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Benefits of Reduced Meat Consumption in the U.S.: Cost-Benefit Analysis of an Increase in Plant-Based Diets

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I. Executive Summary

With negative impacts of climate change looming over our heads, many people believe that there is little a single individual can do to reduce our global environmental footprint. This leads us to the false notion that making small changes in our daily routine (taking shorter showers, driving electric vehicles, investing in solar panels, recycling, etc.) will satisfy our individual necessity to combat climate change. While those incremental changes in lifestyle may be beneficial, the heart of the problem associated with climate change is a result of consumer choices within the food market. Specifically, our excessive consumption of meat and dairy products.

As of 2016, 10.6 million people in the US, or about 3% of the population, are vegan[1]. This CBA aims to increase the amount of non-meat eaters in the US by 10%, resulting in 13% of the population practicing plant-based diets over a 25-year timeframe. The results from this cost benefit analysis show that 13% of the population in 2040, an estimated 49,048,000 people, will not consume meat and save a total 9,809,650 pounds of meat over the 25-year period. Additionally, results show that if 13% of the population did not consume meat, over 16.5 billion gallons of water would be saved - this is a key finding considering the water shortage issues the U.S. is currently facing. This finding also highlights the animal agriculture industry's intensive and inefficient use of our water resources. Furthermore, the animal agriculture industry is a large contributor to greenhouse gas emissions, and the results of this study found that $3.9 billion would be saved in carbon costs. Ultimately, this study determined a positive net present value of $279,471,610. In comparison to traditional benefit-cost analyses, this analysis is more qualitative in nature, and therefore values may be understated. The benefits that a single person gains after transitioning to a plant-based diet are highly dependent on individual characteristics (i.e. health/lifestyle), and therefore vary between each individual. In addition, individual and societal benefits will continue to be received long after the projected lifetime value of 25 years, and generations to come will be able to reap the benefits as well.

In any case, yielding a positive net present value sheds light on the negative externalities associated with the animal agriculture industry, and the social costs incurred by our society and the environment. The results of this study find that it would be beneficial if 13% of the population would switch their diet choices and become plant-based, therefore exemplifying that an increase in the amount of people who do not consume meat would have a positive impact on our society - potentially creating incentive for people to switch their diet choices in order to reduce costs to our culture and economy as a whole. The positive net present value determined by this study shows policy makers the societal benefits (gallons of water saved/reallocated, reduced emissions and carbon costs, increased human health, etc.) of incentivizing a transition in diet. Aside from the analysis, a survey was conducted to consider the trends of diet choices and perspectives of my peers and professors at the University of Rhode Island.

[1] (http://www.vrg.org/nutshell/Polls/2016_adults_veg.htm)

II. Introduction and Background

Food is often thought of as a commodity, when fundamentally it is our nourishment and foundation of life. In the United States, it appears as if we have a functional food system, but in reality what we have is an unsustainable system of industrialized agriculture perpetuated by a disproportionate allocation of resources. Current consumer behavior within our food system is detrimental to future environmental and human well being, ultimately exacerbating the timing and magnitude of global climate change.

A change in diets, and therefore a change in consumer behavior, may be more effective than combatting climate change with technological mitigation strategies alone. At the very least, a reduction in consumption of meats and dairy products is essential to avoid further negative environmental impacts. Reducing meat consumption will create tangible benefits almost immediately through reduction of greenhouse gas emissions[2] and decreased pressure on land and water use. On a global scale, livestock and their byproducts account for at least 32,000 million tons of carbon dioxide (CO2) equivalents per year, or 51% of all worldwide greenhouse gas emissions[3]. In addition, cows produce 150 billion gallons of methane per day globally[4] - methane has a global warming potential 86 times that of CO2 on a 20-year time frame[5]. On a domestic scale, growing feed crops for livestock consumes 56% of water in the U.S[6]. Roughly 2,500 gallons of water are needed to produce 1 pound of beef[7]. Additionally, 5% of water consumed in the US is by private homes while 55% of water consumed in the US is for animal agriculture[8]. Studies estimate that each day, a person who eats a vegan diet saves 1,100 gallons of water, 45 pounds of grain, 30 sq ft of forested land, 20 lbs CO2 equivalent, and one animal's life[9].

