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An HSUS Report: The Implications of Farm Animal-Based Bioenergy Production

The Humane Society of the United States

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Abstract

As the current and potential impacts of climate change become more evident and increasingly urgent, entities such as governments, corporations, and non-governmental organizations (NGOs) are seeking out non-fossil fuel-based sources of energy to mitigate those effects. In addition, many governments are investigating ways to promote their own domestic energy sources as a result of rising oil prices. Bioenergy—made from recently living organic matter, such as plants, agricultural waste and crop residue, meat processing wastes, or farmed animals' fats and manure—has quickly become one of the fastest growing, and controversial, alternative energy sources. Globally, production of biofuels, generally used for transport, only accounts for 1% of total fuel production, but that percentage may rise as the costs of petroleum-based fuels increase, encouraging greater numbers of countries to increase biofuel production. While corn and sugarcane are well-recognized sources of biofuels, agribusiness is also using less well-known sources, including manure and fats from animals raised on factory farms, as well as litter from these production facilities, to generate energy. The industrial animal agriculture sector, however, typically ignores the environmental, social, animal welfare, and public health costs of its inputs and practices, and bioenergy production from factory farm-based biofuels will exacerbate the problems inherent in industrial animal agriculture.

Introduction

Bioenergy refers to any type of energy created from recently living organic matter (biomass, biological material from plants and animals) and can be gaseous (biogas) or liquid (biofuel) in form. Unlike fossil fuels such as coal and petroleum, of which there are finite supplies, bioenergy is considered a renewable source of energy as it can be grown or harvested from plants and other organic material, such as manure and farmed animal carcasses, rather than mined or extracted from the Earth.[1]

Biomass can be used to produce fuel for transportation, heat, and electricity.[2] This non-fossil fuel-based energy source has been used for centuries in a variety of ways, such as the wood used in fireplaces for heating homes and the animal dung burned by rural Africans for cooking family meals.[3] Producing energy from organic matter typically involves the direct burning of plants, wood, oils, and fats; the manufacture of liquid fuel sources,[*] such as ethanol or biodiesel;[4] or the use of biogas created through anaerobic digestion or fermentation from animal manure.[5]

Biofuels are liquid fuel or energy sources usually derived from corn, palm trees, soybeans, sugarcane, switchgrass, and other plant matter,[6] as well as from farmed animal products.

World production of biofuels rose an estimated 20% in 2007, with an estimated 54 billion L (14.3 billion gal).[7] Interest—and investment—in biofuels have grown partly due to their purported environmental benefits and confidence that adequate supply will ensure home-grown energy security. As a result, Brazil, China, the United States, and several other countries are investing in the construction of new biofuel plants.[8] The two most well-

[*] Biodiesel is fuel made from plant oils that can be used in diesel engines. Ethanol is an ethyl alcohol-based fuel made mostly from grains. Cellulosic ethanol is chemically identical to ethanol, but is made from grasses, wood, and the non-edible parts of plants.

known biofuels for transportation are ethanol and biodiesel.[9] Ethanol replaces or can be added to gasoline, while biodiesel supplements or replaces petroleum-based diesel fuel.[10]

Ethanol is the most prevalent and fastest-growing biofuel, with global production currently over 45 billion L (12 billion gal) annually.[11] Made from sugar or starch crops,[12] including corn, ethanol is typically mixed with gasoline or other petroleum-based fuels.[13,14] The majority of ethanol produced is used for fueling cars, trucks, and other vehicles.[15]Currently, the United States is the largest producer of ethanol and, along with Brazil, produces 95% of the world's ethanol supply.[16] By the end of 2008, the United States was expected to have doubled[†] its production capacity from 2006.[17] In Brazil, half of the sugarcane crop provides 40% of that nation's fuel for transport.[18]

The production of biodiesel, which is made from vegetable oils and/or animal fats, has grown more than 80% since the 1990s, with supply now exceeding 6 billion L (1.6 billion gal) annually.[19] Soybean oil has been widely used as a source of biodiesel, but other vegetable oils can be used as well.[20] In Europe, particularly in Germany, rapeseed is the primary feedstock for biodiesel.[21] The fat from chickens and other farmed animals are also increasingly being used as biodiesel sources,[22,23] which introduces a number of significant yet presently unaddressed concerns.

