

# *Waste Not, Want Not: An Overview and Combating Food Losses and Food Waste*

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## INTRODUCTION

As we ride out the uncertainties of one of the most challenging economic times in history, some things we know will always remain the same. One of the most consistent of all realities is that no matter who you are, or where you are, you need safe, nutritious, affordable food—every day. Jeff Simmons, the President of Elanco Animal Health has certainly made it a personal mission to educate the consumer on why and how technology is so critical to feeding the projected world population as it swells to about 9 billion people by 2050 (Simmons, 2011). Obviously, I and the company in which I am employed with – Pfizer Animal Health – believe in the creation and adoption of new technologies that increase production efficiency in producing safe, affordable food. However, today more than 1 billion people (one-sixth of the world's population) suffer from chronic hunger. Sad thing about this is that it is certainly not a supply problem, since the current food system continues to provide enough food (in fact twice enough food) to feed the world. One of the reasons for this disconnect is simple waste. By many estimates, one in three food calories is currently wasted. To feed a world of 9 billion people by 2050, to ensure people do not go hungry, and to safeguard food security, significant changes need to occur throughout the current food system, from crop management and harvesting, to meat processing and packaging and ultimately a complete overhaul of consumer expectations and attitudes. In the U.S. this equates to 34 million tons of food waste with 97% ending in landfills or incinerators. U.S. per capita food waste has increased approximately 50% since 1974 reaching more than 1,400 kcal per day or 150 trillion kcal per year. While estimates of the scale of global food waste across the system vary, there is consensus at least that waste is substantial (leafy vegetables, bread, meat, fruits, vegetables waste estimates

are 50%, 33%, 12%, 28% and 22%, respectively). Given the scale of the problem, there are significant opportunities for solutions to be considered by companies, by policy makers, by farmers, and by consumers. This paper provides a view into where food waste occurs, the effects of food waste and actions that are being taken to combat food waste.

## WHERE FOOD WASTE OCCURS

It is estimated that simply halving the current amount of food waste by 2050 could reduce the projected amount of food required to feed 9 billion people by 25 percent compared to today's production numbers. Doing so, however, requires a better understanding of where food waste occurs and its root causes. The causes of food losses and waste in low-income countries are mainly connected to financial, managerial and technical limitations in harvesting techniques, storage and cooling facilities in difficult climatic conditions, infrastructure, packaging and marketing systems. An important fact that in low-income countries food is mainly lost during the early and middle stages of the food supply chain and much less food is wasted at the consumer level (Figure 1).

In fact according to a recent FAO report (FAO, 2011) shows that the per capita food loss in Europe and North America is 290-300 kg/year. In Sub-Saharan Africa and South/Southeast Asia is 120-170 kg/year. With those numbers in mind, it should be noted that food wasted by consumers in Europe and North America is 95-115 kg/year, while this figure in Sub-Saharan Africa and South/Southeast Asia is only 6-11 kg/year (Figure 1). This discarded food adds up to approximately US\$2,200 annually of a household's food bill (Bloom, 2010).

In the case of meat and meat products (Figure 2), losses and waste in industrialized regions are most severe at the end of the food supply chain explained by a high per capita meat consumption combined with large waste proportions by retailers and consumers, especially in Europe and the U.S. Waste at the consumption level makes up approximately half of total meat losses and waste (FAO, 2011). It should be noted that the relatively low meat

