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**WASTED:
UNDERSTANDING THE ECONOMIC AND SOCIAL IMPACT OF
FOOD WASTE**

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WASTED: UNDERSTANDING THE ECONOMIC AND SOCIAL IMPACT OF FOOD WASTE.

ABSTRACT

Over one-third of global food production goes to waste while over 850million people are fighting chronic hunger. The United States is the world's largest food waster. One third of America's food with an economic value of US\$161 billion is wasted and less than 7% is recycled. American food waste ends up in landfills creating powerful methane gas emissions. South Korea, on the other hand, has implemented the world's strictest food waste laws, and today diverts 93% of wasted food away from landfills turning such waste into powerful economic opportunities. This Master Thesis investigates the reasons behind global food waste by comparing South Korea and the US. It explores what these two nations are doing to address their respective food waste problems, South Korea successfully, the US not. The paper looks at the two countries' respective policies and national characteristics, which impact decision-making and recycling processes. The effort concludes that South Korea has embarked on a necessary paradigm shift turning food waste into powerful economic drivers leading to a sharp decline in food waste. In the US, food waste continues to be a major problem without a national strategy to remedy waste. Any effort in the US, while laudable, is sporadic and local, and hence the US misses out on possibly important economic growth opportunities.

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1 INTRODUCTION

1.1 Food Waste – Why it Matters

About one-third of global food production goes to waste.ⁱ What societies thoughtlessly leave to rot in fields, landfills, and refrigerators may contribute to helping end world hunger – quickly, simply, and perhaps even permanently. In contrast, an estimated 842 million people around the world are suffering from chronic hunger.ⁱⁱ

Wasted food is the tragic byproduct of wealthy and developed nations, yet its ripple effects are felt half a world away from the developed world's doublewide refrigerators and overflowing landfills. Over the past decade, the World Food Price Index has doubled, and grain stocks have dropped to new lows; this trend has been amplified with the ever-rising demands of developed countries food that is increasingly at odds with the needs of developing nations.ⁱⁱⁱ Today, importing countries are buying large tracts of foreign land to grow food for their own, and to protect vital future food supplies. Experts are beginning to pose some troubling questions: Will food become the next breaking point for the rich nations of the world as it was for so many civilizations in the past? Are more food riots, political instability, and mass migration around the corner?

The environmental impact is equally significant. Forests are destroyed to create agricultural land for crops that aren't needed, and 10% of the greenhouse gas emissions from First World countries are released to grow food that will never be consumed.^{iv} Global food waste is a major international challenge. While one can argue that there is a moral imperative to

tackling food waste, there are other important factors that necessitate addressing the global food waste problem, especially when considering the following facts:

- Hunger is the world's number one health-risk. The World Food Programme reports that hunger kills more people every year than AIDS, malaria, and tuberculosis combined.^v
- One in seven people in the world goes to bed hungry every night – that is more than the combined populations of the United States, Canada, and the European Union.^{vi}
- The fossil fuels wasted growing, processing, transporting, and refrigerating the food Americans throw out instead of eating it each year equals 70 times the amount of oil spilled into the Gulf of Mexico during the Deepwater Horizon disaster.^{vii}
- In South Korea, over 93 percent of food waste is recycled.^{viii} In the United States, 93 percent is not.^{ix}

Putting on an economic value analysis lens, this Master Thesis compares two developed countries, which are on the opposite spectrum of dealing with their respective food waste problems.

- The United States is the world's leading food waster. According to the US Environmental Protection Agency over 36 million tons of food waste generated by restaurants, stores and households winds up in landfills each year.^x Only 5% is diverted from landfills and incinerators to composting facilities.^{xi} In other words, over 93% of American food waste is not recycled.^{xii} Food waste in America has an economic value of \$161 billion per year.^{xiii}

- Over the last forty years, South Korea has undergone an impressive economic transformation – dubbed *The Miracle on the Han River*. South Korea emerged from a country with the GDP levels on par with that of poorer African nations to become an economic powerhouse.^{xiv} With rising income levels, the Country has also faced major environmental challenges. Pollution resulting from a weak waste infrastructure that did not develop at the same pace as the Country's rapid urbanization ultimately forced the Government to develop and implement the world's strictest food waste law (the connection between regular waste and food waste will be explained below in more detail). Today, only 3% of the country's food waste ends up in landfills.^{xv} As a matter of fact, the Country now understands that food waste is not merely waste to be discarded but has the potential to be a major economic growth driver.

1.2 Focus & Objective

This Thesis investigates the global food waste problem researching by comparing the US and South Korea. It argues that addressing global food waste is not only a necessity but is also closely linked to other major international issues such as climate change, poverty and security. Food commodity prices have close to doubled in the last ten years, and changing climate patterns will continue to drain the planet's already strained resources. According to an independent 2005 Report backed by 1,360 scientists from 95 countries "human activity is putting such a strain on the natural functions of the Earth that the ability of the planet's ecosystems to sustain future generations can no longer be taken for granted."^{xvi} Creating economic and supply chain efficiencies from farm to table while encouraging consumer awareness is now a matter of necessity, not luxury.

As will be explained in more detail, this paper explores whether the US and other developed countries must rethink the food value paradigm. To show that addressing food waste is indeed possible, the Thesis studies both South Korea and the United States to understand: (1) what led to South Korea's food waste problem. The thesis suggests that the US is dealing with a similar food waste problem today – one that South Korea has successfully tackled – and that ignoring the problem means also ignoring potential economic growth opportunities; (2) explores the government policies South Korea has embarked upon to address the problem, and (3) what lessons the US can draw upon from the South Korean experience.