The animal agriculture industry inefficiently exhausts our scarce resources like land and water, and highly contributes to global greenhouse gas emissions. Farmed animals are fed more than 70% of the grains (corn, soy, wheat) grown in the US. It takes 4.5 pounds of grain to make 1 pound of chicken meat and 7.3 pounds of grain to produce 1 pound of pork. 700 calories worth of feed are needed to produced one 100 calorie piece of beef - these ratios are extremely inefficient, as an estimated 1.4 billion people could be fed with the grain and soybeans fed to cattle aone. The amount of feed we need to produce a 8-ounce steak would fill 45-50 bowls with cooked cereal grains[10]. In addition, growing feed crops for livestock consumes 56% of water in the US. Therefore, when grain supplies are fed to livestock rather than directly to humans, it is

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2 U.N. Press Release, Climate Summit 2014.

3 Goodland, R Anhang, J. "Livestock and Climate Change: What if the key actors in climate change were pigs, chickens and cows?"

4 Ross, Philip. "Cow farts have 'larger greenhouse gas impact' than previously thought; methane pushes climate change." International Business Times. 2013.

5 "Improved Attribution of Climate Forcing to Emissions." Science Magazine.

6 Jacobson, Michael F. "More and Cleaner Water." In Six Arguments for a Greener Diet: How a More Plant-based Diet Could save Your Health and the Environment. Washington, DC: Center for Science in the Public Interest, 2006.

7 Oxford Journals. "Water Resources: Agricultural and Environmental Issues"

8 Jacobson, Michael F. "More and Cleaner Water." In Six Arguments for a Greener Diet: How a More Plant-based Diet Could save Your Health and the Environment. Washington, DC: Center for Science in the Public Interest, 2006.

9 ftp://ftp.fao.org/docrep/fao/010/a0701e/a0701e03.pdf

10 https://www.peta.org/living/humane-home/pays-vegan/

imperative to note the significant amount of energy and resources lost in the conversion of grain calories to meat calories[11]. Moreover, it is evident that the current crop production in the United States is disproportionately structured to meet the needs of feed for animal agriculture instead of direct human consumption.

Information regarding the correlation between the meat industry and negative environmental impacts is not yet widely well-known to the public, leaving many people to question how a reduction in meat consumption would be more effective in reducing emissions than driving an electric vehicle, as they are not able to see the link between animal agriculture and greenhouse gas emissions.

Livestock, especially cattle, produce methane as part of their digestion - a process called enteric fermentation. Methane's lifetime in the atmosphere is much shorter than carbon dioxide, but methane is actually more efficient at trapping radiation than CO2. Pound for pound, the comparative impact of methane (CH4) is more than 25 times greater than CO2 over a 100-year period[12]. Livestock represents almost one third of the emissions from the Agriculture sector. In 2014, greenhouse gas emissions from agriculture accounted for approximately 9 percent of total U.S. greenhouse gas emissions, an 11% increase since 1990[13]. On a global scale, Cattle (raised for both beef and milk, as well as for inedible outputs like manure and draft power) are the animal species responsible for the most emissions, representing about 65% of the livestock sector's emissions[14].

An increase in the population of people who practice plant-based diets, therefore a reduction in the demand for and production of meat, will in turn reduce the amount of grain crops used for feed, and eventually in combination with a rise in demand for vegetable crops, allow more land to be allocated towards such crops. An increase in plant-based population will also reduce intense water usage for animal feed crop and be allocated more efficiently. An increase in plant-based population will contribute to a necessary reduction of greenhouse emissions specifically methane - having a crucial impact on the pace of global climate change.

Aside from environmental aspects, there are a multitude of human health costs linked to the consumption of meat and dairy. "The American Heart Association recommends an upper limit of 138 lbs of lean meat per person each year, more than 80 lbs less than the current average U.S. consumption of 222 lbs. This dietary pattern increases the risk for heart disease, certain types of cancer, stroke and diabetes – four of the leading causes of death in the USA. The costs due to poor diet for just these four diseases are estimated to exceed $33 billion per annum. On the other hand, high intakes of fruits, vegetables and whole grains and 'Mediterranean' dietary patterns, typically high in plant-based foods and unsaturated fats, lower the incidence of chronic diseases

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[11] (https://www.cambridge.org/core/services/aop-cambridge-core/content/view/B22CB5C2097A13C6745A94B6D6B81284/S1368980005000492a.pdf/public-health-implications-of-meat-production-and-consumption.pdf))

[12] (https://www.epa.gov/ghgemissions/sources-greenhouse-gas-emissions)

[13] Ibid.

[14] (http://www.fao.org/news/story/en/item/197623/icode/)

and their risk factors, including body mass index and obesity"[15]. In addition, contrary to popular belief, meat is not a necessary component of a well-planned diet. Current research suggest that diets high in animal protein (regardless of fat content) increase the risk of cardiovascular mortality, and plant-based diets may actually lower the risk for chronic diseases[16].

