THE PENNSYLVANIA STATE UNIVERSITY
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STUDENTS' CORN ETHANOL PERCEPTIONS

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ABSTRACT

Due to increased energy demands from the growing population, ethanol as a fuel source has gained popularity over time. Currently, in the United States, E10 (less than 10% ethanol) is the mainstream option at the pump, and there are two higher ethanol fuel blends commonly available at the pump: E15 (between 10.5%-15% ethanol) and E85 (51%-83% ethanol). This study sought to better understand the existing knowledge and perceptions of college students on corn ethanol as a fuel source. A census sample of predominately undergraduate students in the College of Agricultural Sciences (CAS) at Penn State University was surveyed via Survey Monkey. The survey was administered through a newsletter to all students in the CAS (n=1200), and an estimated adjusted response rate was found to be 34 percent (n=204). Some key findings are that price and location are the two most important criterion for customers to consider when choosing a fuel retailer. In terms of a variety of ethanol issues, the three statements that study participants felt most strongly about were that using ethanol decreased US dependency on foreign oil, benefits rural economies, and has an effect on food prices. Finally, price sensitivity of E15 was analyzed when E15 was priced both above and below parity. Interestingly, approximately 87-90 percent of recipients “may” or “would” purchase E15 when priced below parity, disagreeing slightly with the findings of Sheetz (2017). Ultimately this study represents exploratory research about a sample of educated millennial undergraduates at a major US land grant university located outside of the Corn Belt. Although the sample limits the ability to make inferences to a larger population, it is useful to better understand the perceptions and opinions of a sample of educated millennial undergraduates, which could be interesting to fuel retailers and ethanol producers, among others.

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Chapter 1 :

Literature Review

Introduction: History and Production

What is Ethanol?

Ethanol is an alcohol that can be used for a variety of purposes including recreational consumption, antiseptic or disinfectant, solvent, and fuel. Ethanol is a flammable, volatile, colorless liquid and it is created by fermentation and distillation of crops with high starches or sugars (Lerner and Lerner 2008). Ethanol can be produced from many different feedstocks including, sugarcane, bagasse, miscanthus, sugar beet, switchgrass, barley, hemp, sunflower, cellulose waste, corn, corn stover, and a variety of other crops and materials. The focus of this paper is predominately on corn ethanol used for liquid fuel.

History of Ethanol

The earliest use of ethanol was as a lighting fuel in the mid-1800s until the Civil War, which prompted a need to place a liquor tax on ethanol, making it too expensive to use as a fuel. This caused a dip in production that did not begin to recover until the tax was lifted in 1906 (EIA 2017). Leading into the first days of ethanol's availability for consumer vehicles in the Henry Ford, Model T era. Ford designed his vehicles with the belief that farmers one day may want to produce their own ethanol from crop waste. However, due to an increase in oil production,

companies like J.D. Rockefeller's Standard Oil Trust gasoline became more price competitive, making gasoline the norm. The use of gasoline as the predominant consumer fuel continued throughout the prohibition era because of the ban on ethanol of any kind (Bridgeman 2011). An increase in ethanol production occurred again during WWII due to fuel shortages. However, the ethanol industry as we know it today began in the 1970's (Gutafson n.d.). The increase in ethanol since the 1970's was promoted and encouraged due, in part, to tax benefits and environmental regulations (EIA 2017).

In more recent years, the Energy Policy Act of 2005 set a mandate requiring renewable fuel in various biofuel categories (advanced, biomass diesel, and cellulosic and waste-based). Then, the Energy Independence and Security Act of 2007 increased the mandate to 36 billion gallons of renewable fuel by 2022 (Public Law 110-140). Due to favorable policies and the introduction of Flex Fuel Vehicles that are capable of running with higher ethanol fuel blends, the fuel selection for consumers has grown to allow more choices at the retail pump.

Production of Corn Ethanol

There are two types of starch-based ethanol production that are used domestically; they differ mostly in how they are pretreated (RFA 2017). The first, dry mills, accounted for around 90 percent of ethanol production in 2017 (DOE 2017). This is because they are favored due to lower capital costs (DOE 2017). In the dry mill process (Fig. 1), corn is first separated from husks and ground into flour, then heated with water and enzymes to produce a cornstarch liquid. Next, a second enzyme, often amylase, is used to break the starch into glucose, followed by the addition of yeast to metabolize and ferment the sugars into ethanol and carbon dioxide. When the alcohol reaches approximately 15 percent, the ethanol becomes toxic to the yeast and it dies. The

alcohol is then separated by a process, which involves boiling off the water leaving the co-products of carbon dioxide and distiller's grains. The products (carbon dioxide, ethanol and distiller's grain) are then treated as needed and sent to market. It is important to note that although dry milling is less capital intensive, it yields less ethanol per bushel (Rajagopalann et al. 2005).

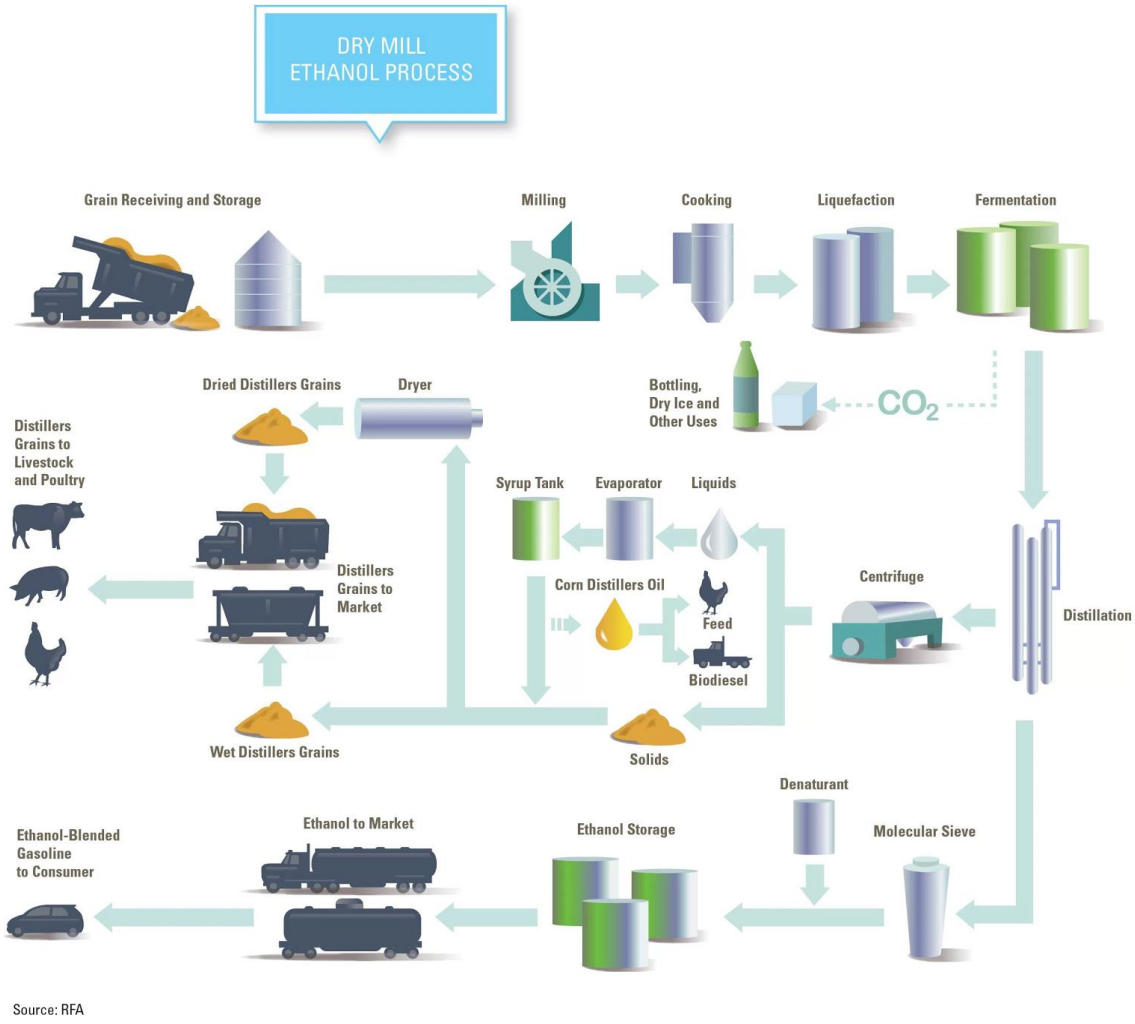

Figure 1. Diagram showing the dry milling process of ethanol and co products (RFA 2017)

The less common technique (Fig. 2) is wet mill corn ethanol production. In wet mill production, the corn must steep for up to 48 hours in order aid in separating the corn kernel components. In the processing of this mixture, the corn gluten and fiber are used for animal feed and the starch is enzymatically broken down and fermented to become ethanol, corn starch, and corn syrup (DOE 2017, RFA 2017).

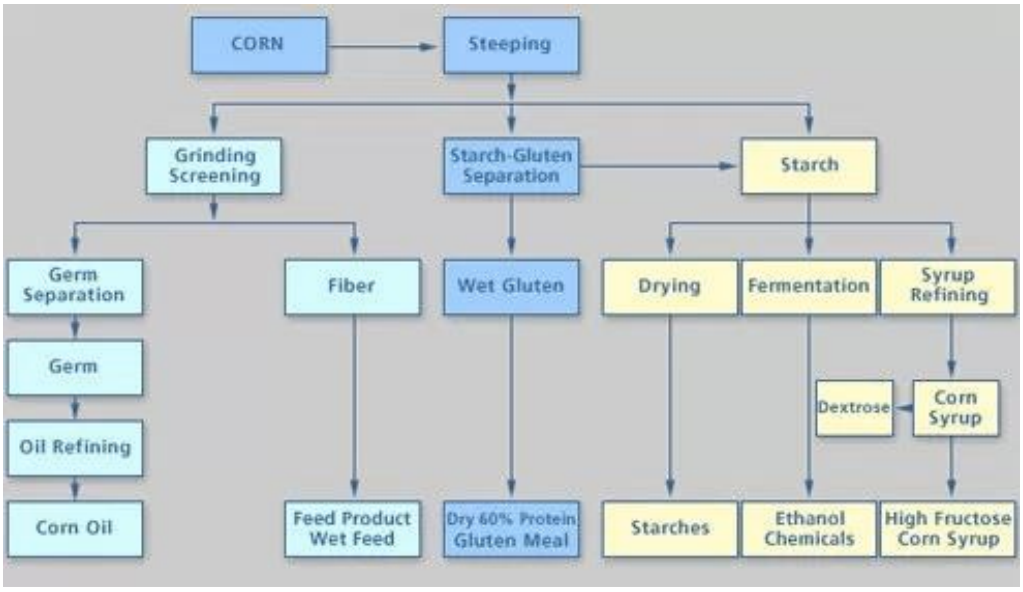

Figure 2. Diagram showing the wet milling process of ethanol and co products (RFA 2017)

Currently, domestic ethanol production is concentrated in the Midwest due to the proximity of feedstock, as seen in Figure 3 (NREL 2012). However, once the ethanol is produced, around 90 percent is sent via truck or train to the population-dense east and west coast regions of the United States (DOE 2017). Distribution can remain a challenge because ethanol is not able to go into pipelines because it mixes readily with water, which would cause consumer problems if it were not removed before arrival. Issues also exist with the corrosion problems that ethanol causes to pipelines, pumps, valves, and engines (Lerner and Lerner 2008).

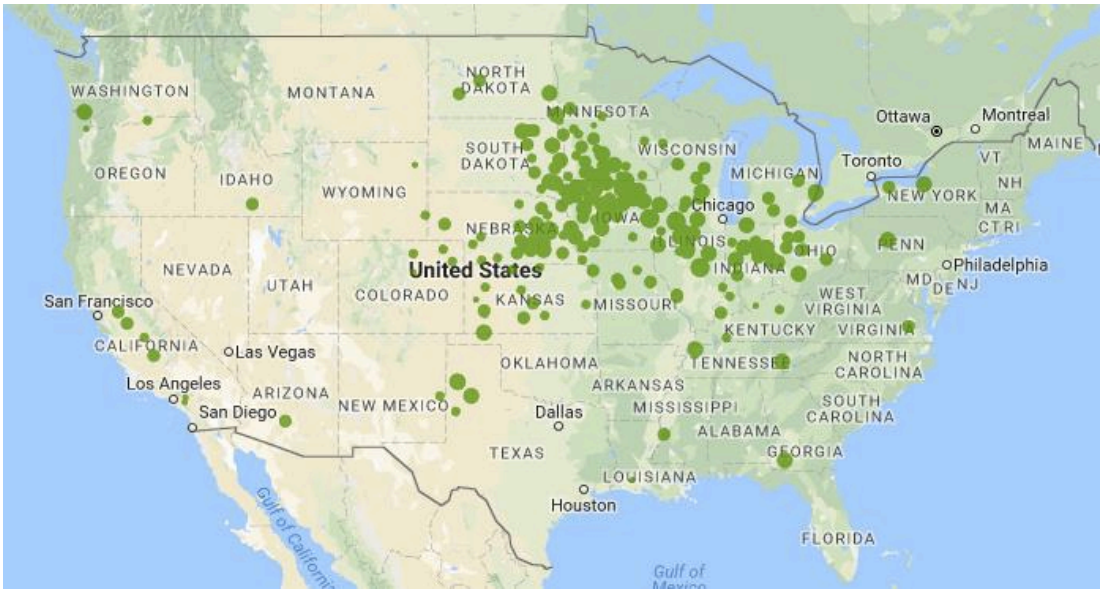

Figure 3. Map of the US showing location of ethanol production facilities (NREL 2012)

Corn has been a preferred feedstock for production of ethanol in the U.S. due to subsidies, abundance, and ease in its conversion to alcohol. Additionally, ethanol has gained government support by mitigating national security issues due to reduced oil dependency (Deutch et al. 2006), the potential to combat rising energy prices, providing economic support to poor farmers, offering economic stimulus to rural communities (Msangi et al. 2007), and improving air quality by decreasing carbon emissions (Balat and Balat 2009). Despite the positives ethanol provides, there is still consumer opposition because of perceptions of a food vs. fuel scenario (Runge and Senauer 2007), land use changes which can lead to greenhouse gas (GHG) emissions, and excessive water use during production (Pimentel and Pimentel 2008).

