

The potential of food preservation to reduce food waste

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1 **The potential of food preservation to reduce food waste**

2

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6

7 **Abstract**

8 While we state it seems unthinkable to throw away nearly a third of the food we produce, we still

9 continue to overlook that we are all very much part of this problem because we all consume meals.

10 The amount of food wasted clearly has an impact on our view of what we think a sustainable meal

11 is and our research suggests food waste is a universal function that can help us determine the

12 sustainability of diets. Achieving sustainability in food systems depends on the utilisation of both

13 culinary skills and knowledge of how foods make meals. These are overlooked by the current food

14 waste debate that is concerned with communicating the problem with food waste rather than

15 solutions to it. We aim to change this oversight with the research presented here that demonstrates

16 the need to consider the role of food preservation to reduce food waste and the requirement for new

17 marketing terms associated with sustainability actions that can be used to stimulate changes in

18 consumption behaviours. We have chosen frozen food to demonstrate this because our research has

19 shown that the use of frozen foods results in 47% less household food waste than fresh food

20 categories. This has created a step-change in how we view food consumption and has stimulated

21 consumer movements that act across different products and supply chains to enable the

22 consumption of the 'sustainable meal'.

23

24 **Keywords;** sustainability, food-waste, consumers, nutrition

25

26 **Introduction**

27 The way in which we utilise food has a very important impact on our perception of value of food

28 and what a sustainable meal actually is. In considering food utilisation, we must understand why

29 we purchase food but do not eat it because the world of 2050 is projected to have in the region of 9

30 billion consumers and meals with less food waste are a sustainable target¹. Waste associated with

31 many consumer goods has been revolutionised in the last two decades by regulations that are

32 focussed on environmental management and the protection of public health; as a general descriptor

33 they enforce the 'polluter pays' principle². The food supply chain does not fit easily into these

34 highly regulated models used for Fast Moving Consumer Goods (FMCGs) such as electronics and

35 fashion. This is because food has the shortest shelf life in the retail and consumer environment that

36 ranges from days to weeks if they are fresh and it is extended to months if they are dried, canned or
37 frozen. The principle of slowing down food degradation using preservation is one that the food
38 industry is built upon with the first food manufacturers recognising the value of extending shelf life
39 so that distribution to large populations was practical and achievable. The initial products of the
40 fledgling food industry included stocks and condiments that had the principle of extending shelf life
41 built-into them. Integrating new product development of foods with sustainability principles is not
42 easy and I suggest that it will only occur if we can reduce consumer and household food waste.
43 Understanding how we can do this provides important insights into defining what a sustainable
44 meal is. I believe the research reported here shows how the reduction of household food waste can
45 be used by manufacturers, retailers and consumers as an understandable and accurate indicator of a
46 sustainable diet.

47

48 **Why is food preservation a sustainability issue?**

49 The development of the frozen food industry is key to the research reported here, it is not a new
50 idea with the commercial reality of it being realised in the 1920s with the extension of Clarence
51 Birdseye's observations of 'icing fish' in Canada to that of the industrial arena. His
52 entrepreneurship extended the range of manufactured foods into consumer lifestyles and his vision
53 of creating foods with 'less fuss and no waste' created a successful brand. His legacy has been to
54 show we can cut through a complex problem of delivering wholesome foods to large populations
55 with the simplicity of using freezing as a preservation method. Of course, the limitations of
56 refrigeration in the household stunted this aspiration until the 1950's when refrigeration became
57 associated with household management, culinary preparation and convenience.

58

59 How the refrigerated supply chain integrates with sustainable goals is not well described even
60 though sustainability has become well described for food supply chains using the metrics of carbon,
61 water, biodiversity impact which has been defined, standardised and tested³. A supply chain
62 perspective here is crucial and these metrics can be described by a relatively concise set of functions
63 such as import and export volumes; nutritional value and the energy used to supply food which are
64 often measured to obtain improved resource utilisation⁴. Such functions are used to assess the
65 utilisation of resources in the four supply chain operations of production; manufacturing and
66 processing; retailing, wholesaling and distribution; and, consumption¹. Life Cycle Assessment
67 (LCA) and footprinting methods help us to define the impacts of these functions and they support
68 many certifications in the food industry. LCA data is now readily available to the food industry
69 because there is often a commercial requirement to build-in sustainability for food products that
70 goes beyond the application of LCA. Furthermore, although the information from LCA and carbon