Determining and quantifying the direct health effects of the reduced consumption of meat is a highly difficult, long-term project, and therefore is beyond the scope of this study. But, one cannot ignore the direct negative impact meat consumption has on human health. Furthermore it is imperative to note that if human health costs were included in this study, they would be the largest driver of the net present value. Again, due to the timeframe and degree of difficulty associated with the human health costs, this study takes a large focus on the environmental effects of reduced meat consumption in the U.S.

III. Objectives

The objective of this cost benefit analysis is to calculate the economic impacts of a reduction in meat consumption in the US. This analysis, qualitative in nature, is conducted in attempt to assess the desirability of a plant-based diet. The benefit-cost analysis will be based on the assumption that non-meat eaters in the US will increase by 10%, resulting in 13% of the population on a plant-based diet over a 25-year period. This study assess positive and negative impacts associated with a reduction in the consumption of meat products. The analysis will take the environmental effects of the proposed shift in consumption, such as the social cost of methane and carbon dioxide equivalents and water usage.

As a result of this analysis, I expect to see that a reduction in meat consumption will not only yield positive a net benefit, but reduce environmental impacts highly correlated to global climate change and cause a continuous shift in consumer choices. The outcome of this analysis seeks to provide a foundation upon which feasible recommendations are constructed.

IV. Analysis

This benefit cost analysis will consider possible benefits that will be derived from a reduction in the consumption of meat, beef, and poultry over a 25-year period. The 25-year project timeframe was determined under the assumption that 25 years is a generation's length of

[15] Walker. "Public health implications of meat production and consumption" Public Health Nutrition: 8(4), 348–356
[16] Ibid.

time. As education and information regarding the correlation to diet choices and environmental impact expand over time, this study aimed to determine the benefits of a shift in consumer choices over one generation's time - providing a basis for incentive to switch diet choices.

Benefits

As of 2016, roughly 3% of the population do not consume meat/practice a vegan diet. The benefits were determined based off of the project assumption that the non-meat eating population will increase 10%, resulting in 13% of the population practicing plant-based diets by 2040.

The pounds of meat saved was determined by multiplying the average pounds of meat consumed by Americans by the number of people transitioning to a plant-based diet over the 25-year timeframe. This analysis will assume and consider an increase in worker wages resulting from farms switching from animal agriculture to crop production. To determine the benefit of switching, the average income of animal agriculture workers is subtracted from the average income of crop production workers. Subsequently, the increase in worker wages is determined by multiplying the number of farms that produce livestock by the benefit to switching to crop production; the result is then multiplied by the percent population of non meat eaters subtracted by 0.033 (representing the 3.3% population vegan in 2016).

The cost of carbon equivalent monetary value is calculated by multiplying the amount of greenhouse gasses emitted per animal (cow, pig, chicken) by the social cost of carbon equivalent, which was $40 per metric ton[17].

The water usage is determined first by finding the amount of water needed per pound of meat for each type of animal - this value is then multiplied by the pounds of meat saved. Due to the debated ambiguity that comes with the topic of water usage in projects such as this, a value of $0.01 for each gallon of water saved is used. Therefore, the monetary value of total average gallons of water saved is calculated by multiplying the pounds of meat saved by the average animal water usage and the cost of water ($0.01).

The net present value is equal to the difference between the present value of costs and the present value of benefits discounted at 7% rate. Given the intensity of the negative externalities associated with the animal agriculture industry, a positive NPV was expected. The NPV $297 million seems low given that the entire U.S. population is taken into account and the average american household spends $7,000 on food each year. But, in fairness, only 13%, a small portion of the entire population was considered to reduce their consumption. The discounted horizon value is $161661044.2, resulting in the increased NPV of $441,132,654.

[17] http://costofcarbon.org/faq

Pounds of Meat Saved	9,809,650
Cost of Carbon Equivalent ($ billion)	$3.9
Total Average Gallons Saved (Water)	165,959,212,591
Water Value	$1659,592,126
Worker Wage Increase	$6,948,153,749
Present Value	$279,471,610

Costs

The lost wages from the meat industry workers was determined by multiplying the average wage per worker in the meat industry ($32,250) by the number of displaced workers as a result of the project (assuming a 3% displacement). The cost of loss profits from meat sales was calculated by taking the average price of meat, $4.41 and multiplying this value by the pounds of meat saved by the increase in vegan population.