Existing Consumption

Currently, it is estimated that 143.4 billion gallons of finished motor gasoline consumed in the US contained about 14.4 billion gallons of ethanol in 2016, which is slightly less than 10 percent of the total volume of finished gasoline available for motor consumption (EIA 2017). As for specific ethanol blends, some amounts of E0 (ethanol free gasoline) are available, estimates suggest it is less than 7.6 billion gallons, as of 2015 (EIA 2017), but E10 (up to 10% ethanol) is the most common type of gasoline purchased in the US. E10 (up to 10% ethanol) refers to regular (87), plus (89), and premium (92) varieties. Some fuel retailers also offer consumers higher ethanol fuel blend options like E15 (between 10.5%-15% ethanol) and E85 (51%-83% ethanol). In all blends, the non-ethanol portions are traditional petroleum-based gasoline.

Higher Ethanol Fuel Blends (HEFB)

In the United States, the two higher ethanol fuel blends commonly available at the pump are E15 and E85. These two fuel blends are used for many reasons, including as a way to satisfy the Renewable Fuel Standard and the Energy Policy Act. E15 (10.5%-15% ethanol and the remainder gasoline) is a relatively low-level blend that is approved to be used in motor vehicle models later than 2001 and newer light-duty conventional vehicles. Misfueling, meaning that the wrong fuel is used in a vehicle, is a concern associated with E15. As a result, several EPA requirements exist for E15 retailers notably, E15 does not qualify as a renewable fuel under the Energy Policy Act, but it does satisfy the RFS. Conversely, E85 (51-83% ethanol and the remainder gasoline) is a high-level ethanol fuel blend, often known as a Flex Fuel, and is only suitable for use in Flex Fuel Vehicles (FFV). FFV are designed by manufacturers and have an

internal combustion engine that is designed to be able to run on gasoline or any ethanol blend lower than 83 percent ethanol, including E85. Although it is dependent on the geography and season, E85 often qualifies as an alternative fuel under the Energy Policy Act, therefore also satisfying the RFS. However, E85 is not designed for conventional gasoline-powered vehicles due to higher octane, thus it is illegal to be advertised to do so (EIA 2017).

Current State of Corn Ethanol

Ethanol Perceptions

Both historically and today, many consumers are not aware of the capacity of ethanol in current fuel markets and attitudes remain a key player in the consumer choice toward higher ethanol fuel blends (E15 and E85) (Sheetz 2017 and Ulmer et al. 2003). Ulmer et al. (2003), conducted a study gauging Oklahoma consumers' perceptions of corn ethanol to establish baseline data regarding corn-ethanol knowledge and awareness. At that time, ethanol fuel blends were not yet available in Oklahoma but fuel blends were gaining in popularity in other places throughout the Corn Belt. The mail survey of a sample of 685 registered voters in Oklahoma was conducted to address the negative history of ethanol in Oklahoma, and the perceptions, knowledge and key factors to the reintroduction of ethanol as a fuel source. Major findings suggested that cost is more important to consumers than environmental benefits, but many see how increased ethanol could be a positive thing for the state of Oklahoma. Respondents also believed that the greatest benefit to the increased use of ethanol-blended gasoline would be the reduction in foreign oil imports (Ulmer et al. 2003).

More recently, Aguilar et al. (2015) verified the findings of Ulmer et al. (2003) in a mail survey of 102 respondents from the Missouri Department of Motor Vehicles office. The survey investigated the general attitude of alternative fuels, fuel technology, and willingness to pay related to corn ethanol. Additionally, the study considered other aspects of consumer choice, particularly related to higher ethanol fuel blends. The findings indicated that the majority of Americans favored the use of ethanol, mostly due to lower cost. However, approximately 20 percent had a strong unwillingness to buy ethanol fuel blends (Aguilar et al. 2015). Furthermore, U.S. consumers lacked complete awareness of higher ethanol fuel blend availability, and for the case of higher ethanol fuel blend selection, the driving factors for consumer choice were the price per gallon and miles per gallon. Currently, there is a dearth of peer-reviewed literature examining consumer awareness for higher ethanol fuel blends (HEFB) or the identification of the drivers and barriers associated with greater HEFB implementation. However, Sheetz, an American convenience store chain, conducted an internal study in 2017 of their loyalty-program customers to determine their perceptions of, and the drivers and barriers to purchasing E15 (Sheetz 2017). This thesis aims to begin to answer some of these questions.

In Sheetz's study (2017) of loyalty card members who had purchased E15 or E85 in the past, a key finding was that there is limited consumer knowledge about ethanol availability. This is demonstrated by the 57 percent of study respondents who were either uncertain of, or believed, that they had never purchased E15, despite being a sample selected for this reason. Additionally, 83 percent of customers stated that they know "a little about E15" or "nothing at all about E15". Aside from findings related to the tremendous lack of knowledge about HEFB, the Sheetz study concluded that cost is the most important factor for customers in automotive fuel selection. However, the confusion that exists about the safety of E15 for use in a consumer's vehicle is also

problematic. Due to the newness of E15, it has not gained very much market share, thus regular unleaded (87) remains to be the fuel that is most commonly suggested by a manufacturer and most commonly used in cars.

To consider ethanol-blended fuels on a global scale, Pacini and Silveira (2011) investigated the effect of the presence of HEFB in Brazil and Sweden. The study focused on the change in consumer choice related to ethanol and gasoline. This was studied through the examination of data related to prices and demand data for both countries. Brazil and Sweden were selected due to the established distribution network and the numbers of adoptions of flex fuel vehicles (FFV), which gained popularity globally after they were introduced in 2003. From an international perspective, it is found that FFV has enabled competition between ethanol and gasoline markets. Like the US, it is also found that consumers make fuel selection choices mostly on prices. However, consumers from Sweden appear to be more sensitive to price than Brazilians. This is believed to be the case because of the fact that bioethanol is generally the most cost-efficient fuel (Pacini & Silveira 2011).

Arguments for and Against Ethanol

Many people have strong opinions associated with ethanol, both pro-ethanol and against it. Some of the key arguments against ethanol in gasoline are outlined below:

Reduction in Fuel Energy

Ethanol does not have the same energy content (lower gas miles per gallon (mpg)) as gasoline, the typical comparison in the consumer automotive industry. Ethanol has

approximately 30 percent less energy (per unit volume) than pure gasoline. This means that a gasoline blend containing 10 percent ethanol, which is standard today, will have around 97% efficiency in comparison to pure gasoline (EIA 2007; Nersesian 2016). For E15 there can be between a 3 to 4.5 percent energy content reduction, and for E85 the energy content lost is between 15 and 25 percent.

Contamination, Engine Damage, Water Content and Corrosion

Unlike gasoline, ethanol is water soluble, meaning that it has issues with fungibility in pipelines and inside of car engines. Due to its solubility, ethanol is capable of picking up contaminants that gasoline does not, therefore creating a risk that those contaminants would be deposited inside the engine of the automobile or other fuel-powered devices. Additionally, fungibility makes ethanol not suitable for pipelining, therefore increasing transportation costs. This is because when ethanol comes in contact with water, it is capable of "picking up" both remaining excess water and other contaminants that may be left inside the pipeline. When the ethanol is completely mixed with water it simply lowers fuel efficiency; however, when ethanol, or gasoline blended with ethanol, is combined with water, it is capable of allowing the water or contaminants to deposit in the engine, thus creating future problems (Nersesian 2016). This phase separation is particularly problematic if fuel is left in an engine for an extended period of time or subject to dramatic temperature changes (RFA 2016). These issues are most commonly seen in rarely or seasonally used engines, such as lawnmowers or chainsaws. Ethanol is also a corrosive substance that is capable of causing shrinking and swelling in machinery, particularly

if it is older and weaker. Thus ethanol can cause machinery to be problematic and lead to leaks (Lerner and Lerner 2008).

Increased Competition for Crops and Feedstock Pricing

Currently, 40 percent of the corn crop in America is used for the production of corn ethanol and its co-products. Although there is a debate about whether or not this land is really being taken from food, corn use in the ethanol industry is something that is controversial. The food vs. fuel debate exists because the increased demand for corn can lead to increased food prices (Harrison 2009). When people think of corn they are typically thinking of sweet corn, the kind you can buy on the cob, frozen, or in a can. However, this is one of the least popular types of corn grown in the US. It is believed that for every acre of sweet corn grown, there are 260 acres of field corn grown. The field corn is then used for ethanol production (around 40%) and animal feed (Nersesian 2016).

Additionally, Rathman et al (2010) found in their review article that although agro-energy, including corn ethanol, has altered the land use dynamic, it has not done so significantly. They also found that in the short run there was a slight increase in food prices, but it is likely not the only factor determining this trend nor should this trend continue in the long run. Ajanovic (2011) validates this finding stating that since there is no significant impact on feedstock prices related to the production of biofuels. Additionally, Ajanovic (2011) suggests that co-existence of biofuel and food production is possible, particularly for second-generation biofuels, such as corn stover.

Limited Availability for Higher Ethanol Fuel Blends

At this time there are regulations capping the percentage of ethanol available in regular (87) commercial gasoline at 10 percent (Qui et al. 2014), yet ethanol has the capability of existing at higher blend ratios. This can be seen directly in E85 (a gasoline equivalent fuel that is 51%-83% ethanol and the remainder gasoline), which is commercially available to consumers and sold as a "flex fuel" (Alternative Fuels Data Center: E85: An Alternative Fuel n.d.). Due to the current 10 percent blend cap, or the "blend wall", among other issues, the industry will fall short of the renewable fuels mandates outlined by the EPA. However, in 2010 the EPA released a partial waiver allowing E15 to be sold in attempts to begin to combat the "blend wall" problem (Alternative Fuels Data Center: E85: An Alternative Fuel n.d.). Despite the policy change, E15 is being sold in very few locations due to issues with liability, compliance, lack of product demand, and upgrade costs (NACS 2013).

Sustainability

There are conflicting opinions related to the argument about whether or not biofuels are more sustainable. Some believe that biofuels, including corn ethanol, could be the solution to combatting issues associated with climate change. Research supporting corn ethanol from Farrell et al. (2006) found that current corn ethanol technologies are much less petroleum-intensive than gasoline, but may have similar greenhouse gas emissions. Additionally, poor understanding of corn ethanol technology remains problematic. This poor understanding could largely be attributed to lack of specific metrics or flaws in life cycle analysis. Similarly, some research has found the implementation of biofuels to be a strategy to begin to mitigate climate change for the

next 50 years utilizing already existing technology (Pacala and Sokolow 2004). However, in the most simple sense, it is argued to be renewable because corn and other ethanol producing crops can be grown each year and gasoline cannot ("Ethanol" n.d.).

Conversely, other research suggests that biofuels may negate climate change. For example, Crutzen et al. (2008) find that the N_2O release from biofuel production overrides the positive effects of replacing fossil fuels. There is also some question that based on life cycle analysis it could be better to save and restore forest instead of using the land for agriculture to grow ethanol feedstock (Hill et al. 2006). However, this issue is more prevalent for regions of the world that have converted tropical forest to agricultural land (Righelato and Spracklen 2007).

US Oil Dependence

The use of ethanol in fuel, particularly HEFB, has made some impact in the demand for oil, although this impact has been pretty small. However in the 2000's when prices for oil rose from around $26 per barrel in 2001 to over $130 per barrel in 2008 the demand for alternative fuels increased. Domestically, the alternative fuel that was focused on most predominately was corn ethanol due to the existing facilities and infrastructure ("Ethanol" n.d.). Additionally, in 2015, there was an eight percent reduction in the amount of petroleum that was used domestically because of the increased production and consumption of ethanol. This major reduction stems from the fact that approximately three-fourths of domestic petroleum consumption is attributed to transportation fuels, which now are being blended with ethanol. Some of the other major reasons for increasing ethanol was to lessen the effect of the international supply disruptions, diversify US transportation fleet, benefit the nation's energy

security, and support the US economy ("Alternative Fuels Data Center: Ethanol Benefits and Considerations," n.d.).

