



Food waste in the United States: A contributing factor toward environmental instability

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The world's population continues to increase at record rates along with corresponding nutritional needs and related agricultural consequences. In the United States, food waste levels serve as dominant components of land-fill masses, oil and freshwater waste, methane and CO₂ emissions, damage to wildlife ecosystems, and substantial financial losses. Agricultural effects on the environment were investigated through various research studies, referenced in this document, and efforts made toward food waste recycling were discussed as noteworthy models concerning improvements in sustainable agricultural practices. Food waste levels in the United States can be traced as faults of consumers, agricultural businesses, as well as federal legislation and there is an evident need for reform to maintain consumer health, viable foreign affairs, and environmental sustainability. Present agricultural practices are intense and rapid, increasing the risk of soil infertility and commercial alterations in production yields; repercussions well documented in neighboring nations. Experts argue that food waste in developed countries damages food availability around the world and, based on current agricultural practices and production, there is debate concerning the earth's sustainability of the human population in coming generations. This article delineates the extent to which food waste in the United States serves as an integral factor toward environmental instability on a global scale with emphasis on the critical capacity of public reception of the content discussed herein.

Keywords: food waste, environment, unsustainability, environmental instability, the United States' food waste, food demand

INTRODUCTION

FOOD LOSSES IN THE UNITED STATES

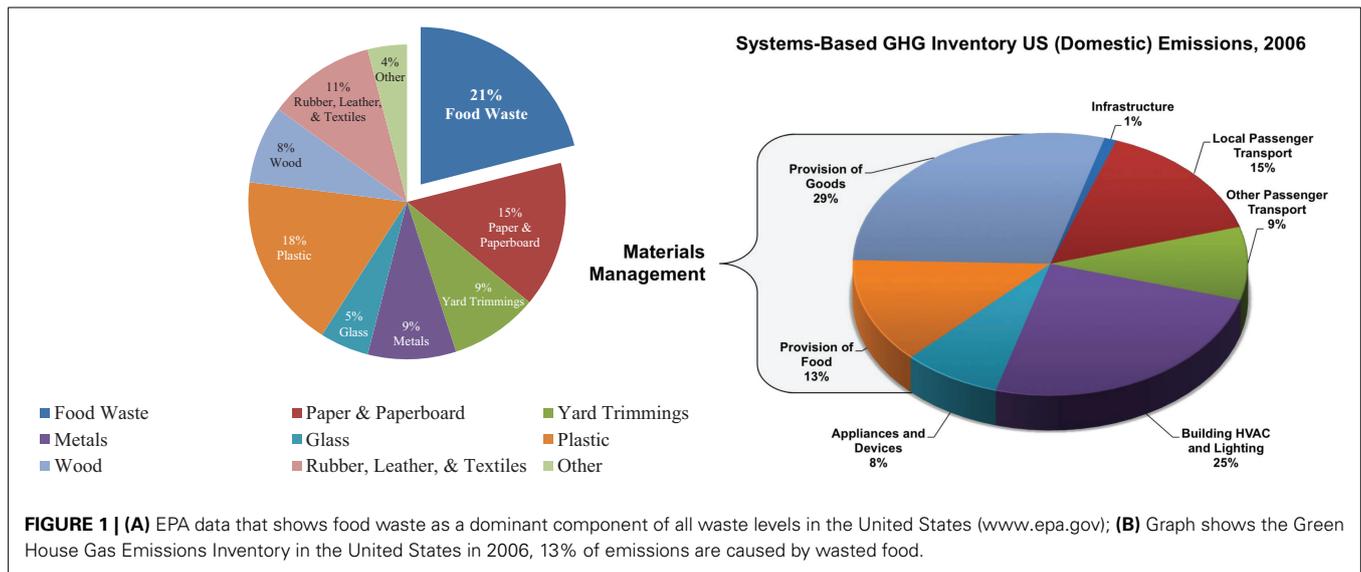
Most of the population growth is expected to continue in under-developed countries with limited technologies and venues (the Food and Agricultural Organization of the United Nations, 2009). The demand for food and water must be met as the human population is expected to rise to nine billion people by the year 2050. With current food consumption and trends, this means we must increase overall food production by over 70% (the Food and Agricultural Organization of the United Nations, 2009). This increase cannot be sustained and food prices cannot be afforded.

