



Conference on ‘Sustainable food consumption’

The potential of food preservation to reduce food waste

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While we state it seems unthinkable to throw away nearly a third of the food we produce, we still continue to overlook that we are all very much part of this problem because we all consume meals. The amount of food wasted clearly has an impact on our view of what we think a sustainable meal is and our research suggests food waste is a universal function that can help us determine the sustainability of diets. Achieving sustainability in food systems depends on the utilisation of both culinary skills and knowledge of how foods make meals. These are overlooked by the current food waste debate that is concerned with communicating the problem with food waste rather than solutions to it. We aim to change this oversight with the research presented here that demonstrates the need to consider the role of food preservation to reduce food waste and the requirement for new marketing terms associated with sustainability actions that can be used to stimulate changes in consumption behaviours. We have chosen frozen food to demonstrate this because our research has shown that the use of frozen foods results in 47 % less household food waste than fresh food categories. This has created a step-change in how we view food consumption and has stimulated consumer movements that act across different products and supply chains to enable the consumption of the sustainable meal.

Sustainability: Food-waste: Consumers: Nutrition

The way in which we utilise food has a very important impact on our perception of value of food and what a sustainable meal actually is. In considering food utilisation, we must understand why we purchase food but do not eat it because the world of 2050 is projected to have in the region of 9 billion consumers and meals with less food waste are a sustainable target⁽¹⁾. Waste associated with many consumer goods has been revolutionised in the past two decades by regulations that are focussed on environmental management and the protection of public health; as a general descriptor they enforce the ‘polluter pays’ principle⁽²⁾. The food supply chain does not fit easily into these highly regulated models used for fast moving consumer goods such as electronics and fashion. This is because food has the shortest shelf life in the retail and consumer environment that ranges from days to weeks if they are fresh and it is extended to months if they are dried, canned or frozen. The principle of slowing down food degradation using preservation is one that the food industry is built upon with the

first food manufacturers recognising the value of extending shelf life so that distribution to large populations was practical and achievable. The initial products of the fledgling food industry included stocks and condiments that had the principle of extending shelf life built into them. Integrating new product development of foods with sustainability principles is not easy and I suggest that it will only occur if we can reduce consumer and household food waste. Understanding how we can do this provides important insights into defining what a sustainable meal is. I believe the research reported here shows how the reduction of household food waste can be used by manufacturers, retailers and consumers as an understandable and accurate indicator of a sustainable diet.

Why is food preservation a sustainability issue?

The development of the frozen food industry is a key to the research reported here; it is not a new idea with the

Abbreviations: EU, European Union; LCA, life cycle assessment.
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commercial reality of it being realised in the 1920s with the extension of Clarence Birdseye's observations of 'icing fish' in Canada to that of the industrial arena. His entrepreneurship extended the range of manufactured foods into consumer lifestyles and his vision of creating foods with 'less fuss and no waste' created a successful brand. His legacy has been to show we can cut through a complex problem of delivering wholesome foods to large populations with the simplicity of using freezing as a preservation method. Of course, the limitations of refrigeration in the household stunted this aspiration until the 1950s when refrigeration became associated with household management, culinary preparation and convenience.

How the refrigerated supply chain integrates with sustainable goals is not well described even though sustainability has become well described for food supply chains using the metrics of carbon, water, biodiversity impact, which has been defined, standardised and tested⁽³⁾. A supply chain perspective here is crucial and these metrics can be described by a relatively concise set of functions such as import and export volumes; nutritional value and the energy used to supply food, which are often measured to obtain improved resource utilisation⁽⁴⁾. Such functions are used to assess the utilisation of resources in the four supply chain operations of production; manufacturing and processing; retailing, wholesaling and distribution; and consumption⁽¹⁾. Life cycle assessment (LCA) and footprinting methods help us to define the impacts of these functions and they support many certifications in the food industry. LCA data is now readily available to the food industry because there is often a commercial requirement to build in sustainability for food products that goes beyond the application of LCA. Furthermore, although the information from LCA and carbon footprinting studies is often openly available it is not universally used by food supply chains, largely because consumers need to relate sustainability metrics to practical culinary preparation and the experience of consuming foods⁽⁵⁾. It is evident that there are barriers to using these LCA resources and new marketing methods are required to link the sustainability of meals to their consumption in order to overcome them. The development of platforms that communicate the social and financial values of food waste reduction provide a means to achieve this because they utilise LCA information and relate this to meal outcomes, as such, food waste may represent a universal language for sustainability across the food supply chain from producer to consumer.