Rural Economic Development

Ethanol can be a tool to help benefit the rural farm economy in the United States. It is estimated that in 2015 ethanol production led to nearly 86,000 direct jobs across the country and 330,000 indirect jobs—often in rural areas where there is a greater need for employment opportunities ("Alternative Fuels Data Center: Ethanol Benefits and Considerations," n.d. and "Ethanol" n.d.). Ethanol production can also serve as an additional market to help balance commodity prices, which benefits thousands of farmers annually (Ethanol" n.d.). In addition to this, there has been a policy that has helped to promote domestic production of ethanol. This can be seen primarily with the American Job Creation Act of 2004, which provided a tax credit to gasoline blenders. Finally, an import tax was placed on all ethanol imported for fuel.

Octane

Octane has become important to fuel because of the development of engines that have higher compression and improved breathing, thus increasing power. This then can lead to detonation of combustion knock during higher temperatures. However, using fuel with a higher-octane content can eliminate this problem. Up until the mid 1990's lead was used in gasoline to do this, but in 1995 the federal government mandated the use of a new substance to start to reduce the smog in cities. As a result methyl tert-butyl ether (MTBE) was used in higher quantities, although it had been present to some degree since 1979. Overtime, though, MTBE

was phased out because it was found to be a groundwater pollutant and was completely phased out in 2006. This led ethanol refineries to switch to ethanol as a gasoline additive, and therefore increasing the demand of ethanol ("Gasoline | Methyl Tertiary Butyl Ether (MTBE) | US EPA" n.d.).

In order to put these substances in perspective to understand their octane the Anti-Knock Index (AKI) is used. This system was developed in the 1920s by Russell Maker to provide an octane rating system for fuels ("Fuel Ethanol" n.d.). This number is known to be a fuel's ability to resist engine knock. The aforementioned fuels and additives have AKI of 110 for MTBE, 87 for domestically produced normal unleaded gasoline, 100 for pure ethanol and 112 for blends of gasoline and ethanol (Demirbaş et al. 2015).

Current Ethanol Pricing

A current analysis was conducted using existing price data to compare costs between higher ethanol blend fuels (HEBF), such as E85 and E15 to Regular (87) gasoline. Table 1 below depicts this information. The top region of the table is showing the differences in price in terms of percent change, the middle region is the price changes per gallon by dollars, and the bottom is the prices that were used when these calculations were made.

Table 1. Price information calculations comparing differences between E85 and E15 to Regular gasoline.

Type/Location	Smithfield, NC	Powhatan, VA	Milton, WV	Bethel Park, PA	State College, PA	Roxboro, NC	Lancaster, PA
% Change in Price vs. Regular							
E85* (83% ETOH)	7.36%	7.61%	-7.29%	10.35%	10.03%	8.02%	3.33%
E85* (51% ETOH)	-2.84%	-2.59%	-17.49%	0.15%	-0.17%	-2.18%	-6.87%
E15* (15% ETOH)	2.31%	1.70%	2.35%	2.68%	2.64%	2.39%	-3.34%
E15* (10.5% ETOH)	0.96%	0.35%	1.00%	1.33%	1.29%	1.04%	-4.69%
Price/gallon vs. Regular							
E85* (83% ETOH)	$0.14	$0.13	$(0.12)	$0.24	$0.23	$0.16	$0.07
E85* (51% ETOH)	$(0.04)	$(0.04)	$(0.27)	$0.02	$0.01	$(0.03)	$(0.13)
E15* (15% ETOH)	$0.05	$0.04	$0.05	$0.07	$0.07	$0.06	$(0.08)
E15* (10.5% ETOH)	$0.02	$0.01	$0.02	$0.04	$0.03	$0.02	$(0.11)
Prices							
Regular	$2.28	$2.14	$2.33	$2.75	$2.69	$2.37	$2.55
E85	$1.88	$1.77	$1.58	$2.35	$2.29	$1.97	$2.00
E15	$2.23	$2.08	$2.28	$2.70	$2.64	$2.32	$2.35

The calculations for table 1 were done by determining the percent of fuel loss as a result of the 30 percent decrease in fuel content in ethanol vs. gasoline. For E85 and E15 there is a calculation done with the high and low ends of the potential blends 83 percent and 51 percent respectively. The E15 data uses the high and low potential blends as 15 percent and 10.5 percent, respectively (Alternative Fuels Data Center: E85: An Alternative Fuel," n.d.). The blend percent can be seen next to the type of gas on the left of the table. Then the price change between ethanol and regular gasoline was calculated. After this, the percent change in price comparing E85 and E15 was found. Then this value was added to the ethanol fuel loss to get the amount more expensive that is listed in the top region of this table. This was also converted to change in price per gallon by taking the middle region of the table and multiplying it by the prices, seen in the

bottom region of the table. All pricing information came from Sheetz website as of 8:00 pm on 10/16/2017 (“Sheetz Online Ordering,” n.d.).

Chapter 2 :

Methods

Population

The population of this study was the approximately 1200 students in the College of Agricultural Sciences who receive the Ag Sci Student News listserv email. In this newsletter, efforts were made to have the survey as close to the top as possible to increase the number of people who saw the entry. However, it was listed fourth and seventh on the initial and follow up entries, respectively (Appendix A). Finally, there are difficulties in identifying specific population due to lack of data collected by the CAS and the nature of a listserv—meaning that it can be forwarded to people outside of the original recipients.

Sampling

A census sample of students in the College of Agricultural Sciences (CAS) was obtained via an online SurveyMonkey® survey during February 2018. This survey was administered twice to the CAS AgSci Student News. The first time was on February 12, 2018, and then the last chance follow up was sent a week later on February 19, 2018, a strategy suggested by Dillman (2000). The newsletter works by listing each of the items in the issue by their title at the top, then below is a hyperlink of the title with a brief description, if the link or "more" option is selected, the student will be taken to an archived CAS webpage where the survey letter and link

is provided (Appendix A). Once the link is selected the student will be taken to Survey Monkey where they can begin the survey (Appendix B).

Response Rate

Since we cannot know what percent of recipients read this announcement in the newsletter, we are unable to calculate a true response rate. However, we do know the listserv included approximately 1200 students, and of that number 212 opened the embedded SurveyMonkey® link in the newsletter, and of those 212, 96 percent (n=204) completed the survey. However, some students outside of the CAS responded to the survey (n=18). Additionally, a student must scroll down approximately two screens in order to see the survey. As a result, we do not have any way of knowing how many students actually saw our link. Anecdotally, we suspect many students (perhaps half) either delete this email upon receipt or did not scroll down beyond the initial headlines. So our best estimates for response rate calculations would be a population of 600, representing the people who saw this email.

Based on this information we could estimate that the response rate is a minimum of 17 percent (204/1200) however is likely much higher because of the number of students who deleted the email upon receipt or did not scroll down. Our best estimate is that these 204 respondents represent approximately 34 percent (204/600) for our adjusted response rate.

Incentive

In order to improve the response rate, an incentive was used, based on the success found in the study conducted by Bright and Smith (2002). Therefore, in this study, it was advertised to students as an opportunity to win one of three free Penn State sweatshirts by completing the survey. The winners were then selected by assigning each respondent a number and using a random number generator to choose the three winners.

Non-Response Bias

Due to the limitation of time, there were not any tests conducted to assess non-response bias.

Chapter 3 :

Results and Discussion

For this study, the analysis focused on several different concepts identified in the questionnaire. Results are depicted below in pie charts, bar charts, and tables. This section identifies key demographics, self-rated knowledge, fuel station selection factors, fuel usage, perceptions of E15 vs. E85 perceptions, an agreement to statements related to ethanol, and E15 price sensitivity.

Demographics

The first section is identifying the key demographics of the sample, including class standing, geographic classification, gender, and age. Figures 4-7 are provided to help understand the demographics of the population that was sampled in this study. In general, it consisted predominately (63%) of upperclassmen (Juniors, Seniors, and Graduate Students), this is likely because of the fact it takes most students a period of time to determine what their major will be in college (Fig. 4). The geographic classification is mostly students who live in the suburbs (46%) which is likely representative of the student population at Penn State, however, there is no way to validate this claim (Fig. 5). Interestingly, the majority of this sample (68%) is female (Fig. 6), which differs from the general University Park population, which is 46.7 percent female (PSU Enrollment by Gender, 2017). Perhaps, the female majority is more comparable to the population within the College of Agricultural Sciences (CAS), but that demographic information is not available at this time. Conversely, it could possibly be explained because of the method of

survey administration, which was through a listserv. Finally, the majority (65%) of students fall into the 20-22 years old category.

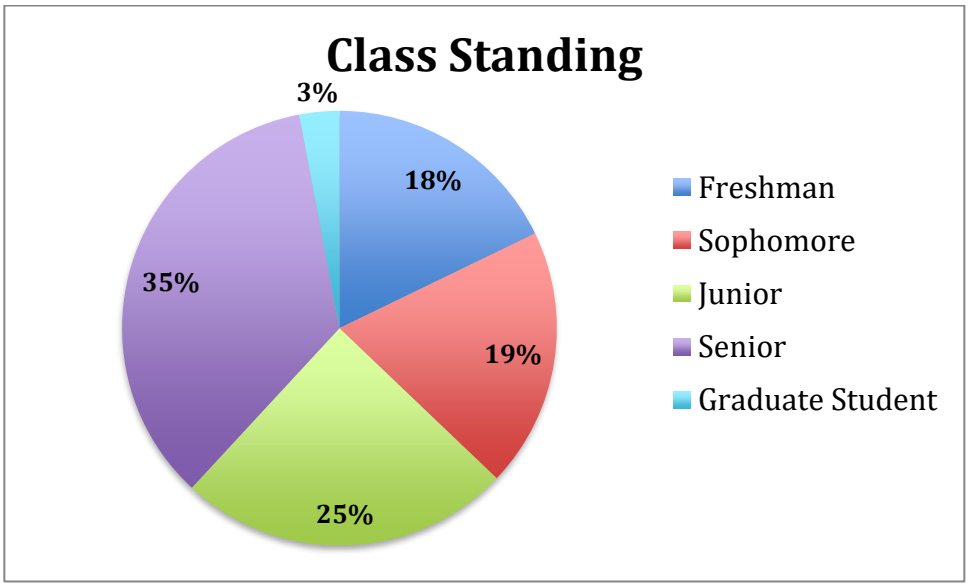

Figure 4. Class Standing breakdown by percent of responses to the survey question, "What is your class status?" [n=202].

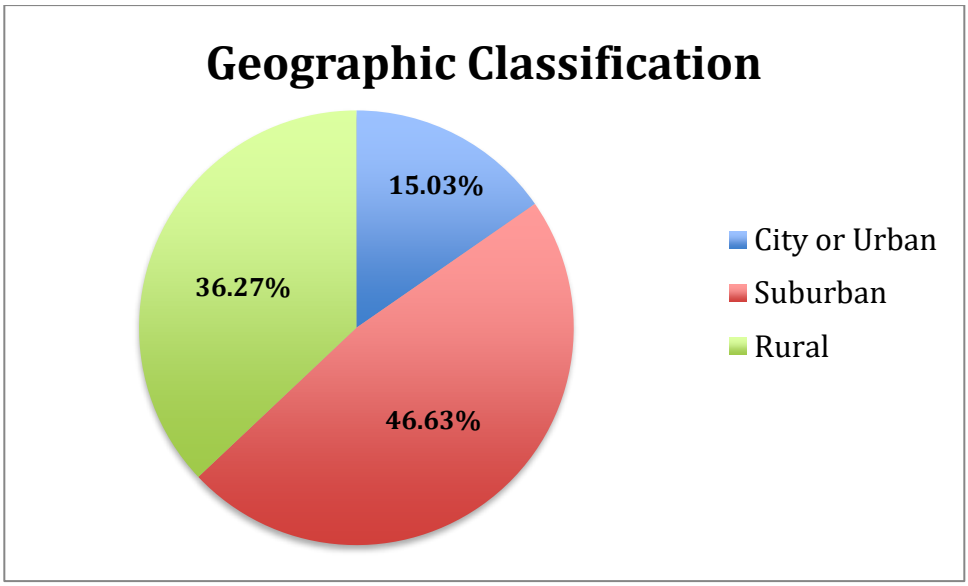

Figure 5. Geographic Classification breakdown by percent of responses to the survey question, "Which of the following best describes the area you live in?" [n=193]

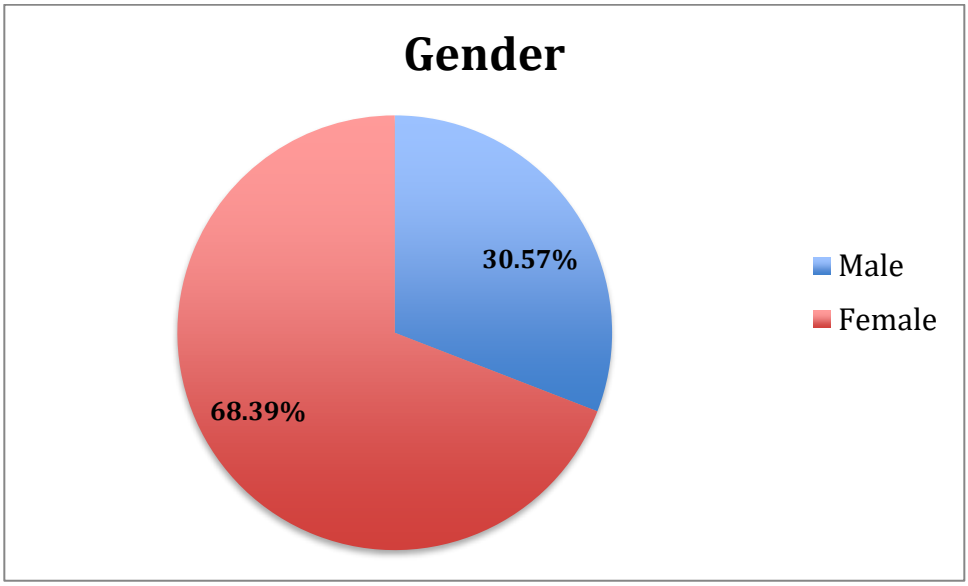

Figure 6. Gender breakdown by percent of responses to the survey question, "What is your gender?" [n=193]