Recent research by the Food and Agricultural Organization (Food and Agricultural Organization of the United Nations, 2013) of the United Nations concluded that the United States consume the most calories per person (2012) and are the second most obese nation (2013) in the world and, according to Buzby and Hyman (2012), account for nearly \$166 billion in wasted food each year. In particular, meats, poultry, and fish account for the highest food loss yields in the United States, followed by fruits/vegetables and dairy products; 41, 17, and 14% of net losses, respectively (Buzby and Hyman, 2012). Warner (2013) concluded that as much as 70% of the average American diet consists of commercially processed foods, as opposed to the perishable goods that account for 72% of the food wasted in the United States (Buzby and Hyman, 2012). Boxstael et al. (2014)

found that more than half of supermarket consumers prefer processed foods when grocery shopping due to their trust in the highly extended shelf-life expiration date shown on the product packaged label. Clarity and trust regarding expiration dates appears to have a significant impact on consumer selection and, as such, a need for shelf-life extension in perishable goods is necessary to improve consumer dieting habits/safety, food loss yields, and environmental sustainability (Mensitieri et al., 2011).

According to the United States Census Bureau (2014), America is comprised of the third largest national population in the world with over 98% of its citizens originating from families native to countries outside of the continent. As such, the United States maintains a larger assortment in daily dieting habits and meal varieties than any other nation with an average of 50,000 different food products available for purchase at the typical American grocery store (Kantor et al., 1997). It has been estimated that as much as 25% of the world's food is lost post-harvest due to microbial spoilage while as much as 40% of America's food is wasted due to inefficient production and careless consumer habits; not accounting for foods lost due to diseased livestock (Nellemann, 2009; Gunders, 2012) (**Figure 1A**).

As described by Botkin and Keller (2011), the world's population has more than doubled in the past four decades and the risk of sustainability-loss concerning earth's resources, relative to population, is at an all times high. Problems in food losses are



seen at the commercial, consumer, as well as food service levels and, in addition to environmentally-related issues, result in direct financial consequences as the costs to properly manage such waste continues to increase over time (Payne-Palacio and Theis, 2011). With a number of major famines impacting regions such as East/West Africa, North Korea, Vietnam, Russia, and China within the last century alone, there is a very real risk that the United States are equally as susceptible to mass food shortages due to economic recession, ties to international warfare, or even global climate change (Weber and Stern, 2011). Furthermore, effort toward resource sustainability concerning foods in the United States must be increased and awareness of such possibilities needs to be expressed at a public level to present meaningful change and promote long-term public safety.

ENVIRONMENTAL FACTORS CONCERNING FOOD WASTE

It is estimated that more than one-fourth of the freshwater used each year in the United States is lost in the irrigating of crops that are never consumed; a 50% increase in only three decades (Hall et al., 2009). In addition, Hall and his associates (2009) concluded that approximately 300 million barrels of oil are wasted each year, due to such food losses, in transporting perishable goods for consumer distribution which accounts for nearly 4% of the United States' annual oil consumption. It is apparent that the mismanagement of perishable goods in the United States acts as a strong contributing factor toward economic instability, consumer health, and environmental change. According to the United States Environmental Protection Agency (EPA), food waste accounts for at least 17% of the nation's land-fill masses and has exceeded \$1.3 billion in waste management expenses, to date (Schwab, 2010; Buzby et al., 2011). Additionally, freshwater- and fossil fuel-use increase considerably relative to food waste levels and result in excess carbon dioxide (CO₂) and (CH₄) methane emissions from decomposing foods (Hall et al., 2009). Buzby et al. (2011) explained that the decomposition of food waste in United States landfills contributes to as much as 34% of all human-related methane emissions in the world; a chemical emission that is 21

