IEA Bioenergy

Food Waste Digestion

Anaerobic Digestion of Food Waste for a Circular Economy

Summary Series

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Executive Summary

There is increasing awareness of the quantities of food that are lost every year across the globe; while the quality of available data varies, estimates suggest the total is around 1.3 billion tonnes. These losses occur at all stages of production, from pre-harvest on the farm through to post-harvest losses during processing, distribution, retailing and consumption. This report considers only those harvested food materials that are never consumed, but ultimately find their way into the waste stream (Figure 1).

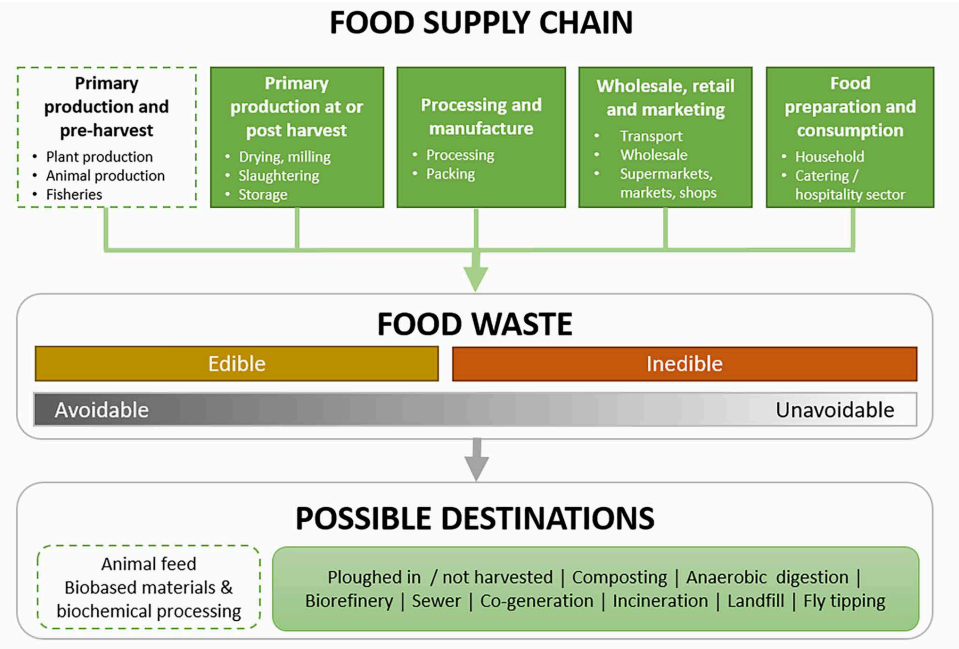

Figure 1: Framework defining the food supply chain and food waste destinations (based on JRC, 2017)

By far the largest proportion of this material is generated at the point of consumption, in the home or in cafeterias, canteens and restaurants. Some of this waste is avoidable, but a proportion is unavoidable as it consists of parts of the product that are not edible (such as shells, bones and peels). Better understanding of the origins and fates of unconsumed food has led to the development of food waste hierarchies where prevention is the first objective, and only material that is unfit for human or animal consumption becomes waste. Where food wastes are generated, however, the first option to consider is anaerobic digestion or industrial use in biorefineries as these offer the greatest opportunities for both resource and energy recovery.

The proportion of food entering the waste stream reflects socio-economic and other factors. It is still only poorly quantified, but where good quality data exist anything from 25 to 65% of the municipal waste stream may be comprised of food materials, depending on geographical region. In Europe this equates to approximately 173 kg per person per year. Although the appearance of food waste may differ depending on its origin, due to local food preferences and habits, in biochemical terms it is generally very similar. It shows roughly the same distribution of proteins, fats, carbohydrates and essential elements, is easily biodegradable and has a high biochemical methane potential (BMP).

Despite these apparently ideal properties, the first food waste digestion systems showed signs of severe inhibition after some months of operation. This was caused by the build-up of ammonia, which reached concentrations that are inhibitory to some groups of methane-producing microorganisms. Improvements in our understanding of the complex interactions between acid-producing bacteria and methanogens made it possible to identify a solution; this was to promote alternative metabolic pathways to methane production that are mediated by more ammonia-tolerant species. This process requires some trace elements that are normally only present in low concentrations in human food and must therefore be supplemented for stable food waste digestion.

Food waste digestion is now commonly undertaken commercially at a large scale. It is most widespread in the UK, where there are currently 94 digesters producing over 220 MW_e of power from food processing residues, supermarket wastes and kerbside collected source-separated domestic food waste. These processes are efficient, with as much as 85% of the degradable material being turned into biogas, and a similar percentage conversion of the calorific value of the food waste into a usable energy product. A second benefit of the digestion process is that it allows the return of plant nutrients to farms, since the digestate can be applied as a nitrogen-rich fertiliser product without risk to animal health or the environment when the production process is properly controlled and regulated.

Although the main policy aim should be to minimise avoidable food waste, the unavoidable fraction can now be successfully recovered through the anaerobic digestion process as a single feedstock or can be used in co-digestion schemes to maximise the overall potential for recovery of energy and nutrients from manures and wastewater bio-solids. Food waste digestion has only emerged relatively recently at a commercial scale, but case histories for different countries show there is now global interest in taking this technology forward. The full report outlines case studies from eleven countries, namely; Australia, Canada, China, Indonesia, Japan, Malaysia, Singapore, South Korea, Thailand, the United Kingdom and Vietnam.

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