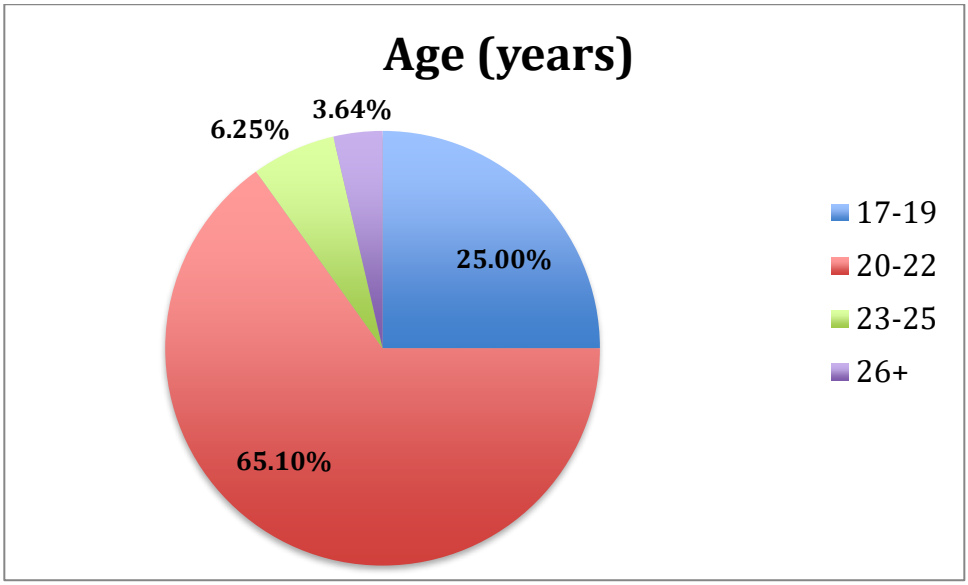

Figure 7. Age breakdown by percent of responses to the survey question, "What is your age?" [n=193].

Self-Rated Knowledge

Participants' knowledge about corn ethanol was gauged by identifying what percent of the population of the sample know what ethanol was made from, the breakdown of how students self-identify their knowledge level related to corn ethanol, and what percent of students have had a college course that has mentioned ethanol. Based on Figures 8-10, there seems to be some discrepancy within the self-rated knowledge section. A majority of students (62.56%, Fig. 8) claim that they know what ethanol is made from, but the majority (53.60%, Fig. 9) state that they know, "very little to nothing" about ethanol, which also contradicts the fact that nearly 72 percent of students have had at least one college course that mentions ethanol as a fuel source (Fig. 10).

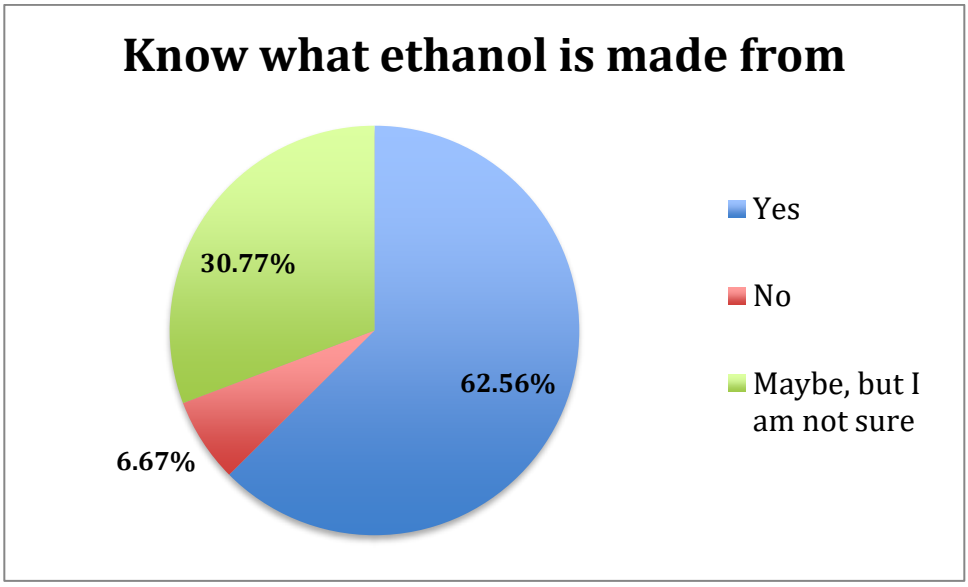

Figure 8. Know what ethanol is made from breakdown by percent of respondents to the survey question, "Do you know what ethanol is made from?" [n=195].

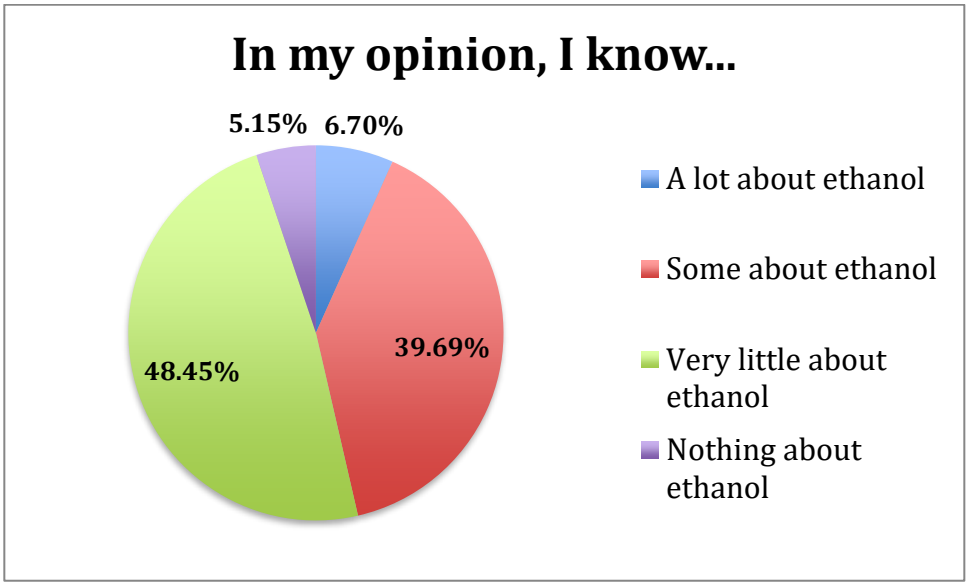

Figure 9. General ethanol knowledge (self-identified) breakdown, in percent, of the population sampled based on the responses from the survey question, "In my opinion, I know…" [n=194].

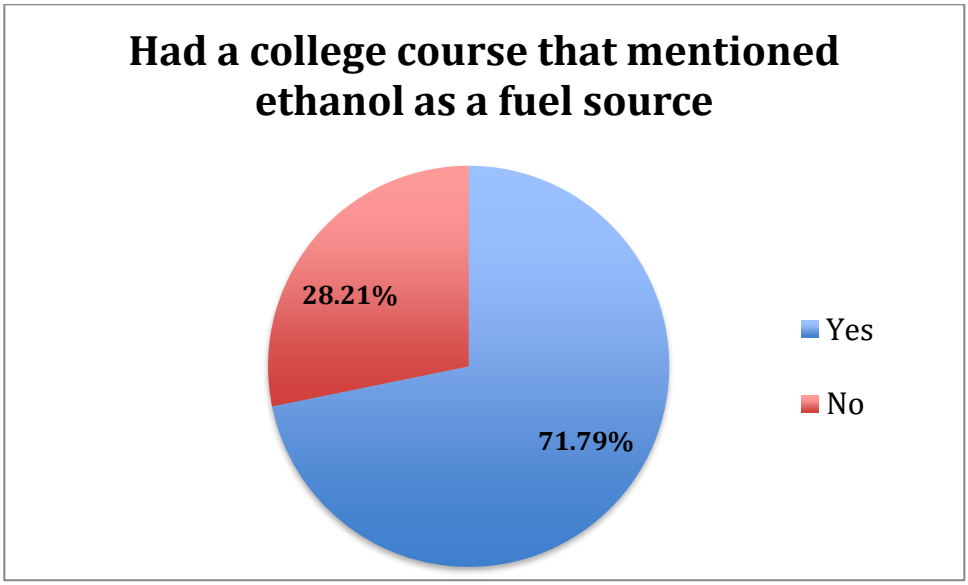

Figure 10. Had a college course that mentioned ethanol as a fuel source breakdown by percent of respondents to the survey question, "Have you ever had a college course that mentioned ethanol as a fuel source?" [n=195].

Fuel Station Selection

Station selection criteria are evaluated based on the question in the survey that required respondents to rank the following criteria: price, food or other in-store activities, fuel options available, location, and ease of accessibility from most to least important. Based on the rankings price was found to be the most important (leading by 57 points), followed by location (leading by 97 points), followed by ease of accessibility (leading by 229 points), followed by food or other in-store activities (leading by 17 points), and then fuel options available. Price and location stand out as being the two most important factors considered by consumers while the food or other in-store activities and fuel options available seem to be the least important (Fig. 11).

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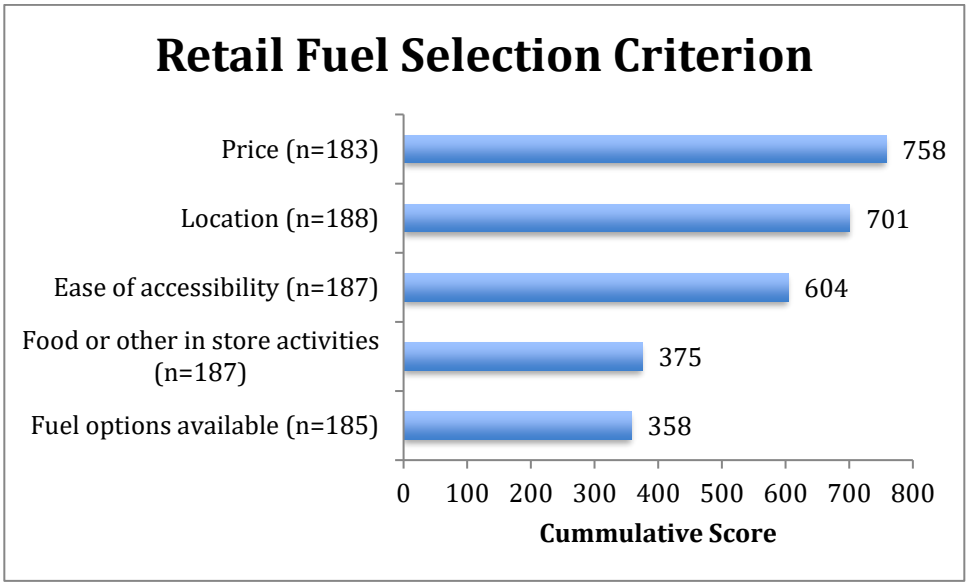


Figure 11. Cumulative score of the 5 retail fuel selection criterion by respondents based on a value weighting of 5 points for #1 criterion ranked retail fuel selection; #2 criterion = 4 points; #3 criterion = 3 points; #4 criterion = 2 points and #5 criterion = 1 point.

Fuel Usage

The fuel use of respondents was identified based on the frequency of fueling and miles driven, which is depicted in Figures 12-13. Based on the frequency of fuel purchases (Fig. 12) the majority (78.61%) of people are purchasing fuel for their vehicle either weekly or bi-weekly. Without knowing the exact mileage on the car an individual is driving/fueling it is hard to validate if this makes sense based on the miles driven annually data (Fig. 13). However, the majority of students (70.31%) are driving less than 10,000 miles annually.

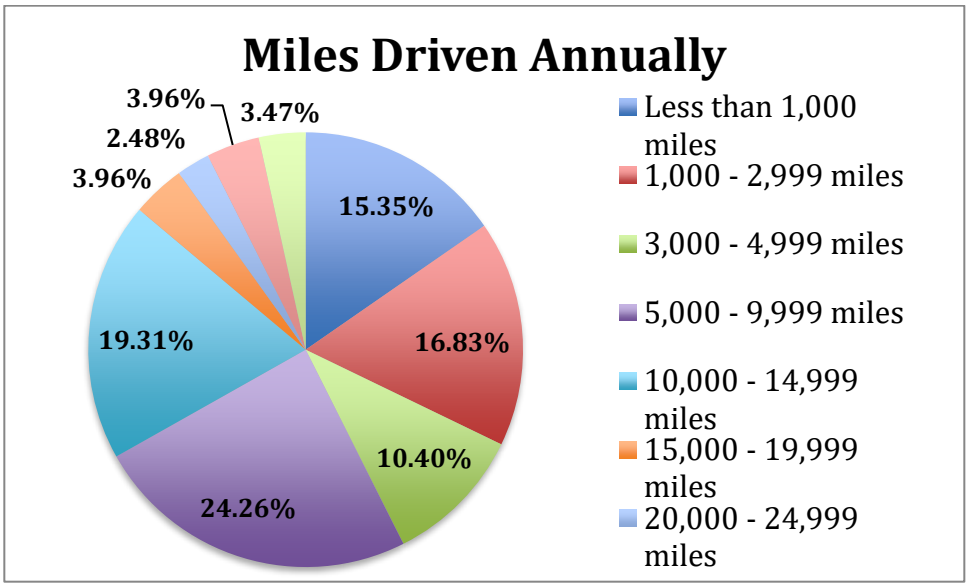


Figure 12. Miles driven annually breakdown by percent of responses to the survey question, "Approximately how many miles do you drive per year?" [n=202].

