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FEEDING THE BRITISH PUBLIC:

a centenary review of food and drink manufacturing

CAS Report 20

Feeding the British public: a centenary review of food and drink manufacturing

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CAS Report 20

October 2014

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ISBN 978 0 7049 1522 0
ISSN 0141 1330

Preface

The Centre for Agricultural Strategy was established in 1975. It exists, primarily, to identify important issues in food and agriculture and to ensure that they are subjected to informed debate. As a result we are pleased to publish this report commissioned by the Food and Drink Federation to celebrate their centenary.

The authors, coming from several different academic disciplines, are drawn from two world-renowned and long-established Schools at the University of Reading: the School of Agriculture, Policy and Development and the School of Chemistry, Food and Pharmacy. However, the views herein expressed cannot be attributed to either the University of Reading or the Food and Drink Federation.

I hope readers will find the report useful and informative and will then appreciate the important role the British food and drink industry has played over the last 100 years in feeding the Nation.

Richard Tranter
Director
Centre for Agricultural Strategy

Contents

List of tables, figures and boxes

Tables

Figures

Boxes

Abbreviations

BBIRA	British Baking Industries Research Association
BBSRC	Biotechnology and Biological Sciences Research Council
BHF	British Heart Foundation
BNF	British Nutrition Foundation
BSE	Bovine Spongiform Encephalopathy
CAP	Common Agricultural Policy
CHD	Coronary Heart Disease
CJD	Creutzfeld Jakobs Disease
CVD	Coronary Vascular Disease
COMA	Committee on Medical Aspects of Food Policy
DNA	Deoxyribonucleic acid
DRINC	Diet and Health Research Industry Club
DRV	Dietary Reference Values
EAR	Estimated Average Requirement
EFSA	European Food Safety Authority
EU	European Union
FDF	Food and Drink Federation
FDIC	Food and Drink Industries Council
FMF	Food Manufacturers' Federation
FOP	Front of Pack
FSA	Food Standards Agency
FSC	Food Standards Committee
FTIR	Fourier Transform IR
GC	Gas-liquid Chromatography
GDA	Guideline Daily Amount
GDP	Gross Domestic Product
GM	Genetically Modified
HACCP	Hazard Analysis Critical Control Point
HMF	5-hydroxymethylfurfural
HPLC	High-performance Liquid Chromatography
IGD	Institute of Grocery Distribution
IR	Infrared
LRNI	Lower Reference Nutrient Intake
NDNS	National Diet and Nutrition Survey
ONS	Office for National Statistics
RDA	Recommended Daily Allowance
RNI	Reference Nutrition Intake
SACN	Scientific Advisory Committee on Nutrition
t	Tonne
TFP	Total Factor Productivity
UHT	Ultra-high Temperature
UK	United Kingdom
UV	Ultraviolet

Foreword by the authors

This report was commissioned by the Food and Drink Federation: 'a members' organisation which represents the UK food and drink industry, the largest manufacturing sector in the country' (http://www.fdf.org.uk). The sector directly employs some 400,000 people with as many as 1.2 million in ancillary services. In 2013, whilst celebrating its 100th birthday, the Food and Drink Federation approached us to see whether we would be able and willing to produce a report focussing on the transformations in society, and in people's lives, over the last century, linked to developments in the food and drink manufacturing industries. We agreed that there had been radical changes and that, *on balance*, Britons today have access to a safer, more varied, affordable, and conveniently presented range of food products than ever before, although the changes that have brought this about have been multifaceted, and teasing out cause and effect is very difficult. Despite very real concerns about obesity, we are now much better fed than 100 years ago.

Many citizens, ourselves included, have concerns about the behaviour of Corporate Britain: news headlines about bankers' bonuses, businesses apparently minimising corporate tax liabilities, and unethical trading practices, spring to mind. The food supply chain, and its customers, have recently been shocked by the horse-meat scandal; and, as academics studying nutrition, food, and the food supply chain, we were well aware that the food industries have had their critics. Instances of them not operating in the public interest can readily be found.

Nonetheless, *in the round*, we do believe that the public interest is served. Moreover, we have difficulty envisaging how modern society would operate if a sophisticated food and drink manufacturing industry was not in place to take the raw materials produced on farms and from the sea and transform them into a range of complex products for consumers to buy. Consequently, we agreed to undertake the project provided we retained editorial control.

The University of Reading has, for many years, had major research interests in agriculture, food economics and marketing, food science and technology, nutrition and the life sciences in general. Through its many degree programmes it is committed to preparing its graduates to take up challenging and exciting jobs in these industries. We will need more food in the future to feed a rapidly growing world population, but we must find smarter ways to produce, process, and deliver that food and reduce its environmental impact. Our hope is that this report will contribute to a better understanding of the role the food and drink manufacturing industries have played, and must continue to play, in feeding a growing, urbanised population.

We are very grateful to Terry Jones and Fiona Campbell from the Communications Division of the Food and Drink Federation for several useful discussions on the structure, content and nature of the report, providing background information and for helping us obtain product profiles from the Food and Drink Federation's large membership. However, the contents of this report are our sole responsibility, although information for

the Centre Spread of product and brand profiles was provided by the seven companies concerned. Thus, we would also like to thank apetito, McCain Foods, Nestlé, Princes, Tropicana, Walkers and Warburtons for providing us with the details and history of their products showcased here in the Centre Spread.

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Executive Summary

Continuity and change

- Today we are richer, better fed and healthier than our forebears a Century ago because of major advances in science and technology harnessed by powerful economic forces.
- Food accounted for about 45% of the expenditure of working class households in 1900. In 2011, by contrast, the 20% of households in the lowest income groups devoted 17% of their household expenditure to food and non-alcoholic drinks.
- Although some manufactured foods entering our kitchens in the 2010s are very similar to those of the 1910s, others are quite different, not just in terms of their range and variety, but also in how they are prepared and presented.
- Many manufactured food products offer a level of convenience not available in the past: new technologies in the factory and the kitchen have contributed to a dramatic fall in the time it takes to prepare meals.
- We have a vast array of food products to choose from, particularly if we shop online, in a superstore, or on a busy high street.
- In presenting this array of goods, the food industries have had to react to consumer concerns about how food is produced.
- The food and drink manufacturing sector plays a pivotal role in the food chain, linking the farmer through to the final consumer. Science and technology, and entrepreneurial skills, have been brought to bear on an industrial scale to tackle the age-old requirements of preserving seasonal food so it could be stored, avoiding spoilage and preparing palatable food that consumers want to purchase and eat.

Nutritional discoveries

- Over the last 100 years, nutrition research has moved through a number of ages, from
  - the discovery of compounds causing deficiencies;
  - through to an examination of the relationship between diet and disease;
  - to developing policies and population-based recommendations to achieve optimal nutrition and health; and
  - now in the genomics age, exploring diet and DNA interactions and asking whether it may be possible to develop individual dietary recommendations and foods based on a person's genotype.

Science, technology and innovation

- Food manufacturers can now employ knowledge of underlying chemical reactions occurring between food components during processing, storage and cooking to deliver consistent and high quality of flavour, colour and texture. This has allowed the development of convenient and other rapidly prepared foods that have dramatically cut the time spent preparing meals in the home.

- Over the last 100 years, the food industry has shown itself able to continuously adapt to advances in science and technology, and has kept the best interests of consumers to the fore, whether nutritional, hedonistic enjoyment or safety.

Food quality and safety

- Today it is recognised there needs to be a partnership between Government and industry but a Century ago, food legislation was in its infancy. Even in the interwar years of 1918-1938 the food industry was uncertain of the need for legal controls and often opposed their imposition as an unnecessary impediment to business freedom. However, scientific evidence was increasingly indicating that consumers needed protection.
- The Second World War required stringent controls to ensure both fair distribution of food and the maintenance of its quality. The use of compositional standards and enhanced food labelling was seen to provide consumers with better protection. The re-establishment of a secure food supply, advances in food science and technology and developments in food toxicology during the 1950s - 1970s led to a more varied food supply but also an increase in legal controls.
- In the 1980s and 1990s, the growing power of the retailers, and their focus on the consumer, encouraged food manufacturers to adopt enhanced approaches to both food quality and food safety whilst trying to offer value in an increasingly competitive market.
- Towards the end of the Century, consumer confidence in the safety of food and the overall food supply was severely damaged by major incidents such as BSE and salmonella in eggs. The increasingly global nature of the UK's food supply has brought additional concerns in managing risk. New approaches to control were considered necessary and have been implemented although the food industry has to remain vigilant to new risks.

Future challenges

- In the future, the food industry must contend with increasing consumer concerns about the application of new science and technology to foods, particularly the thorny issues of GM food and nanotechnology for example. Consumers will continue to demand protection by effective legal control and industry will need to demonstrate a responsible approach to the UK's food supply, especially in relation to sustainability issues.

1. Introduction

A Centenary offers a marvellous opportunity to reflect, with the benefit of hindsight, on the major changes and trends that have occurred in an industry. In 1913 the Board of Trade was considering extending the coverage of the Trade Boards Act 1909 to the confectionery, jam, pickle and sauce making trades. The Act had provisions for establishing minimum wages in an industry. This prompted the formation of the Confectionery and Preserved Food Manufacturers' Federation, which had some 230 members by October 1913[1]. Four years later this federation was reconstituted as the Food Manufacturers' Federation (FMF) (French and Phillips, 2000) which, after its merger with the Food and Drink Industries Council (FDIC) in the mid-1980s, became today's FDF.

Here, we review some of the key developments in food and drink *manufacturing* in the United Kingdom (UK) since 1913. It does *not* claim to be an economic history of the industry. That has still to be written, although Oddy and Drouard (2013) and others have done much to fill many of the gaps. Scholars from the University of Reading have also made significant contributions, for example the history of Huntley and Palmers by Corley (1972), work on the North American influence on Britain's food manufacturing by Collins (2009) and Godley and Williams (2009) on the poultry meat industry. Nor is this review a political history of the FMF/FDF, although several authors have used the FDF archives in their studies (e.g. French and Phillips, 2000).

Our focus is food and drink *manufacture*, rather than a wider discussion of the food industries or of food policy. Clearly, however, it is difficult to separate *manufacture* from the other crucial components of the food chain. To explain how the dairy industry has evolved for example, involves consideration of cattle breeding and milk composition, hygiene on the farm and throughout the distribution chain, to retail and the household fridge. In the 2010s, all these elements differ significantly from those prevailing in the 1910s. The computing technologies of the 2010s were unimaginable in the 1910s; and the way we transport our goods is radically altered. Henry Ford started marketing his Model-T in 1908, but it was not until the 1980s that out-of-town supermarkets began to attract the motorised shopper, reflecting earlier developments in the USA (Wrigley and Lowe, 2002). Other industries mattered including, crucially, the manufacture of the machinery the food and drink manufacturing industries use, and the non-agricultural raw materials needed to make a processed food product. Johnston (1976) for example, claims that one factor hindering the early development of the British canning industries was the quality, and cost, of British tinplate.

In the next Chapter of this *review*, we give a brief indication of the socio-economic changes over the century, highlighting economic and political developments that impacted on the lives of the British public. Food is now more affordable, more varied, and more conveniently presented than it was in the 1910s, and we highlight why this is so.