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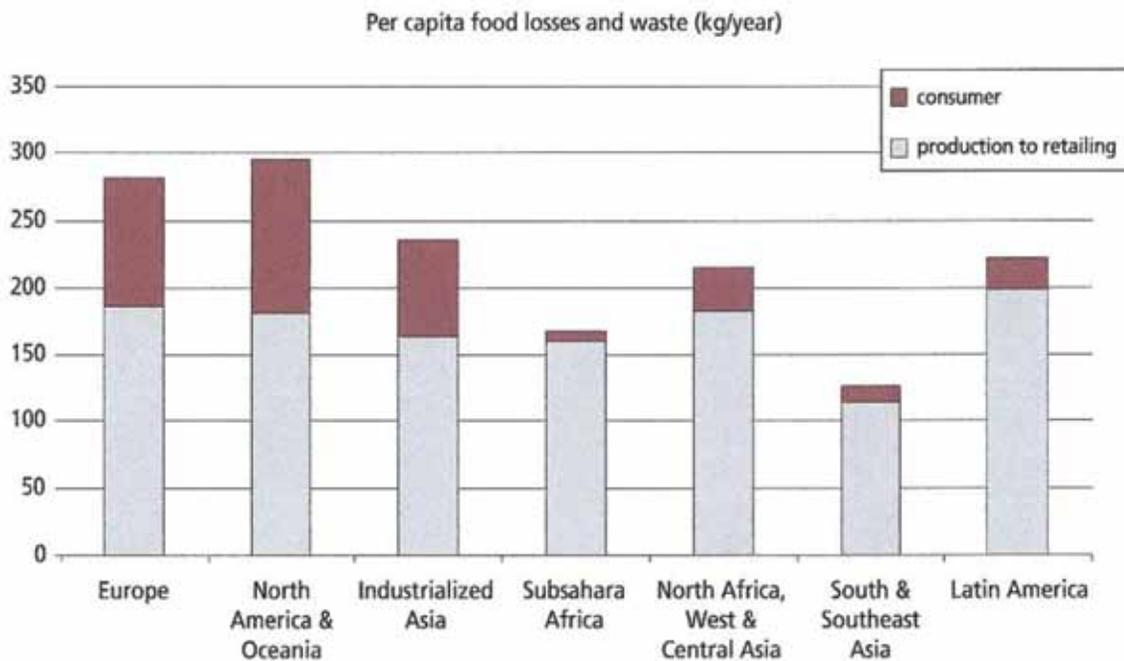


Figure 1. Per capita food losses and waste, at consumption and pre-consumption stages in different regions (Source: FAO, 2011)