Indeed, like any agricultural product, biofuels can be produced in many different ways—including the use of by-products from animal agriculture, such as the methane emissions from manure decomposition, as well as fats and oils from farmed animals. Though, at present, the production and market for these products are relatively small compared to plant-based biofuels, demand is growing as interest in alternative fuels increases.

Biogas and Anaerobic Digesters

During anaerobic digestion (a decomposition process that breaks down manure without oxygen), methane is released[24,25] which can then be collected for fuel, often referred to as biogas.

In the developing world, biogas projects can help small farmers with reduced fuel costs, a financial benefit of growing importance as the price of both fuel and food rises. Biogas has long been used on a small scale on pig farms in countries such as China, India, the Philippines, and Taiwan, as well as in parts of Latin America. In the Philippines' Pampanga province, for example, demonstration projects initiated by Dublin-based EcoSecurities, a company that develops greenhouse gas (GHG) reduction programs worldwide, are helping pig farmers not only capture methane for on-farm use, but also treat effluent so it is safe for irrigation of crops.[26] For families raising pigs or cattle on a small scale, primarily for personal consumption, biogas can provide a cheap source of energy for cooking food.[27] Manure can be collected and deposited into a small, air-tight pit, which is connected to a pipe that runs into the home. As the manure decomposes, it releases methane and carbon dioxide, which can be ignited for cooking and heating.[28,29]

Small-scale and medium-sized farmed animal production operations in both developing and developed countries may find environmental and economic advantages, such as additional revenue garnered through reduced on-site energy costs or selling bioenergy to clients, as well as better odor control, by installing digesters.

Concerns with Large-Scale Digester Systems

Scaling up these systems at factory farms, however, may encourage further industrialization of operations that typically ignore animal welfare[‡] and the treatment of workers,[§] as large-scale production facilities generate and thereby could profit from massive quantities of manure as a source of fuel.

[†] As of this report's publication, statistics for U.S. production capacity in 2008 were unavailable.
[‡] For more information, see www.hsus.org/farm/resources/research/.
[§] For more information, see "Blood, Sweat, and Fear: Workers' Rights in U.S. Meat and Poultry Plants," published by Human Rights Watch, at www.hrw.org/en/node/11869/section/1.

Aided by the World Bank and the U.S. Environmental Protection Agency (EPA), larger projects are in development in Southeast Asia, estimated to prevent annual methane emissions of 5,000 tons of CO_2-equivalent per 20,000 pigs.[30] Storing and utilizing manure from medium- and large-scale biogas systems, according to the EPA, is better for the environment than conventional storage tank, storage pond, or manure lagoon systems, and additional purported benefits are better odor control, improved water and air quality, and the "opportunity" to capture biogas and reduce GHG emissions.[31] The conventional liquid and slurry manure storage systems on some industrial farmed animal production facilities emit large amounts of methane, a GHG with 21 times the global warming potential (GWP) of carbon dioxide. As discussed above, digesters recover and combust methane either to be used for fuel or to operate machinery on site or to be sold to public utilities that then sell that energy to customers.[32]

The EPA estimates that anaerobic digestion systems are feasible at approximately 7,000 dairy and pig production operations.[33] Currently, digesters provide renewable energy to power more than 20,000 average U.S. homes, reducing annual methane emissions by about 1.5 million tonnes of CO_2-equivalent.[34] Many of these systems, however, are supported by state government grants or subsidies[35,36] and may only be profitable at industrial animal production operations.

Installing anaerobic digesters can require significant investment depending on the type of system used. Typically, large digesters are designed to handle a great deal of manure and work best on industrial factory farms that have "stable year-round manure production" and the infrastructure in place necessary to collect at least half of that manure every day.[37] However, the proliferation of anaerobic digestion systems at large-scale animal production facilities represents a potentially disastrous trend for small- and medium-sized farms that wish to control their GHGs but are unable to compete with the larger operations for government funding.[38]