By exploring the challenges and successes of South Korea, this Thesis suggests that attaching economic value to food waste is not only crucial in addressing the problem but that countries that indeed attach concrete monetary value to food waste can transform “waste” into valuable economic growth drivers. The paper will consider a Washington, DC based case study in support of this premise to showcase the limited, grassroots efforts that are taking place in the US.

1.3 Methodology

There is limited prior research available comparing the US and South Korea in English language publications. Research on food waste itself is an emerging field of study. Hence, this Thesis aims to pursue exploratory research, and as such make a small contribution in linking food waste to economic drivers. It also argues the need for forward thinking

policymaking. The benefits are not only financial and economic in nature but also address important global issues such as poverty and climate change.

The following references form the foundation for this research methodology:

Interviews (list of interviewees in Appendix A) in South Korea and the US with important and well-established individuals in Food Waste including scientists, policymakers, members of civil society and individual consumers. Interviewees were selected with two goals: first, to be able to accurately describe the food waste supply chain from harvest to retail to consumption to disposal (or recycling the case of South Korea) and second, due to their ability to connect food waste to larger and more complex global issues (particularly in the US case).

- Data analysis and other research available that explain the scale and economic impact of food waste. As stated, there are limited publications available hence this Thesis is explorative and relies on online research and personal interviews.

2 THEORETICAL BACKGROUND

2.1 Climate Change and the Food Waste Connection

In order to understand the importance of addressing food waste, it is important to point out that food waste is not an issue that should be merely looked at in a silo. It is apparent that the planet is experiencing significant demographic changes. At the same time, we know with certainty that climate patterns are shifting and that there are limits to valuable water and food resources. In this vein, food waste takes on new meaning and importance and

warrants further exploration. The United Nations estimates that by 2050, approximately 9 billion people must be fed, a dramatic rise from the 7.05 billion people inhabiting the planet today.^{xvii} Scientists warn that the planet will continue to witness dramatic increases in droughts, floods and shifting rainfall patterns that will create unprecedented challenges on how to meet increased global demand for food. The United Kingdom's Chief Scientist, Professor Sir John Beddington, stated in an 2013 interview that the current "variation we are seeing in temperature or rainfall is double the rate of the average. That suggests that we are going to have more droughts, we are going to have more floods, we are going to have more sea surges and we are going to have more storms. These are the sort of changes that are going to affect us in quite a short timescale."^{xviii}

Scientists such as Sir Beddington argue that changing climate pattern will lead to falls in global wheat and maize production, a vital source of the human diet. Climate change will also affect fish, another key nutritional source for developing countries, and the millions of people inhabiting coastal communities dependent on fisheries for their daily survival. The UN Food and Agriculture Organization (FAO) in a 2010 Report states that the "world's fishing fleet is 2-3 times larger than what the oceans can sustainably support."^{xix} As of 2010, the 53% of the world's fisheries are fully exploited and 32% are overexploited, depleted or recovering from depletion.^{xx} The FAO warns that if no urgent steps are taking the world's eatable fish supply will collapse by 2048.^{xxi}

While fish consumption has peaked at an all time high, technological advancements have kept in line with worldwide seafood demand thanks to the industrialization of the fishing industry. Consumers today can access any type of fish at relatively low prices. Regardless,

consumers are generally unaware that global fish stocks are diminishing. In the US alone, the average person throws away 33% of purchased fish, as shown in Graph 1.

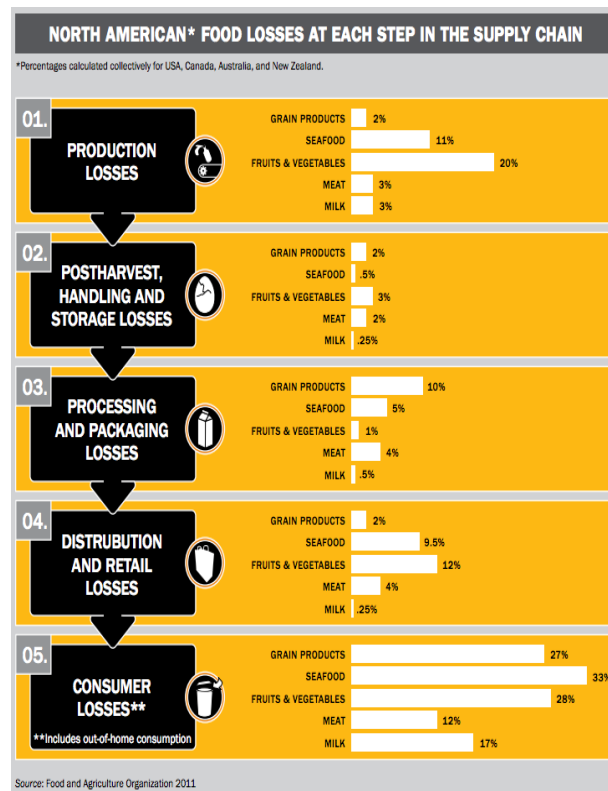


Figure 1: FAO (2011) North American Food Losses at Step of the Supply Chain

In parallel, approximately one third of all global food production is wasted. The carbon food print of consumed food is the equivalent of 3.3Gtonnes making it the third largest pollutant emitter after the US and China.^{xxii} Using a different analogy, the fossil fueled lost every year for food that is harvested, transported and refrigerated but uneaten equals to 70 times the oil spilled into the Gulf of Mexico as a result of the BP disaster, and that in the US alone.