Lost Wages in Meat Industry	$5,999,988,000
Lost Meat Sales	$642,042,585
Present Value	$1,223,788,672

Survey

A survey was conducted in conjunction to this analysis in order to gain further insight on the knowledge, perspective, and attitudes of the environmental impact of diet choices.The two-part survey was administered at the University of Rhode Island 2017 Honors Colloquium. 150

copies of each survey was printed - Survey I received 37 responses and Survey II received 17 responses, therefore, while the results are not statistically significant, conclusions still can be drawn and discussed. The first survey, 'Our Diets and the Environment I' was administered before the audience viewed a poster containing infographics regarding the environmental impacts of the animal agriculture industry. The second survey, 'Our Diets and the Environment II' was administered after I explained the information and answered any questions. The purpose of the sequential surveys was to assess the knowledge and attitudes prior to and after the audience was exposed to such information. Given a larger sample size, significant information could be determined and incorporated in further analysis and policies.

Survey I contained 6 questions and received 40 responses. The questions were aimed towards general demographics and knowledge of environmental topics.

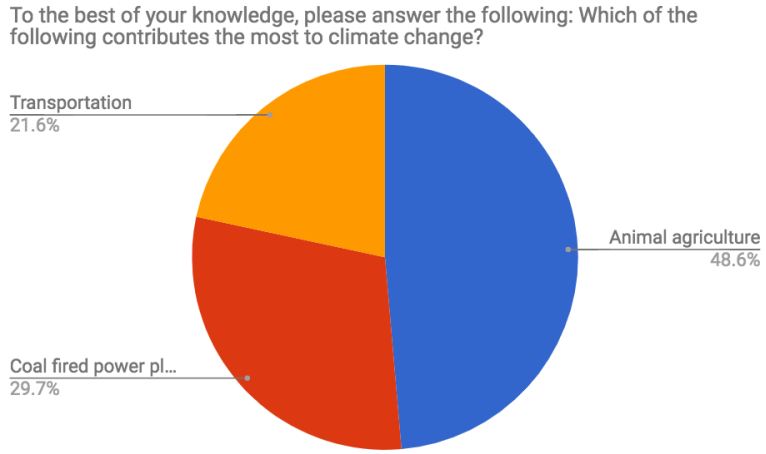

Figure 1. Survey I response to: Which of the following contributes the most to climate change? The correct answer to the question is animal agriculture - the question was posed to assess basic knowledge of the topic, based off of the assumption that many people are not aware that animal agriculture is more harmful to the environment than coal or other sources. This figure illustrates that almost half of the sample answered correctly, but a slight bias should be considered due to an assumption being made because the audience was aware of the general topic of my poster.

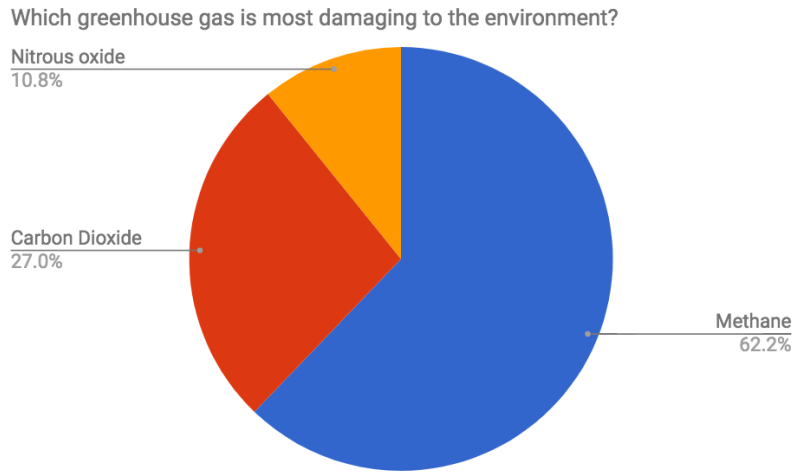

Figure 2. Survey I response to: Which greenhouse gas is most damaging to the environment? The correct answer to the question is methane. This question was posed with the same intent and bias as *Figure 1*. Again, the figure illustrates that the majority of respondents answered correctly, but the same bias applies. 27% of the sample responded carbon dioxide, which could be concluded that they are unaware of the impact of methane and further, the connection that methane has to animal agriculture industry.