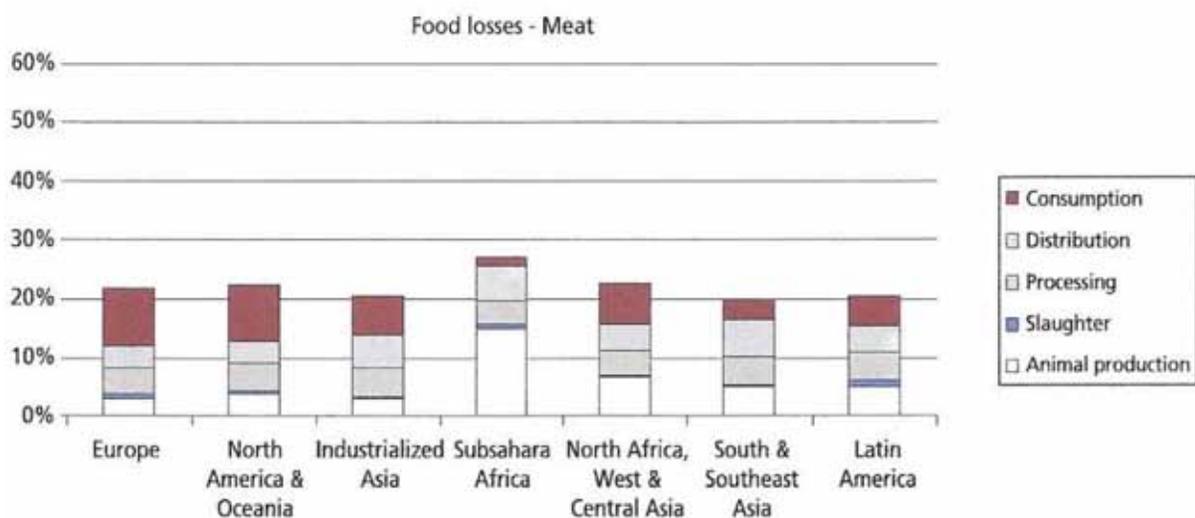
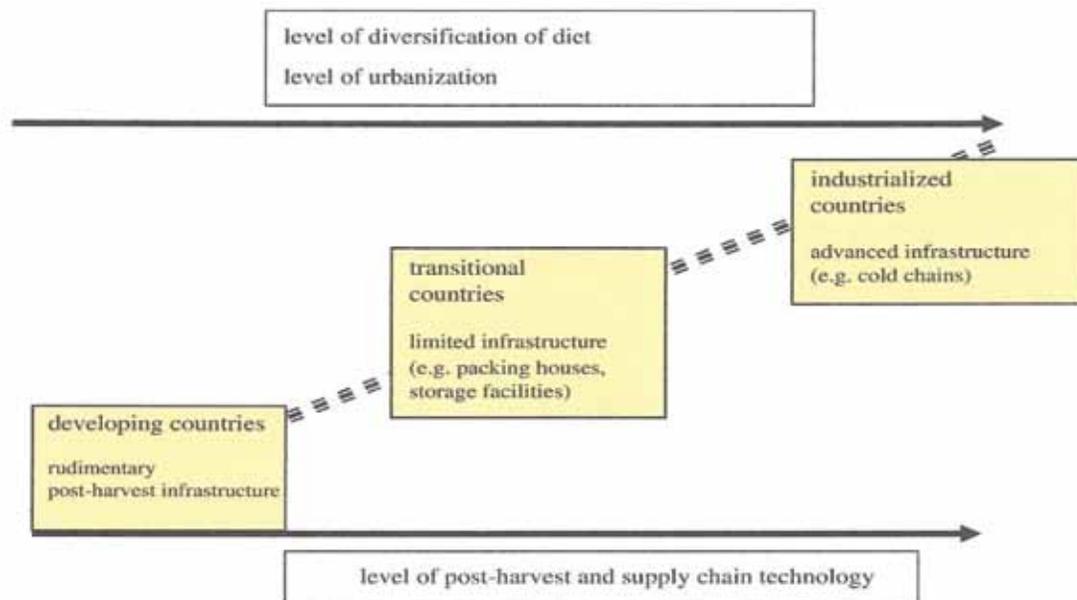


Figure 2. Part of the initial production lost or wasted for meat products at different stages in the food supply chain in different regions (Source: FAO, 2011)

and meat products losses during pre-consumption periods is attributable to efficiencies during animal production, transportation and harvesting stages of the operation.

Obviously, post-harvest losses are partly a function of the technology available in a country, as well as the extent to which markets have developed for agricultural products (Figure 3).

Three inter-related global drivers (urbanization and the contraction of the agricultural sector, dietary transition and increased globalization of trade) provide an overall structure for characterizing supply chains and future trends in developing and transitional countries (Parfitt et al., 2010). From an urbanization point of view, the proportion of the world's population employed in agriculture has declined



**Figure 3. Schematic development of food supply chain in relation to post-harvest infrastructure**  
(Source: Parfitt et al., 2010)

in recent decades and 50 percent of the world's population now lives in urban environments. This proportion is expected to rise to 70 percent by 2050 (United Nations, 2008). Rapid urbanization has created the need for extend shelf life capacities to supply food for urban populations. For efficiencies in the food supply chain, countries need improvements in roads, transportation and distribution infrastructure to keep food affordable for less developed countries as well as lower income consumers. Secondly, everyone has a general understanding that as growth in household income occurs, a decline in the consumption of starchy food staples and increased diversification of protein sources such as dairy, meat and fish simultaneously occurs. This transition conforms to Bennett's Law (Bennett, 1941), where the food share of starchy staples declines as income increases. As expected, this shift in dietary wants of more vulnerable, shorter shelf-life items is associated with greater food waste (Lundqvist et al., 2008). The transition varies by country to country and culture to culture, e.g. in India where there is less pressure on resources compared to China, where the demand for meat is increasingly rapidly.