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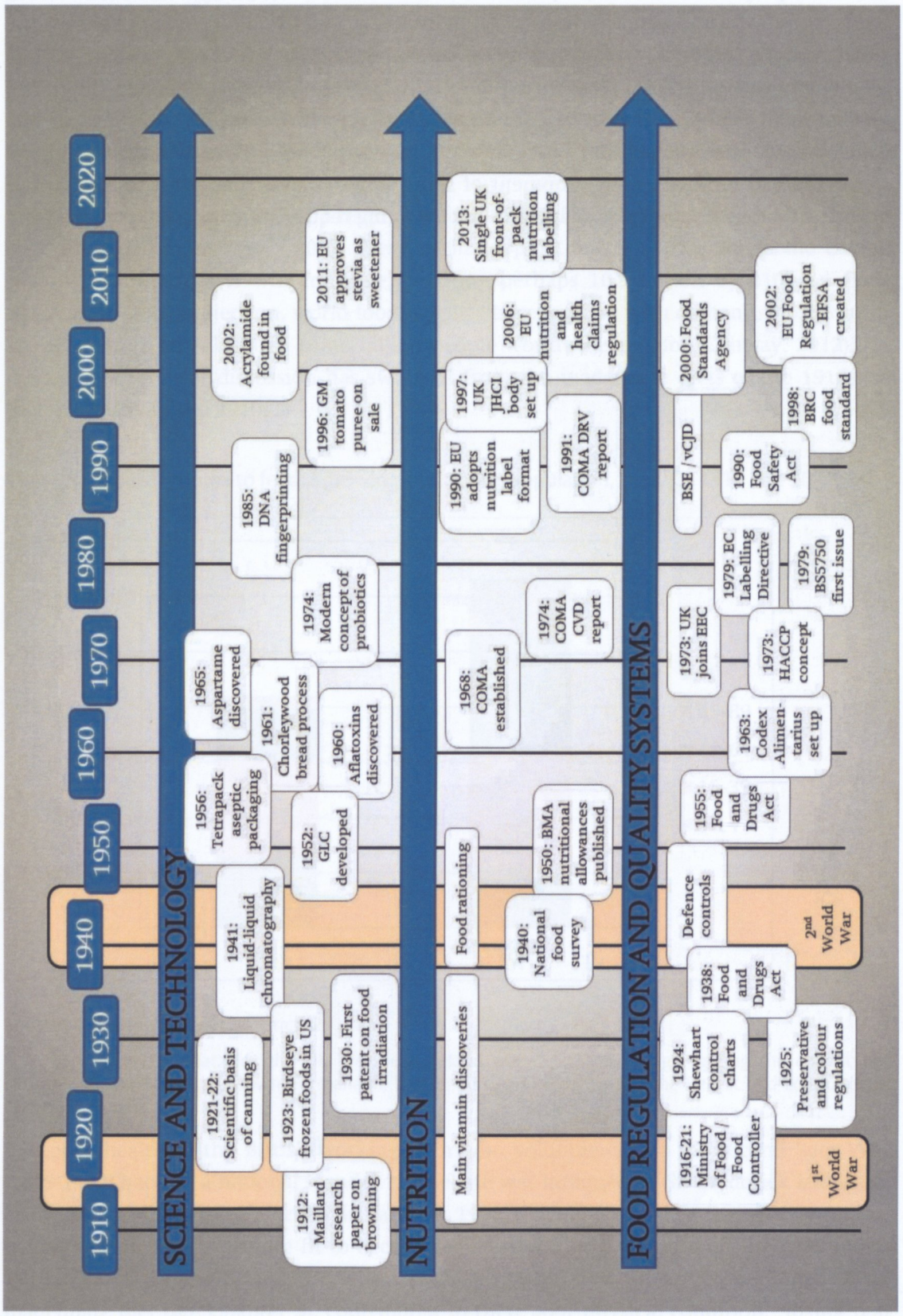
[1] Confectionery and Preserved Food Manufacturers, *Financial Times*, 22 October 1913, p 10.

Figure 1.1. Timeline showing developments in the food and drink manufacturing industry over the last century.



In Chapter 3 we outline the ways in which nutrition science has developed over the century, improving our understanding of diet, and influencing the way in which the food industries prepare our food. Chapter 4 focuses on science, technology and innovation in food manufacturing and its impact on consumers; whilst Chapter 5 explores the Government's role in assuring food meets consumer and societal needs with respect to quality and safety. A final section reflects briefly on some past achievements and future challenges. The timeline in Figure 1.1 gives a synoptic overview of some of the developments over the century. With the help of a sample of FDF member companies, a Centre Spread profiles the development of some iconic brands that attest to the various ways the food industries have adapted to the changing requirements of their customers.

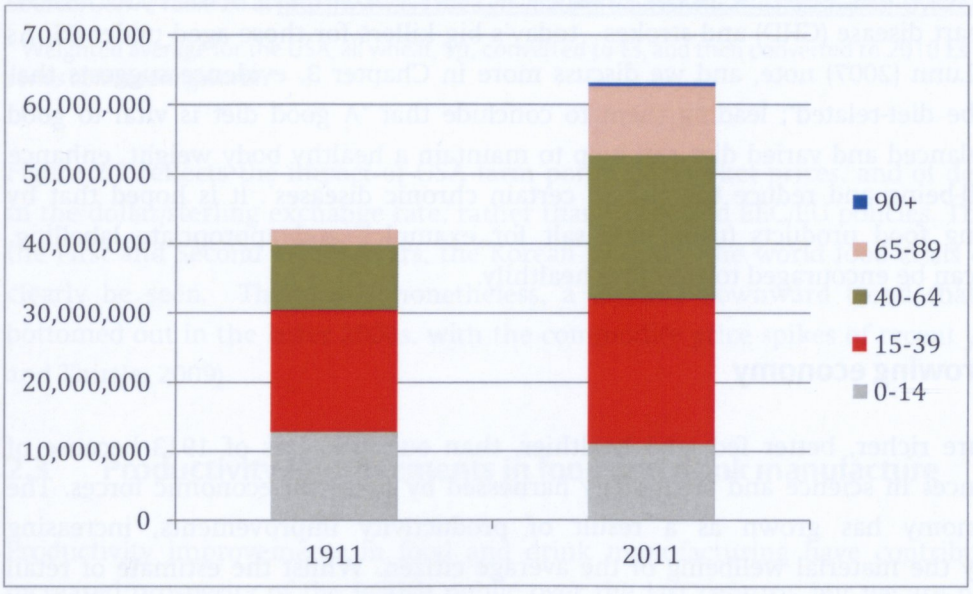
2. Continuity and change

2.1 Us: then and now

In 1911 the UK's population was 42.1 million; in 2011 it had reached 63.2 million, a 50% increase (Figure 2.1). The ageing population evident in Figure 2.1 creates new challenges, and marketing opportunities, for the food industries, for example in formulating nutrient-rich and energy-dense oven- (or microwave-) ready meals for this specialist market.

Meanwhile world population had risen four-fold, from 1.75 billion in 1910 to 7.2 billion in 2013 (United Nations, 1999; 2013). Despite this population explosion, which the United Nations (2013) suggests will continue, reaching perhaps 10.9 billion by 2100 on their 'medium-variant' projection, world food supplies have kept up with demand. Most Britons are adequately fed, although some billion people worldwide are not (Conway, 2012). In the UK, the focus of discussion has switched from the inadequate diets of the 1910s, to that of obesity in the 2010s.

Figure 2.1. More mouths to feed: a growing, but ageing population, the UK*, 1911 and 2011.



Source: Office for National Statistics (2012a).

* To construct 1911 data for the UK, Northern Ireland was created from aggregating the constituent counties (Antrim, Armagh, Down, Fermanagh, Londonderry and Tyrone) and the Belfast and Londonderry County Boroughs.

The poor health of the British working men who volunteered for the second Boer War (1899-1902) became a national scandal: the debate was inflamed by Sir Frederick Maurice's claim in the *Contemporary Review* in January 1902 that 'out of every five men who are willing to enlist only two are fit to become effective soldiers' (Floud *et al.*, 1990; Maurice, 1913). Stunted growth, and conditions such as rickets, now known to be linked to an inadequate diet (see Chapter 3), contributed to their poor physical condition. Rising real incomes, and the ready availability of affordable food, sometimes fortified by the addition of vitamins and minerals, have largely eliminated this scourge. Dirty milk and other

contaminated foods in the 1900s were still a major transmitter of disease, and hence milk was 'a dangerous cocktail for those who drank it raw'. The two major causes of 'milk-related deaths amongst infants were tuberculosis and diarrhoea' (Atkins, 2003). More hygienic conditions in the cowshed, and the bottling of milk rather than its sale from the churn, helped clean-up the milk supply, but the transmission of tuberculosis 'from diseased cattle to unwitting consumers ... was only brought under control gradually as milk was increasingly pasteurized in the 1930s and 1940s' (Atkins, 2003). The emphasis today is on hygienic conditions throughout the supply chain, but the acrimonious debate today over the alternative strategies of culling badgers, because of their potential to transmit tuberculosis to cattle, as opposed to vaccination, is illustrative of the continuing struggle to safeguard public health (House of Commons, 2013).

The risk faced today from food poisoning is much lower than a century ago. Foster and Lunn (2007) comment that 'the overall mortality from food poisoning is very small ... and, in terms of other public health issues, it could be considered relatively trivial'. Food poisoning, nonetheless, remains a very real risk and requires constant vigilance throughout the food chain and in the kitchen.

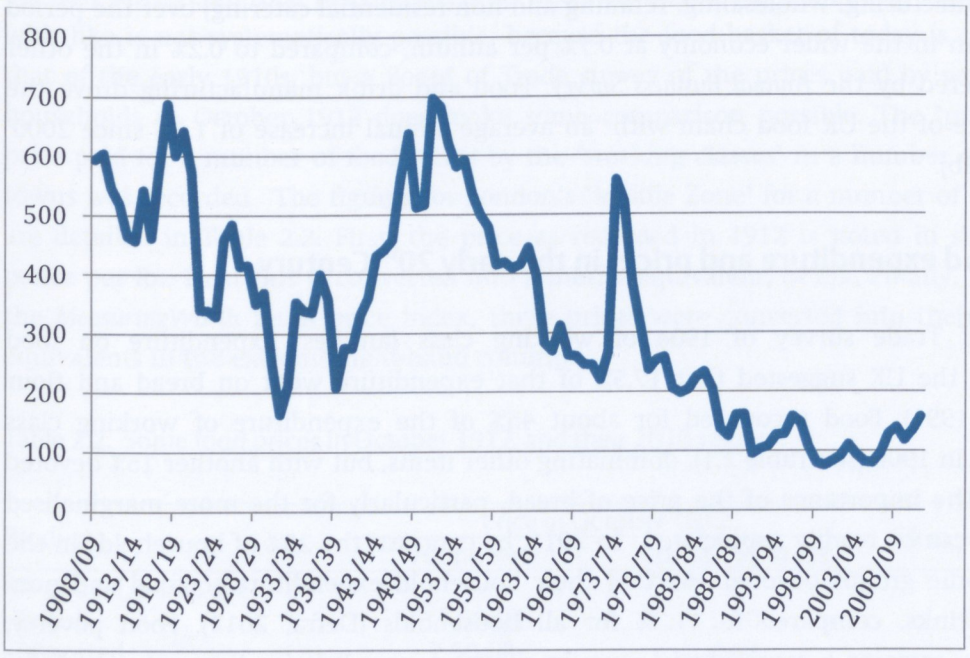
Where we have not made as much progress is with the chronic diseases of cancer, coronary heart disease (CHD) and strokes - today's big killers for those aged under 65. As Foster and Lunn (2007) note, and we discuss more in Chapter 3, evidence suggests that these 'can be diet-related'; leading them to conclude that 'A good diet is vital to good health; a balanced and varied diet can help to maintain a healthy body weight, enhance general well-being and reduce the risk of certain chronic diseases'. It is hoped that by reformulating food products (using less salt for example), and appropriate labelling, consumers can be encouraged to eat more healthily.

