Policy Summary of Study 367

Illegally Green: Environmental Costs of Hemp Prohibition

by Skaidra Smith-Heisters

INTRODUCTION

Cannabis sativa L. is the most politicized plant in U.S. history—so much so that science too often falls to the wayside as factions attempt to either demonize or venerate the plant. Complicating the debate, two very different varieties of the plant are common: the pharmacological variety, marijuana, and the agricultural variety, hemp. Hemp is the subject of this study.

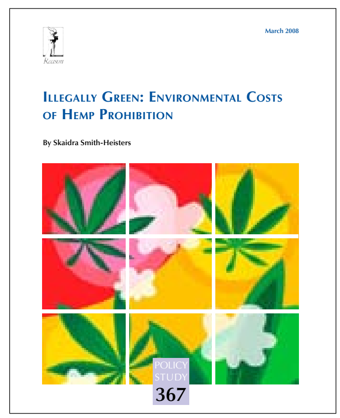
Hemp offers three products: the long "bast" fibers, similar to flax or jute fibers; the short "hurd" fibers, which have a number of industrial uses; and finally the seeds. Emerging industrial applications include composite construction materials and biofuel sources. Hemp is often evaluated for performance alongside biomass and oilseed crops, fiberglass and agricultural byproducts like wheat straw.

Hemp cultivation is not permitted in the United States today. In its final decades as a domestic crop prior to 1958, government regulation hindered its competitiveness in world markets.

This study seeks to add to the discussion about hemp prohibition by comparing the environmental efficiency of hemp to its substitutes in a few key applications.

BACKGROUND

In the early years of the United States, hemp was an essential industrial crop, used primarily in sails and rigging for ships, and in paper and clothing. Thomas Paine in *Common Sense* wrote that "hemp flourishes even to rankness," first among the fledgling nation's assets in the fight for independence.



This is a summary of Reason policy study no. 367 Illegally Green: Environmental Costs of Hemp Prohibition *by Skaidra Smith-Heisters. The entire study can be found at reason.org/ps367.pdf.*

Cultivation peaked between 1840 and 1860, after which farm labor grew more expensive and the invention of the cotton gin made cotton a stiffer competitor. The drilling of the first oil well in the United States in 1859 and a tax on alcohol led to a new focus on petroleum-based textiles, limiting the domestic market even further. But already at the turn of the century, the petroleum industry faced vocal criticism from champions of bio-based fuels and plastics.

Despite decreased domestic production, hemp was second only to jute as the most commonly used bast fiber as late as 1913. Growth in demand was met with imports. The Federal Bureau of Narcotics reported a steep decrease in hemp crop acreage between 1880 to 1933, from 15,000 to 1,200 acres—followed by an increase from 6,400 acres to 10,900 between 1934 and 1937.

In the 1930s, technological breakthroughs in hemp fiber processing reawakened interest in the crop. But that interest was squelched almost immediately when the U.S. government, purportedly to curtail marijuana cultivation, began to regulate hemp in 1937 via the Marihuana Tax Act. Although hemp was technically exempted, it soon became clear that the narcotics bureau considered any hemp stalks that bore leaves in violation.

Hemp experienced its final hurrah during World War II, when supply disruptions in the tropics restored the need for local hemp. The Marihuana Tax Act was temporarily suspended and domestic production peaked at 178,000 acres. After the war, the government reinstated regulation and hemp suffered once again. Between 1958 and 1999, when the government issued a permit for experimental test plots in Hawaii, no hemp was grown legally in the United States.

Today's major producers include China, Russia, Hungary, and France, where hemp production has always been legal. In the 1990s, legislators re-legalized hemp in countries such as Great Britain, Germany, Austria, Switzerland, Canada, and Australia.

Beginning in Kentucky in 1994, individual U.S. states began to introduce legislation authorizing feasibility studies for industrial hemp production. To date, reports from Arkansas, Illinois, Kentucky, Maine, Minnesota, Missouri, North Dakota, Oregon, Vermont and Wisconsin have indicated potential for state production of industrial hemp.