Food waste is also a major consumer of fresh water. “Globally, the blue water footprint of food wastage is about 250km³- equivalent to the annual water discharge of the Volga River or three times the volume of Lake Geneva.”^{xxiii} And in terms of land measures, “produced or uneaten food occupies 1.4billion hectares of land, close to 30% of the world’s agricultural land area.”^{xxiv}

In an interview conducted with Mathy Stanislauf, the US Environmental Protection Agency’s Assistant Administrator for the Office of Solid Waste and Emergency Response, Stanislauf emphasized that food waste is the largest solid waste contributor to US landfills. Food waste rotting in landfills produces highly toxic methane gas, which has 20 times the global warming impact of carbon dioxide.^{xxv} In subsequent studies, the EPA shows that removing food waste from landfills would make the same positive gas emission contribution as taking 25% off all cars currently traversing America’s roads.^{xxvi} In the US, 40% of food goes to waste.

2.2 The Food Waste Supply Chain

It is important to understand at what stages food waste takes place and for what reasons.

Developing economies tend to incur food losses because of lacking infrastructure and logistic capacities, such as a weak transportation system or deficient refrigeration technologies that can preserve and move the harvest in the short and medium term. Here, food is largely wasted because it loses its nutritional value and therefore becomes inconsumable. In developed countries, food waste takes place at “the retail and consumer level...where it accounts for 31-39% of total wastage.”^{xxvii} This Paper will look at food waste in developed countries (South Korea and the US).

According to the Food and Agriculture Organization 54% of the world's total food waste occurs upstream and “happens during production, post-harvest and storage... while 46% happens downstream, at the processing, distribution and consumption stages.”^{xxxviii} In an interview, Dana Gunders of the National Resource Defense Council (NRDC), a leading American environmental advocacy organization, estimates that losses at the retail level are approximately 43 billion pounds. That means that close to 10% of American food is wasted alone at the storefront level.^{xxix}

2.3 Food Waste in America

Getting food to America's tables eats up 10% of the total US energy budget, uses 50% of America's land and swallows 80% of the country's freshwater consumption. 40% of American food today goes uneaten – that's about 20 pounds of food per person per month with a total economic value of \$161 billion.^{xxx} The scale of American food waste becomes more transparent when compared to US poverty levels: a small, 15% food waste loss reduction could feed 25 million Americans every year at a time when one in six Americans worries about how to put enough food on the table.^{xxxi}

This \$161 billion in uneaten foods every year^{xxxii} is equivalent to an estimated 25 % of the food Americans bring home.^{xxxiii} A typical American throws out 40% of fresh fish, 23% of eggs, and 20% of milk.^{xxxiv} This is enough food to fill the famous 90,000-seat Rose Bowl stadium in Pasadena, California, every day,^{xxxv} and makes rotting food in landfills the single largest component of US municipal solid waste,^{xxxvi} while adding financial a burden of \$750 million a year in disposal fees.^{xxxvii} Moreover, rotting food in landfills is a

significant source of methane, a potent greenhouse gas with 20 times the global warming potential of carbon dioxide. In the United States, landfills account for more than 20 percent of all methane emissions.^{xxxviii}

2.4 South Korea Economic Transformation: The Miracle on the Han River

The reason as to why South Korea warrants an analysis in this Thesis, and offers a compelling comparison vis-à-vis the United States, theoretical background on the country's remarkable development must be presented. Its food waste problem will be discussed in more detailed in a subsequent section. Post World War II South Korea experienced rapid transformation, and the Country flourished into an industrialized economy with a well-developed high tech backbone. As early as in the 1960s, South Korea's GDP was on par with that of the poorer African countries but by 2004 the Country joined the "trillion dollar club of world economies"^{xxxix} emerging to become the world's 12th largest economy. Today, the Country is Asia's fourth-largest economy. According to the World Bank Group, exports make up over 50% of the South Korean economy, making it one of world's largest exporters, particularly when compared to China, which has exports of roughly 30%. Global consumers have come to appreciate many of the country's flagship brands such Kia, Hyundai, LG and Samsung.

Throughout its economic development, South Korea did exhibit a number of serious fundamental structural weaknesses, which became apparent during the financial crisis of the late 1990s. High consumer saving rates as well as high debt to equity ratios coupled with proportionally high levels of short and medium term borrowing, forced the Government to implement significant reforms to drive economic growth. Its response to the

crisis instituted a succession of four major reform plans, entitled the Five Year Plans (the policies that led to the South Korea's 'economic miracle' are beyond the scope of this Thesis, however, they are important to point out as further economic growth led to a major food waste problem, which in turn encouraged "out of the box" solutions). While GDP levels continued to fluctuate over the years and the Country was not immune to the 2008 global economic downturn, the implementations of such reforms allowed South Korea to emerge into a regional commercial and business hub.

Per Capita Income increased from \$80 per year in 1961 to reach \$33,189 today^{xi}. Nowhere, is this economic transformation more evident than in Seoul, the Country's capital city whose wider metropolis is home to close to 25 million people today, half of the Country's 50 million citizens. This urbanization process and the subsequent increase in living standards led to major infrastructure challenges related to the collection of food waste.