The actual barriers of accessing LCA information *in situ* during product development and meal preparation remain a challenge because while many sustainability attributes are understandable to consumers with respect to climate change and poor health their scale of impact on individual consumption practices is hard to visualise. This is because small changes in behaviour or consumption by individuals are perceived as relatively unimportant in the preparation of an individual meal even though they have large impacts in populations at national scales, which are of most importance to policy makers.

Current sustainability communications for food supply are not helpful at alleviating the perception that small dietary changes can have large impacts because they are focussed on these high-level policy issues of global climate change, biodiversity loss and food security challenges⁽⁶⁾. This lack of connectivity between policy and consumer requires a language that both can use and reducing consumer food waste provides this because it transfers policy goals to the practice of making meals that in turn create sustainable diets that stimulate positive nutritional and environmental outcomes.

There is no doubt that such momentum exists to reduce food waste because food industry actions have been successful at improving the resource utilisation in supply chains and the impact of how we consumers make meals is now a focus for these actions⁽⁷⁾. It is well documented that reducing food waste from the consumer operations in the food supply chain will result in alleviating food security challenges because food not wasted by consumers has the chance to be consumed by others, if optimal preservation and efficient supply chain infrastructure is in place to make this work. Waste reduction is also familiar to consumers because communications and social media have established the link between wasting food and household financial losses.

The multifaceted nature of sustainability in the creation of diets

European Union (EU) member states have highly variable manufacturing, service sector and consumer food waste amounts per capita (FAOSTAT food balance data) and we can reduce this in all member states, so that sustainable outcomes are realised. However, we must be careful in interpreting what is a sustainable meal because reduction of food waste is not necessarily an outcome of this and to demonstrate I cite the population models we have developed that can calculate the greenhouse gas emission outcomes of different diets for regional populations⁽⁸⁾. These models use the National Census and the National Diet and Nutrition Survey to obtain typical food consumption metrics and this has been reported for the South Yorkshire region in the UK. The research has shown the region produces 17 000 tonnes greenhouse gas emissions each week from the consumption of household meals that have used foods purchased from retailers. The greenhouse gas emissions can be reduced by reducing the meat content of diets; however, in such scenarios meat is replaced with increased amounts of perishable foods including fruit and vegetables⁽⁹⁾. Current statistics show consumers waste greater amount of these perishable goods than meat products resulting in the negative outcome of a lower greenhouse gas emission diet creating more food waste. Such insights demonstrate the importance of trade-offs in meaningful sustainable dietary policy, which account for such complexity and highlight the role of food preservation in ameliorating the negative impacts of wasting perishable foods. This research



enables us to pressure-test the food policy arena so that we can understand how the food industry can respond positively to dietary transitions in marketplaces such as the current move in Europe to diets that contain less meat⁽¹⁰⁾.

