Food Waste in the Developing World

The potential impact of engineering less waste

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Key messages

- We produce approximately 4 billion tonnes of food globally each year.
- We waste 30–50% of all food produced.
- Levels of wasted food lead to overproduction in both the developed and the developing world.
- Engineering solutions can reduce food waste and protect the food-growing environment.
- Engineering solutions can use food waste for heat, power and fertilizer.
- Less food waste and good engineering practices can lead to better access to food for those in developing countries.

Definitions

Food loss
The decrease in edible food mass at the production, post-harvest, processing and distribution stages in the food supply chain. These losses are mainly caused by inefficiencies in the food supply chains, like poor infrastructure and logistics, lack of technology, insufficient skills, knowledge and management capacity of supply chain actors, no access to markets. In addition, natural disasters play a role.

Food waste
Food which is fit for consumption being discarded, usually at retail and consumer level. This is a major problem in industrialized nations, where throwing away is often cheaper than using or re-using, and consumers can afford to waste food. Accordingly, food waste is usually avoidable.

Food wastage
Any food lost by wear or waste. Thus, the wastage is here used to cover both food loss and waste.

Source: Food Wastage Footprint and Environmental Accounting of Food Loss and Waste. Concept Note. Natural Resources Management and Environment Department, Food and Agriculture Organization of the United Nations. March 2012.

Diminishing resources, rising energy costs

Across the globe we currently produce around four billion metric tonnes of food per annum. The UN has projected that by 2100 the population could peak at 9–12 billion, creating an extra 3–5 billion mouths to feed. Today we waste some 30–50% of all food produced: this happens at farms, in storage and transportation, in factories and retail outlets, as well as in the home. In spite of this huge wastage, people starve and depend on social safety nets and food banks in both the developing and the developed world.

> "Today we waste some 30–50% of all food produced"

The United Nations describes three types of countries: developing economies, economies in transition, and developed economies. The classifications are designed to reflect the characteristics expected with each type of economy, and some countries in the transition category will appear in more than one cat-

egory.[1] This article will consider developing and transitioning nations together and developed nations separately.

The Institution of Mechanical Engineers in its 2013 Global Food report identified three areas where impacts will continue to cause problems for food production and climate change in the future. They are:

- The area of land available for agriculture will diminish due to factors including environmental degradation, stresses related to climate change, and restrictions aimed at preservation of ecosystems, as well as competition with other demands on land use, such as biomass-derived energy initiatives, urbanization, transport, industrial and leisure needs.
- Increased competition for available water from urban developments and industry will reduce the quantities available for crop and livestock production. This will happen in a world of uncertain rainfall patterns, drought and flooding, due to the effects of global warming. The impact of global warming on water resources, the potential regional losses of fresh water, the rise of sea levels and the subsequent consequences for agriculture present a future global challenge whose extent is currently unclear.
- Energy costs, particularly for fossil fuels, are likely to rise substantially, with increasing demand for, and diminishing availability of, easily exploitable secure supplies. This applies to fuels used directly to power agricultural machines, processing equipment, transportation and storage facilities, as well as to the significant amount of natural gas that is used in the production of fertilizers and pesticides.

Tackling these three challenges will be key to successfully reducing not only food waste but also the unnecessary waste of energy, water, human resources and emissions, as well as the associated damage to soils and ecosystems. This will lead to more efficient food production, better access to food globally, and a reduction in the impact of food wastage.

Developing and transitioning nations

Food loss is created in the developing world primarily through poor or low-tech approaches to the farming, storage and transportation of crops. This may occur through inefficient farming techniques whereby food is damaged or remains unharvested and is left to rot.

This type of harvesting may be followed by inappropriate storage, where there is not sufficient cooling to keep crops fresh or else early biodegradation is increased through dense storage techniques that create excess heat. Further losses can occur in the transportation of food: this may be due to lack of refrigeration or to damage caused to badly secured food products in transport. This can be seen in rice losses in South East Asian countries: in China, a country experiencing rapid development, the rice loss figure is about 45% of the crop, while in less-developed Vietnam, rice losses are as high as 80%.[2]

Despite huge advances in agricultural technologies, some 30–50% of all food produced is lost

As nations move into a transitional phase of development, the technologies used for efficient farming reduce the waste at production, but an increase is seen further along the food chain at transportation, storage, retail and consumption.

