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Haiti, Biogas

Haiti: Approaching the Future with Biogas

In the country of Haiti and around the world, there is a great need for recycling waste and producing the renewable energy biogas. Haitians suffer from hunger, poor sanitation, deforestation, lack of energy resources, poverty, lack of housing, health issues, and the spread of diseases. The production of the renewable energy biogas can help improve conditions in Haiti not only through energy production, but also help with decreasing deforestation, managing and recycling waste products, decreasing contamination and pollution of soil and water, decreasing pathogens, and improving the overall health of Haitians. It is important to address the barriers to building anaerobic digesters, but also important to address the solutions to the barriers in moving forward to build anaerobic digesters so Haiti can begin reaping the multiple benefits of producing biogas.

Haiti is a country with environmental, poverty, hunger, housing, and energy issues. The country of Haiti covers an area of 10,714 square miles and covers one third of the island of Hispaniola (Gale). Haiti was once covered in forests now has only 4% forest land left (Gale). The depletion of forests has led to soil erosion, loss of topsoil, and increased the country's vulnerability to flooding due to eroded slopes and the inability to retain rainfall (Gale). Haiti is subject to extreme weather, including cyclones, droughts, hurricanes, and flooding (Gale). Haiti is the poorest country in the western hemisphere and is one of the poorest countries in the world (Shah). Haiti is the third hungriest country in the world after Somalia and Afghanistan (Shah). 80% of Haitians live in poverty (Shah). More than half of Haiti is under the age of 20 (Haiti Population 2018). There are 11.11 million people in Haiti (Haiti Population 2018). In Port-au-Prince the capital and the largest city of Haiti there is an estimated 65,000 people per square mile (Haiti Population 2018). On average country wide there is an estimated 907 people per square mile (Haiti Population 2018). Approximately 78% of people living in Haiti live on less than \$2.00 a day (Shah). Small-scale subsistence farming employs two-thirds of the workforce with 70% of Haitians depending on agriculture to make a living (Gale). There is a housing deficit of an estimated one million homes needed with a shortage of low cost housing in Haiti (Gale). The housing problem has been affected by natural disasters which have impacted available housing (Gale). Households on average have 5-6 people living in a two or three-room residence (Gale). Outside of major cities, housing in Haiti is primitive, mostly without sanitation and 40% of houses have dirt floors (Gale). The impact of the 2010 earthquake was devastating to Haiti (Shah). There were 222,570 deaths and 300,572 injuries sustained from the earthquake (Shah). It left 105,000 houses destroyed and 188,383 houses badly damaged (Shah). Approximately 2.3 million people left their homes, leaving 302,000 children displaced from the devastation (Shah). Only a quarter of the Haitian population has access to electricity (Ruiz). Half of these customers were obtaining electricity, illegally (Ruiz). The electricity that is available is inconsistent, weak, and not dependable forcing households and business to use diesel generators which are expensive, inefficient, and environmentally damaging (Ruiz).

Inadequate handling of waste and sanitation is affecting the Haitian population. The sanitation needs of Haiti are a pressing issue for the development of the country (Lansing). Haiti does not have a centralized sewage treatment system (Lansing). It is one of the many countries in the developing world that does not have adequate waste treatment, an inability to remove and dispose of septic sludge from decentralized systems, and has limited access to energy (Lansing). It is estimated 63% of the population does not have access to clean water or sanitary restrooms (Gale). The amount of urine and feces excreted daily varies individually from person to person depending on climate, water consumption, diet, and occupation, it is between 70 and 520 grams excreted daily (Lansing). Approximately 1,400-1,600 tons of municipal solid waste is produced every day in the city of Port-au-

Prince (Lucky). Approximately 65-75 percent of Haiti's municipal solid waste comes from food waste (Lucky). The organic matter in the food waste can be used to produce methane, which could be used to power generators or cooking fuel (Lucky). Bio-digesters not only improve sanitation, provide methane, but they also produce fertilizer (Lucky). The technology exists to convert urine and feces into safe fertilizer for agricultural purposes (Lansing).

Haiti is having serious problems with pollution and contamination that is affecting Haitians and their environment. When waste is inadequately managed, it can have a negative impact on health, water, soil, and air quality (Ruiz). The main source of energy used by Haitians is firewood and charcoal (Lansing). By relying primarily on charcoal and wood for their energy needs, has led to deforestation and soil erosion in Haiti leaving only 4% of the land forested (Lansing). Solid fuels, including wood, dung, coal, and agricultural residues are used by over three billion people worldwide for their energy needs (Bond). Only 10% of the Haitian population have electricity (Lansing). Charcoal and wood supply 70% of the energy in Haiti (Lansing). Families spend \$6-10 per week for cooking fuel expenses which is 25-50% of their daily income (Lansing). Cooking stoves and cooking with solid fuel over open fires is responsible for air pollution due to small particles and carbon monoxide emitted into the air and is also responsible for 2.7% of disease globally (Bond). Exposure to wood smoke causes serious health problems including pneumonia, cardiovascular disease, lung cancer, chronic obstructive pulmonary disease, acute respiratory infections and cataracts (Dohoo). The United Nations in September 2010 announced the initiative of the Global Alliance for Clean Cookstoves to deliver 100 million clean cookstoves by 2020 globally (Bond). By introducing clean cookstoves it helps to promote the use of biogas and domestic digesters (Bond).