The value of developing meal solutions for dietary sustainability

The dominance of specialist LCA reporting in the consumer arena has tended to create a vacuum across the supply chain with manufacturers not using LCA information available and consumers not engaging with communications concerned with sustainable diets. If the language used for sustainable diet is not resonating with end-users then we must ask what communications should be used? We can begin to test popular terms associated with sustainable eating using the Twitter or Google web-crawler applications that quantify the volume of search citations associated with specific terms or words. If we search for specialist terms such as 'low greenhouse gas emission foods' or 'sustainable foods' the searches return extremely low volumes of citation from Google Trends. The Google Trends web-crawler measures the number of times a specific search term is used as a proportion of the total times it is used over a specific time period and it plots the trend in interest for that search term⁽¹¹⁾. When trends are identified for terms associated with 'recipes', 'organic foods' or 'meals' the volume of citation returned by the web-crawler tools are far greater than for specialist LCA terminology. This suggests the language of specialists is clearly not resonating with consumer lifestyles and I would go further to state that it currently tends to make consumers feel guilty about consumption practices because it rarely considers the positive outcomes of consuming food⁽¹²⁾. The sustainable meal and diet debate is often focussed on the negative such as increasing obesity, loss of biodiversity and consuming what 'may not be good for you'. This needs to change if sustainable actions by consumers are to be realised and reducing food waste can embody many of these actions.

The current status is, the sustainability arena is dominated by expert information that is not utilised and this vacuum is readily occupied by celebrity and media where traceable evidence is rarely framed in the debate. This naturally leads us to consider what can we do as scientists to transfer robust meaningful data to European consumers? There are notable successes where specialist science has complemented the strong cultural interest in preparing food and these have communicated the benefits of dietary change effectively such as the Total Well Being diet from the Commonwealth Scientific and Industry Research Organisation in Australia. The Total Well Being has used dietary trials and recipe listing to promote health and sustainability in domestic food preparation; it uses meal groups or meal solutions to communicate or change sustainable consumption practices⁽¹³⁾. Indeed, this approach is familiar to the food industry in linking branded food products to lifestyles

through meals. This is what the food industry has done exceptionally well in terms of supplying high volumes of affordable, wholesome and assured produce. It is important for us to consider how we might link successful brand communication techniques to sustainability communications and the household management of food groups in dietary scenarios that are familiar to us when we consume meals. The development of such systems that utilise meal groups is established with the expert use of nutritional profiling tools that have linked food product development with nutritional outcomes and how consumers make meals⁽¹⁴⁾. This approach has been tested for assessing the sustainability metrics of high-meat and low-meat diets but it is highly likely that such meal grouping methods will provide further insights into designing sustainable meals⁽¹⁵⁾.

Resource utilisation; a critical investigative tool for identifying pre-consumer waste challenges

EU food supply chains have undergone a resource efficiency revolution that has reduced food waste to the point of purchase by consumers and this has been stimulated by associating financial and regulatory efficiency with the waste reduction capability of businesses. The pre-consumer resource utilisation achieved by manufacturers in the food supply chain has reduced food waste to below 5% of production in many food categories as reported by FAOSTAT food balance statistics. As an example, the pre-consumer meat waste volume for the EU is significant at 85 172 tonnes/year; this has decreased from maximum values of 130–140 kilo-tonnes in the 1961–2011 period. Using such a mass-intensity approach whereby food waste is presented as a proportion of production, the total pre-consumer waste for meat varies between 0.35 and 0.10% of EU production of meat over this period. This is indicative of an extremely efficient supply chain that has designed out waste and diverted resources into co-products and feed supply. Vegetable supply chains also show high resource utilisation with 1% waste during the 1961–2011 period, although a far greater amount of waste is produced at 5–8 million tonnes/year in the EU. These indicators show efficient resource utilisation in supply chains and highlight the challenge of reducing food waste from food products purchased by consumers⁽¹⁶⁾. This type of mass intensity balance approach for resource utilisation and waste reduction is an important tool for assessing supply chain waste and it is also used by the pharmaceutical industry as an emergent way of applying 'green principles'⁽¹⁷⁾. While this approach provides optimism for supply chain efficiency, it is very clear that the food supply chains of Europe have a waste reduction challenge that lies with retailer to consumer operations because these are estimated to be 35 million tonnes domestic food waste produced across the EU each year⁽¹⁸⁾. This challenge is recognised by the next Courtauld Commitment in the UK, which will maintain resource efficiency improvements within supply chains and target reducing consumer food waste⁽⁷⁾.