A country that is densely populated, landfill space in South Korea has always been limited. Between 2008 and 2012, food waste output increased 3% annually.^{xii} The mountain ranges surrounding Seoul provide the City with limited inhabitable space, and as a result the vast majority of Seoul's people live in large apartment complexes. The city is organized into grids, and aerial views show apartment clusters stretching for hundreds of miles. With the Country's rapid industrialization and urbanization, apartment buildings were the only vehicle to accommodate the influx of people coming from rural areas to join the Country's growth. Today, 60% of all South Koreans live in apartment buildings compared to just 1% in the 1970s according to Park Cheol-soo, a professor at the University of Seoul.^{xlii}

3 ANALYSIS & SOLUTIONS

3.1 The US: Loss Drivers

There are multiple issues that warrant exploration in order to understand the scope and scale of American food loss. As mentioned above, food loss in the developed world takes place mostly in later stages of the supply chain and is particularly pronounced at the retail and consumer levels.

3.1.1 Cosmetic Reasons - The Consumer

In the US, everyday advertising reinforces the idea of the perfect fruit and impeccable vegetable traveling from farms all across the globe to the shelves of America's grocery stores. There, thousands of pounds of produce without any imperfections are beautifully displayed. Such imageries have led consumers to believe that produce with bruises or blemishes are not acceptable, and possibly not save for consumption. The reality is that produce is as unique as any other natural occurrence – no two apples, tomatoes or cucumbers are the same. However, retailers reject hundreds of thousands of pounds of perfectly good and healthy produce for cosmetic imperfections. Consumers in turn continue to carefully select out the perfect piece of produce that finally does enter their shopping bags (Graph 2).

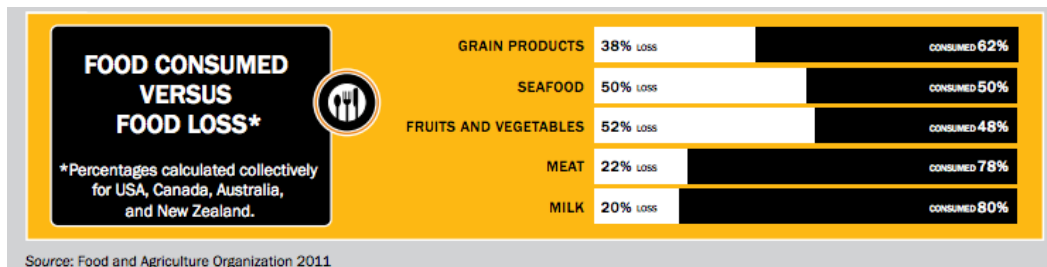


Figure 2: FAO (2010) Consumer Food Loss

One example is worth highlighting. One major tomato grower (who asked to stay anonymous) stated that major retailers, such as Safeway, Giant, Costco and Walmart will only accept four tomatoes to the vine, which means that any other vine with more or less than four tomatoes will be automatically rejected even though the tomatoes are in perfect shape and nutritional. When interviewed, this grower was ready to discard about 250,000 pounds of fresh tomatoes from his facilities alone. The current market price is US\$1.60^{xliii} per pound of fresh tomatoes at the retail level. The financial loss in this instance alone is US\$400,000. The farmer was ready to donate the tomatoes at no charge in order to avoid the loss but could not find the appropriate logistics infrastructure to ship the produce to a charity or another recipient. In short, the scale of loss is significant and the infrastructure not sufficiently developed to absorb the high levels of American food waste, as will be discussed in the next section. Consumers, unaware of the scale of the problem, continue to proliferate this cycle by further weeding out produce at the retail level, as they seek out the best looking piece of vegetable or fruit. “In 2005 and 2006 (the last available data), annual supermarket losses averaged 11.4% for fresh fruit and 9.7% for vegetables.”^{xliv} This is on top of the careful selection process that retailers have already undertaken in filling their own grocery store shelves.

3.1.2 Food Logistics – Farm to Retail

Addressing food waste in the US is a logistics challenge. Despite the boom in local markets and farm to fork initiatives such as local produce-only grocery stores and trendy farmers markets, American food production is a heavily industrialized business. Produce travels hundreds, if not thousands of miles, from large-scale farms to reach grocery chains/ super stores where a majority of Americans purchase their food, often in large quantities. As a matter of fact, 40% of American produce is purchased by three major retailers.^{xlv}

According to Roger Gordon, Founder of Food Cowboy, an organization in Washington, DC that utilizes technology to reroute food that has been rejected by major retailers to not-for-profits and smaller mom-and-pop stores willing to take it, the American food waste problem can only be solved if we understand how produce is moved. According to Gordon:

“...basically food goes to waste because its expensive to move and maintain. It goes to waste because it is expensive to transport and keep cold. If you don’t have an immediate buyer for it, the most business responsible thing to do is to throw it away. Food (in America) is bought on the phone; there is a contract to move the food and take it to a distribution center. The farmer does not get paid unless the food is accepted as wholesome and marketable and until the store manager confirms that the barcode on the food is the right barcode. If the produce manager sees that boxes are ripped, they will often say, don’t even take it off the truck. So the farmer does not get paid until the food is accepted at the delivery point.”

Gordon stated in the same interview that when a farmer uploads his produce onto the delivery trucks, the farmers carries little bargaining power and maintains 100% of the risk until the retailer has accepted the loads.^{xlvi} According to Gordon, the truck drivers and farmers have a standing agreement that stipulates that drivers get rid of the food as quickly as possible if the food has been rejected. The drivers are hundreds of miles away from the farm and when they arrive at the delivery point between 2am and 3am, the usual time food is delivered, truckers have little choice but to dump the produce. Truckers also face their own professional pressures. They carry other loads that need to reach other destinations and hence are keen to get back to the roads. Truckers will do all possible in order to avoid rush hour traffic on the major highways that carry America's food (Graph 3).