Of significance is that anaerobic digestion—whether on a small-scale farm or a large industrial facility—does not make manure disappear. In the United States, confined farmed animals produce 500 million tons of manure per year,[39] and that waste—whether or not used in bioenergy production—must still be stored or used as fertilizer. On farms raising both plants and animals, manure is typically a very efficient and available source of nutrients for crops, often eliminating the need for any artificial fertilizers. However, on factory farms, the huge quantity of waste produced makes it nearly impossible for the manure to be utilized as fertilizer on nearby cropland, a problem made worse by beef, chicken, egg, and dairy operations increasingly sited far from where crops are grown. The government funding to support anaerobic digestion systems on industrial animal agriculture operations has been criticized by environmental and sustainable farming advocates, such as Food First and Food and Water Watch,[40] as rewarding the companies culpable of generating the most manure in inherently unsustainable and inhumane ways. Additionally, some environmental organizations have cautioned about the use of manure and fat from farmed animals raised on industrial operations, citing concerns about the pollution from factory farms.[41] Indeed, given the problems associated with industrial animal agriculture, it is unlikely that using the factory-farm waste will be viewed as a green energy source.

Concerns with Burning Farmed Animal Waste

Factory farms are also beginning to generate energy by burning manure, fat, skin, feathers, and even carcasses of farmed animals. In the United Kingdom, three plants owned by the energy company Fibrowatt are using poultry litter, including excreta, feathers, spilled feed, substrate, soil, and dead birds,[42] to provide electricity for 150,000 homes. These plants transport litter from farms and combust the waste at 815°C (1500°F) to heat water and create steam that drives a turbine and generator to produce electricity. Fibrowatt's technology, reports the company, "has been operating safely and reliably" since the 1990s at its plants in the United Kingdom and has "converted more than three million tons of poultry litter to electricity."[43]

In 2007, the same technology was introduced in the United States when Fibrowatt[44] began building a 50-megawatt poultry litter-fired power plant in Benson, Minnesota.[45] The company reports that its plant will help reduce GHGs in the state, at a GHG-savings equivalent of taking 500,000 cars off the road.[46] As reported in the

International Herald Tribune, however, some environmental advocates claim that the power plant releases toxic chemicals into the air, diminishing any green aspects of its product or bioenergy process. Indeed, one of the plant's permits issued by the state for emissions reportedly states that the "plant is a major source of particulate matter, sulfur dioxide, carbon monoxide, nitrogen oxides and hydrogen sulfide." Additionally, the electricity produced by the plant is more expensive than energy produced by coal-fired power plants, and a substantial amount of turkey excrement and litter is needed to produce a relatively small amount of electricity. Reportedly, approximately 500,000 tons of waste from turkeys produces enough electricity for only a few small rural communities a year.[47] As well, conversion of turkeys' excrement into a biofuel requires the use of fossil fuels that emit GHGs, possibly eliminating any of the environmental benefit of using waste for fuel.

A state legislative mandate requiring Xcel Energy, Minnesota's primary utility, to either construct or contract with a wind or biomass plant in order to expand the state's energy sources was the primary impetus behind the development of the turkey litter plant.[48,49] As a result, Xcel entered into a 21-year agreement with Fibrowatt, stipulating that Xcel would buy power from the poultry litter-fired power plant at twice the price of electricity generated by fossil fuels.[50] While this agreement could reduce reliance on fossil fuels for energy over time, it could also encourage industrial turkey operations to become even bigger to ensure greater quantities of litter to supply the bioenergy plant.

Fibrowatt is also building a $200-million plant that will use poultry litter to generate energy in Sampson County, North Carolina. Construction is expected to be completed by 2011. Reportedly, the county is giving Fibrowatt a $2.5-million ten-year tax-incentive package, as well as "assistance with infrastructure improvements, including water and sewer services."[51]

Manure can also be combined with fats from both animals and plants to make biodiesel, which can be used to power vehicles. While a small number of environmentally minded drivers have been fueling their cars with old vegetable oil from restaurants for years, the availability of biodiesel and its use are still not widespread, and using animal fats for diesel fuel has been even less common. That is changing, however, as higher prices for vegetable oils are making unused fat from chicken processing operations a financially attractive alternative for some investors. In 2007, the cost of fat from chickens was about half as much as soybean oil. Vernon Eidman, a biofuels expert at the University of Minnesota, reportedly estimates that by 2012, the United States will produce nearly 4 billion L (1 billion gal) of biodiesel, with half coming from animal fat.[52]