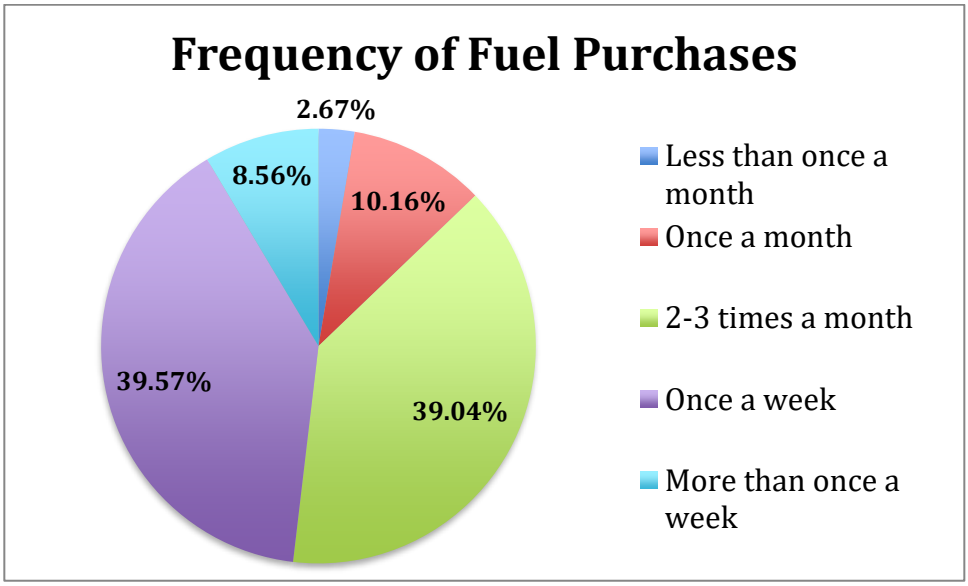


Figure 13. Miles driven annually breakdown by percent of responses to the survey question, "On average, how often did you purchase fuel for your primary vehicle?" [n=187].

E15 vs. E85 Perceptions

Participant perceptions associated with E15 (a fuel with between 10.5%-15% ethanol and the remainder gasoline) vs. E85 (a fuel with between 51%-83% ethanol and the remainder gasoline) are examined through responses to six statements related to E15 and E85, using a five-option Likert agreement scale (Fig. 14). For each of the statements related to fuel efficiency in miles per gallon, fuel retailer environmental responsibility, and station selection associated with E15 and E85 it seems that the general feeling of students is to not have much of an opinion. This is demonstrated in the means for each statement being close to three and the standard deviations being small and including three within the range. Although it seems that there is little opinion associated with the statements, slightly more people did seem to agree that the availability of E15 and E85 made a retailer more environmentally conscious, but the pretense of E15 or E85 was not a strong reason for a fuel consumer to select a particular retailer (Fig. 14).

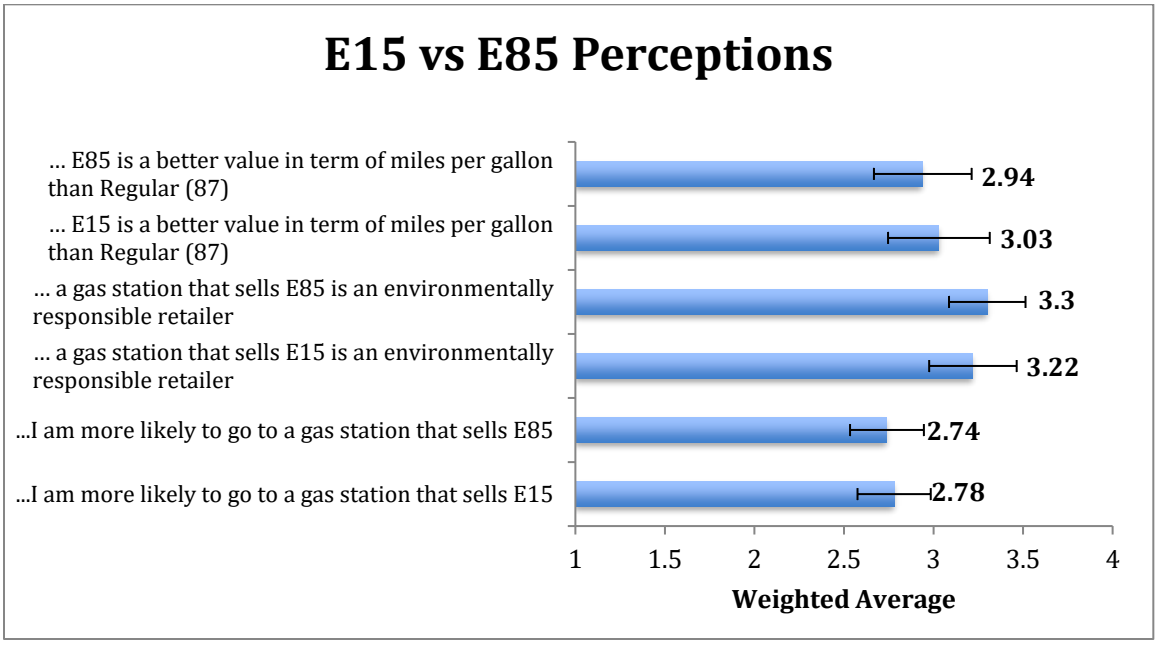


Figure 14. Respondent perceptions of E15 vs. E85 on ranking on 3 variables using a Likert scale with means calculated based on Strongly Agree = 5 points, Agree = 4 points, Neither agree nor disagree = 3 points, Disagree = 2 points and Strongly Disagree = 1 point, with error bars depicting standard deviation [n=192].

Ethanol Agreement Statements

In this section, nine pairs of statements (18 total statements) examined how students perceived some of the key issues associated with the use of corn ethanol as a fuel. Figure 15 depicts the 18 separate statements in the order of most agreed with to least agreed with. Figure 16 focuses on the nine pairs of statements to see which have the biggest difference in means. Together these graphs can be interpreted to make some of the following conclusions.

The statement agreed upon the most is that ethanol reduces US dependence on foreign oil, followed by ethanol benefitting rural economies, and then having an effect on food price. Ethanol reducing US dependence on foreign oil is seen by it having the highest mean of 3.92 and validated by it having the lowest mean of 2.07 (Fig. 15). Additionally, it has the greatest

difference in means of 1.85 (Fig. 16). This is an accurate claim that is validated in the literature, particularly in the early 2000's when oil prices increased rapidly ("Ethanol" n.d.). Next the benefitting of rural economies can be seen by it having the second highest mean rating (3.84, Fig. 15), the converse paired statement of ethanol harming rural economies with the second lowest mean rating (2.32, Fig. 15), and the second highest difference in means (1.52, Fig. 16). Again, this statement agrees with the existing literature which states that in 2015 ethanol production led to nearly 86,000 direct jobs across the country and 330,000 indirect jobs—often in rural areas where there is a greater need for employment opportunities ("Alternative Fuels Data Center: Ethanol Benefits and Considerations," n.d. and "Ethanol" n.d.). Following ethanol's benefit to rural economies, the next most agreed upon statement is that it does have an effect on food prices, seen by the third highest mean (3.66, Fig. 15), the converse statement with the third lowest mean (3.35, Fig. 15), and the third highest spread (1.31 Fig. 16). Unlike the previous leaders, this is actually a statement that is debated in the scientific community (Rathman et al. 2010, Ajanovic 2011, and Nersesian 2016). However, this belief is likely explained by the food vs. fuel debate that has been regularly reported on in the media (Harrison 2009).

Regarding issues with ethanol associated to sustainability, the environment, and greenhouse gasses, a smaller trend emerged. There is some agreement that ethanol is "more sustainable" (vs. petro-fuel) (mean=3.52) [vs. less sustainable (mean=2.53) and (difference in means = 0.99)], "good for the environment" (mean=3.52) [vs. bad for the environment (mean=2.49) and (difference in means = 1.02)], and "reduces greenhouse gas emissions" (mean=3.44) [vs. increases green house gas emissions (mean=2.62) and (difference in means = 0.82)]. This lack of a strong opinion is supported by ongoing debates within the scientific community about whether or not ethanol is sustainable, beneficial to the environment, or causes

any reduction in greenhouse gas emissions (Farrell et al 2006, Pacala and Sokolow, 2004, and "Ethanol" n.d.).

Finally, participants seem uncommitted regarding various statements associated with presence of water in ethanol, harm to engine, and harm to parts of vehicle other than engine. Generally, participants' neither agreed nor disagreed with these three statements and the difference in means were only 0.60 for water content, 0.32 for benefit/ harm of engine, and 0.27 for benefit/ harm to parts of vehicle other than the engine. This lack of a strong opinion is likely explained by the lack of knowledge associated with this subject.

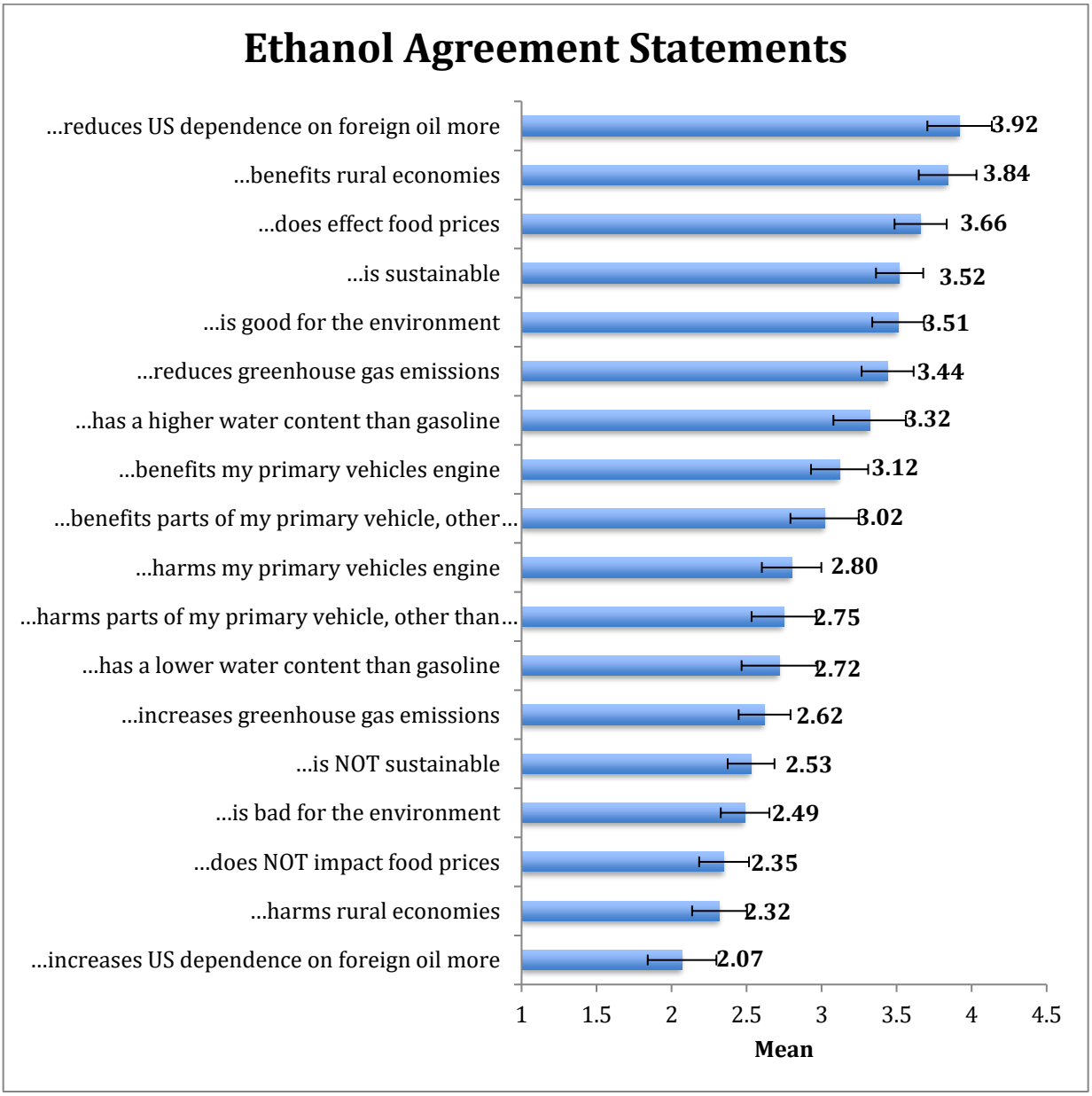


Figure 15. Respondent perceptions to ethanol agreement ranking on 16 variables using a Likert scale with means calculated based on Strongly Agree = 5 points, Agree = 4 points, Neither agree nor disagree = 3 points, Disagree = 2 points and Strongly Disagree = 1 point, with error bars depicting standard deviation [n=195].