2.2 A growing economy

Today we are richer, better fed, and healthier, than our forebears of 1913 because of major advances in science and technology harnessed by powerful economic forces. The British economy has grown as a result of productivity improvements, increasing considerably the material wellbeing of the average citizen. Whilst the estimate of retail price movement is that, in 2012, prices were 83 times higher than in 1913, *real incomes* (that is after the effects of inflation) over the same period rose four-fold (Clark, 2013).

But it is not simply that real incomes have risen over the last 100 years. There has also been a fall in the real price of agricultural commodities, as illustrated in Figure 2.2 for wheat, reflecting world-wide improvements in agricultural productivity that have more than kept pace with population growth.

Figure 2.2. USA wheat prices, 1908/9 to 2012 (£/t at 2010 prices*).



Source: USDA, Table 20 at http://www.ers.usda.gov/data-products/wheat-data.aspx#.Uf-UyRZjvww),

* Weighted average for the USA, all wheat, $/t, converted to £s, and then converted to 2010 £s using the data series at *MeasuringWorth*.

Figure 2.2 reflects the impact of USA farm policy on market prices, and of developments in the dollar/sterling exchange rate, rather than of UK and EEC/EU policies. The impact of the First and Second World Wars, the Korean War and the world food crisis of 1973 can clearly be seen. There was, nonetheless, a marked downward trend that may have bottomed out in the latter 2000s, with the commodity price spikes of recent years (Piesse and Thirtle, 2009).

2.3 Productivity improvements in food and drink manufacture

Productivity improvements in food and drink manufacturing have contributed to this increased prosperity of the British public over the last century, but we are not aware of any attempt to assess this for the UK over the time horizon covered by this review. The measurement of changes in total factor productivity (TFP) is a relative new device in the economist's toolbox: TFP is an attempt to assess changes in the ratio of output to *all* inputs, and is seen as superior to partial measures such as output per employee, or the yield of wheat per ha. During the interwar period, Matthews *et al.* (1982) suggest that for 1924-29 'food, drink and tobacco' manufacturing TFP grew at 1.4% per annum, compared with 1.8% for all manufacturing, and at 1.9% per annum in the period 1929-37 compared to 2.4%. A post-war study suggested that in 1960-77, growth in TFP in food and drink manufacturing lagged behind that of manufacturing more generally, but with considerable variation between sectors (Mordue and Marshall, 1979).

More recent, and sophisticated, analysis suggests faster growth in TFP in the UK food chain (manufacturing, wholesaling, retailing and non-residential catering) over the period 2002-11 than in the wider economy at 0.7% per annum, compared to 0.2% in the other sectors covered by the *Annual Business Survey*. Food and drink manufacturing drove the performance of the UK food chain with 'an average annual increase of 1.1% since 2000' (Defra, 2013b).

2.4 Food expenditure and prices in the early 20th Century

A Board of Trade survey of 1904 of working class families' expenditure on food throughout the UK suggested that 17.5% of that expenditure went on bread and flour (Feinstein, 1991). Food accounted for about 45% of the expenditure of working class households in 1900 (see Table 2.1), dominating other items, but with another 15% devoted to drink. The importance of the price of bread, particularly for the more marginalised household, can be readily appreciated. In 2011, by contrast, the 20% of households in the lowest income groups devoted 16.6% of their household expenditure to food and non-alcoholic drinks, compared to 11.3% for all households (Defra, 2012). Food poverty, nonetheless, remains a controversial issue in contemporary Britain. A recent report, for example, claims that 500,000 people are 'reliant on food aid', in the form of food banks and food parcels, and talks about an 'exponential rise in the creation of food banks' (Cooper and Dumpleton, 2013).

Table 2.1. Estimated distribution of household expenditure, circa 1900 (%).

	Proportion of household expenditure by 6.6 million working class families	Proportion of household expenditure by 2.3 million middle and upper class families
Food	45.2	19.3
Rent	6.2	10.5
Rates and water	2.0	3.3
Clothing and shoes	9.8	8.9
Fuel and light	5.6	2.8
Laundry, soap, etc.	1.1	1.7
Furniture, pottery, hardware, etc.	3.2	4.0
Other goods	0.6	5.5
Beer	10.1	3.4
Spirits	4.2	3.2
Other drink	0.7	2.2
Tobacco	1.9	1.4
Railways and trams	3.8	1.0
Cars and other travel	0.4	5.6
Domestic service	0.0	7.7
Life assurance and funeral expenses	1.1	0.9
Medical services	1.5	2.8
Entertainment and betting	0.9	3.1
Other services	1.8	12.8

Source: Adapted from Feinstein (1991) who made use of data compiled by Professor A.R. Prest.

So, how have retail food prices moved between the 1910s and the 2010s? Comparing like with like is not systematically possible, because the food basket of today is quite unlike that of the early 1910s, but a Board of Trade survey of the prices paid by working class households in October 1912 does make some comparison possible. The 'predominant' price paid for a number of food items by the 'working classes' in a number of industrial towns was recorded. The figures for London's 'Middle Zone' for a number of these items are detailed in Table 2.2. First, the price as recorded in 1912 is noted in shillings and pence per lb. Next this is converted into a metric equivalent, of £/k. Finally, again using the *MeasuringWorth* retail price index, these prices were converted into their year 2010 equivalents in the extreme right-hand column.

Table 2.2. Some food prices in October 1912, and their 2010 values*.

Product	Price in October 1912		£/k in year 2010 £s
	At the time	Converted to £/k	
Rib of beef, prime cut			
- British	11.00d/lb	0.10	7.80
- Imported	7.50d/lb	0.07	5.32
Leg of mutton			
- British	9.60d/lb	0.09	6.81
- Imported	6.30d/lb	0.06	4.47
Tea	1s 4.20d/lb	0.15	11.49
White granulated sugar	2.00d/lb	0.02	1.42
Canadian or American Cheddar	8.45d/lb	0.08	5.99
Household flour	11.1d/7lbs	0.01	1.12
Bread	5.65d/4lbs	0.01	1.00

Source: Board of Trade (1913).

* Predominant retail prices paid by the working classes in October 1912, London Middle Zone converted to 2010 £s using *MeasuringWorth*'s retail price index.

In comparison to today's prices, the meats and cheese seem cheap, whereas tea, sugar and bread (certainly compared with the basic sliced loaf available in supermarkets today) appear to have been more expensive. Trade, and farm policies, do of course play a part. In 1912 the import tariff on sugar was 1s. 10d. per hundredweight (Johnstone, 1976), representing about 10% of the retail price. In 2013, following the latest 'reform' of European farm policy, Defra's Secretary of State claimed that it was still 'driving up the wholesale price of sugar by 35% and adding 1% on our food bills' (as quoted in Glotz, 2013).

In making price comparisons, however, it must be recalled that *real* earnings have increased four-fold: thus even if it could be definitively established that the 2010 price was exactly the same as that for 1912, its *affordability*, in terms of what else could be bought, would be dramatically improved.

2.5 Food and drink manufacturing and retailing before the Great War

By 1911, 48% of the population in England and Wales was living in 97 urban districts with populations exceeding 50,000[2]. These urban consumers relied upon a complex food chain of manufacturers, wholesalers and retailers to deliver food from the farm or the fishing boat to the table. Moreover, with 42% of Britain's meat supplies imported in 1913, and 80% of its wheat and flour (Perren, 1995), the extended supply chain posed challenges for all. How to ensure that the consumer was neither cheated, nor poisoned, was a recurring theme (French and Phillips, 2000), which resonates still. One scandal reported in March 1913, for example, was the prosecution of a trader selling horseflesh as beef (Anon, 1913a).

In the 1910s, both food and drink manufacture and retailing juxtaposed the modern and the traditional. Large-scale retailing had developed rapidly in the early 20th Century in a number of sectors, including imported meats, tea, and manufactured products. By 1914, the meat firms Eastmans and James Nelson & Sons, had over 1,000 branches each, whilst the Home and Colonial Tea Company, the Maypole Dairy Company, and Lipton Ltd., each had over 500 (Jeffreys, 1954). Jeffreys (1954) estimated that in 1915 the multiple shop retailers (those with ten or more outlets) had between 8.0 and 10.5% of sales in his 'food and household stores' category, while the Co-operative Retail Societies had between 10.5 and 12% of sales.

These multiples and cooperative stores operated alongside many thousands of small retail establishments, stressing their commitment to quality and price. When John James Sainsbury opened his first Islington branch in 1882 'The fascia board proudly proclaimed: *J. Sainsbury's Shilling Butter is the Best Value in the World. Quality Perfect, Prices Lower*'[3]. Whilst it was the independent traders that often found themselves in court, for selling adulterated or unsafe products, the multiple retailers were not immune. Anon (1913b) for example, cites two cases involving the India and China Tea Company: in Worcestershire on 31 March 1913, of selling 'as Demerara sugar, a white sugar coloured by means of an artificial dye' at their 'branch shop' in Bewdley (fined £5); and on 11 April for selling 'baking powder which was not of the nature, substance and quality demanded' in Blackwood, Monmouthshire (case dismissed).

On Monday 8 June 1914, *The Times* published a 44-page supplement. Both the advertisements, and the editorial content, give interesting insights on pre-War Britain. Whilst marvelling at the UK's dependence on imported foods, with maps illustrating their provenance, the editorial content seems quite unperturbed about the prospect of war, and the consequent disruption to food supplies! The food manufacturers advertising in this supplement were significant and established businesses, many of which are still operating today. J. & J. Colman Limited, for example, advertised Colman's Mustard ('A valuable aid

[2] 1911 Census of England and Wales, General Report with Appendices, Table 9.

[3] http://www.museumoflondon.org.uk/Collections-Research/Research/Your-Research/SainsburyArchive/Themes/Places/Expansion/Islington.htm , last accessed 14 August 2013.

to digestion'); Crosse & Blackwell Limited declared it had been 'Established in the Year 1706'; and Henry Tate & Sons Limited claimed to be 'the largest sugar refiners in Europe'.

Many of the companies in the supplement emphasised their use of up-to-date manufacturing facilities, and the application of science. For example, St. Ivel Limited of Yeovil wrote: 'an example of what can be accomplished when scientific genius is directed by sterling business ability', accompanied by a drawing of 'The Laboratory' depicting no less than 7 men in lab coats. Almost all noted the wholesomeness of their products. Given the then public concern about adulteration, this was clearly an important marketing message to convey.

Huntley & Palmers Ltd. of Reading - 'The largest biscuit manufacturers in the world' - remarked upon: 'The exquisite cleanliness and perfection of all their processes and methods; the avoidance of substitutes of all kinds; the expensive character and purity of the materials used; the fastidious rejection of biscuits having the slightest suspicion of imperfection'. Interestingly, given the UK's dependence on imported foods, particularly wheat, the company highlighted its local sourcing: 'Nine-tenths of the thousands of tonnes of flour annually used by Messrs. Huntley and Palmers are grown and milled in the neighbourhood of Reading, on England's finest wheat lands'. In 1912-13 nearly 50% of its sales were overseas, which proved problematic with the outbreak of war (Corley, 1972). Indeed, its masthead in *The Times* advert proudly declared its Royal Appointment not only to a series of European Royal Houses, but also to the King of Siam and the Imperial House of Japan. Nearly 7,000 'hands' were employed to make biscuits and 'the packages to contain them'; with the company claiming that Reading's population had 'risen from 17,000 in 1841 to nearly 88,000, chiefly as a result of George Palmer's enterprise'.