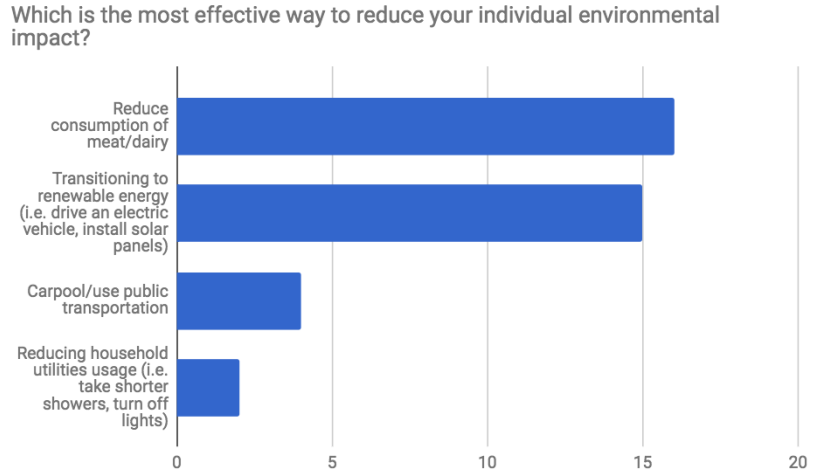

Figure 3. Survey I response to: Which is the most effective way to reduce your individual environmental impact? The desired answer is to reduce consumption of meat/dairy. This question was posed to draw conclusions about the perspective of the sample in regards to their individual ability to manage their impact on the environment. The same intent and bias as Figure 1 and 2 is implied.

Survey I revealed that 78% of the sample was of the age 18-24. This age range was expected, as the survey was administered at a university student event. In addition, 40.5% of the sample graduated from college, 32% had 3 years of college education, 16% completed graduate school, and 10% had some graduate school - representing that the entire sample had at least 3 years of higher education. 73% of the sample was female. This is interesting because the targeted

audience is also associated with being more environmentally conscious as well as having more control in household food-choice/consumption decision making.

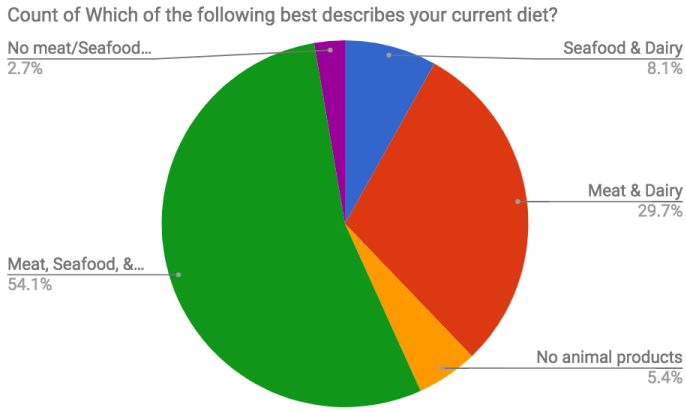

Figure 6. Survey I response: Which of the following best describes your current diet? This question was posed to assess the diet choices of the sample. 54% of the sample had a diet consisting of meat, seafood, and dairy - the most resource exhaustive of the options.

35% of the sample agrees that they feel well informed and the environmental impacts of their diet. The results from Survey I reflect that the entire sample had at least some college education, 35% somewhat agree that they are aware of the environmental impact and 29% somewhat disagree.

Survey II had 4 questions and received 17 responses. This survey was administered after information was displayed regarding the negative environmental impacts caused by the animal agriculture industry. The purpose of this survey was to assess any change in perspective/attitude within the sample after being exposed to information.

47% of the sample was somewhat aware and 29% were completely aware of the environmental impacts of their diet choices. 47% somewhat agree that they feel well informed about the environmental impacts of their diet choices, and 41% strongly agree. 41% Reduce meat consumption by practicing “a day without meat”. 29% only eat meat at certain meals. Eat more poultry and fish and cut back on red meats. 23% would not consider. 50% are unlikely to reduce their consumption of meat or animal products because they like the taste. 35% are unlikely because it was be inconvenient not to. 42% because their friends and family eat meat.

VII. Horizon Value

The horizon value determined from this analysis takes the overall health benefits derived from the individuals who chose to convert to a plant-based diet into consideration. Studies show that mortality rates due to adopting a healthier diet will decrease from 9% to 15%. In addition, there are numerous non monetized effects that were not included in this study, such as pesticide usage, runoff of fertilizers, waste management, and the future impact that decreasing greenhouse gasses will have on the environment and human health. Therefore, to calculate the horizon value of this project, the 49,048,000 individuals who switched to the vegan diet is multiplied by the value of a statistical life which was found to be $3.6 million per person. This value is then multiplied by the decrease in mortality rate of 6%. The horizon value of this analysis is determined to be $2309443488, and the future generations that will continue to reap benefits should be taken into consideration as well.