### CURRENT AND POSSIBLE PREVENTION OF FOOD LOSSES AND WASTE

Food is wasted throughout the food supply chain from initial agricultural production down to final household consumption. In medium- and high-income countries food is to a high extent wasted, meaning that it is thrown away, even if it is still suitable for human consumption. Significant food loss and waste do, however, also occur earlier in the food supply chain especially in low-income countries

where food is lost during the production-to-processing stages of the food supply chain. The following section will overview science to cultural potential solutions that exist along the food chain for reducing the amount of food lost and wasted.

### NATIONAL RESEARCH CENTERS

The arguments in favor of tackling food waste are compelling. According to Dr. W. Edwards Deming, "If you can't describe what you are doing as a process, you don't know what you're doing." Today, several research centers are being created which is trying to better understand food loss and wasting and ultimately developing expertise which will provide intelligent solutions which will help improve environmental sustainability. The Zero Waste South Australian Research Center at the University of South Australia is an international leader in research dealing with systems thinking in sustainability, design and waste-related issues. Their main program focuses on understanding and changing consumer behavior through partnering with government, industry, business and community to promote environmental sustainability in Australia and Asia-Pacific Region. One of their most recent projects entitled, "Zeroing in on food waste" has led to better measuring, understanding and reducing food waste in South Australia from producers to consumption. The U.K. region has initiated a Waste and Resources Action Program (WRAP) which not only focuses on home waste, but also concentrates on the entire food production chain. One of the driving forces behind this government investigation was that the U.K. implemented the Climate Control Act which set legally binding emission

reduction targets for year 2020 (reduction of 34% greenhouse gas emissions) compared to 1990 reported levels. One of the initial studies implemented in WRAP was a household food waste prevention study which attempted to understand how consumers currently store fresh fruit and vegetables, identify what advice consumers were receiving on food storage at their retail store location, development in-home perishability ratings and methods that increase fruit and vegetable storage characteristics. Initial WRAP findings uncovered that 65% to 70% of fruit stored in a bowl; however, fruit which was stored in the refrigerator demonstrated much longer perishability ratings (oranges and pears lasted up to 2 weeks longer in refrigerator than in storage bowl). In the U.S. there have not been any comparable food waste research institutes, however, several waste reduction business are beginning to make their way into the mainstream. One of these programs is an operation called Waste Reduction Technology which is utilized by several of the Fortune 500 companies across the U.S. Dispensing of waste has become more expensive every year for businesses. Waste haulers sign long-term agreements with municipalities and in effect become monopolies that increase rates as much as 100% per year. Through utilization of a program similar to this, my current employer has been able to reduce waste by as much as 93% and have saved \$2.25 million annually. Within our program, management programs include efforts to reduced, reused and recycled solid waste, eliminate electronic waste, composting of grass clippings and leaves as well as recycling hazardous waste such as medical, tires, paint and petroleum products. Today landfills produce 34% of all methane emissions in the U.S. A gas that is 20 times more harmful to the environment than carbon dioxide. It should be noted, however, that Waste Reduction Technology does not have a food waste entity in their offering.

### **COLD CHAIN MANAGEMENT PROGRAMS**

California based company, Intellex promises a reduction of more than \$15 billion due to management of storage related food waste. Their RFID based system enables grocers, producers, cooperatives, distributors, retailers and restaurant operators to reduce loss associated with spoilage. Wireless tracking of fresh foods from the field to the grocer is based on temperature profiles of each pallet so that determination of potential stock availability and increased shelf-life. Intellex is quick to point out that they don't track bacteria counts, but do promise that through categorizing products into calculated freshness factors, they do promise great food safety with proper real-time temperature tracking. In London, England the retailer Sainsbury's has been making improvements through new technology that allows them to make real-time supply chain decisions aimed at reducing food waste caused by unexpected weather conditions. Weather plays an important role in consumer buying patterns. Like driving sales of comfort foods during cold spells or lighter foods during warmer periods, the Sainsbury technology gives