To produce biodiesel, fat from chickens is refined—melted and strained—and then typically mixed with soybean oil for use as fuel for vehicles and machinery.[53] The free fatty acids in the fat of chickens, however, can raise problems in biodiesel production; these acids can form soaps as a byproduct, which can make it harder to produce a large biodiesel yield since they can clog machinery. Research at the University of Arkansas has found that fat with lower fatty acid content (higher quality fat) works better than fat with higher fatty acid content (lower quality fat).[54] The higher-quality fat, however, tends to be more expensive.[55,56]

The Arkansas researchers have found that by using the supercritical methanol treatment process—a process that uses high temperatures and pressure to create a reaction—the fatty acid dilemma can be resolved and the creation of soaps common in conventional refinery systems that rely on a catalyst to process fat from chickens can be eliminated. This process has the potential to make the production of biodiesel from animal fats less costly, while also reducing production time.[57] Nevertheless, concerns about the treatment of farmed animals, the environmental implications of large-scale animal agriculture, and the possible incentives to further industrialize factory farming remain unaddressed.

Cellulosic ethanol, made from the cellulose, or the non-edible parts, of plants, can be made from a variety of non-food crops, including switchgrass and other woody plants, municipal landfill waste, agricultural residues, and farmed animal manure and litter. These products can be refined or gasified and turned into synthesis gas to produce ethanol fuel.[58] Much less fossil fuel energy may be needed to extract fuel from corn, though, than from switchgrass or wood because there are more energy-rich starches and sugars in corn compared to grass or sawdust and it takes additional treatments to release energy from cellulose.[59]

Corn-based biofuel production in the United States may also counter the billions of dollars of annual feed subsidies supporting industrial animal agriculture. According to a 2008 report by the Food and Agricultural Policy Research Institute (FAPRI), one result of the demand for grain for biofuel production has been "higher prices for corn, soybean meal and hay [that] have increased feed costs for all livestock producers."[60] The decline in factory-farmed meat production and consumption as a consequence of increased feed costs would be expected to have a range of environmental and public health benefits.[61]

Despite some of the potential environmental advantages of different kinds of biofuels, these technologies can allow large-scale, industrial farmed animal production operators to profit from the huge amounts of waste they create—millions of tons of litter and excrement. Bioenergy production from farmed animal waste has the potential to perpetuate the environmental problems[**] created by massive quantities of manure, while giving animal agribusiness the opportunity to greenwash its unsustainable and welfare-unfriendly practices. These farmed animal-based biofuels are not currently reducing consumption of fossil fuel because both biodiesel and the construction and operation of anaerobic digesters require electricity use from burning coal or petroleum. In addition, unlike the waste created on smaller, more environmentally sustainable farms raising both crops and animals, where manure and urine can be utilized effectively for fertilizer, factory-farm waste is produced in extremely large quantities, making it all but impossible to use on farmland. Furthermore, the manure excreted by animals in factory farms often has a range of toxins including antibiotic-resistant residue[62] and endocrine-disrupting chemicals.[63,64] These and other pollutants not only impair environmental integrity; they negatively impact communities surrounding industrial production facilities.[††]

Carbon Offsets

Carbon credits were established by the Kyoto Protocol as a way to enable companies and governments to "offset" the carbon dioxide and other GHGs they create by establishing projects that reduce emissions, which they can trade in the marketplace. These credits, or offsets, are allowances that represent a quantity of carbon dioxide or other greenhouse gases measured in tonnes of CO_2-equivalent.

Established within the Kyoto Protocol, the Clean Development Mechanism (CDM) is a grant-making or funding mechanism financed by the international community to subsidize offsets and ensure that projects 1) actually reduce emissions and 2) are "additional" activities that would not have otherwise been undertaken.[65] A coal-fired power plant that finds it difficult to reduce its own emissions, for example, can buy credits to support new emissions-reducing projects elsewhere, such as wind farms or reforestation projects, particularly in developing countries.