“The farmer usually gives the broker or trucker standing instructions. If you can't sell it, eat it, its yours and the trucker says well I am a hundred miles away from home and I have got a hundred cases of tomatoes. What am I going to do with it? There is a dumpster at the end of every loading dock and its full of fresh produce.”



Figure 3: *Beswick, F. et al, A Retailer's Recipe for Fresher Food and Far Less Shrink*

In an effort to validate this stipulation, a food rescue operation was investigated. In one effort alone, 2,000 pounds of cauliflower were saved, simply because the produce was

deemed marginally too large for consumers and hence had been rejected by the retailer. The multiplier effect is significant. Perfectly good food gets rejected for cosmetic or other trivial reasons every day all over the United States, reaching a major exponential food waste factor. The US Department of Agriculture estimates that “in-store food losses in the United States totaled an estimated 43 billion pounds in 2008, equivalent to 10 percent of the total food supply at the retail level.”^{xlvi}

3.1.3 Expiration Dates - Contamination versus Spoilage

The US Food and Drug Administration (FDA) is responsible for “protecting the public health by assuring the safety, efficacy and security of ... (the) nation’s food supply...”^{xlvi} As such Americans assume that expiration labels on food is governed by FDA regulations. Surveys show that 9 out of 10 consumers are throwing out food because they trust those label dates.^{xli} In reality, the only food product that is federally regulated is infant formula. Otherwise expiration information are for the most part at the discretion of the manufacturers. According to an interview with Dana Gunders at the NRDC, “many people look at those dates and think there is this official system for how they arrived at (the date) but its kind of more like the Wild West. You just have manufacturers who are coming up with those dates.”

Hence, as to Gunders, one primary driver for household waste is the misinterpretation of expiration labels, which are remnants of the best-buy dates dating back to older regulations from the 70s when consumers started to change their purchasing patterns away from farmers and small stores to major retailers. Households today discard billions of pound of food per year because they believe that consuming food past the expiration label poses

health factors while in reality expiration dates are ‘suggested best by dates’ set by the manufactures to propose “when the food is at its peak quality, not when it is unsafe to eat.”^{lv}

Barbara Cohen, a food safety expert, goes as far as to say that food safety has no correlation to expiration dates and urges consumers to use their own best judgement to measure the quality of their product. Common sense such as taste, smell and feel should be the dictating factors as to the quality of food and not arbitrary expiration labels. As to Cohen, there is a major misunderstanding when it comes to determining whether food is save to consume: food contamination derives from bacteria that are the result of mishandling the product not because of spoilage, and consumers can’t get ill from spoiled food. Spoilage occurs weeks if not months past the expiration labels^{li}.

Simple consumer behavior change goes a long way in addressing household level food waste. More importantly, there are other economic benefits. The average American household throws away between \$1,600-\$2,000 worth off purchased food per year.^{lii} The same survey conducted by the Food Marketing Institute shows that nine out of ten Americans who needlessly throw away food,^{liii} are also unaware of the financial burden of their total waste per year.

3.2 The Emergence of South Korea’s Food Waste Problem

Juxtaposed with the United States, South Korea’s food waste problem is both a result of the Country’s rapid growth and its unique historical, cultural and social fabric. As the Country’s middle class continued to grow, in 2012 South Korea produced about three times as much food waste as Taiwan, despite having only twice its population.^{liv} In 2012, South

Korea's 50 million citizens produced on average 17,100 tons of food waste per day.^{lv} Treating most of this waste at sewage plants, the resulting grey water was dumped into the country's surrounding coasts at a rate of about 3,800 tons daily.^{lvi} This practice turned out to negatively impact coastal populations and polluted the food source for seafood and seaweed to dangerous levels.

South Korea's food history is rich, and there are more eateries and restaurants in Seoul than in virtually any other city in the world. While the country's food culture has become more elaborate and plentiful with rising income levels, South Korea's culinary traditions have not changed throughout the country's recent history. Kimchi, fermented vegetables, which come in hundreds of styles and flavorings, are still a staple of everyday consumption. Kimchi is presented to guests at home and in restaurants (at no charge) prior to the main courses. As South Korea's middle class developed over the last decades, offering more side dishes showcased not only hospitality but was meant to display wealth, and hence social status. South Koreans will philosophize that "their fast-paced lives, which helped build their country's economy into one of the biggest in the world in a matter of decades, owe much to the invigorating qualities of kimchi. And when South Korean photographers try to organize the people they wish to take pictures of, they yell, "Kimchiii."^{lvii}

In an interview with Eun-kyeong Ko, the Waste Management Manager at the South Korea Environment Corporation, Ms. Ko stated:

“Our country has a unique food culture that prefers rich and abundant side dishes, this attribute to the 800 billion won (\$7.8million) worth of food waste processing cost per year. This led to a situation where the food resource’s economic worth reached approximately 18 trillion won (US\$17,642,340,000 – *as stated interview*), which is a huge amount, equivalent to 5-6% of government’s budget.”

And according to Ms. Suk-gil Lee, Bureau Chief of the Korean Food Recycling Association, Ms. Lee pointed out that South Korean food has particularly unique characteristics that amplified South Korea’s challenges. Local food is moisture heavy with a moisture content rate in the 80s percentile. During the 80s and 90s, at a time when there was a weak waste collection or recycling infrastructure, all waste was shipped to landfills or dumped into watersheds and coastal areas. There, during its natural decomposition process, it developed leachate, “water that has percolated through a solid state and leached out some of its constituents.”^{lviii} The result was significant coastal and water pollution with disastrous effects to the country’s fisheries system. In response in 2004, the South Korean Government enacted a ban prohibiting direct food waste dumping into watersheds and coastal areas, according to Lee.