them the ability to make real-time decisions on where to send food from its warehouses rather than making last-minute course changing decisions in the middle of the night since implementing their program. To date, they have reduced food waste at their retail locations by 15% annually. Another Sainsbury's program has surrounded by the confusion associated with the "freeze by" vs. "use by" information provided on the retail packages. As part of the WRAP findings, information suggests that 60% of the consumers believe food has to be frozen on the day of purchase, which is reinforced by current labeling. Changing this advice is expected to help stop shoppers from throwing away up to 800,000 tons of perfectly good food each year. The "freeze on day of purchase" advice needs to be changed as there is no food safety reason why it cannot be frozen at any point prior to the use by date. Research from Sainsbury's shows that 62 percent of the UK regularly uses the freezer to lengthen the life of food, while in a separate study by WRAP, only 21 percent of the people interviewed had frozen food nearing its use by date. For this reason it is hoped that new labeling that reads "Freeze as soon as possible after purchase and always within the use by date, once frozen consume within one month. If defrosted use the same day."

### **RETAIL PACKAGING EFFORTS**

Food that is wasted before it is consumed requires ten times more energy and materials to produce than the packaging used to protect it (Advisory Committee on Packaging, 2008). In the U.K., two of their largest retailers (Tesco and Marks & Spencer) have unveiled new revolutionary packaging which they claim will extend the life of fruit stored in the refrigerator by up to two days which in turn reduces food waster at the consumer level. Both of the supermarket giants are partnering with UK-based "It's Fresh Ltd." to trial a patented strip containing a mixture of minerals and clay that absorbs ethylene. Ethylene acts at trace levels throughout the life of the plant by stimulating or regulating the ripening of fruit, the opening of flowers, and the abscission (or shedding) of leaves. Commercial ripening rooms use "catalytic generators" to make ethylene gas from a liquid supply of ethanol. Typically, a gassing level of 500 to 2,000 ppm is used, for 24 to 48 hours. The strip measures 8 cm x 4.5 cm and does not affect the recyclability of the packaging and the retailers claim that there is no extra cost to the consumer of the packaging. Trials carried out in the two retail chains has demonstrated that the "It's Fresh" technology showed a minimum wastage savings of 4% during the peak strawberry season which equates to approximately 40,000 packages or 800,000 strawberries. In conjunction with this technology, U.K. retailers are utilizing another patented time and temperature indicator label (TTi) which utilizes the "Best Before" and "Use By Date" on the label. The TTi system uses a traffic light display to show the freshness of the food during retail display as well as during home usage. Color indicators correspond to green being prior to

the best fore date is reached, amber color indicates when the best before date has been passed and a red light is displayed when the use by date has arrived. It should be noted that Tesco using the TTI system now has a “Buy One, Get One Free Later” incentive system instead of the traditional “Buy One, Get One Free” approach. Additionally, frequent shoppers have an app on their phone which alerts them of amber colored produce and significant discounts are available on those items. A new piece of technology has been developed by the Harvard Wyss Institute for Biological Inspired Engineering group has developed an artificial and edible substance that reduces food waste. Referred to as “WikiCells”, this edible packaging system consist of a charged polymer liquid and actual food particles, which when hardened around a food substance will contain the food much like the hard shell of an egg that can be chipped or cracked open (Organic Authority, 2012). The WikiCells can be included as a meal component or such as the tomato membrane (gazpacho soup) or grape membrane (wine). Currently, the Harvard group is attempting to develop a WikiCells-based bottle product for the water business.