The consumer; the food preservation potential and the frozen food case for reducing food waste

A critical influence in determining the amount of consumer food waste produced for a specific food product or group is the method of food preservation used in households. This is because preservation extends shelf life and builds in the opportunity to optimise the utilisation of a food product for consumption. This effect has been demonstrated by a study that has assessed how consumers utilise fresh and frozen food categories in meal preparation across eighty-three households⁽¹⁹⁾. This pilot study has initiated future studies that will have larger samples and provide more detailed insight into how we utilise different preservation formats in households when we prepare meals. There are currently few consumer studies that identify how consumers utilise foods in the domestic and service environments. The methodology reported by Martindale⁽¹⁸⁾, has utilised a sample of 250 households that took part in food sensory panels and the study selected eighty-three households that used both fresh and frozen food products. A survey asked consumers to indicate the amount of food waste produced from fresh and frozen foods using illustrations of food plate shapes. This data was used with household purchasing volume data to calculate the volume of waste from different food products. This type of visual referencing and association is used regularly in recipes by using the teaspoon, tablespoon and handful schematics. It is not an unfamiliar method of relating mass of ingredients to meals in the consumer arena and it is particularly advanced for those ingredients that have specialised health messaging associated with them⁽²⁰⁾. The visual referencing association is also used for the leisure and conservation arenas where association of quantitative land management attributes with qualitative consumer values is required by return on investment assessments⁽²¹⁾. This principle has been successfully used in the nutritional arena with dietary behaviour survey and it is a familiar approach in dietary research⁽²²⁾.

The frozen food study provided insights into how the frequency of purchase is decreased for frozen foods and the periodicity of disposal of foods from different preserved formats has an impact on waste volume with frozen foods having the least food waste⁽¹⁸⁾. In the case of frozen foods, the purchase frequencies are decreased compared with fresh foods and the time in the household is extended whether the food is purchased frozen or a product is frozen. This evidence has supported the Forever Food Together programme developed by Iglo Foods Group Ltd as part of their Corporate Social Responsibility reporting⁽²³⁾. This study of frozen food utilisation was developed to extrapolate these levels of waste reduction associated with frozen food use to a EU scale. This demonstrated that if frozen food products were not available across meat, fruit and vegetable product categories, then there would be 5.5 million additional tonnes household food waste produced each year across the EU. This is a crucial projection because frozen food purchases will be less than 10 % of all food purchasing so a modest increase in the purchasing of frozen

foods or the management of freezing food in the home would decrease domestic food waste dramatically. The EU produces over 30 million tonnes domestic food waste each year and a significant amount of this could be reduced by re-thinking how preservation of food is utilised by consumers in households.

What is staggering to think, is that using the method of preservation in households to reduce food waste is far from a new idea, it is not disruptive or revolutionary but it has been overlooked and forgotten in the sustainable diet arena. A convenient example of food preservation legacy is provided by the first Women's Institute meeting, which took place over 100 years ago in the UK⁽²⁴⁾. A key subject of this Women's Institute meeting and many others after it was promoting culinary knowledge to improve household management of food. Indeed, the Institute has said its establishment was to 'educate rural women, and to encourage countrywomen to get involved in growing and preserving food to help to increase the supply of food to the war-torn nation'. Of course, times have changed and lifestyles have improved across Europe but I would emphasise the need to understand culinary practices within the sustainable diet arenas still exists. While it is now demonstrated that food preservation can reduce food waste I believe that it can provide a focus for the practical implementation of policies that aim to develop sustainable eating across Europe.

Developing a model of a sustainable diet that can be used by consumers

We are currently testing models of food preservation in the home to enable building in sustainability to food product and menu design by tackling two fundamental issues that make sustainable diets so difficult to understand for manufacturers, retailers and consumers. (1) We assess all the decisions associated with meals not individual food products; (2) We provide connectors in methodologies that manufacturers, retailers and consumers can use when making supply chain or meal preparation decisions; an example of a connector is the measurement of food waste.