VII. Recommendation

After analysing the results of the data from this project, it is recommended that this would be a good project to implement. The benefits of a transition to plant-based diets outweigh the costs. The amount of meat that the average American consumes is neither efficient nor sustainable and will not be able to keep up with population growth rates. This fact is why it has become a necessity that more people start switching to less meat intensive diets or even to the extreme of the vegan diet. This diet switch will not only be better for the environment but also for personal health. Therefore, I recommend choosing the plant-based diet for human health, environmental, and moral reasons. Although this analysis constitutes of many qualitative benefits and costs, ultimately, reduced meat consumption will benefit society on a global scale. Meat production and consumption is a large contributor to climate change, and a massive transition to plant-based diets is imperative to a sustainable future and combatting impending climate change. It is important to recognize the power that the meat industry holds in the US market, so altering it through policy may have to be done cautiously and may take time that we do not have to spare. The animal agriculture industry is extremely water intensive, and on a global scale, we have constant reduction in our freshwater supply, therefore even a small reduction in water use practices would have an impact and tangible benefit.

Although ultimately a net present value was determined, there are limitations to this study that should be acknowledged as caveats to the analysis. This study did not consider an increase in prices over time, which would occur as a result of higher transportation costs, less available land and water. In addition, there may be a variation in pounds of meat consumed by individuals. There are also variations in prices for carbon, water, and land use. Moreover, as previously mentioned, this study did not take the (potentially large) health benefits into account.

Efficient relevant policies would maximize incentives for sustainable agriculture techniques and take into account local ecology and strive to achieve little to no not loss of resources. Such policies would include decreasing subsidies for the production of grain and

incentive toward multi-rotation crop agriculture. Effective policies should encourage diets lower in meat and higher in vegetables, fruits, and grains in attempts to curb the current amount of high-meat diets. These policies should integrate education regarding food choices and the connection between nutrition and environmental impact. Policies should attempt to create a framework that captures the real externalities of meat production and include such costs in the market price of meat.

In conclusion, the results of this study show that a reduction in meat consumption would yield positive benefits and measures should be taken by policy makers to incentivize a switch in diets and sustainable agricultural practices.

Appendix

Assumptions Table

% of Vegans	13
Meat Eaters Population Change	.82 to .5
life of project (years)	25
population 2016	323,996
population 2041	380,200
Pounds of meat consumed	200
Gallons of water per pound of corn	147
Gallons of water per pound of beef	1800
feeding cow 3 months (lb/feed)	1000
number of beef cows (millions)	30.3
chickens (billions)	8.6
hogs (millions)	112
pounds of pork (billions)	23.2
pounds of chicken(billions)	38.4
workers were employed in the meat and poultry packing and processing industries.	482,100
In all, companies involved in meat production, along with their suppliers, distributors, retailers and ancillary industries employ	6.2 million people
Total Wages	$200 billion

value of water ($/gal)	$0.01			Range	
cost of carbon per metric ton (co2e)	$40.00			36-100	
1 lb beef/lb grain(feed)	15.43				
1 lb pork/lb grain(feed)	8.81				
1 lb poultry/lb grain(feed)	2.2				
Emissions by animal CO2e metric tons			Carbon costs per animal type (Millions)		Benefit from switching from animal to crop farming
beef cow	216		$8,634.80		$38,172.00
pigs	27.66		$1,106.40		
chickens	4.98		$199.20		

Average Income Animal Production	$32,250.00	Total	$3,313.47		
Average Income crop Production	$70,422.00				
Crops sales ($ billions)	$212.40				
Livestock sales($ billions)	$182.20				
farms that mostly produce livestock	143,242				
social cost of job loss	10.00%				

Average Price of Meat In The US

	Avg meat price calculations			
Ground chuck, 100% beef, per lb. (453.6 gm)		4.119	3.791	3.742
Ground beef, 100% beef, per lb. (453.6 gm)		4.083	3.665	3.679
Ground beef, lean and extra lean, per lb. (453.6 gm)		6.097	5.764	5.693
All uncooked ground beef, per lb. (453.6 gm)		4.572	4.22	4.158
Chuck roast, graded and ungraded, excluding USDA Prime and Choice, per lb. (453.6 gm)		5.104	4.88	4.836
Chuck roast, USDA Choice, boneless, per lb. (453.6 gm)		5.546	5.163	5.129
Round roast, USDA Choice, boneless, per lb.		5.523	5.016	4.82