At the same time, the Government was facing increasing pressures to meet its international treaty obligations. As a party to the “Convention on the Prevention of Marine Pollution by Dumping of Wastes or Other Matter 1972,” also known as The London Convention, South Korea had committed to protecting its marine environments from human activities with the “objective to promote the effective control of all sources of marine pollution and to take all predictable steps to prevent pollution of the sea by dumping of wastes and other matter.”^{lix}

That meant that food waste dumping was a direct violation of South Korea's London Convention commitments, and solutions needed to be found.

3.2.1 The Polluter-Pay Principle

According to South Korea's Ministry of Environment, food waste is generated at its largest amounts at homes and small eateries (70%), followed by big restaurants (16%) and farm produce markets (4%).^{lx}

In efforts to aggressively curb food waste on the consumption and retail levels as well as to create consumer-wide accountability, the Government since 2010 has implemented various programs meant to sharply reduce food waste, collectively known as the Polluter-Pay Principles. These programs charge residents and businesses for the exact amount of food they throw away. Initially, the Government piloted various pay-by-weight program targeting households, restaurants, street-food carts, and grocery stores alike. To track food waste, municipalities are able to choose from one of three billing systems: curbside food waste bins with bar codes, prepaid garbage bags priced by volume, or Radio Frequency Identification (RFI) where residents scan personal ID cards on specially designed bins that weigh food scraps and bill the user accordingly.

For restaurant owners, the added expense for food waste has become part of their variable operating costs. Some restaurants now donate leftovers to charitable organizations in an effort to avoid high food waste fees. Interviewing a number of Seoul residents, such as the Won family, it is evident that while the added expenses do not present a significant financial burden for the middle class, South Koreans have a vivid memory of their own

family's past generations living in poverty. Hence, they will go to great lengths to avoid paying fees. For example, the Won family will strain all of the water from their own food waste in order to reduce its weight, and therefore fees. The family will also avoid leftovers by carefully planning meals and using all edible parts of vegetables.

These Polluter-Pay Principles are now expanding to government facilities. For example, the Ministry of Environment has set up a system of fines at its main cafeteria at the Integrated Government Building. After each meal, employees must place their plates on a scale and if they leave more than 20 grams of food on the plate, they have to pay 500 won (about .47 USD) into a public fund^{lxi}. Although the amount is small, it sends a message, and food waste has been reduced at the cafeteria by about 40 percent.^{lxii}

There are three existing systems that are currently in place, and they charge waste generators (be they households or businesses) a fee that is correlated to the respective food waste produced. As stated, the overarching goal of these programs is to hold residents and businesses accountable for the exact amount of food they throw away and to ultimately reduce food waste. Raised public awareness on waste reduction seems to be working. In Seoul, which implemented the programs on a trial basis in 2012, food waste generation dropped from 116,845 pounds per day to 90,389 pounds per day in the span of a few months.^{lxiii}

The various programs, described below in more detail, target households, restaurants, street-food carts, and grocery stores alike. Currently, municipalities can choose from one of

three billing systems: Radio Frequency Identification system (RFID), curbside food waste bins with bar codes and prepaid garbage bags priced by volume.

RFID (Radio Frequency Identification System)

The RFID system is the country's newest and most promising standard, and is currently piloted in a number of Seoul's municipalities (Image 1). The system is expected to be utilized nationwide by 2015, and then slated to become the only national standard. Each household is provided with a RFID card (similar in look and feel to a regular credit card). Apartment buildings are furnished with high tech garbage disposal bins in communal areas where all the building residents' trash is collected. When users are ready to discard their food waste, which they collect individually in small plastic containers, they must tap their card against a card reader, which then automatically opens the bin. Residents go on to dispose the food waste into the larger bin, which proceeds to measure the weight of the food waste. A fee is automatically charged on a monthly basis to the household based on total monthly waste.



Figure 4: The RFID System (Chrobog)

The food waste in the communal collection bins are collected by the various municipalities for recycling. There are three recycling methods: fertilizer, animal feed and biofuel. The volume and collection operations are managed by the Country's telecommunication operators, such as Korea Telecom, which works hand in glove with the municipalities to ensure that pickup and disposal are properly managed. The telecommunication companies inform the municipalities when the bins have reached their capacities and food waste needs to be collected. It also allows the Government to collect and analyze data, which tracks the Country's progress in minimizing food waste.

As of January 2013, 126 out of 144 local governments are participating in the RFID program while 18 have yet to join.^{lxiv} Households pay approximately 30-40 won (US\$0.03) by kilogram. According to analysis and interviews, households in South Korea throw out approximately 900 grams of food waste per day, or close to 27kg per month, and are hence responsible for a fee of 1000 Won (\$US1.00) per month.

According to Eunkyung Ko at the Waste Management Agency at the Environment Corporation, an environmental research complex for the Ministry of Environment, the RFID system has had significant success to date. Ms. Ko states that:

“Since the government ... agreed to pilot project the RFID method ... performance resulted in more than 20% reduction, the excellent progress was acknowledged. From 2012, we are expanding our reach of localities nation-wide, and as a result of the national spread of this method, currently in March 2014, approximately 90

localities nation-wide had this method introduced, and consequently, the food waste was reduced by more than 24% compared to last year.”