71 footprinting studies is often openly available it is not universally used by food supply chains,
72 largely because consumers need to relate sustainability metrics to practical culinary preparation and
73 the experience of consuming foods⁵. It is evident that there are barriers to using these LCA
74 resources and new marketing methods are required to link the sustainability of meals to their
75 consumption in order to overcome them. The development of platforms that communicate the
76 social and financial values of food waste reduction provide a means to achieve this because they
77 utilise LCA information and relate this to meal outcomes, as such, food waste may represent a
78 universal language for sustainability across the food supply chain from producer to consumer.

79
80 The actual barriers of accessing LCA information *in-situ* during product development and meal
81 preparation remain a challenge because while many sustainability attributes are understandable to
82 consumers with respect to climate change and poor health their scale of impact on individual
83 consumption practices is hard to visualise. This is because small changes in behaviour or
84 consumption by individuals are perceived as relatively unimportant in the preparation of an
85 individual meal even though they have large impacts in populations at national scales which are of
86 most importance to policy makers. Current sustainability communications for food supply are not
87 helpful at alleviating the perception that small dietary changes can have large impacts because they
88 are focussed on these high-level policy issues of global climate change, biodiversity loss and food
89 security challenges⁶. This lack of connectivity between policy and consumer requires a language
90 that both can use and reducing consumer food waste provides this because it transfers policy goals
91 to the practice of making meals that in turn create sustainable diets that stimulate positive
92 nutritional and environmental outcomes.

93
94 There is no doubt that such momentum exists to reduce food waste because food industry actions
95 have been successful at improving the resource utilisation in supply chains and the impact of how
96 we consumers make meals is now a focus for these actions⁷. It is well documented that reducing
97 food waste from the consumer operations in the food supply chain will result in alleviating food
98 security challenges because food not wasted by consumers has the chance to be consumed by
99 others, if optimal preservation and efficient supply chain infrastructure is in place to make this
100 work. Waste reduction is also familiar to consumers because communications and social media has
101 established the link between wasting food and household financial losses.

102

103 **The multifaceted nature of sustainability in the creation of diets**

104 European Union member states have highly variable manufacturing, service sector and consumer
105 food waste amounts per capita (FAOSTAT food balance data) and we can reduce this in all member

106 states so that sustainable outcomes are realised. However, we must be careful in interpreting what
107 is a sustainable meal because reduction of food waste is not necessary an outcome of this and to
108 demonstrate I cite the population models we have developed that can calculate the GHG emission
109 outcomes of different diets for regional populations⁸. These models use the National Census and
110 the National Diet and Nutrition Survey (NDNS) to obtain typical food consumption metrics and this
111 has been reported for the South Yorkshire region in the United Kingdom. The research has shown
112 the region produces 17 000 tonnes of GHG emissions each week from the consumption of
113 household meals that have used foods purchased from retailers. The GHG emissions can be
114 reduced by reducing the meat content of diets, however, in such scenarios meat is replaced with
115 increased amounts of perishable foods including fruit and vegetables⁹. Current statistics show
116 consumers waste greater amount of these perishable goods than meat products resulting in the
117 negative outcome of a lower GHG emission diet creating more food waste. Such insights
118 demonstrate the importance of trade-offs in meaningful sustainable dietary policy which account for
119 such complexity and highlight the role of food preservation in ameliorating the negative impacts of
120 wasting perishable foods. This research enables us to pressure-test the food policy arena so that we
121 can understand how the food industry can respond positively to dietary transitions in marketplaces
122 such as the current move in Europe to diets that contain less meat¹⁰.