ENVIRONMENTAL COSTS OF HEMP SUBSTITUTES

The substitution of hemp with hydrocarbon industrial feedstocks has resulted in elevated industrial emissions. The commodities that have replaced hemp over the past 150 years have also carried other considerable environmental externalities.

Consider polyester. Polyester fiber manufacturing requires six times the average energy required to produce hemp fiber. Or consider cotton. Cotton is one of the most water- and pesticide-intensive crops in the world. It is notoriously difficult to put a dollar value on non-market costs, but one researcher has estimated environmental and societal damages resulting from pesticide use in the United States at $9.6 billion annually. Hemp is naturally far more resistant to pests and weeds than cotton.

Industrial hemp experts consider it a low-input, low-impact crop. High-input crops create more pollution—from the manufacture of chemical fertilizers, herbicides, and pesticides, to their shipment, storage, and delivery. Crop irrigation can also represent a substantial energy input.

Recently, policymakers have paid considerable attention to the contribution of petroleum products to carbon dioxide emissions, helping to revive interest in plant-derived industrial crops such as hemp. Net carbon sequestration by industrial hemp crops is estimated to be comparable to urban trees, helping to mitigate elevated atmospheric carbon dioxide levels.

Wood-based paper manufacturing, which has replaced hemp-based manufacturing, accounted for 5.6 percent of industrial carbon dioxide emissions in 2005. The manufacturing process is far more energy-intensive than that of hemp paper due to the need to remove plant glues in the

wood. Manufacturing wood paper also requires sulphur and chlorine, both known to cause environmental harm.

Hemp can also be used to make composite construction materials that are environmentally preferable to concrete, fiberglass, cement, and lime. These materials involve energy-intensive manufacturing, and cement and lime production are extremely carbon-intensive. In Britain, researchers are studying hemp-based alternatives to create more energy-efficient construction. Such research in the United States is stymied by lack of a domestic hemp fiber supply.

The U.S. government not only prohibits hemp production but directly subsidizes competing commodities that might be environmentally inferior. The Environmental Working Group reports that, from 1995 to 2005, the government paid $51.3 billion for propping up corn, $21 billion for wheat, and $530 million for tobacco. Also heavily subsidized are cotton ($15.8 billion), timber and petroleum (indirectly), and biofuel crops such as soybeans and canola.

CROP INPUTS AND REQUIREMENTS

Countless varieties of industrial hemp have been bred by farmers around the world. Research continues to breed varieties optimized for specific qualities: cellulose for biofuels, fiber yield for textiles, proteins for food, and so on.

One rigorous life-cycle analysis has been conducted on field production of fiber hemp. The study, conducted in France, concluded that fiber hemp crops, compared to other crops studied, had consistently low environmental impacts in categories that included climate change, acidification, and energy use, among others.

The inputs and requirements for hemp crops include:

A short harvesting period: Hemp requires relatively little time between seeding and planting—90 days for fiber harvesting and an additional 30-45 days for seed. This makes it an ideal candidate for complementary crop rotation, an important economic and agronomic consideration.

Low or no herbicide and pesticide inputs: Herbicides are not needed for hemp fiber crops because they are seeded at very high densities, crowding out weeds. (This is not the case for hemp seed crops.) Currently, industrial hemp is grown profitably without the use of pesticides. While pests and disease would likely develop over time if hemp were grown intensively, this tendency could be minimized by rotating crops and boosting genetic diversity.

Potentially low fertilizer requirements. Reported fertilizer inputs for hemp range widely, ranging up to requirements similar to corn. Hemp grown for fiber requires less nitrogen than that grown for seed. Farmers may minimize inorganic fertilizer needs by applying organic mulch or growing the hemp in rotation with a nitrogen-enriching crop.

Low irrigation requirements. Hemp needs less water, and thus less irrigation, than many of the competing crops.

Broad adaptability to different climates. Wild hemp, a relict of historic hemp crops, grows so prolifically in parts of the country that it constitutes 98 percent of the plants seized every year by the government under marijuana eradication initiatives.

YIELD AND QUALITIES AS AN INDUSTRIAL CROP

No current yield data for U.S.-based industrial hemp production exist, but a realistic estimate seems to put productivity in the range of two to five tons of dry stems per acre—less than any number of common crops, including corn and sugar cane. However, biomass may be the least important measure of hemp yield. Processing, which includes technical innovation at every stage, is a huge factor for yield. Fiber length and cellulose and lignin content all affect yield for industrial use, as well.