times more powerful than CO₂ in contribution to global warming. In addition to its chemical emissions, food waste acts as a medium for microbiological growth that greatly increase the risk of pathogenic vector (i.e., Mosquito) transfer. Collectively, food waste levels directly influence the health of municipal waste workers, most notably via inhalation of resulting toxins, and are of major concern in landfill-exposure associated congenital malformation effects (Giusti, 2009). Stuart (2009) discussed the idea that more food wasted in developed countries increases the demand to replenish goods in those countries which, in turn, depletes the availability of foods in underdeveloped regions of lesser economic magnitude to the industry. Even small change by United States consumers would result in mass increases in food availability around the world as even a 15% decrease in food waste would be enough to feed at least 25 million people (Food and Agricultural Organization of the United Nations, 2012).

Corresponding with such trends in modern agriculture, issues concerning sediment and air pollution, damage to wildlife and aquatic ecosystems, and soil losses have been concluded as resulting effects of agricultural practices (Reimer and Prokopy, 2014). In addition, recent research by Datta (2014) argued that the majority of innovative, cutting-edge agricultural practices in developed countries are focused solely on rapid crop growth and food production that is proven damaging to the long-term fertility of the respective soil being used; suggesting that large United States agricultural businesses will be forced to relocate to eastern countries in a matter of decades. Similarly, Kagabo et al. (2013) report substantial decreases in agricultural production in Rwanda due to intensive farming practices that left slope-lands infertile in a short time. The scientific notion that soil fertility is impermanent sufficiently describes the significance of the issue at hand, concerning the value of food wasted in the United States and its effects on surrounding nations.

RESOURCEFUL EFFORTS TO RECYCLE AND REDUCE FOOD WASTE

Second only to paper-based products, foods are one of the largest components of municipal waste in the United States, while only

3% is utilized for recycling purposes. When taking into account the effect of methane emissions from land-fill impacted food, the process of composting for use as a fertilizer appears to be a novel trend in resourcefully managing food waste (Saer et al., 2013; Sundberg et al., 2013). Yan et al. (2011) found that composting of food waste can be specialized in the synthesis of various products, such as ethanol, by use of specific enzyme applications and research in the area is gaining global popularity. Furthermore, trends in food waste composting have been proven as promising alternatives to destructive agricultural pesticides and the practice is required by federal law in Japan (Takata et al., 2012). Relative to advancements in food waste recycling, research is being conducted to develop a sink-intact garbage disposal system that purifies and recycles water from food waste for dishwasher use (Hanson, 2011). Additionally, in attempt to rely less on motor oil, major steps are being taken to optimize cooking oil-waste as a primary component in bio-fuel. Kalam et al. (2011) described the use of palm and coconut oil-waste as novel foundations for bio-diesel blends in automobile use, concluding that food-based oils contribute significant reduction in emissions as alternative motor vehicle fuels. The Environmental Protection Agency (2014) has developed a *Food Recovery Challenge* to which any business or organization is encouraged to participate voluntarily to improve food waste levels, support the community, diminish landfill masses, reduce greenhouse gasses, and be recognized for participation on a national scale; all data being monitored by the EPA. In any case, resourceful efforts in food waste recycling are premature and needs for increased efficiency in use of such renewable resources are essential to maintain environmental sustainability in the United States.