The American Electric Power Company (AEP), an Ohio-based utility, is one such corporation engaging in carbon offsets. AEP releases approximately 145 million tonnes[‡‡] of carbon dioxide each year, more than any other company in the United States, according to a 2007 *Wall Street Journal* article.[66] Instead of implementing CO_2 control strategies at its own operation, the company has elected to offset its emissions from burning coal by partnering with the farmed animal industry and paying for the installation of lagoon covers at factory farms to reduce their methane emissions.[67]

Farmed animal production operations can also benefit directly by earning carbon credits upon installing anaerobic digesters. According to an October 2007 press release from Western United Dairymen, a California dairy producer organization, "[f]arms with digesters or lagoon covers not only generate revenue from carbon

[**] For more information, see "An HSUS Report: The Impact of Industrialized Animal Agriculture on the Environment" at www.hsus.org/farm/resources/research/enviro/industrial_animal_ag_environment.html.
[††] For more information, see "Factory Farming in America: The True Cost of Animal Agribusiness for Rural Communities, Public Health, Families, Farmers, the Environment, and Animals" at www.hsus.org/farm/resources/research/enviro/factory_farming_in_america.html.
[‡‡] One tonne is one metric ton, or 1,000 kg (approximately 2,205 lb).

credits, but also have the potential to save money from using methane gas to generate electricity."[68] In fact, animal agribusiness corporations in several developing countries have already initiated projects under the CDM. In the Yucatán region of Mexico, for example, Grupo Porcícola Mexicano, a pig producer,[69] is installing anaerobic digesters under the CDM to control methane production.[70] In Brazil, one of the country's confined pig production operations developed a project under the CDM to install anaerobic digesters and generate electricity from methane.[71] However, as discussed above, factory farms, whether they install digesters or not, continue to produce large amounts of manure and other wastes. Furthermore, in Brazil and other parts of South America, tropical rainforest and grasslands are being destroyed for both the construction of factory farms and slaughter plants and for soy production for farmed animal feed.[72]

Unlike carbon offsets, which are enforceable under the CDM, Voluntary Emission Reductions (VERs) are completely unenforceable, yet in essence strive to attain the same goal for which other carbon offsets were created: to establish a market for reducing greenhouse gas emissions.[73] However, while VERs can provide power for on-farm use and save producers money, and provide an additional revenue stream that, when combined with potential bioenergy sales, can dramatically improve the economics of installing anaerobic digester systems,[74] they can vary dramatically in quality and effectiveness of reducing emissions. Additionally, VERs and other offset programs may also have the potential to encourage the expansion of larger farmed animal confinement operations, producing more manure and GHG production.

Indeed, while carbon offsets or VERs may appear to be effective mechanisms for controlling factory farm emissions, they may incentivize animal production operations to become even larger without working to regulate their water and soil pollution or improve animal welfare. In effect, carbon offsets and VERs may allow polluting industries, including industrial animal agriculture, to continue business as usual while profiting from their unsound practices.

Ethanol Co-Products and Farmed Animals

Many factory-farmed animals, including cattle, pigs, and chickens, are typically fed diets consisting of corn and soybeans. While these diets can cause a number of health problems for ruminants, including acidosis, they also induce rapid weight gain.[75,76] Cattle and pigs are also being fed co-products of ethanol production, such as distillers' grains (DGs), which is what is left after the starch from corn is removed to make ethanol, as well as corn gluten feed and meal.[77,78] These products are popular feed sources because they are a concentrated protein source.[79] Due to increasingly higher grain prices and the growth of the ethanol industry, their use as a feed source is becoming even more prevalent. A 2007 U.S. Department of Agriculture (USDA) report by its National Agricultural Statistics Service found that in the United States in 2006, ethanol co-products were used on 38% of dairy operations, 36% of cattle feedlots,[§§] 13% of farms raising cattle for beef who were also grazed on pasture, and 12% of operations raising pigs.[80,81] Some ethanol manufacturers claim that DGs are highly nutritious for farmed animal feed and allow crops to be used for both biofuels and feed.[82] In the United Kingdom, Ensus, a biofuels company, reportedly claims that DGs used as feed could also reduce the amount of soy imported by animal agribusiness.[83] As ethanol production increases, the number of animals being fed these co-products is likely to rise. In fact, some ethanol plants in the U.S. Midwest are now being built next to some feedlots in an effort to create a "symbiotic relationship" between the biofuels industry and factory farming.[84]