Aggressive crop research and development, including selective breeding and genetic engineering, might help U.S. growers to realize a yield in the range of six to eight tons of dry stems per acre, comparable to hemp grown in the early United States and currently elsewhere in the world.

INDUSTRIAL APPLICATIONS

Industrial hemp applications include both traditional and distinctly modern uses, with varied costs and benefits compared to substitutes.

These applications are listed below. Among them, biocomposites may represent the most environmentally beneficial and cost-effective application. This is likely to continue to be the case, albeit limited in the United States by the expense of importing fiber from overseas producers.

A. Paper

Trees, where available, are often a more efficient source of pulp than are hemp and other non-wood fiber crops. Even though hemp requires less energy and time to process, this advantage is offset by other factors. For example, hemp crops require more irrigation, pesticides, and fertilizers than do tree forests or plantations. So while hemp is superior to wood for the production of paper, the investment in producing the hemp may offset any benefit. In the United States, much of the future demand for paper will likely be met with increased plantation forests and paper recycling.

B. Cloth

Hemp offers some environmental benefits over cotton for use in cloth, although it appears the degree of increased efficacy has been exaggerated by earlier studies. Hemp fiber yield appears to be roughly three times per acre that of domestic cotton, with a shorter growth cycle. It is more durable than cotton, making it well-suited to jeans. As well, cotton, unlike hemp, requires multiple annual herbicidal treatments.

C. Fuel

Corn ethanol is the biofuel most favored by current government subsidies for renewable fuels. While the environmental cost-benefit analysis of fuel produced from an agricultural rather than petrochemical source is complicated and controversial, what can be said is that hemp is an improvement over corn-based ethanol on several counts: slightly higher soil conservation, lower herbicide and pesticide requirements, higher potential yield, and greater suitability for cellulosic (as opposed to grain) ethanol production.

Although it remains a subject of intense debate, proponents of cellulosic ethanol production posit that it could reduce greenhouse gas emissions more than 80 percent below gasoline, as compared to a 20 or 40 percent reduction in emissions derived from grain ethanol. Research into the cost-effective production of cellulosic ethanol is in progress, with commercial breakthroughs some years away. At present, biodiesel is more readily produced from hemp, although canola has been found to be a cheaper and more efficient source. At most, given current technology and the higher value of hemp for other uses, biofuels might be a secondary market for industrial hemp.

D. Composites

The use of hemp fibers in composite materials is relatively new but already well-proven, offering environmental and performance benefits in a number of applications. These include automotive and general construction materials, geotextiles, and filters.

Industrial hemp is now widely used in natural fiber-reinforced plastics for interior lining, insulation, and structural panels in a variety of vehicle makes. Natural fiber suppliers have reported annual growth of 10 to 15 percent in the automobile market since 2000. Natural fiber blends are common, but manufacturers would use more hemp if supplies were dependable and cost-competitive.

Using hemp in car parts saves energy not only in production, but also by creating a more lightweight product. Natural fiber components can be 20 to 30 percent lighter than conventional composites, which improves fuel efficiency for the life of the vehicle. Currently, 10 to 20 pounds of natural fibers can be used per vehicle.

Finally, hemp composites provide an environmental advantage at the end of a product's lifecycle. In its unalloyed form, hemp composts naturally and the carbon dioxide it has sequestered is released back into the air. When it is used in a composite with petroleum-based plastics, it is usually incinerated at the end of its use. At that point, it offers more combustion value than its glass-reinforced counterparts.

Other construction materials made from hemp include fiberboard, plasters and concrete alternatives. These products share many of the favorable qualities of the bio-composites discussed above.

E. Other Uses

Other uses of hemp include food, oil and cosmetics made primarily from seed crops. Canadian hemp acreage has grown from 3,200 acres in 2001 to 48,000 acres in

2006 to meet the demand for such products at home and abroad. These products are both legal and popular in the United States. However, the environmental significance of this market is minimal.