In contrast to combating the results of food waste, many researchers have focused their efforts toward evading the cause. As much as one-fourth of total food losses are caused by microbial growth and degradation that render food products unsuitable for human consumption (Nellemann, 2009; Gustavsson et al., 2011). While careless consumer habits, such as discarding daily-leftover dinner scraps, cannot be regulated or maintained through legislative control, natural inhibition remedies of microbial growth and activity on foods remains a plausible vector of interest toward extending perishable shelf-life as well as consumer health. Furthermore, recent efforts in environmentally friendly packaging of perishable goods have shown promising involvement in shelf-life extension and research in modified-atmospheric packaging is frequently applied toward commercial sales (Macé et al., 2012; Alfaro and Hernandez, 2013). There remains, however, vast room for improvement in food waste control and management as waste levels will inevitably increase with the human population that is expected to reach 9 billion by the year 2050 (Botkin and Keller, 2011) (Figure 1B).

FEDERAL INFLUENCE ON AGRICULTURALLY-RELATED ENVIRONMENTAL ISSUES

According to Iowa Senator Charles Grassley, the recently enacted Agricultural Act (2014), valued at \$956 billion in citizen tax payments, offers as little as 10% of farmers in the United States as much as 70% of federal benefits that are not available to the remaining 90%, suppressing small or medium farm growth due to

disadvantages in federal relations; the few benefactors described are the wealthiest farmers in the nation. Senator Grassley (2014) further discussed the notion that loop-holes exist in current agricultural legislation that allow over-funneling of government funds to agricultural managers that are not legally deserving and promote corruption in the industry as well as tax increases to the general population. Mardsen and Morley (2014) share consistent views in their argument that privatized versus public innovations in food production will serve as strong contributors to food crises world-wide. Furthermore, there is evidence that privatized food industries have access to advanced technologies, commercial processes, and federal benefits to which public sector companies are denied; resulting in stronger reliance and power contributed to larger food corporations that are in majority control of certain agricultural commodities (Deibel, 2013). There is apparent disorder in agricultural legislation that must be addressed further as the cost of such entropy is not limited to financial consequence but to the sustainability of earth's resources for generations to come. The fate of the United States lies heavily in the hands of the federal government and, as such, legislative officials hold responsibility to positively impact the environment through reasonable agricultural practices and related ethics in commercial sales.

Relative to legislative regulations, the International Organization for Standardization (ISO)—the world's largest independent organization for the voluntary development of international standards—has served a critical role in the advancement and configuration of international standards concerning food production of plant and animal origins (Becchetti and Neri, 2013; Arvanitoyannis et al., 2014). Though manufacturers are not required by law to follow the framework, ISO has implemented *ISO 14040: Life Cycle Assessment (LCA)* which offers food production companies international standards for use toward maintaining records of the environmental impacts that are exhibited as a result of the life cycle of a given product before, during, and after processing (Arvanitoyannis et al., 2014). Such innovations in regulatory concepts establish integral vectors of data compilation that provide and enhance foreknowledge of causal environmental consequences related to every stage of food production. Though recently confirmed and revised for validity (Finkbeiner et al., 2006), some experts argue that ISO 14040 is vulnerable to inconsistent interpretation which leads to inapplicable variables, invalid trends related to product demand, inconsistent data overall, and is ultimately more financially costly than productive (Weidema, 2014). Arvanitoyannis et al. (2014) supported this notion by explaining that the lack of public databases containing comprehensive levels of ISO 14040 data actually hinders interdisciplinary interactions in the industry which force LCA studies to focus on one aspect of agricultural production over others of equal importance to the processes involved (Koroneos et al., 2005). Weidema (2014) explained that such a lack in consistency of the interpretation of LCA reduces the probability of ISO 14040 implementation on a global scale. In any case, *ISO 14040: Life Cycle Assessment (LCA)* appears to hold the legitimate potential to manipulate the present food developmental processes toward a universally transparent and environmentally sustainable industry. If enhanced to a consistently accessible and interdisciplinary-recognized source for the

monitoring of all environmental consequences associated with each stage of food processing and production, LCA could potentially serve as the foundation for a new framework of agricultural legislation in the United States. Furthermore, food companies with LCA data that conclusively support the environmental benefits of their respective food production processes will have access to substantial marketing advantages over competitors which, if not explored properly by the federal government, could drive agricultural commerce out of the United States due to environmentally active agricultural conglomerates overseas.