The supplement makes little reference to exports, although it seems clear that whisky, beer, biscuits, jams and preserves were being dispatched to Britain's colonies and dependencies around the world. Dundee, 'one of the busiest industrial centres in the United Kingdom', is identified as the 'Home of the Marmalade Trade', although biscuits, jams, and other preserves were made there too. Burton on Trent is labelled 'the metropolis of beer', producing 10% of the UK's brew. Other sources suggest that the canning industry was not well developed at the time - although significant imports of canned meat, fish, condensed milk, tomatoes, and fruits in syrup were taking place – but *The Times* does claim that a 'astonishing number' of meats, mixtures of meat, soup, fish and pastes were produced by the 'larger firms'. In what today reads rather politically incorrect, *The Times* supplement states:

> 'The most important branch of this business is the export trade. As a result of the tinning process the Englishman can now bring his native foods with him to every corner of the earth in a compact and portable form. The pioneer also is no longer at the mercy of the food of the country - often scanty, lacking in nourishment, and, perhaps, positively dangerous - but whether in chilly northern latitudes or under the tropical sun, can enjoy the various kinds of meat and vegetable to which he has become accustomed at home. Nor do these firms confine

themselves to such perishable products. To meet the demand of their customers abroad they put in tins such other articles as salt, mustard, pepper, sugar, tea, coffee, suet, flour, rice, curry powder, grated cheese, and plum puddings.'

But how representative of the generality of food and drink manufacturing were these companies that advertised in *The Times* June 1914 supplement? Unfortunately, the 1907 Census of Production does not give the size distribution of establishments: it was not until the third such census, in 1930, that data relating to the employment size of establishments became available (Business Statistics Office, 1978). French and Phillips (2000) show that, in 1930, of the 'more than 5,000 firms ... active in the food trades', 4,465 employed 11-99 staff, accounting for 30.4% of the workforce, and 24.2% of the net output, of the sector as recorded by the Census (firms employing 10 or less were excluded from the Census). They go on to suggest that, in the 1920s and 1930s, because the state 'tended to assume that the manufacturing conditions in the minority of large enterprises were representative of those in the industry as a whole' this 'ensured that a minimum of new regulations were introduced after the First World War'.

The 1907 Census of Production excluded agriculture, and services were not included, which extended to tea blending and packing, and coffee roasting, grinding and packing. Similarly 'persons working on their own account' were not required to submit returns (Board of Trade, 1912). If the food and drink manufacturing industries of 1907, as seen by the Census of Production were to be defined in terms of employment, then they were dominated by grain-milling and bread and biscuits on the one hand, and brewing, malting

Table 2.3. Employment in the food and drink manufacturing sector*, 1907.

Trade	% of total
Grain-milling	8.3
Bread and biscuits	25.5
Cocoa, confectionery and fruit preserving	14.1
Bacon-curing	1.7
Preserved meat, poultry, fish, pickle, sauce, and baking-powder	3.1
Butter, cheese and margarine	2.2
Fish-curing	5.8
Manufacture of farinaceous preparations and trade and household articles for cleaning and polishing (except soap)	2.7
Cattle, dog and poultry food	0.5
Ice	0.3
Sugar and glucose	1.5
Brewing and malting	19.6
Spirit distilling	1.5
Spirit compounding, rectifying and methylating trades	0.3
Bottling	4.7
Aerated waters, cider, British wines, non-alcoholic beverages (brewed) and vinegar	6.6
Seed-crushing	1.8

Source: Board of Trade (1912).

* Section VII food, drink and tobacco trades (*but excluding tobacco*) *plus* seed-crushing from Section VIII chemical and allied trades.

and bottling (mainly of beer) on the other, as shown in Table 2.3. Cocoa, confectionery and fruit preserving, are also important; but the dairy and meat industries barely figure in this official perspective on the industry.

2.6 Governments, wars and economic crises

2.6.1 The historical context

Over the last 100 years Britain has been involved in two World Wars, and other military conflicts; shed itself of its Empire and joined what is now known as the European Union (EU); absorbed several waves of migrants; and suffered economic recessions and periods of high inflation. These events, and successive Governments' attempts to guide the Nation through turbulent times, have affected our food choices and the operations of the food and drink manufacturing industries.

2.6.2 The Great War

In 1914, when war broke out 'no overall scheme for putting the entire food supply on a war footing had been prepared' (Barnett, 1985). Sugar proved particularly problematic as Britain imported virtually all its supplies as raw sugars for refining in the UK, with over half coming from Germany and the Austro-Hungarian Empire. It was not until 1924 that the Government encouraged the development of beet sugar production through 'substantial subsidies' (Astor and Rowntree, 1939). Moreover, and perhaps now surprisingly, in 1914 sugar was seen as a key food in the diet of working class children. To protect the interests of the refiners, and secure access to this essential food, the Government took immediate responsibility for importing sugar. Even so, during the first week of the war its retail price soared by 80%, although it later abated somewhat (Barnett, 1985).

The price of other foods increased too, as shortages developed. By the end of 1917 queues were forming outside grocers, with 3,000 people queuing for margarine outside a shop in South East London on 17 December (Barnett, 1985). There was a good deal of industrial unrest. Sugar rationing was introduced at the end of 1917, and not rescinded until 1920. From November 1917 a number of localised rationing schemes for basic foods had applied, becoming a national scheme in July 1918[4]. Bread, however, was not rationed.

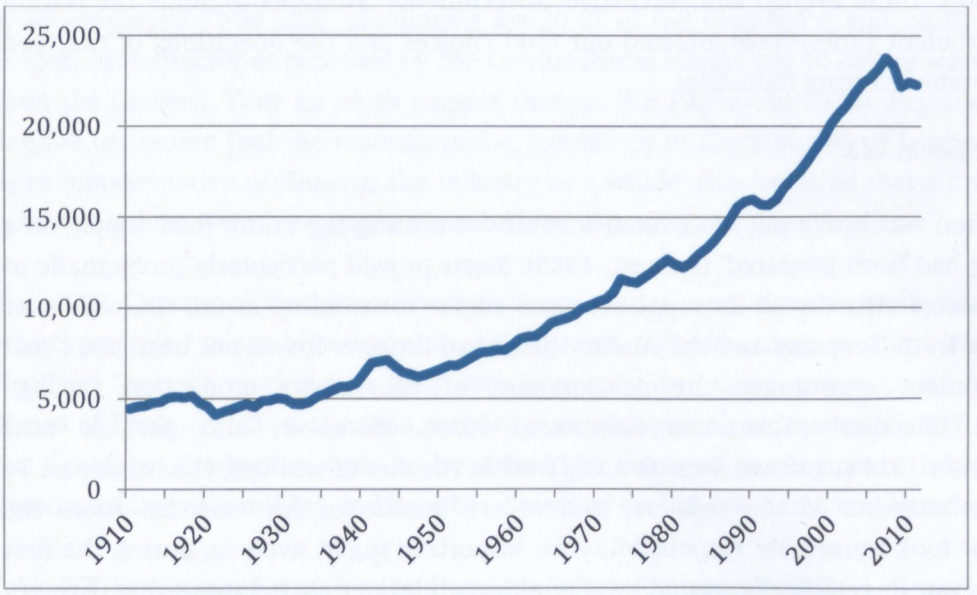
The Ministry of Food and other agencies gained extensive powers over the whole food chain as the Government struggled to feed the army, its allies, and the civilian population, in the face of severe shipping losses to U-boat attacks, and shortages of the foreign currency needed to buy imports. In March 1916, for example, industrial users of sugar were restricted to 75% of their 1915 usage, prompting Huntley and Palmers to prune products heavily reliant on sugar from its lists (Corley, 1972); and in December 1917 the manufacture and sale of ice cream was banned because of shortages of milk and sugar (Crowhurst, 2000).

[4] Imperial War Museum: http://archive.iwm.org.uk/server/show/ConWebDoc.1270, last accessed 29 August 2013.

2.6.3 Inter-war: hunger marches, and enhanced commercialisation of manufactured foods

The economy barely grew during the interwar period. Figure 2.3, showing Gross Domestic Product (GDP) per capita in real terms, suggests there was no overall growth in the economy until the late 1930s when the country began gearing-up for the next war. In this period the fortunes of British families varied enormously. In general, the middle classes prospered, and were able to enjoy the range of new consumer goods and services that were rapidly becoming available. But many working class families struggled.

Figure 2.3. Real GDP per capita, UK, 1910-2011*



Source: Officer and Williamson (2013).

*Nominal UK GDP per capita, adjusted by the GDP deflator (2008 = 100).

The return to the Gold Standard in 1925 meant that much of British industry, particularly shipbuilding and mining, remained uncompetitive on world markets. The Wall Street Crash of 1929 led to the *Great Depression*, a worldwide collapse in employment and trade that hit industrial Britain particularly hard. By the end of 1930, unemployment had doubled: in Jarrow in 1932-33 it claimed more than 80% of the workforce following the closure of the Palmer's shipyard (Wilkinson, 1939). As Ellen Wilkinson, MP for Jarrow, was later to write: 'the plain fact *[is]* that if people have to live and bear and bring up children in bad houses on too little food, their resistance to disease is lowered and they die before they should. Their babies die, too, at an unnecessary and easily-preventible high rate' (Wilkinson, 1939). John Boyd Orr's influential study *Food, Health and Income* in 1936 suggested that 'at least one-third of the British people were so poor they could not afford enough food to maintain health' (Foster and Lunn, 2007).

But this food poverty co-existed with a major growth in the supply of manufactured foods. Several American firms exported to the British market before the First World War and, then in the inter-war period consolidated their presence. Coca-Cola began bottling on

contract in 1924, and established its own bottling plant in 1935; Kraft established a factory in the west of England in 1928; Kellogg opened a factory in Manchester in 1938. Unilever (an Anglo-Dutch concern formed in 1930) and General Foods launched a joint venture in 1937 to exploit the Birdseye patent. And, finally, Forrest Mars left the family firm in the USA to found his own British company in 1932 which then introduced the Mars Bar (Collins, 2009).

Ward (1990) documents the 'extensive, well-designed marketing campaigns which created brands such as Kellogg's, Ovaltine, Cadbury, Kit Kat and Horlicks'. He claimed: 'The food industry ... lead the way in marketing expertise in this period'. Radio Luxembourg was appealing to a growingly affluent mass market, and a number of food manufacturing companies used this medium. For example, Ovaltine sponsored one of the station's most successful children's programmes - *The Ovaltineys' Concert Party* - with its own club that had 5 million members by 1939 (Crisell, 2002). Collins (2009) concludes that 'By the late 1930s, most of the elements that were to underpin the food revolution of the post-war period were already in place. Food manufacturing was a modern consumer-goods industry, convenience foods an integral part of the nation's diet, and packaged branded goods the grocers' chief stock-in-trade'.

2.6.4 The Second World War, austerity, and then the post-war boom

The Second World War ushered in a new period of rationing to cope with the food shortages caused by the submarine blockade and the increasingly acute lack of foreign exchange, despite the apparent generosity of the USA in its Lend-Lease programme. The commodity price surges associated with the Korean War did not help. In the period of post-war austerity meat rationing persisted until July 1954. Sweets came off ration in February 1953, after an abortive attempt in April 1949, although sugar was still rationed and sweet and confectionery manufacturers were limited to 54% of their pre-war supplies[5].

Harold Macmillan's claim in July 1957 that '... most of our people have never had it so good. Go around the country, go to the industrial towns, go to the farms and you will see a state of prosperity such as we have never had in my lifetime - nor indeed in the history of this country'[6] was ridiculed by some. But rationing was over, and the economy was clawing its way up, into the boom years of the 1960s. Until the 1950s overseas travel was largely the reserve of the wealthy but, by the late 1950s package holidays were opening up a mass market, flying for example from Luton Airport following its return to civilian use in 1952[7]. Together with new waves of immigration, and the popularity of ethnic restaurants, British tastes in food were changing.