Hemp might help farmers as a secondary crop with value-added benefits for other harvests. For example, planted between either organic or conventionally grown crops, hemp could naturally reduce weeds and other pests. In China, hemp is reportedly used as a barrier to protect vegetable crops from insects. Studies in the Netherlands have found that rotating hemp crops with others offers benefits for pest reduction and crop yield, among other factors.

Finally, hemp has been found to be a top candidate in bioremediation, using crops to extract heavy metals from industrially contaminated soils. It has been extensively tested in Australia and Europe and was cultivated on radionuclide-contaminated soils at the Chernobyl nuclear reactor site. Although hemp is not considered a "hyperaccummulator" of heavy metals, many researchers believe it has strong potential for use due to its high adaptability to a number of environmental conditions. It performs as well or better compared to many plants of equal economic value. Further research and development may make it even more appropriate for this use.

LEGAL ISSUES

The Drug Enforcement Administration (DEA) has assumed responsibility for the regulation of industrial hemp and marijuana alike. Although a growing number of states have passed legislation to allow for limited research or cultivation of hemp, the DEA has generally sought to expand its regulation.

Under current federal regulation, DEA-issued permits to grow *Cannabis* are subject to onerous security requirements that make the conduct of research unfeasible.

In 1994, a crop grown in Brawley, California, licensed by the U.S. Department of Agriculture, was destroyed by state officials before the crop was fully mature. The first DEA permit issued in recent years went to the Hawaii Industrial Hemp Research Project in 1999, but its success was hindered by administrative delays at the DEA.

The DEA has sought to regulate processed hemp products containing miniscule amounts of THC (delta-9-tetrahydrocannabinol, the regulated component of marijuana), and would likely push to prohibit industrial hemp even if zero-THC strains were developed for use.

The Industrial Hemp Farming Act of 2005 (HR 3037) was the first legislation introduced at the federal level to exempt industrial hemp from the Controlled Substances Act. No action was taken on the bill, and the legislation was re-introduced in 2007.

Meanwhile, the World Trade Organization and the NAFTA and GATT trade agreements all recognize industrial hemp as a legitimate crop. In most hemp-producing countries marijuana cultivation is regulated, only in the United States has concern regarding potential for illicit marijuana cultivation remained a significant obstacle.

TECHNOLOGICAL FEASIBILITY

In the United States, technological advances are required to make industrial hemp production economical. It is expensive to process, especially given labor and environmental standards that may be lower among other producer countries. As long as highly centralized and mechanized processing is the norm, smaller hemp mills will also have difficulty creating competitive economies of scale.

For 50 years, the prohibition of industrial hemp in the West has inhibited technological advance in hemp production. Today, many countries are lifting prohibition, opening up the possibility of progress.

If the prohibition is lifted in the United States, researchers might exploit similarities between hemp and flax or hemp and other cellulosic biofuel feedstocks, adapting advances in one for use in the other. However, a domestic

industry would still have to compete with better-established industries such as corn ethanol and with more experienced foreign producers. Greater utilization of the hemp plant will improve its market viability. Other advances of potential importance to hemp's future success include: plant breeding or genetic engineering, streamlined harvesting, and developments in ethanol production, among many others.

CONCLUSION

Prior to prohibition in the United States, industrial hemp raised considerable excitement and speculation. The same is true today. Interestingly, the newest technological applications of this ancient crop may be the most promising.

Nations that followed the United States in prohibiting hemp cultivation have, for the most part, rescinded those laws—some more than a decade ago. The United States is now the only developed nation in which hemp is not an established crop.

It seems likely that the United States cannot prohibit the crop indefinitely. Reports from a number of states on the feasibility and environmental impact of hemp have all been positive. Social pressure and government mandates for lower dioxin production and greenhouse gas emissions, greater bio-based product procurement, and a number of other environmental regulations all seem to directly contradict the prohibition of this evidently useful and unique crop.

Ultimately, the costs of hemp prohibition are abstractions and cannot be fully calculated. The full potential economic and environmental value of hemp can only be tested if the crop is legal and unrestricted in the U.S. market.

ABOUT THE AUTHOR

Skaidra Smith-Heisters is a policy analyst at Reason Foundation, a nonprofit think tank advancing free minds and free markets.

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