The co-products that come from oil seeds for biodiesel production are also used as feed. These products include the remnants of soybeans, sunflowers, mustard, camelina, and canola after the oil is extracted. Soybean meal, considered to be the most digestible of all the oilseeds, is used extensively by pig and chicken producers. Other oilseed meals, according to a 2008 report by the Western Organization of Resource Councils (WORC), have lower digestibilities and less favorable amino acid profiles compared to soybean meal. However, these meals,

[§§] "Cattle on feed" are industrially raised cattle and calves who are fed a ration of grain, silage, hay, and/or protein supplement for the slaughter market. These animals are expected by the USDA to produce a carcass that will achieve a higher "grade" (quality of meat). This category excludes cattle who are "backgrounded only" for later sale as "feeders" or later placement in another feedlot.

says WORC, can still be very useful, particularly for feed for ruminants, animals with multiple stomachs such as cattle, because amino acid profiles and fiber content are not as problematic for them as they are for monogastric animals, those with one stomach.[85]

Recycling ethanol co-products, however, may not always be healthy for animals or humans. Research from Kansas State University in 2007 shows that cattle who are fed DGs have a higher likelihood of harboring *E.coli* O157 in their hindgut, or colon.[86] This led to speculation that DGs were responsible for increased beef recalls in the United States. In 2007, for example, there were nearly 163% more beef recalls than the previous year and reportedly about one-third of the recalls were prompted by reports of human illness, while none in 2006 were.[87,88] A more recent study, however, failed to find any food safety significance to the feed use of DGs.[89]

In addition, ethanol co-products fed to farmed animals can have higher levels of mycotoxins,[90,91] carcinogenic products of molds that can contaminate certain crops, including corn, soybeans, and wheat. Ingestion of mycotoxins can have both acute and chronic effects, including cardiac and central nervous system problems.[92] The mycotoxins of "greatest concern" in ethanol co-products and which pose the greatest risk for animals are vomitoxin, the fumonisins, aflatoxins, and possibly other trichothecenes. Pigs, lactating cows, and calves have a greater sensitivity to vomitoxin than other farm animals.[93]

While there are guidelines in place in many countries to limit the amount or level of vomitoxin, aflatoxin, and other mycotoxins present in animal feed, there are currently no regulations for mycotoxin levels in crops grown for ethanol. In fact, because "lower grades" of crops are used for fuel, mycotoxins could be concentrated more than two-fold in the co-products that become animal feed.[94]

DGs can also cause environmental damage, according to a study in the *Journal of Environmental Quality*. When used as feed, dried DGs can elevate the phosphorous content of manure. Feeding farmed animals wet DGs reduces the energy costs of drying grain, but requires that feedlot operations be near where ethanol is being produced, further separating crop and farm animal production sites.[95]

Conclusion

Additional research on the sustainability of farmed animal-based biofuels is needed. Environmental attorney Nicolette Hahn Niman calls the energy created from manure "brown power" because of all the environmental problems its production can create.[96] As discussed above, without substantial investment or subsidies, using manure for energy is not cost-effective on a large scale, according to research from the University of Minnesota, and manure digesters, incinerators, and biodiesel facilities are very expensive to build and run, making them cost-effective typically only for large, industrial animal production operations.[97] Subsidizing bioenergy production from these large-scale operations allows factory farms to continue business as usual—harming the environment, workers, and animals—and even expand their operations. Meanwhile, often many smaller-scale farmers do not qualify for subsidies, making it even more challenging for them to compete with larger operations.[98]

In order for bioenergy production to be responsible, it requires strong government policies and regulations. Biofuels and other energy produced from biomass are only part of the solution to current energy problems. Also needed is additional investment in other renewable sources of energy, including solar and wind, which tend to have fewer environmental impacts than fossil fuel-based energy sources.

While encouraging consumers to buy more energy-efficient appliances, eat fewer animal products, or drive less are important measures for energy conservation, investments also need to be made in infrastructure, such as better public transportation systems, as well as support for more sustainable and higher animal welfare production practices, including pasture-raised systems. Those investments will help ensure that GHGs are reduced and that energy is produced in a way that minimizes threats to public health, the environment, and farmed animals.

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