THESIS PROJECT PORTFOLIO

Corn Bioethanol Production Facility Design

(Technical Report)

The Corn Industrial Complex

(STS Research Paper)

An Undergraduate Thesis

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Ethanol is mandated in the United States to be blended with gasoline, and as such, over 14 billion gallons are needed each year. This massive demand for ethanol places a strain on the corn producers and the approximately 200 ethanol plants currently in production. The ethanol industry is valued at $100 billion dollars, and this market is mainly supported by the federal government. The clean energy subsidies that incentivize the production of ethanol allow for the industry to remain profitable, though if these price floors and mandates were removed, the industry would severely decline. Since 2005, the United States ethanol industry has existed mainly off corn as the raw material, and because of this, approximately a third of all corn grown is sent to ethanol facilities. These facilities require a massive amount of corn to produce a massive amount of ethanol, and the scope and logistics is explored through my thesis. To address this issue, my technical project will address the design and operation of a 150-million-gallon ethanol facility. The plant will produce fuel grade ethanol, and feed-grade dried distillers' grains and solubles, DDGS. The STS research paper will explore the interconnection between corn demand and subsidies on the American health crisis, food prices, and the environment. The technical focuses on the actual logistics of building, designing, and running a corn to ethanol production facility, while the STS project explores the interconnection between corn subsidies and a complex web of actors.

The technical project tackled the design and operation of a 150-million-gallon corn to ethanol production facility, with a secondary product of salable DDGS. A combination of literature research, industry consultation and computer simulation were used to design the plant. The overall plant design required research into raw material sourcing, equipment pricing, and utility estimates. The results were a full ethanol plant design estimate, with the overall plant cost estimated at $338 million. The estimated yearly revenue of the ethanol plant is $471 million

dollars, with the expenses estimated at $340 million a year. The major cost stems from the cost of corn needed to run the facility, as well as the utilities needed to process the corn into ethanol. Overall, the plant was found to be profitable using current market conditions, but advised to not pursue as the price of ethanol is at an all time high and will most likely correct. The plant design and operation planning were a success, with each major plant component examined and decided. The overall plant design would be profitable using current market conditions, and market demand for ethanol production could be met.

The STS research paper will explore the connection between corn subsidies, the American health crisis, food prices, and the environment. The farm bill established corn subsidies in the 1930s, and in the 1970s the creation of high fructose corn syrup led to a rise in obesity and diabetes. This spike was eventually curtailed by price competition for ethanol plants. The corn became too expensive to use as a sugar substitute, as all the surplus corn was being used to make ethanol. This caused the obesity trend to reverse, which it has done since 2005, when blending was mandated. The impact of corn subsidies on the American consumer were examined through the lens of commodity price increases as well, where the average price of meats and other animal derived products has increased in correlation with ethanol fuel demands. As the price of corn rises, with a competition for supply caused by ethanol blending, the price for animal feed, which is derived from corn, increases as well. This causes the price of poultry, beef, and pork to increase, as well as other animal derived food items. The subsidization of corn led to its proliferation in the United States, and as such an increased competition for limited corn supplies. This large demand for corn has led to negative environmental impacts, to which farmers are not economically incentivized to respond, as the volatile nature of corn subsidies doesn't guarantee future farm profits. Because of this volatile nature, where farmers don't know

the value of next years crop, only this one, they are incentivized to maximize yields by any means. This has proven detrimental to the environment in a number of ways, including an estimated 4,300 premature deaths per year.

The technical and STS research papers were both successful in reaching their prescribed roles. The technical paper fully encompassed a corn-to-ethanol production facility, and the work required to provide these designs was instrumental in furthering my education. In addition, the STS research paper allowed me to dive further into the world of socio-technical impacts, and explore correlations that I had not thought of previously. Overall, both papers were effective in their goals, the technical in describing a chemical plant design and operation, and the STS research in proving a link between my technical and society. To take these two projects further would be to examine the technical project through the frame of environmentalism and exploring how to neutralize the impact of the plant. Though the plant cannot redistribute corn or its waste, there are ways that the products could be recycled or processed in a manner that could alleviate other identified impacts.