(453.6 gm)				
All Uncooked Beef Roasts, per lb. (453.6 gm)		5.762	5.315	5.277
Steak, round, USDA Choice, boneless, per lb. (453.6 gm)		6.209	6.067	5.807
Steak, round, graded and ungraded, excluding USDA Prime and Choice, per lb. (453.6 gm)		6.174	5.738	5.755
Steak, sirloin, USDA Choice, boneless, per lb. (453.6 gm)		8.802	8.585	8.323
Beef for stew, boneless, per lb. (453.6 gm)		5.579	5.05	5.196
All Uncooked Beef Steaks, per lb. (453.6 gm)		7.836	7.51	7.413
All Uncooked Other Beef (Excluding Veal), per lb. (453.6 gm)		4.648	4.503	4.497
Bacon, sliced, per lb. (453.6 gm)		5.899	5.481	5.375
Chops, center cut, bone-in, per lb. (453.6 gm)		4.106	3.89	3.92
Chops, boneless, per lb. (453.6 gm)		4.355	4.031	3.945
All Pork Chops, per lb. (453.6 gm)		3.875	3.662	3.632
Ham, boneless, excluding canned, per lb. (453.6 gm)		4.232	4.126	4.054
All Ham (Excluding Canned Ham and Luncheon Slices), per lb. (453.6 gm)		3.155	3.135	3.105
All Other Pork (Excluding Canned Ham and Luncheon Slices), per lb. (453.6 gm)		2.803	2.694	2.665
Bologna, all beef		2.65	2.657	2.718

or mixed, per lb. (453.6 gm)				
Chicken, fresh, whole, per lb. (453.6 gm)		1.43	1.487	1.502
Chicken breast, boneless, per lb. (453.6 gm)		3.356	3.244	3.305
Chicken legs, bone-in, per lb. (453.6 gm)		1.61	1.548	1.509
Turkey, frozen, whole, per lb. (453.6 gm)		1.558	1.649	1.692
		4.580115385	4.341192308	4.297961538
		Average Meat Price		$4.41

Benefit Calculations

	%vegan	lbs of meat saved total	cost of carbon saved (millions $) %vegan-.033*carbon cost per animal type	water usage total avg (gallons) lbs meat saved * av usage	income increase from project (all farms) farms that produce livestock *benefit to switching * %vegan - 0.033
2016	0.033	2138373.6	0	2435607530	0
2017	0.037	2417032.4	13.25388	2752999904	23160512.5
2018	0.041	2699899.2	26.50776	3075185189	46321024.99
2019	0.045	2986956	39.76164	3402142884	69481537.49
2020	0.049	3278129.4	53.01552	3733789387	92642049.98
2021	0.053	3573355.4	66.2694	4070051801	115802562.5
2022	0.057	3872557.2	79.52328	4410842651	138963075
2023	0.061	4175657.4	92.77716	4756073779	162123587.5
2024	0.065	4482582	106.03104	5105660898	185284100

2025	0.069	4793223	119.28492	5459480997	208444612.5
2026	0.073	5107459.6	132.5388	5817396484	231605125
2027	0.077	5425127.4	145.79268	6179220109	254765637.5
2028	0.081	5746107.6	159.04656	6544816556	277926150
2029	0.085	6070241	172.30044	6914004499	301086662.4
2030	0.089	6397355.6	185.55432	7286588028	324247174.9
2031	0.093	6727341	198.8082	7662441399	347407687.4
2032	0.097	7060048	212.06208	8041394672	370568199.9
2033	0.101	7395341.2	225.31596	8423293627	393728712.4
2034	0.105	7733166	238.56984	8808076074	416889224.9
2035	0.109	8073368.4	251.82372	9195566608	440049737.4
2036	0.113	8416014	265.0776	9585839946	463210249.9
2037	0.117	8760983.4	278.33148	9978760093	486370762.4
2038	0.121	9108275	291.58536	10374325225	509531274.9
2039	0.125	9457825	304.83924	10772462675	532691787.4
2040	0.129	9809650.2	318.09312	11173191578	555852299.9
		total	3976.164	165959212591	6948153749
			3976164000	1659592126	
	first year		13253880	$24,356,075.30	
	first year total	$60,770,467.80			
	total benefits: cost of carbon millions +water usage * 0.01 + income increase				
	12583909875				
	$6,688,211,314				
	horizon value	2309443488			
	PV	2744088108			
		161661044.2			