Pre-paid garbage bag

Residents may purchase small plastic bags for their individual food waste collection. Bags are available at all major grocery stores and prices vary pending the size and volume of the plastic bags. In Seoul, a regular 10-liter food waste garbage bag will cost about around 190 won (US\$0.20). While this system is still widely in use, it will be discontinued due to the negative environmental impact of the plastic bags themselves. The use of plastic bags may have helped address the food waste problem but plastic are a major contributor of environmental degradation. When interviewed, Ms. Ko of the Ministry of Environment’s research center, admitted that this system was indeed flawed and would be phased out:

“Beginning in June 2015, the use of standard plastic garbage bag method will be restricted. Because the separated and discharged food waste either become forage or composts. They are used as recovered resource, but the garbage bag in resource recovery causes adulteration ... So beginning in June 2015, the use of standard plastic garbage bag method is to be restricted and either apply the pay-as-you-go system to the garbage bag method, or the municipalities will convert to the RFID method, or the payment collection type. So the trend is preferentially recommending the RFID method, and we plan to introduce it to municipalities worldwide.”

Bar code management system



Figure 5: Bar Code Bin (Chrobog)

Consumers may collect their individual food waste in small containers (Image 3). They purchase small code stickers, and the containers are left outside homes for regularly scheduled collection times. The stickers must be attached prior to each collection. The program is unpopular with residents as there is room for fraud. Studies have shown that residents will dump their food waste into other households' bins. This system is expected to be phased out in the coming years.

3.2.2 Landfills and Power Production

Half of South Korea's 50 million people live in the megacity of Seoul. With its 45,000 people per square mile, this City is one of the most densely populated places on the planet. According to Sungwoong Kim, Spokesman and Chief of the Sudokwon Landfill Site Management Corporation, the people of Seoul generate about 14,000 tons of waste-per-day. This waste is absorbed in one major landfill site, with four subdivisions that each become operationally as each division is filled up. Each fill is organized into individual cells, and one cell is 300 meters horizontally and 300 meters vertically.

A key fundamental driver for South Korea has been the recognition that all waste, and particularly food waste, has an important economic value. This holds true at all stages of the value chain. At landfills, gasses that are the byproducts of the natural rotting process are captured and turned into power generation and converted into electricity. The Sudokwon landfill produces electricity estimated to be worth over 20 billion won (US\$19,489,200.00). Its 50 megawatts plant is the largest of its kind and is entirely operated through waste generation. Other countries like Malaysia and China operate waste plants but their largest plant reaches a 5 megawatts capacity.

3.2.3 Turning Food Waste into Animal Feed

There are a number of other pilot projects taking place in Seoul. Seoul's Song-pa District is one of the most populous residential areas in the City. Its 680,000 residents produce approximately 360 tons of food waste. About 180 tons of this food waste is brought to the Song-pa Food Recycling Plant. Of these 180 tons of food waste, approximately 10% are turned into animal feed products, or 36 one ton-bags.

The sales generated from food waste, turned animal feed, are worth approximately 12 billion won (US\$11,693,520.00) per month, and the facility's operating cost accounts for approximately 9 billion (US\$8,770,140.00), according to figures provided by the Song-pa Food Recycling Plant. 40% of the food waste treatment cost is supported by Song-pa District Office, the municipal government, and the remaining 60% is covered through the residents via the Polluter-Pay schemes.

3.3 DC Central Kitchen: An American Experience

Solving the food waste problem in the United States (and beyond) is not only a moral issue with implied theoretical connections to larger international topics (eg. climate change, poverty or food security). The best case to be made for addressing food waste is an economic one. Repurposing food waste can be a job creator, and develop and add to important value chains. Turning waste into viable and usable commodities benefits local economies. There is hope that at least on the grassroots levels some compelling initiatives are taking place. The following analysis shows that if even only at the local level, small organizations are indeed recognizing the economic potential of food waste.

In few places in the US is income disparity and poverty more apparent than in Washington, DC where nearly 20% of all citizens live at or fall below the official poverty line. The poverty rate in Washington continues to be the highest of any state, and the trend is rising, especially amongst children. A 2014 Washington Post study shows that nearly one out of three children in the District lives in poverty, double the national average. In comparison, two Washingtonians waste enough food that potentially could feed a third person.^{lxv}

Since food waste in developed countries occur at the retail and consumer levels, local organizations can play an important part in repurposing food waste and generate income and employment opportunities. One such example is DC Central Kitchen, based in Washington. The Organization rescues food that would have been destined for the garbage bin, because the produce was rejected by the retailers.

DC Central Kitchen CEO Mike Curtin stated in an interview that the Organization recovers close to 750,000 pounds of food every year because rejected food does not meet retailers' strict cosmetic requirements. Recovered food, at the time of rescue has zero dollar economic market value (its loss value is \$1,000,000), until it is received at the organization's kitchen facilities, and then processed. Once it has gone through DC Central Kitchen and has been repurposed, the same 750,000 pound increase in value to US\$2million. DC Central is able to turn food waste into over 5000 meals every day that are prepared at its facilities, and then delivered to the City's most vulnerable citizens.

At the same time, repurposing recovered food has created hundreds of jobs for individuals who are deemed "difficult to employ." A vast majority of the organization's employees are former inmates, offenders and substance abusers. In DC with its high poverty rates, this one institution employs 144 people, and trains 80 program graduates each year (of which 75% are ex-offenders) from its own culinary training program. 90% of graduates find full time employment within 3 months of graduation. According to Curtin, the organization then re-invests into the City saving valuable taxpayer dollars and creating new tax revenues. Reselling the meals at low costs, has allowed the organization to invest over \$150,000 into local farms. Since its inception in 1989, DC Central Kitchen has repurposed over 24 million pounds of food, prepared over 27 million meals and graduated about 1000 people through its culinary school program.^{lxvi}

4 CONCLUSION AND LESSONS

Until 2000, all of Seoul's waste, including food waste, was discarded into landfills but with new laws and international treaty obligations, food waste is no longer permitted into the landfills. South Korea can be credited for using smart legislation, sophisticated awareness raising campaigns while at the same leveraging its technological supremacy to face a major environmental problem.