DISCUSSION

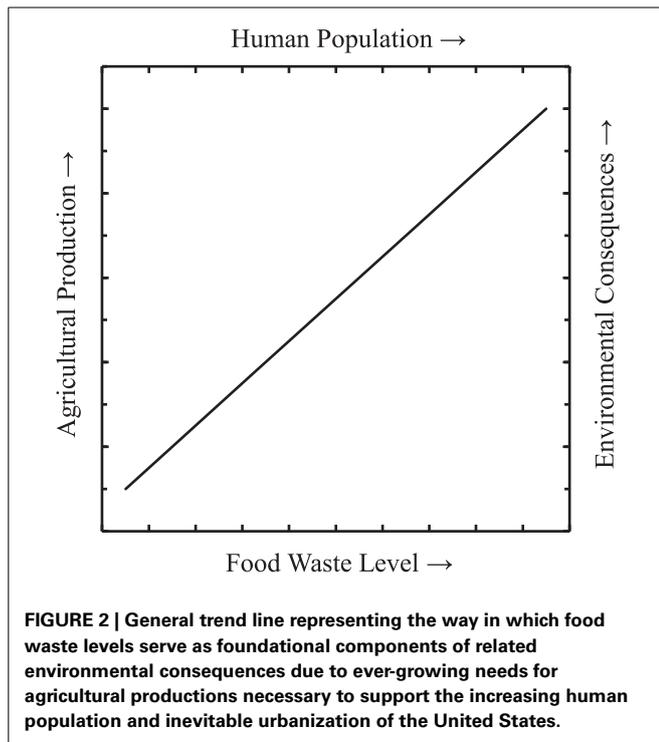
American diets continue to stray from perishable foods as meal choices are increasingly dominated by convenience and ease of preparation (van der Horst et al., 2010; Warner, 2013). As a result, United States' consumers progressively waste costly, perishable goods and promote excessive agricultural commerce that contributes to food shortages in underdeveloped regions, as well as over-use and abuse of earth's soil (Stuart, 2009). Considering that nearly three-fourths of food waste is composed of perishable items, while 70% of the American diet consists of commercially processed foods, there is strong evidence that irresponsibility in shopping habits acts as a major gateway to food waste in the United States (Buzby and Hyman, 2012; Warner, 2013). Although it would be ideal for American citizens to collectively strive for environmentally friendly food practices, that is not the case and, as with any issue concerning the mass population, the most prominent course of valid change must begin at the source. Food companies must adopt the obligation to safely extend the shelf-life of their products in order to minimize food waste levels and to increase food availability around the world. By offering extended shelf-life to perishable food products, an increase in likelihood that the food items are consumed will be exhibited. Most notably, Kuswandi et al. (2012) developed a colorimetric packaging label using a specialized nanofiber-based film that can easily distinguish spoilage levels on a given food product via label color change. If such technologies were universally adopted or required by law, an essential trust in perishable purchases would be exhibited by consumers, food items would remain in storage rather than wrongfully discarded, and zip-lock bags or plastic saran-wrap would serve as increasingly essential accessories of consumer food managements in the home setting. Because the major concern of modern corporations is largely financial, incentive must be offered to encourage such commercial transformations by either compensation, efforts in research, or federal legislation.

Consistent with conclusions made by Yan et al. (2011), that food composting can be specialized for purpose by specific enzymatic presence, it seems that waste management practices could serve as the most viable gateway toward diminishing food waste effects on the environment. Just as recycling practices have been in high promotion within the last few decades, with distinct blue waste-bins for example, specialized waste containers or aerosol sprays can be distributed that contain natural enzymatic cocktails favoring environmentally friendly decomposition of food waste; significantly decreasing methane and CO₂ emissions, land fill masses, as well as waste management expenses nationwide. In

any case, statistics concerning food waste and its negative effects on global climate change represent the need for mass alterations in waste management practices and many public sector waste management companies are studying methods that allow the capturing of methane emissions for recycled use as heat energy (Themelis and Ulloa, 2007).