Cost Calculations

year	population	lbs meat saved	Number of people emplyed by meat market	loss wages	cost of lost meat sales--> lbs meat saved * av price meat
2016	323,996	2,138,374	6,200,000	$0	$9,422,579
2017	326,626	2,417,032	6,192,560	$23,999,952	$10,650,467
2018	329,256	2,699,899	6,185,120	$47,999,904	$11,896,898
2019	331,884	2,986,956	6,177,680	$71,999,856	$13,161,792
2020	334,503	3,278,129	6,170,240	$95,999,808	$14,444,825
2021	337,109	3,573,355	6,162,800	$119,999,760	$15,745,716
2022	339,698	3,872,557	6,155,360	$143,999,712	$17,064,125
2023	342,267	4,175,657	6,147,920	$167,999,664	$18,399,713
2024	344,814	4,482,582	6,140,480	$191,999,616	$19,752,153
2025	347,335	4,793,223	6,133,040	$215,999,568	$21,120,968
2026	349,826	5,107,460	6,133,040	$239,999,520	$22,505,628
2027	352,281	5,425,127	6,125,600	$263,999,472	$23,905,407
2028	354,698	5,746,108	6,118,160	$287,999,424	$25,319,781
2029	357073	6,070,241	6,110,720	$311,999,376	$26,748,050
2030	359402	6,397,356	6,103,280	$335,999,328	$28,189,455
2031	361685	6,727,341	6,095,840	$359,999,280	$29,643,511
2032	363920	7,060,048	6,088,400	$383,999,232	$31,109,558
2033	366106	7,395,341	6,080,960	$407,999,184	$32,587,002
2034	368246	7,733,166	6,073,520	$431,999,136	$34,075,601
2035	370338	8,073,368	6,066,080	$455,999,088	$35,574,677
2036	372390	8,416,014	6,058,640	$479,999,040	$37,084,518
2037	374401	8,760,983	6,051,200	$503,998,992	$38,604,599
2038	376375	9,108,275	6,043,760	$527,998,944	$40,134,913
2039	378313	9,457,825	6,036,320	$551,998,896	$41,675,178
2040	380219	9,809,650	6,028,880	$575,998,848	$43,225,469
					$642,042,585

jobs lost	Total wage loss	social cost
186000	5999988000	599998800
jobs lost per		

year		
7440		
	total costs	PV
	$6,642,030,585	$1,223,788,672
	first year	
	$33,422,531	

Net Present Value Calculations

Assumptions:						
Horizon Value		$2,309,443,488				
Annual Discount Rate		0.07				
Annual Growth Rate of Benefits		0.0033				
Costs		$33,422,531				
First Year Benefit		$60,770,468				
			Annual	Annual	Annual	PV Annual
	Year	Year	Cost	Benefit	NB	NB
	2016	0	$33,422,531	0	-$33,422,531	-$33,422,531
	2017	1	$33,532,825	$60,770,468	$27,237,643	$25,455,741
Net Present Value	2018	2	$33,643,483	$60,971,010	$27,327,527	$23,868,920
$279,471,610	2019	3	$33,754,507	$61,172,215	$27,417,708	$22,381,017
	2020	4	$33,865,897	$61,374,083	$27,508,186	$20,985,864
	2021	5	$33,977,654	$61,576,617	$27,598,963	$19,677,679
	2022	6	$34,089,781	$61,779,820	$27,690,040	$18,451,043
	2023	7	$34,202,277	$61,983,694	$27,781,417	$17,300,870
	2024	8	$34,315,144	$62,188,240	$27,873,096	$16,222,395

	2025	9	$34,428,384	$62,393,461	$27,965,077	$15,211,149
	2026	10	$34,541,998	$62,599,360	$28,057,362	$14,262,940
	2027	12	$34,655,987	$62,805,937	$28,149,951	$12,498,915
	2028	13	$34,770,351	$63,013,197	$28,242,846	$11,719,777
	2029	14	$34,885,093	$63,221,141	$28,336,047	$10,989,208
	2030	15	$35,000,214	$63,429,770	$28,429,556	$10,304,179
	2031	16	$35,115,715	$63,639,089	$28,523,374	$9,661,853
	2032	17	$35,231,597	$63,849,098	$28,617,501	$9,059,568
	2033	18	$35,347,861	$64,059,800	$28,711,938	$8,494,827
	2034	19	$35,464,509	$64,271,197	$28,806,688	$7,965,289
	2035	20	$35,581,542	$64,483,292	$28,901,750	$7,468,761
	2036	21	$35,698,961	$64,696,087	$28,997,126	$7,003,185
	2037	22	$35,816,768	$64,909,584	$29,092,816	$6,566,632
	2038	23	$35,934,963	$65,123,785	$29,188,822	$6,157,291
	2039	24	$36,053,548	$65,338,694	$29,285,146	$5,773,467
	2040	25	$36,172,525	$65,554,312	$29,381,787	$5,413,570
					NPV	$279,471,610