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[5] BBC On This Day. *1953: Sweet rationing ends in Britain*: http://news.bbc.co.uk/onthisday/hi/dates/stories/february/5/newsid_2737000/2737731.stm, last accessed 29 August 2013.

[6] BBC On This Day. *1957: Britons 'have never had it so good'*, http://news.bbc.co.uk/onthisday/hi/dates/stories/july/20/newsid_3728000/3728225.stm, last accessed 29 August 2013.

[7] *History of Luton Airport*, http://www.luton-airport-guide.co.uk/history.html, last accessed 29 August 2013.

With increased prosperity, the pre-war concerns about the ability of much of the population being able to afford an adequate diet were banished, although they resurfaced in the 2010s, and had never really gone away. In the 1970s real disposable income rose by 32%, and yet real per capita expenditure on food increased by only 4% as households re-focussed their spending on other consumer goods and services. As Ashby (1983) noted, consumers 'did not buy more food but more services incorporated in food'; including, of course, in manufactured products.

2.6.5 Retailing

In 1947, *The Grocer* had somewhat rashly declared: 'The people of this country have long been accustomed to counter service, and it is doubtful whether they would be content to wander round a store hunting for goods' (cited in Brown, 2012). But clearly they were wrong, as very quickly grocers began adopting the self-service format. The Co-op, J. Sainsbury, and Premier Supermarkets (an offshoot of Express Dairies) were early pioneers.

Very quickly the face of British retailing changed: the number of outlets declined, as did the role of the specialist retailers, such as butchers and greengrocers. Between 1970 and 1981 the multiple grocers increased their share of grocery sales from 44% to 63%, at the expense of the independent stores. The number of superstores went from 32 in 1971 to 318 in 1982 (Burns, 1983). This pace of change became even more rapid in the late 1980s, with the superstores often being constructed on easily accessible out-of-town sites surrounded by large parking areas. In the words of Wrigley and Lowe (2002) this was a 'frantic store-building boom' with 'intense competition for development sites'.

These superstores had lower operating costs than the smaller stores they displaced: one important element in their development was the introduction of electronic point of sale data scanning equipment from the mid-1980s (Wrigley and Lowe, 2002). In the early 1980s, the Head of Marketing Services at Sainsbury's PLC had reported that scanning was 'an expensive commitment for retailers'. He explained that scanning only became viable when a sufficiently large percentage of sales were 'source-marked with a bar code'. However, he reported, 30% of unit sales were already bar coded, and this figure was expected to rise to over 70% 'in a year or two' (Hunt, 1983). Today it is very unusual to find an item that is not bar-coded, or a retail establishment that does not scan products at point of sale. Moreover, the technology is widely used to ensure traceability of goods throughout the supply chain, as well as to facilitate prompt re-ordering of products in short supply, and to generate masses of data enabling retailers to analyse the behaviour of their customers.

One feature of food retailing in the UK is the prevalence of so-called own-label, or *retailer* branded goods. At over 50% in the period June 2011 to May 2012, this is much higher than the EU average and several of the larger Member States including Germany, France and Spain (FoodDrinkEurope, 2013).

In the 1980s, British retailers successfully changed the image of own-label brands: no longer were they seen simply as generic, cheaper substitutes or imitations of

manufacturers' branded products, although such items remain. Instead, they were positioned as brand leaders in their own right. Thus 'the major UK food retailers were increasingly drawn into making significant investments in product specification, development, packaging and quality testing, and the developmental role of the retailer's own food technologists became even more critical' (Wrigley and Lowe, 2002). In particular, they pioneered the development of chill-chain products, particularly ready meals, for which they often had to create their own supply chains, and foster the development of specialist suppliers.

2.6.6 Joining the European Union

A significant change, for food consumers and food and drink manufacturers, brought about by EU membership in 1973 was adoption of the Common Agricultural Policy (CAP). After the Second World War, support for British agriculture was maintained, primarily by means of taxpayer funded subsidies for farmers. Although this impacted on the volume of raw materials the food industries sourced in the UK, and hence was particularly relevant for dairies handling raw milk supplies for instance, it had relatively little impact on prices. The CAP was rather different, certainly up until the first reforms of the policy in the early 1990s. Its aim was to increase farm incomes by increasing the market price that farmers received for their products. It meant intervention buying to sustain market prices, resulting in eye-catching newspaper headlines about wine 'lakes' and butter 'mountains'; and a complex array of import taxes and export subsidies on processed foods as well as on agricultural raw materials (Harris and Swinbank, 1997). For consumers, this translated into higher food prices, although not uniformly so: butter, for example, was made much dearer than margarine. Subsequent CAP reforms, and the erosive effect of inflation on unchanged support prices, have largely eliminated these distortive effects of the 'old' CAP, although imports of some products, notably sugar and dairy, are still subject to high import taxes (Swinbank, 2012).

In the early 1910s, when there was little support for British agriculture, the UK imported most of its food supplies. Today, after several decades of protecting agriculture, the situation is rather different. The ratio between the farm-gate value of raw food production and 'the value of raw food for human consumption' currently stands at about 80% for the products that could be produced in the UK, and at about 60% across all food types (Defra, 2013a). Most trade, however, is in manufactured products (see Table 2.4).

Table 2.4. UK imports and exports of food and drink, 2012.

	Imports £ billion	Exports £ billion	Net imports
Highly processed	13.7	10.6	3.1
Lightly processed	16.7	6.0	10.7
Unprocessed	7.1	1.6	5.5
Total	37.5	18.2	19.3

Source: Defra (2013a).

2.7 Freezers, fridges and microwaves

Although some manufactured foods brought into our kitchens in the 2010s are very similar to those of the 1910s, others are quite different, not just in range and variety, but also in their preparation and presentation. This reflects, in part, changing technologies on the farm, in the factory, in distribution and in kitchen appliances in the home; the rise in real incomes and the changing demographics of the population; and the growing demand for convenience. In the 1910s, fresh peas, only available seasonally, had yet to be displaced by today's ubiquitous frozen peas.

By the late 1870s, refrigeration was being commercially applied in the food trade, with the first successful shipment of frozen meat from Argentina to France in 1877-8 on the *SS Paraguay* (Critchell and Raymond, 1912). Indeed the Port of London Authority, in its advert in *The Times* food supplement of 8 June 1914, devotes much space to a description of the major investments made in its frozen and chilled stores to accommodate the surge in imports of meats and dairy products since its first facility had been built in 1882 at the Victoria Dock. But until similar investments had been made in the distribution chain, and in the kitchen, frozen products could not readily be sold to households.

Technological developments included the realisation that quick-freezing was essential if foods were to retain their physical characteristics, and in particular Clarence Birdseye's American invention of a quick-freezing technique in 1924[8]. The earlier system of slow freezing ruptured the cell walls, and resulted in a poor-quality defrosted product. In the UK there was some small scale quick-freezing in the 1930s with Smedley 'installing refrigerated units in 500 major retailers across the country in 1937 to stock frozen fruit and vegetables in waxed milk cartons holding about three pounds' (Ward, 1990). But it was Birds Eye that pioneered the 'manufacture of consumer-sized packs of frozen foods for national distribution ... after the Second World War' (Monopolies and Mergers Commission, 1976). First, a distribution network had to be put in place. The newly emerging supermarket chains were more able than independent retailers to invest, and find room for, freezer cabinets. In 1953-54 'Birds Eye persuaded Prestcold and Frigidaire to design and market an 'open-top' display cabinet and, in 1954, decided to seek new business only with traders who installed open-top cabinets' (Monopolies and Mergers Commission, 1976). In the 1950s, the boom in the sale of frozen foods to British households took off; but at the time few had the means to store frozen foods in their kitchens. By 1980, however, over 90% of British homes had a refrigerator (see Table 2.5). The other item of kitchen equipment particularly relevant for the sale of convenience foods, the microwave oven, was slower to infiltrate British homes: the first models for home use in the UK became available in 1974, 20 years after their debut in the USA[9]. Uptake was slow at first - only 441,000 in British households in 1980, soaring to 11.8 million by 1990 - but by the 2010s microwaves were present in over 90% of British kitchens[10].

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[8] http://www.loc.gov/rr/scitech/mysteries/frozenfood.html , last accessed 14 August 2013.

[9] Microwave Technologies Association, *Microwave Facts*: http://www.microwaveassociation.org.uk/factsheets/facts.php last accessed 2 September 2013.

[10] Department of Energy & Climate Change, *Energy Consumption in the UK (ECUK) Domestic data tables 2013 Update*, Table 3.12: Number of appliances owned by households in the UK 1970 to 2012.

Table2.5. Indicators of growing prosperity, 1960-80.

	1960	1970	1980
Real personal disposable income (1960 = 100)	100	130	170
Percentage of homes owning:			
Refrigerators	22%	66%	93%
Freezers	-	<3%	50%
Cars	30%	50%	58%
Televisions	75%	91%	96%
Number of people taking holidays abroad	4M	6M	10M

Source: Hunt (1983).

2.8 Household size and consumer choices

Not only is the population older than it was in 1911, and more cosmopolitan, particularly in London and other major cities, but the size of households has shrunk. The 2011 Census showed that 28% of UK households had only one occupant, and a further 37% had only two. In only 5% of households were there five or more persons[11]. In 1911 London, however, 37.5% of households had five or more persons, and in Liverpool 3.4% had 10 or more[12].

Smaller households, many allegedly 'cash-rich and time-poor', have presented opportunities and challenges to food and drink manufacturers, retailers, and the catering trade. The media often celebrates the preparation of family meals, from scratch, in a well-provisioned kitchen containing all the raw materials that a particular recipe might demand. Whilst this might reflect the aspirations of many, day-to-day convenience is more often required: a tasty meal, *quickly* prepared. Many manufactured products offer a level of convenience not available in the past: new technologies throughout the food chain have, for example, contributed to a dramatic fall in the time it takes to prepare meals. Kantar Worldpanel (2013) monitor the shopping habits of 30,000 British households: their findings suggest that 'the average time it takes to prepare the main meal has reduced from 60 minutes 20 years ago to 32 minutes now'. Frequently, ready-prepared products incorporate ingredients that we would not normally stock on our kitchen shelves!

We have a vast array of products to choose from, particularly if we shop online, in a superstore, or on a high street with a range of retail outlets. Data from Mintel Global New Products Database suggests that the UK's food and drink manufacturing sector launches over 8,000 new products a year (FDF, 2013). Whilst many will fail, and others might be

[11] Office of National Statistics (2012b) *Family Spending 2011*, Table B5: Characteristics of households, 2011.

[12] 1911 Census of England and Wales, *General Report with Appendices*, Table 78: Families of Various Sizes per 1,000 Families in Six of the Principal Cities of Great Britain: http://www.visionofbritain.org.uk/census/table_page.jsp?tab_id=EW1911GEN_M78&show=, last accessed 3 September 2013.

viewed as minor variants on a theme, the range of products available is huge. The Ocado website, for example, lists 549 items under the heading 'Rice, Pasta, Noodles & Pulses', and 832 under 'Cooking Sauces, Packets & Kits'[13]. Using the 'gluten free' filter their Food Cupboard produces a list of 742 items, whilst 'Fairtrade' generates 94.

In presenting this array of goods, the food industries have had to react to consumer concerns about how food is produced. Vegetarianism and the organic food movement have long histories: The London Vegetarian Society was founded in 1849 (Drouard, 2007). Conford (2001) suggests that 1926 was most probably the starting-point for the development of the organic movement. In recent years the Co-operative Group (2013) has been monitoring sales of vegetarian products, and those with other 'ethical' attributes sought by consumers, such as organic, Fairtrade, and free range, using data from the ethical labelling and other trade associations. In 2011 sales of vegetarian products amounted to about £800 million, just less than 1% of all household purchases of food and non-alcoholic drinks (see Table 2.6). Bigger percentages were generated by the organic and Fairtrade labels, the animal welfare schemes (including Freedom Food), and the relatively new Rainforest Alliance. Products, of course, can have more than one label: a bar of chocolate might be both organic and Fairtrade. But collectively these schemes accounted for a relatively modest 7.1% of household expenditure on food and non-alcoholic drinks in 2011, perhaps somewhat less than their advocates might have wished.

