanto Company. 2007. Conversations about Plant Biotechnology: Discussions with Farmers and Experts around the World. http://www.monsanto.com/gmo//.asp?id=GrahamBrookes#mid (accessed May 10, 2010).

Brookes, a specialist in agricultural economics, discusses the advantages of biotechnology. According to Brookes, the income of farmers around the world has increased due to biotechnology. Another advantage is the global reduction of greenhouse gas emissions by almost 15 million metric tons in 2006 alone. This is the equivalent of taking one-fifth of the cars in the United Kingdom off the road for a whole year. These statistics show the wide-reaching impact of chemurgic research.

Luksan, Don. Interview by author, LeMars, Iowa, May 11, 2010.

Don Luksan is the head pressman for the *Sentinel*, the local newspaper in LeMars, Iowa. According to Luksan, the *Sentinel* has been printed using soy ink for years because it is better for the environment. Soy ink also has several other benefits. It is cheaper, it prints colors more clearly, and paper printed with soy ink is easier to recycle. The

chemurgists developed a soy ink in the 1930s. Now it is used in newspapers all over the country, showing the impact of chemurgic research.

Journals/Magazines

Beeman, Randall. "Chemivisions: The Forgotten Promises of the Chemurgy Movement." *Agricultural History* 68, no. 4 (Fall 1994): 23-45. http://www.jstor.org// (accessed December 29, 2009).

This is the only source I found which described chemurgy negatively. Beeman calls the ideas of the chemurgists "bizarre" and says that they eventually just became insignificant. Rather than reviewing the events of the chemurgic movement, Beeman analyzes the idea of *balance* that many chemurgists embraced. They predicted that the future would see a "rural-urban balance" where "all groups of society were interlinked."Beeman believes science and industry took too much control of agriculture, which is why his piece is entitled "The Forgotten Promises." It was interesting to read this article and compare it to David Wright's "Alcohol Wrecks a Marriage." Wright argues that Beeman did not have enough information to draw the right conclusions about the chemurgy movement.

Effland, Anne B.W. "'New Riches from the Soil:' The Chemurgic Ideas of Wheeler McMillen." *Agricultural History* 69, no. 2 (Spring 1995): 288-297. http://www.jstor.org// (accessed February 15, 2010).

Reading this source gave me good insight into the background of Wheeler McMillen, one of the founders of the chemurgy movement. It also helped me establish the timeline for early publications by McMillen and Hale.

Giebelhaus, August W. "Farming for Fuel: The Alcohol Motor Fuel Movement of the 1930s." *Agricultural History* 54, no. 1 (January 1980): 173-184.

Providing a history of the chemurgic movement, this source helped me to understand how the Farm Chemurgic Council came to focus on the use of alcohol as a motor fuel. In 1933 the council created the Motor Fuel Alcohol Committee to study and encourage the use of grain alcohol as a fuel to reduce agricultural surpluses. The committee believed that by replacing only "two per cent of the nation's consumption of motor fuel, a new use would be established for 120,000,000 to 130,000,000 bushels of corn annually."

"Industrial Biotechnology: Better Living Through Chemurgy." *Economist* (June 26, 2008). http://gwenvironment.com////%20living%20through%20chemurgy.pdf (accessed November 17, 2009).

Declaring, "Now chemurgy is back with a vengeance, in the shape of modern industrial technology," this source helped me establish that chemurgy's influence is significant even today. The essay reviews the origins of chemurgy in Henry Ford and George Washington Carver. Then it gives updated statistics, predicting that global sales of biotechnology products such as paint and plastics will reach $100 billion in sales by 2011, with the sales of biofuels reaching $72 billion at the same time. This proves the impact of the chemurgic movement, even years later.

Pursell, Carroll W. "The Farm Chemurgic Council and the United States Department of Agriculture." *Isis* 60, no. 3 (Fall 1969): 307-317. http://www.jstor.org// (accessed December 29, 2009).

Pursell uses this article to chronicle the growth of the chemurgy movement from the

first Dearborn Conference until WWII. He especially focuses on the impact chemurgy had on the direction taken by the Department of Agriculture. Secretary of Agriculture Henry A. Wallace from Iowa was a scientist himself, so he agreed that the future of agriculture lay in scientific research.

Taylor, Carl C. "Rural Life." *American Journal of Sociology* 47, no. 6 (May 1942): 841-853. http://www.jstor.org// (accessed January 25, 2010).

Taylor chronicles situations which affected farming in the 1930s, including the Depression, droughts, new technology and methods, and federal aid. He explains that these influences led to an "increase in the economic and social stratification of the farmer" as most Americans associated with agriculture were forced to move to lower class living.

Wik, Reynold Millard. "Henry Ford's Science and Technology for Rural America." *Technology and Culture* 3, no. 3 (Summer 1962): 247-258. http://www.jstor.org//3100818 (accessed October 11, 2009).

I used this journal article to gather information about the origins of chemurgy. Wik focuses on Henry Ford, who was a strong advocate of agricultural research. Ford helped fund the movement and supported it in other ways as well, such as supplying a facility to host the first conference, speaking for it in public, and using agricultural products to make his automobiles.

Wright, David E. "Agricultural Editors Wheeler McMillen and Clifford V. Gregory and the Farm Chemurgic Movement." *Agricultural History* 69, no. 2 (Spring 1995): 272-287. www.jstor.org// (accessed November 18, 2009).

Wright reviews the origins of the chemurgy movement and McMillen's role in its birth in this article. McMillen was especially adamant in arguing that chemurgy could help America win WWII by supplying alternatives to products in short supply, such as rubber.