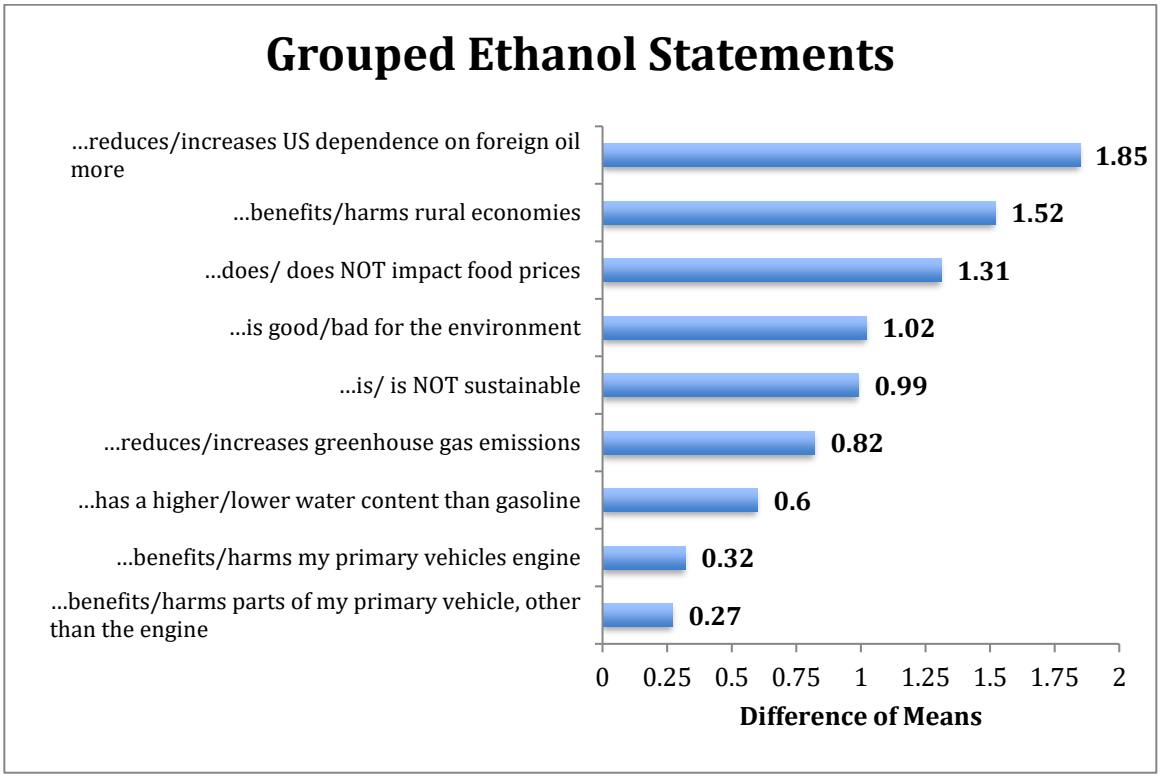


Figure 16. Respondent perceptions to ethanol agreement statement pairs on 8 variables using a Likert scale with the difference in means which are calculated based on Strongly Agree = 5 points, Agree = 4 points, Neither agree nor disagree = 3 points, Disagree = 2 points and Strongly Disagree = 1 point [n=195].

E15 Price Sensitivity

Finally, price sensitivity was evaluated by asking students at what price points they would, may, or would not buy E15 as opposed to regular (87) gasoline. Based on the analysis of price sensitivity it was found that at parity (when E15 is priced the same as regular (87) 38.22 percent, 45.55 percent and 16.23 percent of students "definitely would", "may", and "definitely would not" buy E15, respectively (Table 2). However, when priced below parity, 55 to 65 percent of students would definitely buy E15, depending on how much lower it was priced. It appears that this shift from "would buy" comes predominately from those who originally claimed that they "may buy". Additionally, only twelve to nine percent of students state that they "would definitely not" buy ethanol. This could indicate that, if priced appropriately, E15 could become a fuel option that would interest consumers portrayed in this study since with only a $0.05 decrease in price, 87.46 percent of the population "would" or "may buy" E15. It also suggests that price is something that consumers are very sensitive to which is validated by the 2017 study conducted by Sheetz (Sheetz 2017). An interesting thing to note is that a potential decrease in price seems to have diminishing returns because at $0.20 lower, there is only a 3.12 percent increase in people who would purchase E15 (90.58%) compared to at only $0.05 lower (87.46%). Alternatively, 39.30 to 65.79 percent of people "would" or "may" buy E15 if it is priced above parity, dependent on how much higher it is priced. This could indicate that, with proper marketing communications, E15 has a potential to be a premium product.

Table 2. E15 self-reported purchasing behavior at various price points with means which are calculated based on Definitely WOULD buy = 3 points, MAY buy = 2 points, and Definitely WOULD NOT buy = 1 point, percent of respondents in each category, and count of respondents in each category [n=189]

If E15 was available at your gas station, would you consider purchasing it under the following price scenarios? If Regular (87) is $2.70/gallon, and E15 is priced at…							
	Mean	Definitely WOULD buy		MAY buy		Definitely WOULD NOT buy	
	(n=190)	%	n=	%	n=	%	n=
…$2.90/gallon	1.41	1.58%	3	37.89%	72	60.53%	115
…$2.85/gallon	1.48	4.71%	9	38.22%	73	57.07%	109
…$2.80/gallon	1.62	9.52%	18	43.39%	82	47.09%	89
…$2.75/gallon	1.85	18.95%	36	46.84%	89	34.21%	65
…$2.70/ gallon - parity	2.22	38.22%	73	45.55%	87	16.23%	31
…$2.65/ gallon	2.42	54.97%	105	32.46%	62	12.57%	24
…$2.60/ gallon	2.50	61.26%	117	27.75%	53	10.99%	21
…$2.55/ gallon	2.55	65.26%	124	24.74%	47	10.00%	19
…$2.50/ gallon	2.57	66.49%	127	24.08%	46	9.42%	18

Chapter 4 :

Conclusions and Future Research

Conclusions

As a result of this exploratory study, several interesting findings about a sample of educated millennial undergraduates at a sizeable land grant university can be made. The first is related to self-rated knowledge, where the majority (nearly 72%) of participants have had formal education on ethanol as a fuel source, but over half of students know "very little to nothing" about the subject. Additionally, when it comes to selecting a fuel retailer, price and location are the two most important factors considered. Interestingly, these participants seem to not have much of an opinion when it comes to comparing E15 to E85. However, in terms of a variety of ethanol issues, the three statements that study participants felt most strongly about were that ethanol decreases US dependence on foreign oil, benefits rural economies, and impacts food prices. Finally, price sensitivity was analyzed and when E15 pricing was below parity approximately 87-90 percent of people may or would purchase E15. This could indicate to fuel retailers that with proper marketing, a millennial crowd could be a potential customer to higher ethanol fuel blends.

Although the sample limits the ability to make inferences to a larger population, it is useful to better understand the perceptions and opinions of a sample of educated millennial undergraduates at a major land grant university. This study could be interesting to fuel retailers and ethanol producers, among others. There are many different directions in which this research could be expanded upon in the future.

Limitations

The most critical limitation of this study is the shortage of time available. With additional time this data could have a larger and more diverse sample, be subjected to rigorous statistical analysis, and investigate some of the data that was collected, but not analyzed.

Future Research

To build off of the limitations, some areas for future research could include expanding the sample. This could occur in several different ways such as more universities, more diverse population, or beyond the college setting. For example, this survey could be administered to several different universities throughout the country, perhaps focusing on land-grant universities in different geographic locations. The sample could be diversified by expanding the survey to all majors within a university, as opposed to just the College of Agricultural Sciences. Alternatively, it could also be administered to the general population, as opposed to focusing on college students.

As for increasing the rigor of statistical analysis, some options would be analyzing the differences between demographics vs. knowledge, demographics vs. pricing, demographics vs. perceptions, knowledge vs. pricing, knowledge vs. demographics, and knowledge vs. perceptions, to name a few. As for the statistical methods utilized, they could include t-tests, ANOVA, and correlation to validate some of the trends seen in the data.

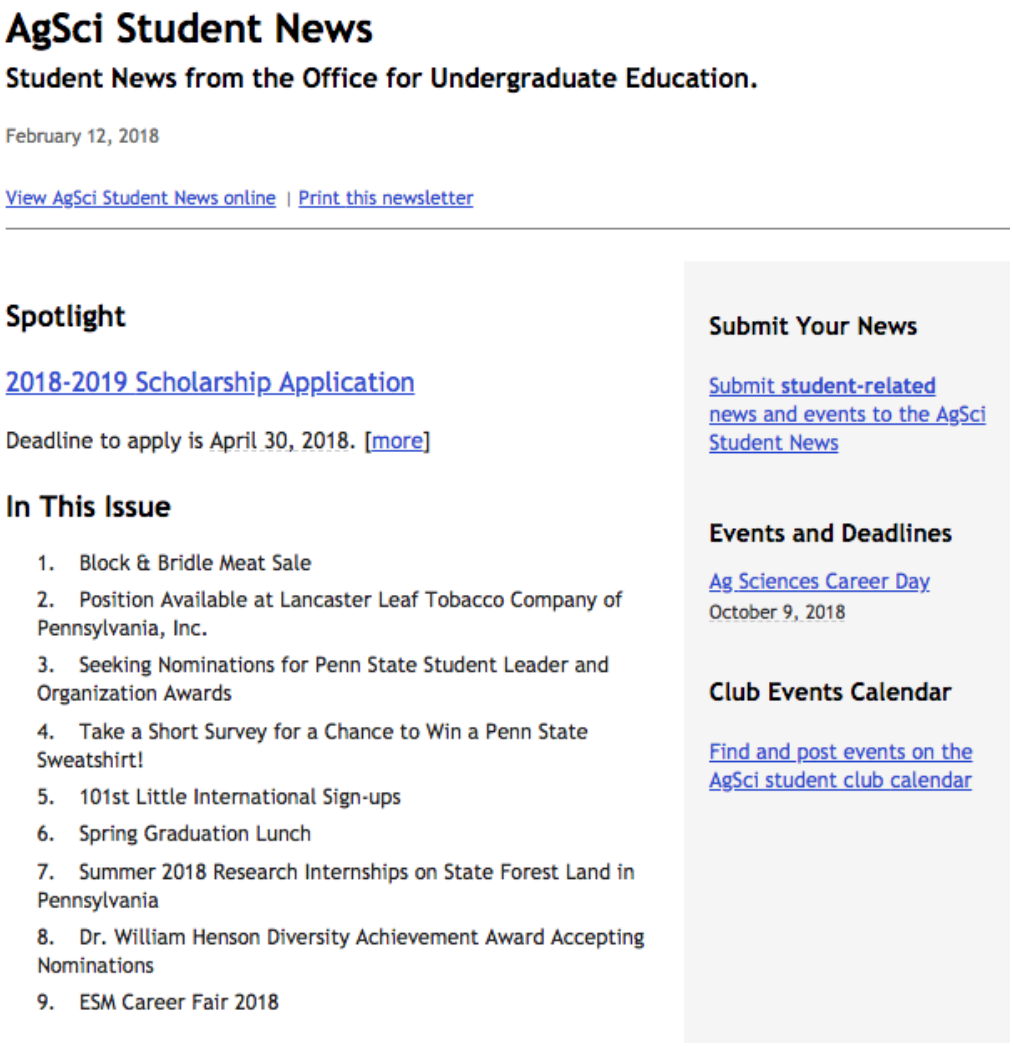
Finally, there was a large amount of data that was collected in this survey that was not mentioned in this thesis. Some of this includes college majors and minors; make, model, and

year of primary vehicles; the presence of hybrid vehicles; ethanol knowledge outside of college courses; the role of corn in the context of ethanol as a fuel source; and pricing for E85. Overall, this was exploratory research and could be expanded in many different directions.

Appendix A

AgSci Student News Posting

This appendix has the images of what the postings from the CAS AgSci Student News contained for the February 12th and February 19th issues.



AgSci Student News

Student News from the Office for Undergraduate Education.