123

124 **The value of developing meal solutions for dietary sustainability.**

125 The dominance of specialist LCA reporting in the consumer arena has tended to create a vacuum
126 across the supply chain with manufacturers not using LCA information available and consumers not
127 engaging with communications concerned with sustainable diets. If the language used for
128 sustainable diet is not resonating with end-users then we must ask what communications should be
129 used? We can begin to test popular terms associated with sustainable eating using the Twitter or
130 Google web-crawler applications that quantify the volume of search citations associated with
131 specific terms or words. If we search for specialist terms such as ‘low greenhouse gas emission
132 foods’ or ‘sustainable foods’ the searches return extremely low volumes of citation from Google
133 Trends. The Google Trends web crawler measures the number of times a specific search term is
134 used as a proportion of the total times it is used over a specific time period and it plots the trend in
135 interest for that search term¹¹. When trends are identified for terms associated with ‘recipes’,
136 ‘organic foods’ or ‘meals’ the volume of citation returned by the web-crawler tools are far greater
137 than for specialist LCA terminology. This suggests the language of specialists is clearly not
138 resonating with consumers lifestyles and I would go further to state that it currently tends to make
139 consumers feel guilty about consumption practices because it rarely considers the positive outcomes
140 of consuming food¹². The sustainable meal and diet debate is often focussed on the negative such

141 as increasing obesity, loss of biodiversity and consuming what ‘may not be good for you’. This
142 needs to change if sustainable actions by consumers are to be realised and reducing food waste can
143 embody many of these actions..

144
145 The current status is the sustainability arena is dominated by expert information that is not utilised
146 and this vacuum is readily occupied by celebrity and media where traceable evidence is rarely
147 framed in the debate. This naturally leads us to consider what can we do as scientists to transfer
148 robust meaningful data to European consumers? There are notable successes where specialist
149 science has complemented the strong cultural interest in preparing food and these have
150 communicated the benefits of dietary change effectively such as the Total Well Being (TWB) Diet
151 from CSIRO in Australia. The TWB has used dietary trials and recipe listing to promote health and
152 sustainability in domestic food preparation, it uses meal groups or meal solutions to communicate
153 or change sustainable consumption practices¹³. Indeed, this approach is familiar to the food
154 industry in linking branded food products to lifestyles through meals, it is what the food industry
155 has done exceptionally well in terms of supplying high volumes of affordable, wholesome and
156 assured produce. It is important for us to consider how we might link successful brand
157 communication techniques to sustainability communications and the household management of
158 food groups in dietary scenarios that are familiar to us when we consume meals. The development
159 of such systems that utilise meal groups is established with the expert use of nutritional profiling
160 tools that have linked food product development with nutritional outcomes and how consumers
161 make meals¹⁴. This approach has been tested for assessing the sustainability metrics of high-meat
162 and low-meat diets but it is highly likely that such meal grouping methods will provide further
163 insights into designing sustainable meals¹⁵.

164
165 **Resource utilisation; a critical investigative tool for identifying pre-consumer waste challenges**
166 European Union (EU) food supply chains have undergone a resource efficiency revolution that has
167 reduced food waste to the point of purchase by consumers and this has been stimulated by
168 associating financial and regulatory efficiency with the waste reduction capability of businesses.
169 The pre-consumer resource utilisation achieved by manufacturers in the food supply chain has
170 reduced food waste to below 5% of production in many food categories as reported by FAOSTAT
171 food balance statistics. As an example, the pre-consumer meat waste volume for the EU is
172 significant at 85 172 tonnes per year, this has decreased from maximum values of 130-140 kilo-
173 tonnes in the 1961 to 2011 period. Using such a mass-intensity approach whereby food waste is
174 presented as a proportion of production, the total pre-consumer waste for meat varies between
175 0.35% and 0.10% of EU production of meat over this period. This is indicative of an extremely

176 efficient supply chain that has designed out waste and diverted resources into co-products and feed
177 supply. Vegetable supply chains also show high resource utilisation with 1% waste during the 1961
178 to 2011 period, although a far greater amount of waste is produced at 5-8 million tonnes per year in
179 the EU. These indicators show efficient resource utilisation in supply chains and highlight the
180 challenge of reducing food waste from food products purchased by consumers¹⁶. This type of mass
181 intensity balance approach for resource utilisation and waste reduction is an important tool for
182 assessing supply chain waste and it is also used by the pharmaceutical industry as an emergent way
183 of applying ‘green principles’¹⁷. While this approach provides optimism for supply chain
184 efficiency, it is very clear that the food supply chains of Europe have a waste reduction challenge
185 that lies with retailer to consumer operations because there are estimated to be 35 million tonnes of
186 domestic food waste produced across the European Union each year¹⁸. This challenge is recognised
187 by the next Courtauld Commitment in the UK which will maintain resource efficiency
188 improvements within supply chains and target reducing consumer food waste⁷.