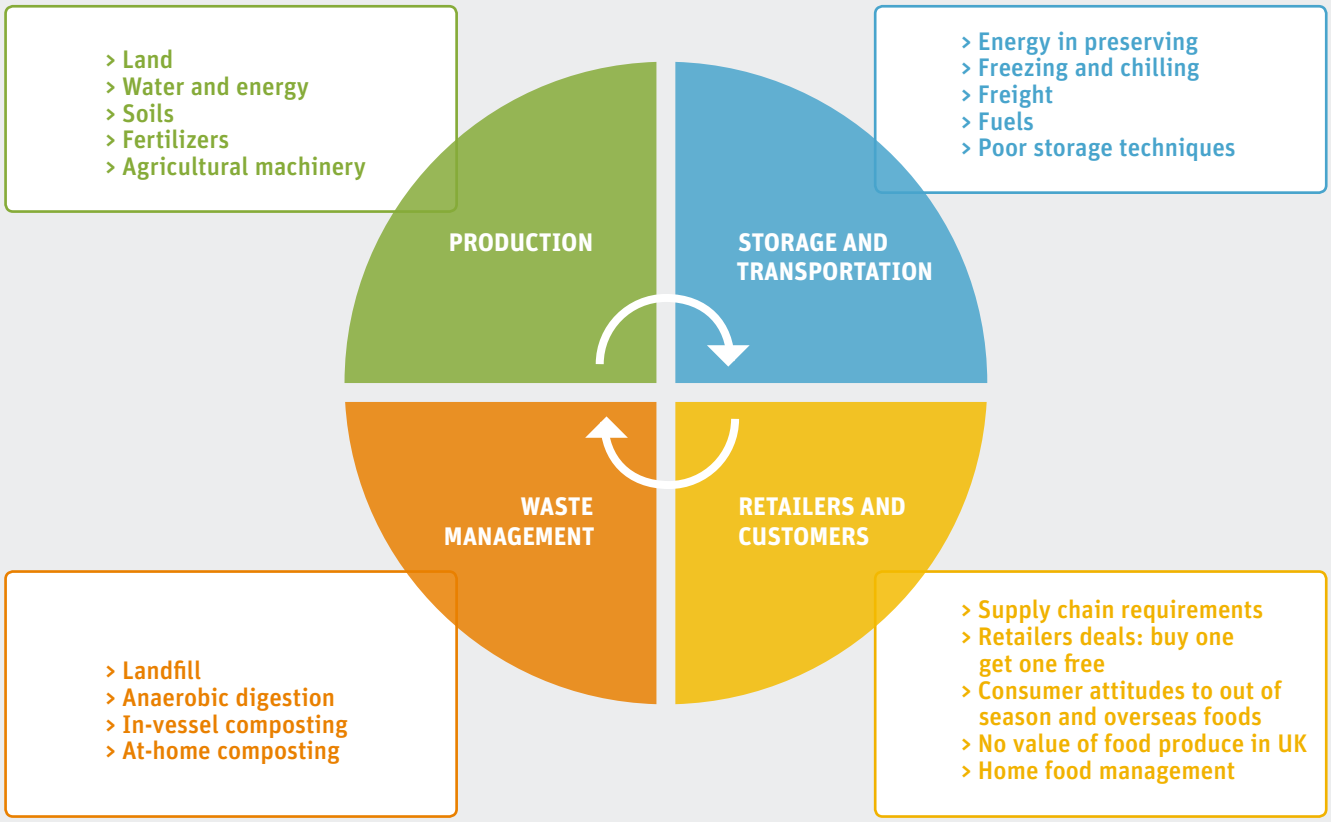
In addition to this food waste being created by easier access and consumption of food in transitioning nations, further packaging waste is produced. This is often unmanaged, as commercial economies experience growth faster than the transitioning nations can build infrastructure to manage wastes. That said, innovations in smart packaging have the long-term potential to reduce food loss by keeping produce fresh and safe to consume for longer.