February 12, 2018

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Spotlight

2018-2019 Scholarship Application

Deadline to apply is April 30, 2018. [more]

In This Issue

1. Block & Bridle Meat Sale
2. Position Available at Lancaster Leaf Tobacco Company of Pennsylvania, Inc.
3. Seeking Nominations for Penn State Student Leader and Organization Awards
4. Take a Short Survey for a Chance to Win a Penn State Sweatshirt!
5. 101st Little International Sign-ups
6. Spring Graduation Lunch
7. Summer 2018 Research Internships on State Forest Land in Pennsylvania
8. Dr. William Henson Diversity Achievement Award Accepting Nominations
9. ESM Career Fair 2018

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Submit **student-related** news and events to the AgSci Student News

Events and Deadlines

Ag Sciences Career Day
October 9, 2018

Club Events Calendar

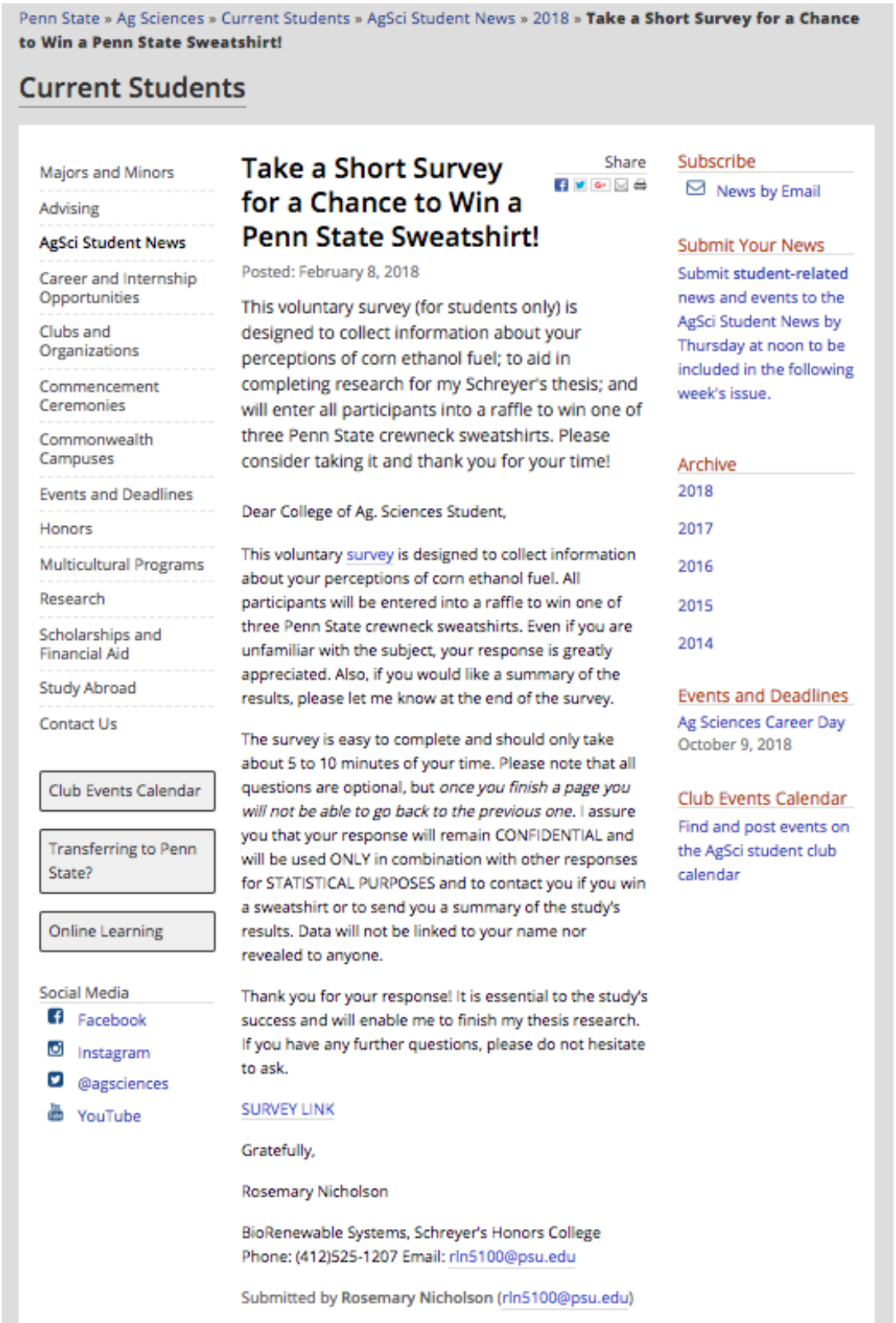
Find and post events on the AgSci student club calendar

February 12th AgSci Student News showing the survey as issue item 4.

4. Take a Short Survey for a Chance to Win a Penn State Sweatshirt!

This voluntary survey (for students only) is designed to collect information about your perceptions of corn ethanol fuel; to aid in completing research for my Schreyer's thesis; and will enter all participants into a raffle to win one of three Penn State crewneck sweatshirts. Please consider taking it and thank you for your time! [more]

February 12th AgSci Student News showing the brief description of the survey.



Penn State » Ag Sciences » Current Students » AgSci Student News » 2018 » **Take a Short Survey for a Chance to Win a Penn State Sweatshirt!**

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Posted: February 8, 2018

This voluntary survey (for students only) is designed to collect information about your perceptions of corn ethanol fuel; to aid in completing research for my Schreyer's thesis; and will enter all participants into a raffle to win one of three Penn State crewneck sweatshirts. Please consider taking it and thank you for your time!

Dear College of Ag. Sciences Student,

This voluntary survey is designed to collect information about your perceptions of corn ethanol fuel. All participants will be entered into a raffle to win one of three Penn State crewneck sweatshirts. Even if you are unfamiliar with the subject, your response is greatly appreciated. Also, if you would like a summary of the results, please let me know at the end of the survey.

The survey is easy to complete and should only take about 5 to 10 minutes of your time. Please note that all questions are optional, but *once you finish a page you will not be able to go back to the previous one.* I assure you that your response will remain CONFIDENTIAL and will be used ONLY in combination with other responses for STATISTICAL PURPOSES and to contact you if you win a sweatshirt or to send you a summary of the study's results. Data will not be linked to your name nor revealed to anyone.

Thank you for your response! It is essential to the study's success and will enable me to finish my thesis research. If you have any further questions, please do not hesitate to ask.

SURVEY LINK

Gratefully,

Rosemary Nicholson

BioRenewable Systems, Schreyer's Honors College
Phone: (412)525-1207 Email: rln5100@psu.edu

Submitted by Rosemary Nicholson (rln5100@psu.edu)

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Student News from the Office for Undergraduate Education.

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Spotlight

2018-2019 Scholarship Application

Deadline to apply is April 30, 2018. [more]

In This Issue

1. American Floral Endowment (AFE) Scholarship Applications Available
2. American Floral Endowment (AFE) Internships Available
3. Ag Scholarships are Available!
4. Sophomores - Have you declared your major?
5. Study Smarter, Not Harder Workshop
6. Part-time summer job opportunity with Student Orientation & Transition Programs
7. LAST CHANCE: Take a Short Survey for a Chance to Win a Penn State Sweatshirt!
8. AgChoice Farm Credit Internships Available
9. Internships with Southeast Agricultural Research and Extension Center
10. AgCareers.com Electronic Internship Flyer
11. Team Leaders needed for Fresh START 2018
12. Career Opportunities in the Confectionery Industry

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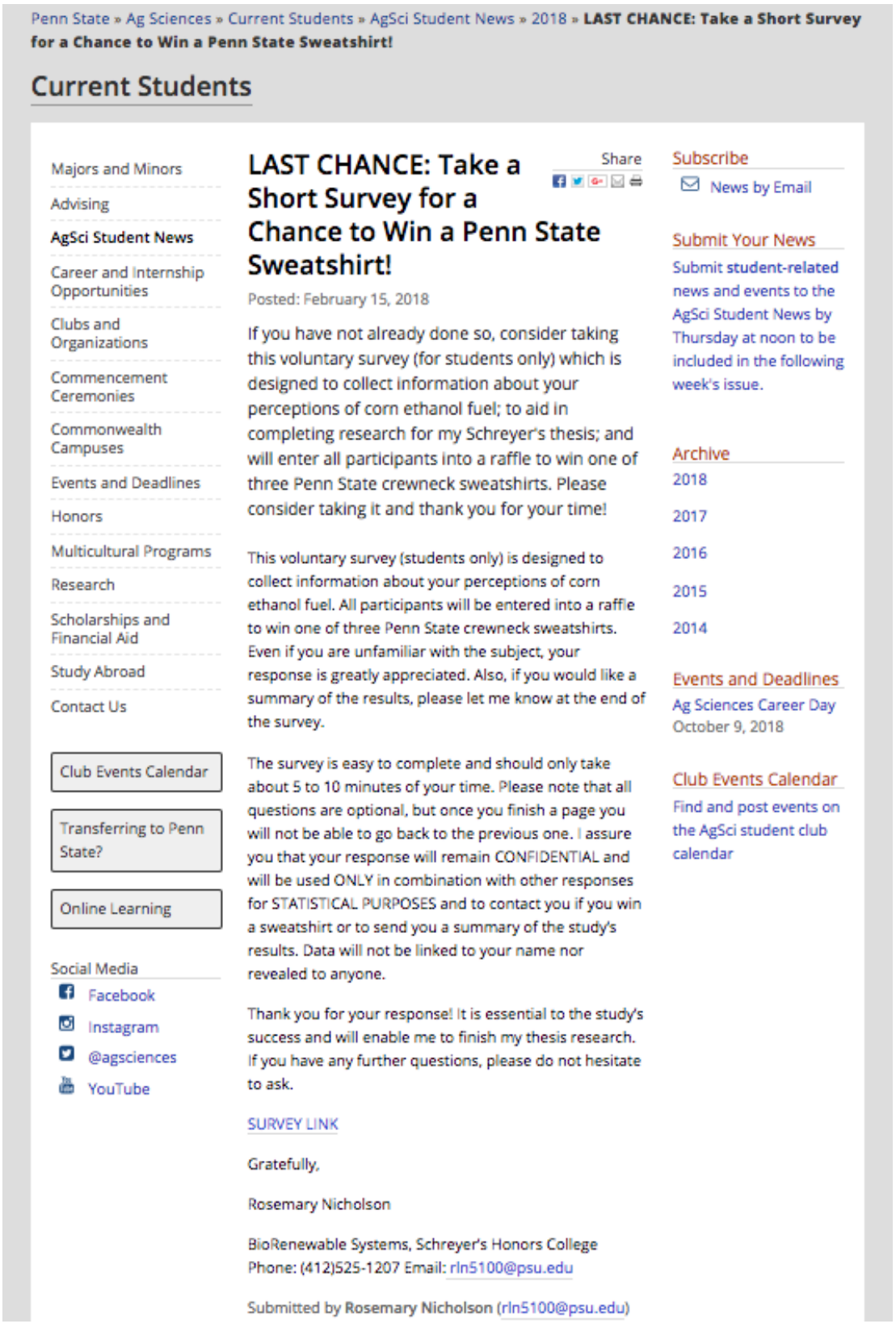
February 19th AgSci Student News showing the last chance follow-up on the survey as issue item 7.

7. LAST CHANCE: Take a Short Survey for a Chance to Win a Penn State Sweatshirt!

If you have not already done so, consider taking this voluntary survey (for students only) which is designed to collect information about your perceptions of corn ethanol fuel; to aid in completing research for my Schreyer's thesis; and will enter all participants into a raffle to win one of three Penn State crewneck sweatshirts. Please consider taking it and thank you for your time! [more]

February 19th AgSci Student News showing the brief description of the survey.



Penn State » Ag Sciences » Current Students » AgSci Student News » 2018 » **LAST CHANCE: Take a Short Survey for a Chance to Win a Penn State Sweatshirt!**

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LAST CHANCE: Take a Short Survey for a Chance to Win a Penn State Sweatshirt!

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Posted: February 15, 2018

If you have not already done so, consider taking this voluntary survey (for students only) which is designed to collect information about your perceptions of corn ethanol fuel; to aid in completing research for my Schreyer's thesis; and will enter all participants into a raffle to win one of three Penn State crewneck sweatshirts. Please consider taking it and thank you for your time!

This voluntary survey (students only) is designed to collect information about your perceptions of corn ethanol fuel. All participants will be entered into a raffle to win one of three Penn State crewneck sweatshirts. Even if you are unfamiliar with the subject, your response is greatly appreciated. Also, if you would like a summary of the results, please let me know at the end of the survey.

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SURVEY LINK

Gratefully,

Rosemary Nicholson

BioRenewable Systems, Schreyer's Honors College
Phone: (412)525-1207 Email: rln5100@psu.edu

Submitted by Rosemary Nicholson (rln5100@psu.edu)

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February 19th archived College of Agricultural Sciences (CAS) webpage.

Appendix B

Survey Draft

Penn State: Corn Ethanol Perceptions

Welcome to My Survey

Dear student,

This voluntary survey is designed to collect information about your perceptions of corn ethanol fuel. All participants will be ENTERED INTO A RAFFLE to win one of three Penn State crewneck sweatshirts. Even if you are unfamiliar with the subject, your response is greatly appreciated. Also, if you would like a summary of this study's results, please let us know at the end of the survey.

The survey is easy to complete and should only take about 5 to 10 minutes of your time. Please note that all questions are optional, but once you finish a page you will not be able to go back to the previous one. I assure you that your response will remain CONFIDENTIAL and will be used ONLY in combination with other responses for STATISTICAL PURPOSES, to contact you if you win the raffle for a sweatshirt or to send your summary of the study's results. Data will not be linked to your name nor revealed to anyone.

Thank you for your response! It is essential to the study's success and will enable me to finish my thesis research. If you have any further questions, please do not hesitate to ask.