To understand the impact of food waste on environmental sustainability in its entirety, comprehension of agricultural pollution is essential. Kersebaum et al. (2003) found that as much as 55% of all non-point water pollution is caused by agricultural runoff to neighboring channels (Environmental Protection Agency, 2012). Although not directly consumed by humans, these polluted water sources are essential to wildlife ecosystems and the negative health effects of such wildlife intoxications are, in the highest probability, unnoticed by the human majority. Volk et al. (2009) explained that intensive-farming, seen heavily in developed nations, requires over-application of nitrogen and phosphorus to ensure crop yields that result in their excessive accumulations in non-point water sources (Buckley and Carney, 2013). In addition, various aquaculture practices require antibiotic applications that can be hazardous among consumption as well as contribute to the decimation of certain target species as a result of agricultural malpractice. According to Cabello (2006), high concentrations of prophylactic antibiotics, that are applied to maintain health in aquacultures, result in the development of antibiotic-resistant bacteria in the gut flora of its consumer. Furthermore, it is suggested that such antibiotic concentrated tanks eventually find drainage to the environment where similar feats are exhibited (Cabello, 2006). In general, agricultural practices are essential to modern society and are wholly positive in their functional processes; however, it is agriculture in excess that acts as an environmentally diminishing practice. If higher levels of wasted food require higher levels of agricultural production to replenish vacancy on grocery store shelves, while higher levels of agricultural production contribute to environmental instability, increasing levels of food waste act as a major influence of consequences related to excessive agricultural production (Figure 2).

In correlation to major increases in human populations over the past few decades, urbanized land in the United States has increased by at least 57% since 1982 and over 4050 square meter of farm land is lost every minute due to the mass urbanization of America (American Farmland Trust, 2007). Notably, urbanization of farmland increases the demand for food availability as human populations rise and viable soil diminishes. As a result, farmland must be maintained in areas of availability which ultimately results in destruction of wildlife ecosystems. For example, as much as 73% of New Zealand's forests have been destroyed for such uses and as little as 3% of native North American prairies still exist today due to destruction for use as farmland (NZB, 2013; WAF, 2013). It is apparent that increased food waste in the United States has damaging effects on consumers worldwide and, as the human population increases, it is reasonable to articulate that wildlife ecosystems will ultimately pay the price of such agricultural carelessness. Short of forcing all Americans to live in apartment style housing, democratic legislation will prevail allowing humans to maintain possession of rights to land



and there will be no viable option for agricultural support of such populations other than declaration of emergency preserved-wildlife-reserve-use for farmland purposes. Looking at the bigger picture, wildlife species bear the burden against near-future food crises and the essential key to avoid tragedy while maintaining an environmentally diverse and sustainable earth is control of food waste.

CONCLUSION

As with most human-induced environmental instability factors, the causal influence of environmental degradation is greed of personal gain. From perspectives of legislation, commercial agribusiness, and consumers, practices of environmental carelessness concerning food waste result in economic control, excess profits, and nutritional indulgence, respectively. As a result of such selfishness on a national scale in the United States, little hope remains as all available evidence collectively suggests that sufficient change will not be exhibited prior to mass famine or financial catastrophe due to immense disorganization at the federal, commercial, and consumer levels. If food waste levels were diminished in the United States, growing populations could be sustained using current agricultural geographies with a lesser need for immediate and continuous expansion of farmland or impact on neighboring nations; an overall practice that additionally sustains earth's wildlife and resources. Instead, the United State's citizens will waste food at levels that cannot sustain the growing population and will be forced to drain neighboring nations of agricultural resources to maintain a viable economy resulting in mass food shortages in underpowered regions and distorted world order. Food waste levels in the United States serve as the key to the sustainability of earth's resources of tomorrow.

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