### **FOOD SERVICE EFFORTS**

While Earth Day is celebrated once a year, at campuses throughout North America, a new program is underway which reduces waste, conserves resources and creates a work-friendly environment. An initiative undertaken by Aramark referred to as “trayless dining” (removing trays from University dining halls), is having a measurable impact on reducing waste and conserving natural resources. According to a national survey, conducted by Aramark Higher Education, trayless dining reduces waste by approximately two ounces per person, per meal. As of spring 2012, more than 300 college and universities in the U.S. have implemented the trayless dining system, diverting more than 15 million pounds of food waste from landfills this year, while reducing trash hauling needs, decreasing water and chemical use and lowering electricity usage. Of the 592 billion pounds of perishables grown in the U.S. each year, it has been estimated that nearly half is discarded (Bloom, 2010). Previous generations considered wasting food considered wasting food as “sinful”, today it has become a social norm. The collateral damage of a highly productive agricultural system that is enabled by efficient production, transportation and disposal capabilities. The healthcare industry is generally considered highly wasteful and has been generally slow to embrace sustainable practices. Yet that is not the case with Gundersen Lutheran Health System, a non-profit hospital group headquartered in La Crosse, Wisconsin. Their award-winning suitability initiatives are now advancing towards the “control” arena through prevention. Their underlying goal is to prevent waste before it is created in the 21,000 meals that they serve per week. They have adopted a program called “ValuWaste” which was developed by the LeanPath Company which helps hospitality and food ser-

vice clients reduce waste at the preparation and operational stages. Collected baseline information identified that Gundersen Lutheran was wasting approximately 24 tons of food annually. Through the use of a ValuWaste scale and monitoring program, their food waste has been lowered by 50% reflected in that their trash bins are only emptied once instead of three times daily. Lastly, the U.S. Government is implementing food wastage reduction programs throughout their many military bases. For example, at Fort Jackson, SC food waste has historically been 40% of the municipal waste generated at this facility. The Army Installation Sustainability Project has implemented menu changes that included the increase of cut fruit, increased management of portions sent to the field and awareness of methods to reduce overall food waste. To date a 10-fold reduction in dining facility waste has been sustained at Fort Jackson which strengthens their operational capability by saving time in food preparation. Additionally, money saved by reducing waste disposal costs can be spent supporting other mission essential needs at military facility.

### **CONSUMER EFFORTS**

Of all the policies and campaigns to save energy in the U.S., from switching to compact fluorescent light bulbs to pumping billions into corn ethanol production, one of the simplest and most underused ways to curb energy use might be to just eat your leftovers and throw less food away. As mentioned throughout this manuscript, Americans on average throw away at least one and a one-half pounds of food that, depending on the numbers you look at, this represent between a third to one-half of all of the food produced in the U.S. In a University of Texas publication determined that the U.S. could save roughly 2 percent of its total energy consumption in one year if it stopped wasting food (Cuellar and Webber, 2010). That number might sound small, but it’s the energy equivalent to saving 350 million barrels of oil. “That’s about twice as much energy as Switzerland consumes in a year for all purposes, so we could power them up and then some,” said Webber an assistant professor in mechanical engineering and associate director of the Center for International Energy and Environmental Policy at the University of Texas at Austin. “The amount of energy embedded in the food we throw away is more than all the energy we get from the corn ethanol we produce in a year,” stated Webber. Food was always not devalued in America. During the two World Wars, being penny-wise with food was considered a patriotic duty, one that could help the war effort, and was emphasized through propaganda posters like “Food is a weapon – don’t waste it” and “Food will win the war.” The sentiment was not just a patriotic guilt trip, it was a necessity. The Great Depression fell between the wars, and in the spring of 1942, the Food Rationing Program was implemented as most Americans struggled simply to get by. In the Jonathon Bloom book, “American Wasteland,” this food waste expert writes that parents of Baby Boomers faced a decision on how to treat

their children that pitted their experiences with hunger in the 1930's and 1940's against the postwar euphoria and abundance sweeping across the nation. They could either preach to their children to clean their plates or let them eat whatever they wanted. According to Bloom, the later idea won. Obviously, with the efficiencies as a result of adaption of fertilizers, insecticides, water irrigation systems and animal pharmaceuticals and growth enhancements has resulted in farmers and ranchers to produce and sell more food and lower prices. There seems to be a behavior issue in the minds of consumers and it's related to how much we spend on food (Figure 4).