The production of food is a service that comes from our planet's natural ecosystems and requires these systems to remain fertile and pollutant-free. In many developing nations, access to fertile land is dwindling. It is expected that the demand for agricultural production will increase by up to 70% by 2050, with particular increases of up to 45% in meat consumption.

Engineering a solution in developing and transitioning nations

Across the globe, engineering has consistently provided solutions to help increase food production. These range from effective techniques for spreading fertilizers and pesticides to advancements in crop management techniques. Today we look to engineering to provide a low-carbon, clean solution that will help developing and transitioning nations to feed their

FIGURE 1: The cycle of production, storage & transportation, retail & consumption, and waste management



populations without devastating the land. This is becoming increasingly important as populations grow and land space for farming shrinks.

Agriculture produces greenhouse gas emissions; these emissions then create a warmer climate that reduces access to water and fertile land areas. The need to engineer out the emissions from agricultural practices and wastes is evident if the vicious cycle described above is to be broken.

As the 21st century unfolds, the role of systems thinking in engineering is beginning to draw in all aspects of life. From food production to the generation of consumer waste, engineering systems can be used to both reduce waste and provide heat and power to communities. These can then be used to facilitate the better storage and transportation of crops.

When considering systems in developing and transitioning nations, there are some technologies that are equally suitable to managing wastes and creating heat and power. The idea of combined heat and power, whereby a small gas or biomass generator provides both electricity and heating, is not new in technological terms, but it is rarely thought of as useful in countries where there is too much heat. Technologies employing anaerobic digestion – a process that digests food and sewage waste and produces a biogas – can be used to generate both electricity and gas for adapted farm vehicles. Waste heat from this process can be used to produce cold from absorption chillers. Cooling can then be transported through pipes to manage storage spaces for food crops.[3]

An absorption chiller is a technology that uses heat and a concentrated salt solution to produce chilled water. Absorption refrigeration uses very little electricity compared to an electric-motor-driven refrigerator. Variable heat sources can be used to drive the absorption refrigerator.[4]

In many developing and transitioning countries where the climate is warm and sunny, solar power for retail and domestic cooling is another technology that could significantly reduce food waste. There are two ways this can be achieved. Solar energy can be harvested through the heating of water on roof tops, and this water can then be used to drive an absorption chiller for air conditioning. The second approach involves using solar panels that produce electricity and can be deployed directly to drive refrigeration.

These types of technology can be particularly useful in regions where continuous mains electricity is intermittent. Taking the off-grid approach to managing cold not only reduces

the food waste and maintains the nutritional value of the food, but also reduces emissions of carbon dioxide and other greenhouse gases.

For this to be successful across the globe, support from developed countries will be required in technology and skills transfer, along with aid to support infrastructure development. These technologies may not be successful if there is not adequate support for governments, locally and nationally, to implement waste collection and management schemes.

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The role of engineering out food waste in nutrition

As an engineer, it is relatively easy to see how we could solve many of the problems globally associated with wasted food. Effective cooling and consumer management of food allows that food to last longer and retain its nutritional value. However, these changes involve new technologies, and they are not being implemented in developed countries due to the financial investment and potential policy changes needed to create a clean, low-waste food chain.

The low political and financial value placed on food loss in developed countries has led to a situation in which low-income families are seeking support from charity food banks and a waste management infrastructure designed to deal with huge amounts of waste that is actually fit for human consumption. In turn, this lack of political will has stifled innovation and created a society in which food must be perfectly formed to merit being consumed, rather than being seen first and foremost as nutritious fuel for humans.

In the developing nations, there is an opportunity – if it can be financially supported by the developed and transitioning nations – to create a sustainable and clean food production environment through the implementation of policies and technologies described in this article. Without forward planning for developing and transitioning nations, there will be a lot more food waste globally, as populations swell and associated resources are wasted, simultaneously contributing emissions to global warming.

We can feed the projected 2075 population today, but it will be necessary to change our attitudes, diets, behavior and technologies to ensure that everyone in the world benefits.

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An agricultural worker in a paddy-field. The world's ecosystems must remain fertile and pollutant-free if the nutritional needs of the rapidly growing global population are to be met.

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