The health of Haitians is being affected by water quality in Haiti. Water contamination in Haiti is a problem for the health of its citizens. The quality of water resources is deteriorating because of contamination from viruses, Escherichia coli, organic matter, micro-pollutants, and pathogens which are spread through drinking water (Lansing). The spread of disease from contaminated water has led to illnesses and deaths (Lansing). Half of all deaths are from malnutrition and gastrointestinal diseases (Gale). After the earthquake in 2010, Vibrio Cholerae spread throughout the country causing over 750,000 cases of cholera (Kirpich). The spread of Vibrio cholerae was increased by 40% of the Haiti population without access to clean drinking water and the increase in the Vibrio Cholerae in the environment (Kirpich). Financial support of \$500,000,000 has been raised internationally to use toward improving drinking water and the sanitation infrastructure in Haiti to work towards eliminating cholera transmission by 2023 (Kirpich). The biggest cause of child mortality and loss of working days is from the contamination of water, soil, and food combined with poor hygiene and the lack of handwashing with soap (Katukiza). One of the most effective ways to improve public health and save lives is to provide access to clean drinking water and safe sanitation. Aerobic digesters helps decrease Vibrio Cholerae, 99.1% of total coliforms, and 98.5% of E. coli which decreases pathogens in the soil and water which is a health benefit for Haitians (Lansing).

Haiti's energy resources need improvement. Haiti does not have any reserves of oil, natural gas, coal, or any oil refining capacities which forces Haiti to import all of their petroleum products and fossil fuels needed for energy (Gale). Haiti's electricity relies on the use of fossil fuels and hydropower to generate electricity (Gale). Developing waste-to-energy biogas plants can help achieve two of Haiti's greatest needs better sanitation and increased access to energy (Lucky).

Methane is an important source of energy. Methane emissions are a lost opportunity for energy (Katukiza). Methane is 21 times more powerful than carbon dioxide an important gas to be utilized

for energy (Lansing). Every year, there is 590-800 million tons of methane lost into the atmosphere through the natural biodegradation of organic matter (Bond). Landfills are the third largest source of methane emissions (Anyaku). The organic fraction of municipal solid waste can be processed through anaerobic digestion and converted to biogas and nitrogen rich compost for fertilizer (Anyaku). Methane has a higher greenhouse effect than carbon dioxide (Barzegaravval). The emission of greenhouse gases into the atmosphere is leading to temperature and climate changes globally (Barzegaravval). The production of Biogas is a way to reduce global warming and produce a safe, clean, and renewable form of energy (Barzegaravval). Biogas technology could decrease methane emissions to 4% (Bond).

Biogas is a renewable energy resource. It is a multipurpose energy source (Burg). Biogas is one of the most energy efficient and environmentally friendly gases (Dohoo). The purpose of biogas is to use domestic resources to produce renewable energy while decreasing destruction to the environment from agricultural, industrial, and household wastes (Skovsgaard). There are advantages to using biogas technology (Bond). Biogas can be transformed into heat, electricity, and fuel (Burg). Developed and developing countries can benefit from using biogas (Burg). Although waste has negative impacts on the environment, it is also a renewable resource capable of helping preserve natural resources by generating energy and helping produce new products (Ruiz). Biogas is made through the anaerobic digestion of fermentable biomass residues (Ruiz). Biogas can be made from a variety of different organic wastes, including animal manure, human excreta, kitchen waste, garden waste, agricultural waste, slaughterhouses, and food industry waste (Bluemling). Some countries use energy crops like barley, lucerne, sunflowers, sorghum, and barley to assist with biogas production (Bluemling). Organic waste used for biogas production can be solids, slurries, concentrated and diluted liquids, and it can even be left over organic material from ethanol and biodiesel production (Feedstocks for Biogas Production). Human excreta has a high nutrient and energy content (Lansing). Biogas is made up of approximately 50-70% methane and 30-50% carbon dioxide and small amounts of hydrogen sulphide and other gases (Bond). Every year, there are 590-800 million tons of methane lost into the atmosphere through the natural biodegradation of organic matter (Bond). By decomposing various types of waste using these biochemical processes a biogas recovery system can produce and capture biogas to be used for energy (Bond). Biogas burns a clean blue flame and can be used in developing countries for cookers/stoves, lamps, refrigerators, and engines (Bond). It is different from other sources of energy like wind, hydropower and solar power where energy is taken directly from the source (Bluemling). Biogas energy is not obtained directly from waste, but it's a product after the waste has gone through the biodigester (Bluemling). Biogas production emphasis has changed from being solely devoted to the production of energy to also include waste management, producing nutrient filled fertilizer, and greenhouse gas reduction (Skovsgaard).