As mentioned earlier in the proceeding paper, a negative relationship exists between what a consumer pays for food and food wastage. However, higher percentages of the more-developed countries are initiating consumer programs which are making consumers more aware along with lowering food waste. One of these countries that have certainly taken the lead on this endeavor is South Korea. In the past decade, South Korea has increased in prominence on the global stage with its hosting of huge international events like the World Cup in 2002 and the G20 Summit in 2010. The cosmopolitan flair of its capital, Seoul, is on display in neighborhoods like wealthy Ak-pujong and artsy Samcheong-dong. Living in what is currently the 13<sup>th</sup> wealthiest nation on earth, South Koreans spend and consume far more than they did a generation ago. In a population dense area like Seoul, recycling has

always been looked upon in a favorable light for some time and they have achieved impressive gains in waste diversion. Starting in 2013, food waste will no longer be accepted to be dumped in the municipal waste facilities. However, Seoul will adopt a volume – or weight – rate disposal system for kitchen waste which will be bagged in a specifically marked bag that is weighed and in turn will charge residents and business owners for the amount of food waste they create. The system promises to work quickly. First, users will insert a RFID card (that doubles public transport fare card) into a reader. The bin's disposal lid opens immediately, allowing the user to throw their food waste in for weighing. The lid closes immediately and the food waste is immediately calculated with a fee charges to the user's card. According to the South Korean government, food waste disposal costs the country about \$15 billion annually. A 20 percent reduction in food waste could reduce those costs by \$4.3 billion and prevent the emission of 4 million tons of greenhouse gases.

## CONCLUSION

Food security is a major concern in large parts of the developing world. Food production must clearly increase significantly to meet the future demands of an increasing and more affluent world population. In a world with limited resources (land, water, energy, fertilizer, knowledge, infrastructure), reducing food losses should not be a forgotten priority.

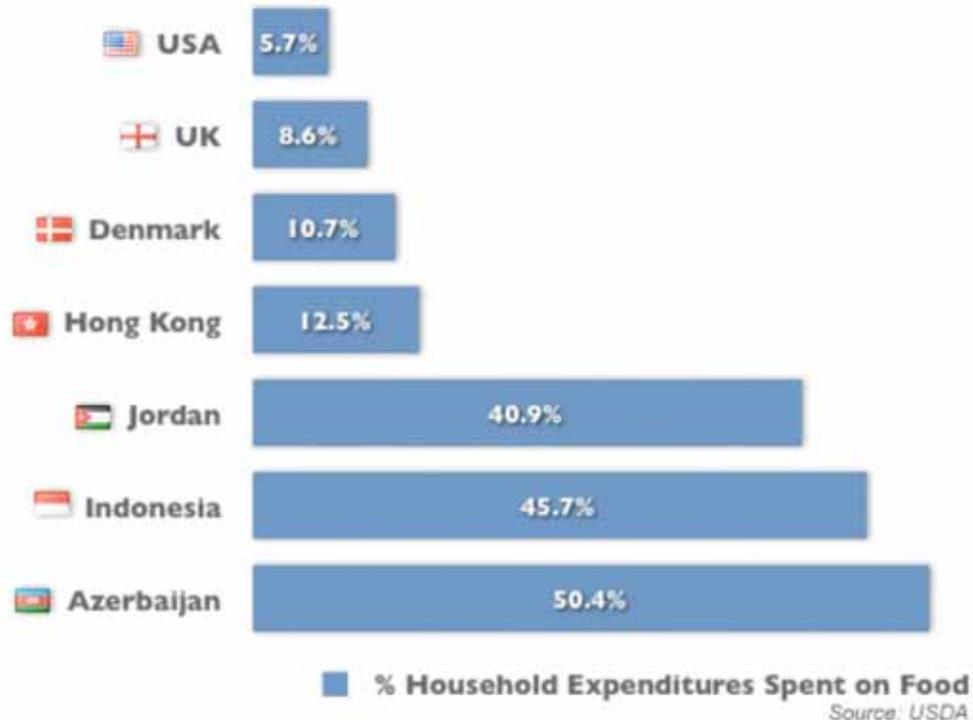


Figure 4. Food expenditures of total income for various countries.

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