Table 2.6. Consumers' expenditure on ethical products*, 2011.

	£ million	%
Vegetarian	800	0.9
Organic	1,500	1.7
Fairtrade	1,262	1.5
Free range eggs and poultry	792	0.9
Freedom Food	149	0.2
Rainforest Alliance	1,346	1.6
Sustainable fish	292	0.3
Total household expenditure on food and non-alcoholic drinks	86,464	100.0

Source: Co-operative Group (2013); and Office for National Statistics (2012c).

* Excluding the data for 'Farmers' markets' and 'boycotts'.

Irradiation has never become an accepted treatment in the UK, its use mainly limited to the treatment of herbs and spices to kill bacteria that cause food poisoning[14]. Although GM (genetically modified) soya and maize is imported in large quantities into the UK for animal feed, no GM crops are grown here commercially, and the use of GM ingredients in manufactured foods is very limited.

[13] http://www.ocado.com/webshop/getCategories.do?tags=%7C20000%7C20424&Asidebar=1, last accessed 30 January 2014.

[14] Food Standards Agency, *Irradiated food:* http://www.food.gov.uk/policy-advice/irradfoodqa/#.Uibh1xZjvww, last accessed 4 September 2013.

2.9 Summary

The food and drink manufacturing sector plays a pivotal role in the food chain, linking the farmer via the distribution, retail and catering trades to the final consumer. Science and technology, and entrepreneurial skills, have been brought to bear on an industrial scale to tackle the age-old requirements of preserving seasonal food, keeping it safe from spoilage, and preparing palatable snacks and meals that consumers want to eat.

The last 100 years have been a period of continuity and change for the food and drink industries and their British consumers, only some of which has been captured in this review. Consumers have always wanted affordable, nutritious, and tempting foods to suit their changing life-styles and, when their incomes allowed, the occasional treat. Doubtless this will remain a truism for the next 100 years. Manufacturers (and retailers) have adopted the new technologies, manufacturing, and marketing techniques that they believed would enhance the appeal of their products, grow their sales, and boost their profits. Reputation has been, and remains, an important consideration, both for the brand and the company: first and foremost with respect to the safety and the wholesomeness of the product sold, but also encompassing wider ethical concerns associated with the production of food and drink.

New technologies have changed the shape of the industry, and we will say more about this in Chapter 4. Not all have survived, or been as successful as was at first envisaged. A British canning industry, for example, was once seen as having great promise (Plummer, 1937), but we can now see it was somewhat eclipsed by frozen foods, and then more recently by ready formulated chill-chain products.

A better understanding of the science of diet and health, as will be discussed in Chapter 3, has changed consumers' attitudes to the foods they eat, and Governments and industry, sometimes slowly, sometimes reluctantly, have reacted to these concerns. The food industry has adapted, although its many critics (e.g. Cannon, 1987; Lang and Heasman, 2004) have not always been impressed by the pace of change. Others have been rather critical of the choices consumers make.

The basic food ingredients of the 2010s are not much changed from those of the early 1910s. Less wheat in our diets, *very* much more chicken (see Godley and Williams, 2009), but fewer fish, are probably some of the most notable changes; though Quorn, a fungi known as mycoprotein, grown by fermentation[15], has taken market share away from meat. Quite what we shall be eating 100 years on is open to speculation.

The level of processing embodied in the typical food purchase in the 2010s is clearly much greater than in the 1910s. The value added by the food industry in part reflects functional attributes (e.g. shelf life, speed of preparation, taste and texture) and, in part, process attributes (e.g. fair trade and animal welfare) and other qualities valued by consumers (e.g. fun-cartoon characters on breakfast cereal packets).

[15] http://www.quorn.co.uk/about/, last accessed 4 September 2013.

If a typical British family of 1913 could be magically transported to 2013, enormous changes would be evident in the way we live our lives, and buy, prepare and eat our foods. Quite what they would think about Pot Noodles brought to life by the addition of boiling water, or an 800 gram 'Bistro Chicken with a Red Wine, Madeira and Mushroom Sauce' dinner for two in its plastic tray and cellophane wrapping, is difficult to imagine.

3. Nutritional discoveries over the last 100 years: from deficiency to DNA

3.1 Introduction

Over the past 100 years, nutrition research has developed through several different phases. Early work focused on the discovery of vitamins and micronutrients with the aim of curing deficiency diseases. Developments in nutritional survey techniques were aimed at a better understanding of the nutritional adequacy of the UK population's diet. The links between diet and disease were investigated using epidemiological approaches, involving the statistical analysis of data, often of large population samples.

The mechanisms between diet and nutrient interactions were examined both in animal and clinical trials, and in the laboratory. This scientific evidence base has been used for the setting of nutritional recommendations such as Dietary Reference Values (DRV) and food-based dietary guidelines. Health professionals have sought to better understand consumer behaviour with the aim of achieving optimal nutrition, with recent endeavours now exploiting advances in nutrigenomics to develop personalised nutrition.

A range of scientists working across many disciplines alongside food industry professionals, health professionals, Government bodies and other stakeholder groups have helped make the UK a global player in nutrition research. The food manufacturing industry has followed these developments closely by:

- adding vitamins and micronutrients to foods ('fortifying' foods) such as breakfast cereals, bread and margarine, sometimes under Government direction as in World War II;
- funding research, such as the recent Biotechnology and Biological Sciences Research Council (BBSRC) *Diet and Health Research Industry Club* (DRINC) initiative[16];
- reformulating its products to reduce the content of salt and saturated fats, most recently under the Department of Health's *Public Health Responsibility Deal*; and
- producing products to meet particular nutritional needs and aspirations, such as the needs of an increasingly ageing population, especially those who have chewing and swallowing difficulties.

In 2013, the Chief Executives of a number of organisations representing those working in the scientific, Governmental and commercial sectors, formed a group to provide a strong voice for nutrition in the UK and to support research and innovation for healthier food and, to coin an old adage, a healthier nation (Buttriss, 2013). The following discussion outlines some key developments in nutrition research and policy in the UK since 1913.

[16] http://www.bbsrc.ac.uk/drinc, last accessed 24 October 2013.

3.2 The 1910s: from vitamines to vitamins - what's in a name?

In 1913, nutrition was very much concerned with the hunt to cure diseases which were then thought to be caused by some unknown deficiencies. Much early work centred on Casimer Funk's deficiency theory of disease, suggesting that disorders like pellagra, scurvy and rickets were all caused by unknown deficiencies and that all shared a common cause. Funk introduced the term 'vitamine' in 1912, coining the name from 'vita' believing the substances were necessary for life and 'amine' as, from reviewing the evidence, he believed that they must belong to a group of organic nitrogenous substances (Funk and Dubin, 1922). A host of alternate names were proposed including food hormones, vitaids, nutramines and advitants to name a few (Maltz, 2013). It was not until 1920, that a standard nomenclature for vitamins was adopted when Drummond (1920) suggested that the alphabetical scheme devised by E.V. McCollum in the USA be used alongside a more acceptable form of vitamine –'vitamin', since the suffix 'in' was acceptable in the conventional nomenclature, to distinguish the individual substances. He also stated that 'this simplified scheme should be quite sufficient until such time as the factors are isolated and their true nature identified'.

3.3 The 1920s and 1930s: a golden age of vitamin discovery

This section provides a whistle-stop tour through some of the key discoveries in vitamins and micronutrients in the 1920s and 1930s, alongside an insight into current thinking and how the food industry has responded.

3.3.1 Vitamin C and scurvy

For 18th Century seafarers, scurvy was a particularly nasty disease, frequently resulting in death. We now know this was due to a vitamin C deficiency, caused by the lack of fresh fruits and vegetables on board ship. Fresh citrus is an effective cure, as shown by Lind (1753), a Scottish physician, who published, a *Treatise of the Scurvy* following his experiments on HMS Salisbury. At the time, lemons and oranges did not keep well, therefore a tincture, perhaps one of the first modern 'functional drinks', was made by preserving the juice in a portion of rum or brandy. It was not until 1928, however, that vitamin C was isolated (Szent- Györgyi, 1928). Vitamin C (or ascorbic acid) is now used to fortify both animal feed and human foods, particularly juices and breakfast cereals. Ascorbic acid also has other functions in food processing: it improves the baking quality of flour, as an antioxidant and, in meat processing, to reduce the addition of nitrite whilst retaining the colour of the meat[17].

3.3.2 Vitamin D and rickets

In 1921, Scottish researchers carried out studies to determine which deficiency was responsible for rickets. Using young dogs living in cities, they found that inadequate fresh air and exercise determined the onset of rickets and that having an outside run was more

[17] http://www.quali-c.com/en/food-technological-uses-and-applications/, last accessed 24 October 2013.

important than intake of milk, which had been cited as the potential causative factor in an earlier study (Findlay, 1908; Paton and Watson, 1921). Around the same time in England, Mellanby (1921) was studying the role of 'accessory food factors' in rickets in young dogs who were kept indoors with a limited milk supply. He found rickets could be prevented with butter and cod liver oil without the dogs going outside or having any exercise.

Sunlight exposure had been used as a traditional Northern European remedy and, in 1919, exposure to ultraviolet (UV) light was also found to be effective in curing rickets. This led to Chick et al. (1922) at the Lister Institute beginning a lifetime's work in this area. They showed that cod liver oil or UV light exposure could cure the condition. The biologically active form of vitamin D was finally crystallised in 1931 (Askew et al., 1931).

Later, with the fortification of margarine and other fats with vitamin D from 1942, it was thought that rickets, as a UK disease, could be consigned to the annals of history. However, in the 21st Century, rickets has reappeared in certain sections of society, especially amongst the elderly and the children of ethnic minority families; and worldwide it remains a problem in the Middle East, Africa and Asia. Research continues into vitamin D's role in health and in particular the interplay with calcium, as it had been suggested that upsets in the balance of these could be linked to the development of cancers, adiposity, ageing, multiple sclerosis and depression. This has led to the ongoing debate as to what the DRV (see Box 3.1) for vitamin D should be (Prentice, 2013). It has afforded opportunities for the food industry to develop functional foods, for example the so-called 'supermilks'. However, findings from the National Diet and Nutrition Survey (2012) have shown that the Reference Nutrient Intakes (RNI) for vitamin D are not being met, with around 20% of both 11-18 year olds and 19-64 year olds, below the lower threshold for vitamin D adequacy. This indicates that further opportunities for the food industry exist in supporting the enhancement of vitamin D in food to meet current dietary recommendations and optimise future health.

Box 3.1. DRV and other terminologies

Dietary Reference Value is an umbrella term. It covers: *Reference Nutrition Intake* (RNI) designed to meet 97.5% of the population's needs; *Estimated Average Requirement* (EAR), to meet 50% of the population's needs; and *Lower Reference Nutrient Intake* (LRNI) which is only adequate for 2.5% of the population. RNI is not the same as the Recommended Daily Allowance (RDA) or the Guideline Daily Amount (GDA).