189

190 **The consumer; the food preservation potential and the frozen food case for reducing food** 191 **waste**

192 A critical influence in determining the amount of consumer food waste produced for a specific food
193 product or group is the method of food preservation used in households. This is because
194 preservation extends shelf life and builds-in the opportunity to optimise the utilisation of a food
195 product for consumption. This effect has been demonstrated by a study that has assessed how
196 consumers utilise fresh and frozen food categories in meal preparation across 83 households¹⁹. This
197 pilot study has initiated future studies that will have larger samples and provide more detailed
198 insight into how we utilised different preservation formats in households when we prepare meals.
199 There are currently few consumer studies that identify how consumers utilise foods in the domestic
200 and service environments. The methodology reported by Martindale¹⁸, has utilised a sample of 250
201 households that took part in food sensory panels and the study selected 83 households that used
202 both fresh and frozen food products. A survey asked consumers to indicate the amount of food
203 waste produced from fresh and frozen foods using illustrations of food plate shapes, this data was
204 used with household purchasing volume data to calculate the volume of waste from different food
205 products. This type of visual referencing and association is used regularly in recipes by using the
206 teaspoon, tablespoon and handful schematics. It is not an unfamiliar method of relating mass of
207 ingredients to meals in the consumer arena and it is particularly advanced for those ingredients that
208 have specialised health messaging associated with them²⁰. The visual referencing association is
209 also used for the leisure and conservation arenas where association of quantitative land management
210 attributes with qualitative consumer values is required by return on investment assessments²¹. This

211 principle has been successfully used in the nutritional arena with dietary behaviour survey and it is a
212 familiar approach in dietary research²².

213

214 The frozen food study provided insights into how the frequency of purchase is decreased for frozen
215 foods and the periodicity of disposal of foods from different preserved formats has an impact on
216 waste volume with frozen foods having the least food waste¹⁸. In the case of frozen foods, the
217 purchase frequencies are decreased compared to fresh foods and the time in the household is
218 extended whether the food is purchased frozen or a product is frozen. This evidence has supported
219 the Forever Food Together programme developed by Iglo Foods Group Ltd as part of their
220 Corporate Social Responsibility (CSR) reporting²³. This study of frozen food utilisation was
221 developed to extrapolate these levels of waste reduction associated with frozen food use to a
222 European Union scale. This demonstrated that if frozen food products were not available across
223 meat, fruit and vegetable product categories then there would be 5.5 million additional tonnes of
224 household food waste produced each year across the European Union. This is a crucial projection
225 because frozen food purchases will be less than 10% of all food purchasing so a modest increase in
226 the purchasing of frozen foods or the management of freezing food in the home would decrease
227 domestic food waste dramatically. The European Union produces over 30 million tonnes of
228 domestic food waste each year and a significant amount of this could be reduced by re-thinking how
229 preservation of food is utilised by consumers in households.

230

231 What is staggering to think, is that using the method of preservation in households to reduce food
232 waste is far from a new idea, it is not disruptive or revolutionary but it has been overlooked and
233 forgotten in the sustainable diet arena. A convenient example of food preservation legacy is
234 provided by the first Womens Institute (WI) meeting which took place over 100 years ago in the
235 UK²⁴. A key subject of this WI meeting and many others after it was promoting culinary
236 knowledge to improve household management of food. Indeed, the Institute has said its
237 establishment was to 'educate rural women, and to encourage countrywomen to get involved in
238 growing and preserving food to help to increase the supply of food to the war-torn nation'. Of
239 course, times have changed and lifestyles have improved across Europe but I would emphasise the
240 need to understand culinary practices within the sustainable diet arenas still exists. While it is now
241 demonstrated that food preservation can reduce food waste I believe that it can provide a focus for
242 the practical implementation of policies that aim to develop sustainable eating across Europe.