The polluter-pay-system provides the South Korean consumers with a viable vehicle to handle their individual food waste in an efficient and cost effective manner. Today, it is estimated that there is only a 5%-7% food waste diversion into the landfills in South Korea compared to 93% in the United States. According to the Ministry of Environment Seoul's food waste along has decreased from 53,000 kg per day before the pay-by-weight scheme was introduced to 41,000 kg per day now, which is a 22.6 percent reduction.

Analyzing South Korea Environment Corporation Waste Management Agency data, it is ascertained that the following savings have occurred:

- Food waste generated by small restaurants decreased 40 percent.
- Landfill food waste diversion has been reduced to 3-5%.
- The RFID system has let to a food waste reduction of 22-25% on the household level.

The Government has set a target for further food waste reduction by 40% over the next three years. It is also on target to meet its zero ocean waste international treaty requirement

by the end of 2014 if existing trends continue to hold and the Government continues to implement its national waste management agenda.

In the US, however, there are currently no national standards for the food waste collection in the US. Under the Resource Conservation and Recovery Act (RCRA), the federal government provides minimum general waste management guidelines to US States that must be met or surpassed by the states.^{lxvii} The states tasks municipalities with local recycling and trash collection. Those are usually outsourced to private companies.

California, New York and Vermont are leaders in recycling practices and are seeking out innovative methodologies for food waste collection, for example, encouraging food composting, or setting up food waste drop-off locations. However, these efforts are sporadic, and ad-hoc efforts.

Food waste in America takes place at multiple levels and understanding the reasons is a precondition to deriving at any viable long-term solution. In researching this thesis and interviewing experts engaged in the food loss analysis, the above mentioned three primary loss drivers reaching from farm to consumer to retail were identified. Many of them can be easily addressed, and numerous grassroots efforts are emerging across the local levels. However, there are also systemic problems that are much more difficult to deal with, amongst them, for example, the industrialization of the US food economy and the bargaining power of the major retailers vis-à-vis the farmers who supply them.

While these numbers may dwarf the magnitude of American (and global food waste), this case study shows that waste commodities ascertained to have minimal financial value can

be growth drivers and should encourage innovative approaches to an everyday problem if accelerated properly.

As we continue to exert strains on the planet's finite resources, it is important to reassess how governments and individuals address food waste in the US, and around the world. While it is easy to lament that wasting food is "immoral" given current world hunger levels, this will not suffice to drive policymaking or convince households to cut back on food waste.

Attaching economic value to food waste by arguing that there is a specific correlation between changing consuming behavior and household cost savings will drive a more aware consumer society. On the other hand, governments will be more open to implementing legislation if there are arguments to be made that food can be turned into valuable economic growth drivers that impact employment and may influence the climate change patterns in the long run.

It is recommended that the US to study South Korea and analyze the Country's progression in turning a major social and environmental challenge into a valuable economic commodity. It is evident that extraneous factors forced South Korea to implement change but the results, as shown in this Thesis, nevertheless deserve consideration by US policymakers.

There are strong similarities between the two countries that lend themselves for such exploration, for example, economic strength, access to financial resources and technologies

and developed logistics systems. Needless to say, there are also country-specific limitations. The US has a significantly larger geography while South Korea is relatively small in comparison.

South Korea's political system allows for swifter decision making processes while in the US waste related issues are delegated to the state and municipal levels. Hence, there must be a limit to the scope of this research project on which others may continue to build.

There are concrete steps that can lead to immediate positive change in the US including: (1) creating awareness around consumers pertaining to their own financial value loss; (2) educating buyers that cosmetic reasons should not impact purchasing behavior; (3) fostering further invention and innovation in the logistics and infrastructure systems, and (4) updating the expiration label system and setting up new nationwide standards.

It is highly unlikely that Americans will accept a polluter-pay scheme as has been implemented in South Korea, given Americans sentiments around any new tax systems (even though that would undoubtedly lead to the greatest change), However, offering tax breaks for best practices may foster behavioral change.

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6 APPENDIX A:

The following scientists, policymakers, members of civil society and individuals were interviewed:

In South Korea:

- Sungwoong Kim, Chief, Sudokwon Landfill Site Management Corporation
- Eun-kyeong Ko, Waste Management Manager, Korea Environment Corporation
- Yong-seok Chung, Team Manager, Songpa-gu Office, Clean City Division
- Jae-kuk Choi, Team Manager, Re-Clean Co. Recycling Center
- Mi-hwa Kim, Secretary General, Korea Zero Waste Movement Network
- Seok-gil Lee, Secretary General, Korea Food Recycling Association
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- Barbara Cohen, Executive President, Food Cowboy
- Robert Egger, President, L.A. Kitchen
- Mike Curtin, CEO, DC Central Kitchen
- Katherine Eklund, Partnerships and Planning Coordinator, DC Central Kitchen
- Amy Bachman, Procurement Manager, DC Central Kitchen
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- Dana Gunders, Health Scientist, Natural Resource Defense Council
- Brett Meyers, Founder, Nourish Now