3.3.3 Vitamin A and xerophthalmia

An unintentional consequence of the inadequate supply of fats in Denmark during World War I led to the observation that children who had received whole cream milk in the previous 6 months did not develop xerophthalmia (a condition when the eye fails to produce tears). At the time xerophthalmia was associated with blindness, but it has since

been found to lead to increased risk of infection and increased childhood mortality. The affected group were given cod liver oil which reversed the conditions and led to increased growth (Bloch, 1919; Wolf, 2002). It was found that the vitamin existed in two forms, one that was highly coloured, such as that in carrots and leaves, termed B-carotene and another colourless form found in animal fat. Subsequent work showed that carotene was a precursor of the final vitamin known as 'retinol'.

Consequently, as well as spreadable fats being fortified with vitamin D in 1942, they were also fortified with vitamin A. But, as with rickets, xerophthalmia has not been consigned to the history books as, although fortification of foods led to ocular vitamin D deficiency being eradiated from developed countries by the second half of the 20th Century it was, and still is, prevalent in emerging economies with an estimated 140-250M children affected worldwide (BBC, 2013). From the 1960s onwards, a raft of initiatives, from dosing to randomised control intervention trials, have shown the benefits of vitamin A in decreasing mortality. However, uptake has been patchy. Therefore, much of the early work in the genetic modification of food crops was aimed at increasing their vitamin A content, with 'Golden Rice' being an example of this. Golden Rice was developed in 1999, but has not yet been grown commercially. Work continues, with crop scientists being to the fore of this and the bio-fortification of other food crops. However, foods developed from such technologies are not without their controversies, widely reported in the media, although they are supported by the majority of the scientific community, with many advocating that this may help secure a sustainable food system worldwide, although the jury is still out on this one (Qaim and Kouser, 2013).

3.3.4 Folic acid, anaemia and neural tube defects

In 1937, Lucy Wills and co-workers in England identified 'vitamin M', after going to India in 1928 to study macrocytic anaemia, which was prevalent in pregnant Muslim women. Initially it was thought this was due to either an infection or a deficiency of vitamin A or C. They found, however, that yeast or 'Marmite' cured the condition. Feeding trials with rhesus monkeys led to the compound being termed vitamin M. Researchers studying poultry nutrition found that feeding chicks a purified diet containing all the other vitamins then known also led to macrocytic anaemia, whilst giving the vitamin Bc extract could prevent this (Campbell et al., 1944). A similar compound was extracted from spinach in 1943 and coined 'folic acid' due to its foliage source (Jukes and Stokstad, 1948) with chemical identification made (Stokstad, 1979). Early work on folic acid focused on anaemia and growth in monkeys and chickens. When large doses of folic acid were given to humans, it was found to stimulate red cell production; however, treatment over several months led to signs of neurological disturbances.

Other insights into the potential role of folic acid emerged from UK observations that unusually high numbers of babies with neural tube defects came from low income mothers, which in itself is multi-causal, but it did lead researchers to examine if dietary factors could be at play. One theory was that high potato consumption could increase risk, whilst another questioned vitamin supplement intake both pre and during pregnancy. Although the latter observation was first cited in the literature by Emanuel and Sever

(1973), the result of the first intervention trial was published by Seller and Nevin (1984), showing the incidence of malformed embryos was 3.6 times higher in the non-supplemented group, compared to the intervention group.

This sparked serious concerns amongst health professionals and, since that time, there has been much debate in the UK as to whether fortification of food with folic acid, especially flour, should be made mandatory. The most recent report evaluating the scientific evidence, published by the Scientific Advisory Committee on Nutrition (SACN) (2006), called for mandatory fortification of flour. It was noted that the National Diet and Nutrition Survey showed that voluntary fortification of breakfast cereals and spreads contributed significantly to UK folate intakes, and that this needed to be considered, as mandatory fortification, alongside voluntary measures, could lead to some sections of society exceeding the guidance limits. Like all other vitamins and micronutrients discussed in this Chapter, discovery and cure was not the end of the story. Following the publication of research in 2007 and 2009 suggesting an increased risk of bowel cancer associated with folic acid, SACN was asked to review its recommendations for mandatory fortification. Its report reaffirmed the recommendations made in 2006 (SACN, 2009). Presently, although many other countries have adopted the mandatory fortification route, the UK Government and food industry have resisted, fearing that it could lead to an unintended masking of vitamin B12 deficiency in vulnerable older adults. However, it has led to opportunities for the food industry to continue with the voluntary fortification of foods that are commonly consumed by women of childbearing age, such as some brands of breakfast cereal.

The 1920s and 1930s were the golden age of vitamin and mineral/micronutrient discovery. Further work in this vein continued in the 1940s and onwards, on vitamin E and K and other micronutrients. As with much work of this period, animal testing was used to identify cures for deficiencies thought to be caused by a lack of vitamins and micronutrients. However, this was just the beginning of the story: there was, and is, much yet to be discovered using emerging research paradigms. From the 1930s, research began to use different approaches to help understand adequate nutrition with nutritional epidemiology being one of these.

3.4 The age of surveying and feeding the Nation: the War years

During World War II, a number of new food and nutrition policies were introduced. With concerns over food security due to threats to UK shipping routes and the safe transportation of food, at a time when imports accounted for over half of food supplies, the Government set up a committee of nutrition experts to advise on strategic food policy in 1938 (Fisher, 1977) which led to a system of food rationing based on calculations by scientists and statisticians. Key to informing this work were John Boyd Orr's surveys.

Boyd Orr (1936) published: *Food, Health and Income. Report on a survey of adequacy of diet in relation to income*. This led to conflict with government at the time, as it reported that fruit and vegetable intake increased with increasing income; and that milk, meat, and vitamin and mineral intake were also correlated with income. It reported that at least a third of

British people were unable to have an adequate diet to maintain their health due to poverty (Boyd Orr, 1936). Boyd Orr was subsequently funded by the Carnegie group to carry out a survey into deficiencies in diet and to investigate the association between economic factors and physical activity, which became known as the Carnegie Survey. Four thousand children were surveyed from 1000 families and the results of this study were used to inform rationing in World War II. In 1988, this work was followed up in an examination of the impact of early nutrition on later-life outcomes, and is still being investigated by George Davey Smith's group at Bristol University to this day (Martin et al., 2005).

The Ministry of Food was established in 1939, with the aim of providing a nutritionally adequate diet during the war. It was responsible for food policy and indeed controlled food supply. Even though individual food choice was severely curtailed, some have argued that it was during the wartime years that the UK had the most nutritionally balanced diet. Rationing began in 1940. Many had a better diet than before the war as all received the same rations, with reduced consumption of meat, fat, eggs and sugar; whilst others, whose diets would have previously been considered inadequate, increased their protein and vitamin intakes which had a positive effect on a variety of health outcomes (Morgan, 2012).

The *Welfare Food Scheme* was developed at the same time as rationing, with the aim of ensuring adequate nutrition of pregnant women and young children. Initially liquid milk, national dried milk, concentrated orange juice and cod liver oil were included. In 1946 the Government decided to continue the scheme and it has undergone several modifications over the following 70 years, with *Healthy Start* its current incarnation (Foster and Lunn, 2007).

The Ministry of Food established the *National Food Survey* in 1940 to monitor the dietary adequacy of working class households during the war (Foster and Lunn, 2007). In 2001, together with the *Family Expenditure Survey*, it was combined into the *Expenditure and Food Survey*, renamed the *Living Costs and Food Survey* in 2008, which collects information on each member of 7000 households over the age of 7 years, who complete a two week diary of all food both entering the home and consumed outside the home. This has facilitated the tracking of dietary patterns both within and outside the home over a 70 year period, giving useful insights on how economic, sociological, behavioural and technological changes have impacted on dietary/food choice.

3.5 The golden age of nutrition

3.5.1 Diet and heart disease

The development of nutrition surveys in the UK and elsewhere allowed researchers to begin examining the relationship between diet and disease in a systematic way and led to the birth of nutrition epidemiology. One of the first areas explored was the links between Coronary Vascular Disease (CVD) and diet.

CVD was diagnosed in the USA in the 1920s (Morgan, 2012) and includes diseases of the heart, brain and other areas of the cardiovascular system. It was observed that CVD decreased in Norway after food restrictions introduced in World War II (Strom and Jensen, 1951), which stimulated interest in possible links between diet and heart disease. A number of forward looking long-term studies (termed prospective studies) were set up in the 1940s, which suggested dietary cholesterol was a risk factor.

Keys (1980) published his seminal *Seven Countries Study*, which indicted a link between dietary fat and CVD, particularly a direct correlation between increases in heart disease and saturated fat, and made suggestions of the potential protective benefits of the Mediterranean diet. Keys' work set the direction of nutrition research for much of the remainder of the 20th Century and led to understandings as to the role of dietary cholesterol versus cholesterol found in the body. It was the latter that was found to be linked to heart disease, and that its levels were driven by dietary fat quality and quantity, and not by dietary cholesterol.

High intakes of total fat, saturates, salt and a low intake of fibre, and fruit and vegetables, increase the risk of CVD with Frayn and Stanner (2005) estimating that up to a third of all CVD deaths are associated with dietary risk factors. Dietary targets with the aim of reducing the UK's CVD rates were first set in 1974, and then periodically updated as the scientific evidence base developed.

The British Heart Foundation (2011) report *Trends in Coronary Heart Disease 1961-2011* showed that CHD accounted for more than 50% of deaths in 1961, but had decreased to 32% by 2009. Nonetheless it is still the biggest killer in the UK. Unal et al. (2005) reported that 58% of the decline in the UK's death rates from CHD, was due to reductions in major risk factors, mainly smoking and diet.

3.5.2 The changing face of fats - friends or foes?

Data from the UK's *National Food Survey* and *Family Food Survey* were used to examine changes in food consumption between 1961 and 2011. The British Heart Foundation (2011) reported a move from the 1960s consumption of whole milk, to semi-skimmed and skimmed milk by the 1990s, and changes in the intake of fats and oils, from that of butter, margarine and lard, to low-fat spreads and oils, all of which have helped decrease saturated fat intake. This change has been facilitated by the food industry, with the reformulation of existing products and the development of new ones, for example 1% milks, and reduced fat spreads.

However, the substitution of partially hydrogenated fats (a form of *transfat*) for saturated fats led to some concerns, as results of studies in the 1990s linked *transfat* intake to CHD incidence. *Transfats* are found in both vegetable and animal sources, and early studies had indicated that those from vegetable sources were more detrimental. The Committee on Medical Aspects of Food Policy (COMA) recommended that *transfats* should account for no more than 2% of food energy (Department of Health, 1994). The Government asked the SACN to review the recommendation in light of increasing concerns linking *transfats* to

not only CHD, but also cancer, obesity and diabetes. Using data from the *National Diet and Nutrition Survey* (NDNS) (2003), *transfats* intake was shown to be below the maximum recommended level, at 1.2%, which had decreased by almost a half from the previous NDNS in 1986/7. SACN were asked to consider if a recommendation of 1% was needed, but the scientific evidence did not support this (SACN, 2007) nor did it show a difference in effect due to source. However, in the face of mounting concerns, the food industry embarked on a programme of removal of partially hydrogenated fats from manufactured products. As part of the Government's *Public Health Responsibility Deal*, the food industry promised to remove artificial *transfats* from manufactured products by the end of 2011. Results in 2012, showed that UK consumption of *transfats* is now at 0.8% of food energy among 18-64 year old adults (NDNS, 2012), reflecting the reformulation changes that the food industry have made.

Other changes in fat intakes reported by the British Heart Foundation (2011) are reductions in red meats, with a switch to poultry meat, which has decreased saturated fat intakes. However this move has contributed to a lowering of iron intake, especially an issue for women. Recent results from the NDNS (2012) showed that 46% of girls, and 23% of women aged 19-64, were not meeting the Lower Reference Nutrient Intake (LRNI) for iron. These figures are of particular concern, as the LRNI has been determined to meet the needs of only 2.5% of the population: 97.5% of the population require more! Iron is included in fortified breakfast cereals, and infant foods; and the food industry has worked to overcome some of the technological issues with adding iron to other food.