———. "Alcohol Wrecks A Marriage: The Farm Chemurgic Movement and the USDA in the Alcohol Fuels Campaign in the Spring of 1933." *Agricultural History* 67, no. 1 (Winter 1993): 36-66.

Although some people had called the chemurgy movement "bizarre" and "eccentric," Wright explains that these historians did not have all the facts available to them about the chemurgists. Looking at recently revealed papers of Hale, McMillen, the Chemical Foundation, and others, as well as Department of Agriculture documents, reveals that chemurgy was actually "an influential and productive enterprise...when science and technology were transforming American agriculture." This shows that the chemurgists were innovative and had significant impact.

Speeches

Carrez, Dirk. "Impact of Industrial Biotechnology." PowerPoint lecture, JRC Stakeholders Meeting; BioImpact Study, Brussels, Belgium, May 22, 2006. http://bio4eu.jrc.ec.europa.eu//_DirkCarrez.pdf (accessed November 17, 2009).

Given as a PowerPoint presentation at a shareholders' meeting in Brussels, Belgium, this source includes facts chronicling the growth of biotechnology industries in Europe. Carrez lists several benefits of this research, including that the feedstock is renewable and that these industries will reduce pollution. According to Carrez, the European Union

is pushing forward to research and develop new ideas. This source helped me realize the global implications of chemurgic research.

Jolliff, Gary D. "Policy Considerations in New Crops Development." In *Perspectives on New Crops and New Uses*, edited by J. Janick, 84-103. Alexandria, VA: ASHS Press, 1999. http://www.hort.purdue.edu///-084.html (accessed April 3, 2010).

This speech was presented at a symposium called "Perspectives on New Crops and New Uses." Joliff reviews the chemurgy movement and other important events in agricultural history, stressing the need for crop alternatives and for a government plan to develop these crops efficiently. He recommends that Congress pass new legislation to "make new crops development a national priority" and to guard it against special interest groups which might oppose it. This source shows that chemurgy is still making an impact today.

Television Program

"George Washington Carver Tech." *Modern Marvels* History Channel, February 18, 2010.

George Washington Carver's many accomplishments are reviewed in this television program, but the one I was most interested in was his influence on Henry Ford. Ford visited Carver and asked him to do chemurgic research with him in Michigan. However, Carver was too dedicated to the Tuskegee Institute to leave. This did not deter Ford from pursuing the idea of chemurgy. He used as many farm products as he could in the making of his cars. The program even shows Ford swinging an axe at a car made completely from soybean products. He wanted to show how durable the car was.

Websites

AAEnvironment. http://aaenvironment.blogspot.com/

This essay calls for government support of chemurgy to create green industries. The author describes some of the environmental hazards of the paper industry and says that chemurgic research will reduce those problems. This source shows that the ideas of the chemurgy movement are significant even today.

Biotechnology Industry Organization (Washington, D.C.). "BIO Invites Nominations for the 2010 George Washington Carver Award for Innovation in Industrial Biotechnology." February 23, 2010. http://www.bio.org///.asp?id=2010_0223_01 (accessed May 11, 2010).

BIO, the Biotechnology Industry Organization, released this press statement to announce its third annual George Washington Carver Award for Innovation in Industrial Biotechnology. According to Brent Erickson, vice-president of BIO, industrial biotechnology may have expanded farther than Carver ever imagined, but it still "remains true to his goal—a sustainable agricultural economy that includes production of useful everyday products." This award shows that chemurgic ideas continue to have great impact on agriculture and industry.

"George Washington Carver." *Echo Studio*. http://www.echostudiochicago.com//washington-carver (accessed April 3, 2010).

George Washington Carver's chemurgic research greatly influenced Henry Ford. I used this website to find a picture of the two men discussing chemurgy.

"Henry Ford's Beloved Bean." *Baggyparagraphs.* http://baggyparagraphs.wordpress.com/// (accessed April 3, 2010).

Henry Ford was intrigued by all the possible uses of the soybean. He even made a car from plastic made from soybeans. This website has a picture of Ford hitting the car with an axe to prove how strong the plastic was.

Kansas-Nebraska Chautauqua. http://www.knchautauqua.org//_workshops.html (accessed April 3, 2010).

This website discusses issues of the 1930s. I used it to get a picture of a protest at the Nebraska state capitol.

"1933 Farm Foreclosures." *Minnesota Historical Society*. http://events.mnhs.org//.cfm?EventID=175 (accessed April 3, 2010).

I found a picture on this website of Minnesota farmers asking for a moratorium on farm foreclosures for two years. The Minnesota state legislature agreed to their demands.

"Radical Farm Protests." *Wessels Living History Farm*. http://www.livinghistoryfarm.org/arminginthe30s/_11.html (accessed April 3, 2010).

This website covers important events in agriculture in the 1920s through the 1960s. I used it to get a picture of farm protests.

Shurtleff, William, and Akiko Aoyagi. "History of Soybeans and Soyfoods: 1100 B.C. to the 1980s." 2004. *Soy Info Center*. http://www.soyinfocenter.com//_movement_industrial_uses.php (accessed October 11, 2009).

Shurtleff and Aoyagi describe seven stages of interest in soybeans in this essay. The timeline ties into the chemurgic movement at the fourth and sixth stages: the Great Depression and the post-WWII era, both times of massive farm surpluses. The chemurgists found ways to alleviate the crises by creating new uses for soybeans.

Spielmaker, Debra. "Lesson 2: 1930-1949—From Defeat to Victory." *Growing a Nation: The Story of American Agriculture*. http://www.agclassroom.org////_defeat.pdf (accessed February 15, 2010).

Presented as a pdf, this source is an instructional unit designed for high school history students to "gain an appreciation of our agricultural history and how agricultural events have affected our lives in America today." It emphasizes the need for change during the farm crisis.

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