Food waste is a function of the food supply chain that can be used to measure the overall sustainability of meals based on the premise that if we appreciate and enjoy meals as consumers, we will waste less of them. Domestic food waste connects many of the sustainability and security issues within the matrix of food choices associated with meals and diets. Consumers waste food because (a) we have too much, (b) we do not like, (c) we have forgotten about it while it has been stored. My experience and research has shown that food manufacturers and food retailers occupy critical control points that can determine how food consumption behaviours are nudged into more sustainable practices and preservation format is an important aspect of doing this. Indeed, this is becoming the driver for developing new branding opportunities and marketing messages that consumers associate with.



Certification

Certification of food products has an important role in creating sustainable foods and should be considered in the models of waste reduction. The impact of certification is evident as an increase in food purchases that have ethical certifications or certifications that are integrated with sustainability messages⁽²⁵⁾. There is no doubt that certification of fast moving consumer goods has revolutionised consumer understanding of ethical purchasing through schemes focussed on fair trade and sustainable fisheries, for example⁽²⁶⁾. However, many certifications can exclude operators in supply chains from engaging with them because they require significant financial investment to start-up and implement. The approach of using food waste reduction as a sustainability indicator of how sustainable a meal is will be accessible for producers to consumers; indeed there are likely to be clear consumer benefits rather than costs if it can be designed into the supply chain.

While our understanding of what a sustainable diet is should relate the higher level values of security and ethics there is a need to also link this understanding to the meals and nutritional solutions consumers prepare for themselves. Clear guidance is necessary to determine what is a sustainable diet and this is not currently communicated in straightforward ways to consumers. The current food waste debate has tended to overlook the importance of the supply chain in assessing how we might tackle reducing food waste and much of the literature and policy initiatives have focussed on the problem of food waste rather than the solutions to it. The nutritional arena is very aware of the perils associated with making consumers feel guilty about the food they eat and creative public health communications do not take this approach to changing consumption. Indeed, they develop certifications that have successful languages of engagement that are clearly understood by the supply chain operators involved with them.

Developing a language for a sustainable diet

We can assess social media trends to provide insights into what consumers regard as important values associated with a sustainable diet. These may be important tools because current communications regarding the environmental and health impacts of unsustainable diets are not creating the outputs policy makers desire. This is evident with the increased frequency of disease in populations associated with the overconsumption of food and a poor understanding of nutrient requirements. We have already highlighted how different terms associated with sustainability messaging using the Google Trends application can be used to search for terms associated with sustainable diets. The approach of using social media and on-line channels to explore sustainability terms has been tested in the conservation and land management disciplines where they relate quantifiable terms such as biodiversity loss to the quality values people associate with conservation⁽²⁷⁾. In a similar way, consumers

of food need to relate measurable sustainability attributes of food such as the carbon footprint of a meal to the values they associate with diets⁽²⁸⁾. The web-crawler search methods used in other disciplines offer us a means to search for these links because they quantify how popular search terms are on specific social media platforms so that a common language is developed. This language is currently lacking in the sustainable diet policy arena and it is dominated by celebrity and media outside policy circles of influence where information provided for consumers often lacks a transparent link to any scientific evidence. Developing language and terms that connect consumers to evidence and science will strengthen the aspiration to eat sustainable meals.

Conclusion

Our goal in this arena is to stimulate a transition from 'LCA-thinking' to one of 'consumer experience-thinking' using food waste reduction as a connecting theme across the food supply chain. This approach leads to the sustainable outcomes of food waste reduction and financial gain, across the supply chain. The impact of food waste reduction is well established for the pre-consumer supply chain and we need to influence post-retail food waste production in future. The food industry can stimulate this action by designing products that build in waste reduction and integrate them into diets to create a zero food option for consumers. The food industry has experience of linking language to values of convenience, acceptability and enjoyment, which are all built into food brands. The emergent commercial goal here to connect these established brand values to sustainability and food waste reduction by consumers must be a candidate to do this.

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