In order to produce biogas, Haiti is in need of low-cost anaerobic digestion facilities for communities to benefit from their waste. There are different types of biogas reactors, but developing countries, mostly use simple reactors that do not have the ability to stir or heat (Bond). They are designed for the digestion of livestock and human waste (Bond). The Taiwanese-model digester can be completely installed for \$300 and has an estimated life of ten years (Lansing). It creates high quality biogas, usable fertilizer, and reduces organic matter (Lansing). As long as there is a way to collect the biogas, a pit in the ground can also be used as a digester (Bond). When biogas reactors use locally available waste products it will decrease or eliminate the transportation costs necessary for biogas production (Ruiz). Haiti can learn from other developing countries such as Colombia, Ethiopia, Tanzania, Vietnam, Cambodia, China, Costa Rica, Bolivia, Perú, Ecuador, Argentina, Chile, and Mexico on how they have successfully implemented low-cost anaerobic digesters in their country (Marti-Herrero). Facilities would provide Haitians renewable energy through the production of methane enriched

biogas, treatment of wastewater to create nutrient rich fertilizer that has a reduction in pathogens by 99%, and providing financial incentives for the collection and treatment of human waste (Lansing). Biogas reactors have two main functions one is to manage waste materials and the other is power generation (Ruiz). Fertilizer can be produced and used on the land by the digestate generated from the biogas plant and eliminate the need for commercial fertilizers (Ruiz). There are benefits to using slurry and composted manure after the digestion phase (Bluemling). They can safely be used to improve soil conditions as fertilizer and irrigation water which will increase crop production, prevent soil erosion, decrease the use of pesticides, and save families money by decreasing the use of chemical fertilizers (Bluemling). Haitians widely use agricultural chemicals, DDT, and oil with high lead content which are causing soil and water pollution (Gale). Anaerobic digestion provides improved fertilizer quality, decreased odors, and limits pathogens from waste (Burg). Due to the positive benefits of waste it should be regarded as a crucial resource used to provide renewable energy, soil fertilization, and a way to reduce greenhouse gas emissions (Burg). Manure has an increased alkalinity due to its high-fat content which makes it a desirable source to be used for a co-digestible anaerobic reactor (Lansing). Co-digestion is a process where multiple waste sources can be treated in the same anaerobic biodigester (Lansing). Studies have been done to test methane production from the co-digestion of mixing manure with other organic material (Lansing). In one study, diluted poultry manure was mixed with olive mill wastewaters which showed an increase in methane production by 150% without adding any additional chemicals (Lansing). Several factors determine the type of anaerobic digester needed including, cost, size, type of waste, location, and availability of organic waste resources (Lansing).

There are several barriers to the production of biogas in developing countries like Haiti. One of the biggest barriers is the cost (Lucky). Digesters costs vary from 100 to around 2000 dollars (Orskov). People do not have the financial resources for construction costs to build bio-digesters for biogas production (Lucky). There is also the cost of a storage facility for storing the municipal solid waste and gas (Lucky). Cultural beliefs also need to be acknowledged as some people do not want to use waste for energy (Lucky).

There are ways to make anaerobic digesters more affordable and acceptable for Haitians. One of the ways to make digesters available is by lowering production costs (Lucky). Building low-cost non-mechanized anaerobic digesters that do not require heating or stirring and are a more affordable option for Haitians to make (Lucky). Another way to keep costs down is to implement systems which provide additional income, such as renewable energy, water, and recyclable materials (Katukiza). Another solution is an internet-based approach where many people donate small amounts of money for a project where the pledged sum cost is small for each donor (Orskov). A community fund can also be established to build a digester (Orskov). Subsidies, foreign aid, and income from fertilizer and gas production can also help pay for the production of a digester (Burg). Education and training is an important piece for people regarding anaerobic digesters and their potentials for use (Burg). Providing the benefits of producing biogas for their health, energy production, and sanitation will assist Haitians in implementing the production of aerobic digesters for biogas (Burg). A way to increase biogas demand is to reduce the cost of operations and to make it more affordable to use than fossil fuels (Anyaku).

There are many issues that face the country of Haiti that have a direct impact on Haitian health and the environment they live. There is a link between poorly managed waste, contamination, pollution,

and the spread of disease and illness. Limited energy resources are having an impact on the country of Haiti. There are ways Haiti can use methane to their benefit. The production of biogas can have positive effects on Haiti and Haitians quality of life. Anaerobic digesters are necessary for producing biogas. There are barriers that need to be addressed by building anaerobic digesters in Haiti. Solutions are available to assist in building anaerobic digesters and promote the use of renewable energy and biogas production to make biogas a reality for Haiti

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