Gratefully,

Rosemary Nicholson

BioRenewable Systems, Schreyer's Honors College
Phone: (412)525-1207
Email: rln5100@psu.edu

Penn State: Corn Ethanol Perceptions

School Demographics

What is your class status?

What is your major?

What is your minor(s)? *if applicable

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Sweatshirt Information

By completing this survey you are eligible to win a Penn State sweatshirt. Please provide the following information which will only be used if you are selected as a winner.

What sweatshirt would you like?

- ◯ Navy Penn State Crewneck
- ◯ Grey Penn State Crewneck

What Size?

Please enter a way to contact you if selected as a winner below (ex: email). As a reminder, this information will only be used if you are selected for a prize and will be kept confidential.

Driving Information

Primary vehicle is defined as the vehicle you fill with fuel the most frequently.

Approximately how many miles do you drive per year?

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Vehicle and Fueling Information

Primary vehicle is defined as the vehicle you fill with fuel the most frequently.

What is the make of your primary vehicle?

What is the model of your primary vehicle?

What is the year of your primary vehicle?

Hybrid

- Yes
- No

On average in 2017, how frequently did you purchase fuel for your primary vehicle, on average?

Of the 5 fueling station selection criteria listed below, please rank from most to least important to you. (1= Most important, 2=Second most important, 3=middle, 4=second least important, 5=least important)

- Price
- Food or other in store activities
- Fuel options available
- Location
- Ease of accessibility

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Course Information

Have you ever had a college course that mentioned ethanol as a fuel source?

- ◯ Yes
- ◯ No

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Course Quantification

In how many college courses has ethanol, as a fuel source, been mentioned?

Out of Class Information

Have you learned about ethanol, as a fuel source, outside of your college courses?

- ◯ Yes
- ◯ No

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Out of Class Information (specific)

If yes, in what places have you learned about ethanol as a fuel source? (select all that are relevant)

- [ ] News
- [ ] Informational Video
- [ ] Course (outside of college)
- [ ] Friend
- [ ] Family member
- [ ] Other (please specify)

Ethanol Knowledge

In my opinion, I know...

- ○ A lot about ethanol
- ○ Some about ethanol
- ○ Very little about ethanol
- ○ Nothing about ethanol

Do you know what ethanol is made from?

- ○ Yes
- ○ Maybe, but I am not sure
- ○ No

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Ethanol Knowledge (specific)

Please finish this statement to the best of your ability:

Ethanol is made from...

E10 Fuel Knowledge

Do you know what E10 stands for, in the fuel context?

- ◯ Yes
- ◯ Maybe, but I am not sure
- ◯ No

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E10 Fuel Knowledge (specific)

The **E** in E10 stands for...

The **10** in E10 stands for...

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Ethanol Agreement

To what extent do you agree or disagree with the following sixteen ethanol statements, using the following agreement - disagreement scale:

Ethanol...

	Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree
…benefits my primary vehicles engine	○	○	○	○	○
…harms my primary vehicles engine	○	○	○	○	○
…benefits parts of my primary vehicle, other than the engine	○	○	○	○	○
…harms parts of my primary vehicle, other than the engine	○	○	○	○	○
…is good for the environment	○	○	○	○	○
…is bad for the environment	○	○	○	○	○
…reduces greenhouse gas emissions	○	○	○	○	○
…increases greenhouse gas emissions	○	○	○	○	○
…is sustainable	○	○	○	○	○
…is NOT sustainable	○	○	○	○	○
…benefits rural economies	○	○	○	○	○
…harms rural economies	○	○	○	○	○
…reduces US dependence on foreign oil more	○	○	○	○	○
…increases US dependence on foreign oil more	○	○	○	○	○

	Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree
…does NOT impact food prices	○	○	○	○	○
…does effect food prices	○	○	○	○	○
…has a higher water content than gasoline	○	○	○	○	○
…has a lower water content than gasoline	○	○	○	○	○

E15 and E85 Fuel Options

To answer the following questions, E10 is a fuel with 0% -10% ethanol, the remainder gasoline; E15 is a fuel with 10.5% to 15% ethanol, the remainder gasoline; and E85 is a fuel with 51% to 83% ethanol and the remainder gasoline (also called Flex Fuel).

To what extent do you agree or disagree with the following six statements related to E15 and E85, using the below scale:

Regarding E15 and E85...

	Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree
...I am more likely to go to a gas station that sells **E15**	○	○	○	○	○
...I am more likely to go to a gas station that sells **E85**	○	○	○	○	○
...a gas station that sells **E15** is an environmentally responsible retailer	○	○	○	○	○
...a gas station that sells **E85** is an environmentally responsible retailer	○	○	○	○	○
… **E15** is a better value in term of miles per gallon than Regular (87)	○	○	○	○	○
… **E85** is a better value in term of miles per gallon than Regular (87)	○	○	○	○	○

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Fuel Purchasing

To answer the following questions, E10 is a fuel with 0% -10% ethanol, the remainder gasoline; E15 is a fuel with 10.5% to 15% ethanol, the remainder gasoline; and E85 is a fuel with 51% to 83% ethanol and the remainder gasoline (also called Flex Fuel).

Have you purchased E15 or E85 for your primary vehicle in the past 12 months?

- ◯ Yes
- ◯ No
- ◯ I don't know

If **E15** was available at your gas station, would you consider purchasing it under the following price scenarios?

If Regular (87) is $2.70/gallon, and E15 is priced at…

	Definitely **WOULD** buy	**MAY** buy	Definitely **WOULD NOT** buy
…$2.90/gallon	◯	◯	◯
…$2.85/gallon	◯	◯	◯
…$2.80/gallon	◯	◯	◯
…$2.75/gallon	◯	◯	◯
…$2.70/ gallon - parity	◯	◯	◯
…$2.65/ gallon	◯	◯	◯
…$2.60/ gallon	◯	◯	◯
…$2.55/ gallon	◯	◯	◯
…$2.50/ gallon	◯	◯	◯

If **E85** was available at your gas station, would you consider purchasing it under the following price scenarios?

If Regular (87) is $2.70/gallon, and E85 is priced at…

	Definitely **WOULD** buy	**MAY** buy	Definitely **WOULD NOT** buy
…$3.30/gallon	○	○	○
…$3.15/gallon	○	○	○
…$3.00/gallon	○	○	○
…$2.85/gallon	○	○	○
…**$2.70/ gallon - parity**	○	○	○
…$2.55/ gallon	○	○	○
…$2.40/ gallon	○	○	○
…$2.25/ gallon	○	○	○
…$2.10/ gallon	○	○	○

Open Ended

Do you have any other thoughts, concerns, or opinions related to ethanol or ethanol blended fuel that you would like to share?

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Demographics

Lastly, we have a few optional questions about demographics.

What is your gender?

- Male
- Female
- Prefer not to say

What is your age?

Which of the following best describes the area you live in?

- City or Urban
- Suburban
- Rural
- Prefer not to say
- Other (please specify)

If you would like to receive a summary of the results, please provide us with your email address. Remember, all responses are confidential.

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Academic Vita of Rosemary Nicholson

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EDUCATION:

Penn State University, University Park, PA
Major: BioRenewable Systems
Minors: Entrepreneurship and Innovation; Environmental Resource Management; Agricultural Systems Management
Honors: BioRenewable Systems—BioProducts Option

THESIS:

Title
Supervisor: Paul M. Smith

RESEARCH EXPERIENCE:

NARA BioEnergy REU, Pullman, WA
Research Intern—Pelletized Biochar Production and Characterization from Textile Waste, (May 2017-August 2017)

- Worked both independently and collaboratively with members of the research group to produce and characterize biochar made from waste textiles
- Developed an independent research project that met the needs of the industry partners and principle investigators involved with the project. Communicated status via monthly meetings with WSU faculty and Annex IO industry partners on the project.
- Prepared and presented monthly at meetings with PI's and industry partner, Annex IO, as well as a poster for the Washington State Undergraduate Summer Research Symposium
- Research was conducted with the Biological Systems Engineering department and the Composite Materials and Engineering Center under the supervision of Dr. Manuel Garcia Perez and Dr. Karl Englund, respectively.

The School for Field Studies, Atenas, Costa Rica
Research Assistant—Carbon Storage and Sequestration in Coffee Agroforestry, (January 2017-May 2017)

- Conducted study on, "Above ground carbon storage over time in Costa Rican agroforestry coffee farms"
- Collected field data on 3 coffee farms, and worked with existing data to determine changes in agroforestry practices and their effect on carbon sequestration as a climate change mitigation strategy overtime
- Prepared and presented a final presentation and poster for students and faculty at SFS in Costa Rica
- Research was conducted in conjunction with the Natural Resource Management segment of the program with Dr. Achim Haegar

CenUSA BioEnergy REU, Madison, WI
Research Intern—Techno Economic Modeling of Farm-side Switchgrass Production, (May 2016 – Aug 2016)

- Conducted Study on "Modeling of Switchgrass Harvest Progression in the North-Central US"
- Analyzed weather data over 10 years in 3 locations to model crop drying rates and progression, investigate influence of variables on harvest, and draw conclusions for possible future biorefinery applications
- Developed modeling program using MATLAB and conducted statistical analyses of data
- Prepared and presented a poster for the Iowa State Undergraduate Summer Research Symposium
- Research was conducted with the Biological Systems Engineering department under the supervision of Dr. Kevin Shinners

PRESENTATIONS:

- Penn State University—Honors Student Research Panel (2017)
- Washington State University—Summer Poster Symposium (2017)
- Iowa State University—Symposium on Undergraduate Research & Creative Expression (2016)

PUBLICATION:

"Switchgrass Harvest Progression in the North-Central US", BioEnergy Research, 2017.

PROFESSIONAL EXPERIENCE:

Penn State Learning, University Park, PA
Guided Study Group Leader/ Tutor, Macro Economics, (Jun 2015 – Present)

- Facilitate discussion and student mastery of concepts 3 times a week to supplement lecture
- Design tri-weekly lesson plans for group session, investing over 10 hours per week for the program
- Collaborate with professors, staff, tutors, and students to enhance success for students in course

Mahoosuc Land Trust, Bethel, ME
Summer Intern, (May 2015 – Aug 2015)

- Developed and executed management plans for 6 different properties, ranging 5-200 acres and a pest management plan related to the invasive Japanese Knotweed
- Conducted field work and created baseline documentation reports for 2 potential new properties
- Communicated with local governing bodies, including the Department of Inland Fisheries & Wildlife
- Participated on 4 committees within the organization and contributed to monthly board meetings
- Organized 4 successful community and major donor outreach event

VOLUNTEER EXPERIENCE:

Mid State Literacy Council, State College, PA
Administrative Assistant and Tutor (January 2018-Present)

- Prepare new curriculum and assist with general administrative tasks
- Tutor adult learners to improve literacy and computer literacy skills

Mentor with Avonworth High School, Pittsburgh, PA
Student Mentor, (Oct 2016 – Present)

- Works with developmentally delayed student to help practice communication and assist with academic work
- Meets one to two times per week via phone or Skype
- Helps to practice skills to better written, oral, and in-person communication

Emily Whitehead Foundation, State College, PA
Fundraiser and Volunteer, (August 2016 – Present)

- Designed fundraisers to raise money for pediatric cancer and spread awareness about immunotherapy
- Ran the Philadelphia Marathon with the team to spread awareness for childhood cancer

THON Operations Committee, University Park, PA
TREE Recycling Coordinator, (Oct 2014 – May 2016)

- Organize weekly communication about general recycling and sustainability through THON specific methods
- Present about new methods regarding preparation of THON, THON, and pre-THON events
- Volunteers over 100 hours to set-up/ teardown of various THON related events

INTERNATIONAL EXPERIENCE:

The School for Field Studies, Atenas, Costa Rica
Center for Sustainable Development Studies
Student/Research Assistant
(January 2017- May 2017)

HONORS AND AWARDS:

- Student representative for Food and Bio Entrepreneurship and Innovation minor advisory board (August 2017- Present)
- Ag Springboard Entrepreneurship Pitch Contest Finalist (2016)
    - Developed a business venture associated with recycling and repurposing polystyrene, in the form of used party cups
    - Built a team of people to develop, plan, and execute the pitch
    - Created a video explaining the venture for the preliminary rounds and presented to a panel of distinguished alumni and professionals for the final round
- Dean's List (August 2014 – Present)
- Recipient of the following scholarships for excellence in academics and extra curricular involvement:
    - Baldwin Memorial Scholarship (2016, 2017)
    - J&M Stehman Scholarship (2016, 2017, 2018)

- Smith Scholarship in Ag Sciences (2016, 2017)
- Galen and Beth Clay Scholarship (2016, 2017)
- Dreibelbis Endowment for Excellence in Ag (2017, 2018)
- Shute Agricultural and Biological Engineering Scholarship (2017, 2018)

SKILLS AND EQUIPTMENT:

- Proficiency in Microsoft Word, PowerPoint, Excel, and Pivot Tables
- Understanding of Python, MATLAB, and fundamentals of programming
- Understanding of data carpentry, both the skills and resources available (e.g. SQL and Python)
- Ability to comfortably use equipment necessary to conduct the following tests:
    - Fourier transform infrared spectroscopy (FTIR)
    - Thermogravimetric Analysis (TGA)
    - Elemental Analysis (CHN-O)
    - Surface Area
    - Calorimeter (HHV)
    - Pyro GC/MS