243

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

245 We are currently testing models of food preservation in the home to enable building-in
246 sustainability to food product and menu design by tackling two fundamental issues that make
247 sustainable diets so difficult to understand for manufacturers, retailers and consumers.

- 248 1. We assess all the decisions associated with meals not individual food products.
- 249 2. We provide connectors in methodologies that manufacturers, retailers and consumers
250 can use when making supply chain or meal preparation decisions, an example of a
251 connector is the measurement of food waste.

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

262

263 **Certification**

264 Certification of food products has an important role in creating sustainable foods and should be
265 considered in the models of waste reduction. The impact of certification is evident as an increase in
266 food purchases that have ethical certifications or certifications that are integrated with sustainability
267 messages²⁵. There is no doubt that certification of FMCGs has revolutionised consumer
268 understanding of ethical purchasing through schemes focussed on fair trade and sustainable
269 fisheries for example²⁶. However, many certifications can exclude operators in supply chains from
270 engaging with them because they require significant financial investment to start-up and implement.
271 The approach of using food waste reduction as a sustainability indicator of how sustainable a meal
272 is will be accessible for producers to consumers, indeed there are likely to be clear consumer
273 benefits rather than costs if it can be designed into the supply chain.

274

275 While our understanding of what a sustainable diet is must relate the higher level values of security
276 and ethics to the nutritional solutions consumers prepare for themselves each day clear guidance of
277 what is a sustainable diet is not communicated in straightforward ways. The current food waste
278 debate has tended to overlook the importance of the supply chain in assessing how we might tackle
279 reducing food waste and much of the literature and policy initiatives have focussed on the problem

280 of food waste rather than the solutions to it. The nutritional arena is very aware of the perils
281 associated with making consumers feel guilty about the food they eat and creative public health
282 communications do not take this approach to changing consumption. Indeed, they develop
283 certifications that have successful languages of engagement that are clearly understood by the
284 supply chain operators involved with them.

285

286 **Developing a language for a sustainable diet.**

287 We can assess social media trends to provide insights into what consumers regard as important
288 values associated with a sustainable diet. These may be important tools because current
289 communications regarding the environmental and health impacts of unsustainable diets are not
290 creating the outputs policy makers desire. This is evident with the increased frequency of disease in
291 populations associated with the overconsumption of food and a poor understanding of nutrient
292 requirements. We have already highlighted how different terms associated with sustainability
293 messaging using the Google Trends application can be used to search for terms associated with
294 sustainable diets. The approach of using social media and on-line channels to explore sustainability
295 terms has been tested in the conservation and land management disciplines where they relate
296 quantifiable terms such as biodiversity loss to the quality values people associate with
297 conservation²⁷. In a similar way, consumers of food need to relate measurable sustainability
298 attributes of food such as the carbon footprint of a meal to the values they associate with diets²⁸.
299 The web-crawler search methods used in other disciplines offer us a means to search for these links
300 because they quantify how popular search terms are on specific social media platforms so that a
301 common language is developed. This language is currently lacking in the sustainable diet policy
302 arena and it is dominated by celebrity and media outside policy circles of influence where
303 information provided for consumers often lacks a transparent link to any scientific evidence.
304 Developing language and terms that connect consumers to evidence and science will strengthen the
305 aspiration to eat sustainable meals.

306

307 **Conclusion**

308 Our goal in this arena is to stimulate a transition from 'LCA-thinking' to one of 'consumer
309 experience-thinking' using food waste reduction as a connecting theme across the food supply
310 chain. This approach leads to the sustainable outcomes of food waste reduction and financial gain,
311 across the supply chain. The impact of food waste reduction is well established for the pre-
312 consumer supply chain and we need to influence post-retail food waste production in future. The
313 food industry can stimulate this action by designing products that build-in waste reduction and
314 integrate them into diets to create a zero food option for consumers. The food industry has

315 experience of linking language to values of convenience, acceptability and enjoyment which are all
316 built into food brands. The emergent commercial goal here to connect these established brand
317 values to sustainability and food waste reduction by consumers must be a candidate to do this.

318

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