3.5.3 Is saturated fat the villain?

Recently, the saturated fat-heart disease hypothesis has been revisited, as results from a large analysis of studies including over 350,000 subjects, of which 11,000 had developed stroke or CHD, showed that saturated fat intake was not associated with an increased incidence of either (Jakobsen et al., 2009). Other research questioned whether saturated fats should be replaced in the diet by polyunsaturated fatty acids, or with carbohydrates, and, in particular, by refined carbohydrates (Astrup et al., 2011). Although the recommendation had been to replace saturated fatty acids with other fat types, what instead appears to have happened is replacement with highly refined carbohydrates, which have been linked to weight gain and insulin resistance. The food industry is now working towards substituting saturated fats with other fats, and is co-funding much research at UK universities, including our own, aimed at addressing this.

3.5.4 Omega-3s: to eat or not to eat?

Research has shown that the long chain polyunsaturated fatty acids, *omega-3s*, lower the incidence of CVD and also support foetal development. After reviewing the evidence, SACN (2004) endorsed the recommendation that people should eat two portions of fish a week (a portion being 140 grams), one of which should be oily, although there are no specific recommendations for *omega-3s* themselves. There has been an increase in oily fish consumption, a rich source of *omega-3s*, since the 1990s (BHF, 2011), although current intakes of oily fish are only 54 grams per week in 19–64 year olds (NDNS, 2012). There are

many reasons for the low consumption of oily fish, which include cultural habits, cooking skills, and palatability, amongst others. In order to provide alternative dietary sources of *omega-3s*, the food industry has developed a range of *omega-3* fortified foods, including eggs, milks, yoghurts, breads and spreads, and has developed techniques to maintain the palatability of these foods.

3.5.5 Salt and hypertension

Salt has long been known to be associated with increased blood pressure and hypertension and, in 1991, the RNI for sodium was set at 2.4 grams per day. This was confirmed by COMA's report on *Nutritional Aspects of Cardiovascular Disease* (Department of Health, 1994) as 6 grams of salt per day (sodium is multiplied by 2.5 to get its salt equivalent). Decreases in salt intake leads to decreased blood pressure and decreased CVD risk. The British Nutrition Foundation (BNF) (1994) reported that naturally occurring sodium in unprocessed foods accounts for 15% of intake, with discretionary sources, such as adding at the table, 15-20%, whilst manufactured food products accounted for 65-70%. SACN called for a multiagency approach to the reduction of salt, with particular input from the food industry. The food industry and food researchers have worked over the last twenty or so years to develop technological solutions to reduce salt without comprising either stability or palatability, as the addition of salt to manufactured foods has several functions, particularly contributing to preservation and taste.

As part of the Government's *Public Health Responsibility Deal,* the food industry pledged a 15% reduction in salt by the end of 2012 on the 2010 targets. At the time of writing 80 'partners' are committed to this pledge[18]. The approach is paying dividends, as NDNS (2012) showed a significant reduction in mean salt intake between 2001 and 2011, from 9.5 grams per day, to 8.1. However, 70% of the population has a salt intake of greater than the 6 gram recommendation, so there is still work to be done. Work to date has focused around long-term reformulation projects to gradually reduce salt, development of low salt alternatives and work on the crystalline structure of salt with the aim to give the same taste perception with lower levels. An example of a low salt product which the food industry has developed is 'Soda-Lo', which is claimed to allow salt reductions in food products by 25-50% without loss of taste. This is a product sold by Tate and Lyle, which has altered the structure and is based on salt microspheres - which increase the surface area-to-volume ratio of added salt to increase taste sensitivity.

3.6 The 1980s: the age of affluence and the growth in obesity

Much comment has focussed on our expanding waistlines, the growth in obesity in all age groups and globally since the 1980s, and the links between obesity and chronic diseases. The food industry has responded by working with the Government at a number of levels, including pledges to reduce calories as part of the *Public Health Responsibility Deal* mentioned earlier, with the Institute of Grocery Distribution (IGD) publishing a best practice guide to aid the food industry in meeting these targets[19].

[18] https://responsibilitydeal.dh.gov.uk/pledges/pledge/?pl=9, last accessed 24 October 2013.

[19] https://responsibilitydeal.dh.gov.uk/igd-best-practice-guide/, last accessed 24 October 2013

Other work has led to the widespread adoption of Front of Pack Nutrition (FOP) nutrition labels by the food industry in June 2013, providing easy information at the point of purchase to aid consumers make healthier food choices[20].

The food industry is working with nutrition scientists to develop new products with the aim of helping the population achieve and maintain a healthy weight. An example of this includes Marks and Spencer's 'Fuller Longer' range, launched in 2010 after extensive studies with the University of Aberdeen, led by Alex Johnstone. Johnstone's team are involved in a number of EU-funded projects, examining the regulation of appetite, in which both the UK and the global food industry are partners [21].

3.7 The nutrigenomics age-personalised nutrition and will we eat for our genes?

Over the last 100 years, nutrition research has moved through a number of ages, from:

- the discovery of compounds causing deficiencies;
- through to an examination of the relationship between diet and disease;
- to developing policies and population-based recommendations to achieve optimal nutrition and health; and
- now in the genomics age, exploring diet and DNA (deoxyribonucleic acid) interactions and asking whether it may be possible to develop individual dietary recommendations and foods based on a person's genotype.

This new era of nutrigenomics and 'personalised nutrition' is upon us (Fallaize et al., 2013). Already, food and nutrition scientists and the food industry are working to explore the challenges and opportunities that this emerging science offers[22]. However, will we, as humans, be willing to eat in such a prescribed way? Only the future will answer that question!

[20] https://www.gov.uk/government/publications/front-of-pack-nutrition-labelling-guidance, last accessed 24 October 2013.

[21] http://www.full4health.eu, last accessed 24 October 2013.

[22] www.food4me.org

4. Science, technology and innovation in food manufacturing and its impact on consumers

4.1 Introduction

The 20th Century witnessed development of science and technology that has had a revolutionary impact on our lives today in the age of the microprocessor, mobile communication, genetic engineering and biotechnology. In 1900, we had not yet mastered powered flight, we did not know the structure of the atom (let alone DNA), we were only just beginning to fathom X-rays and radioactivity and the first radio broadcast had yet to occur. Things we take for granted, like commercial air travel and the mobile phone, were not yet imagined.

Developments in science and technology have also had a profound effect on our food, how it is manufactured, where it is manufactured and how it is purchased and consumed. A microwavable meal, ordered on-line, delivered to one's door and ready to eat in minutes is an obvious example. The food we consume today is largely safe, convenient and nutritious as a direct result of innovations in food manufacture that have exploited ongoing developments in fundamental science and technology. This Chapter is not an exhaustive review, but highlights some examples of how the application of science and technology has impacted on our food, its safety and its quality. Some of these examples highlight developments that are specific to food manufacture, while others illustrate the impact of 'outside' developments on food and the consumer.

4.2 Progress in analytical science and its impact on food quality, safety and traceability

The modern food industry may appear to the consumer to be beset with reports and scandals of food adulteration and contamination. However, this perception arises largely because of the successful advancement of analytical science to allow improved, cheaper and more widespread monitoring of food quality and authenticity. A recent food scandal illustrates this well. In February 2013, evidence came to light that food manufacturers had been the victims of fraud through the substitution of beef with horsemeat by suppliers (Food Standards Agency, 2013). In this case, a routine monitoring study by the Food Safety Authority of Ireland (2013) revealed the presence of horse DNA in beef products. The study was based on extraction of DNA and its subsequent analysis through the use of a process known as polymerase chain reaction and DNA profiling. This methodology is more familiar to us as 'DNA fingerprinting', which has become widely used in criminal forensic investigations since first reported by Jeffreys *et al.* (1985). It has also been exploited as a way of detecting genetic modifications in foodstuffs and, as in the horsemeat scandal, tracing food supply from fork to farm. Before 1985 we would have had no such rapid and sensitive method for detecting horsemeat and may have continued unaware of this loss of food chain integrity.

The field of analytical science, and with it food analysis, has developed rapidly over the past 100 years and has been subject to detailed review in the scientific literature (e.g.

McGorrin, 2009; Cifuentes, 2012). During the early 20th Century, food analysis relied on the application of laborious 'wet chemistry' methods, such as titration or solvent extraction, to measure levels of major food components and to protect consumers against fraud. These methods largely relied on subjective measurements of volumes, colour changes, etc. Some of these wet chemistry techniques still persist in use. However, alongside the advancement in the science of food components, analytical methods have evolved to be more robust, efficient, higher sample throughput, sensitive, and cost-effective instrumental analysis techniques.

The first widespread analytical instruments were UV spectrophotometers developed in the 1930s and 1940s that allowed accurate and reliable measurement of light absorbance for colour-based measurements of, for example, vitamin concentration. Infrared (IR) spectrophotometers became available at the same time and allowed characterization of chemical structure such as the assessment of *trans*-isomerism in unsaturated fatty acids, the significance of which will become clearer later in this Chapter. In 1969, advances in optics and computers allowed more sensitive Fourier transform IR (FTIR) spectrophotometers to become commercially available, which collect multiple scans of data covering a wide spectral range and use the mathematical process of Fourier transformation to convert data to spectra (Griffiths and De Haseth, 2007). FTIR technology is exploited in portable milk analysers used to measure fat, protein and other parameters of raw and processed milk and milk products. Portable FTIR spectrophotometers sensitive to the near IR spectrum are also used for a range of other food materials (e.g. flour) for rapid determination of moisture, protein and other information *in situ* without transfer of samples to a laboratory.

These and other technologies based on spectroscopy enabled the development of in-line analysers to allow real time monitoring of food process operations for quality assurance purposes. Allied to these, food manufacturers use X-ray inspection systems to screen products for contaminants to avoid the consumer facing the unwelcome find of foreign bodies in their food. When this does occur, a wide range of analytical testing is available to the food manufacturer in specialist laboratories to identify the contaminant and its source, which allows actions to be taken to avoid a repeat.

However, the most revolutionary advancement in instrumental analysis over the past 100 years is the development of chromatography. This was invented in the early 1900s by a Russian botanist called Mikhail Tswett who observed the separation of plant leaf pigments on a solid absorbent. Tswett's work fell into obscurity until Martin and Synge (1941) developed a technique called liquid-liquid partition chromatography, which was the forerunner to modern high-performance liquid chromatography (HPLC) developed by James Waters in the early 1970s. Not content with this Nobel Prize winning development, Martin went on to devise the technique of gas-liquid chromatography (GC) (James and Martin, 1952). HPLC and GC are immensely powerful techniques that enable the separation of complex chemical mixtures into their component parts and have found widespread use in food analysis of sugars, amino acids, proteins, vitamins, colours, pesticide residues, fatty acids, flavour volatiles, etc. In 1960, the mass spectrometer was linked to GC as a detector, which combined the separation of volatile compounds by GC

with their chemical identification by their unique mass spectrum. The impact on the study of flavour chemistry was seismic as it became possible to identify the trace component volatile compounds responsible for the characteristic aromas and flavours of foods.

The improvement of methodology is ongoing and is focused on the need to guarantee the safety, quality, and traceability of foods in compliance with legislation and consumers' demands, and on widening the practical range of food applications of modern techniques. Indeed, often legislation and consumers' demands follow the improvement in detection limits that allow a case of, for example, food fraud to be detected in the first place. The recent horsemeat incident is a case in point and has highlighted how food analysis is a critical part of regulating the infrastructure of the global food distribution system. However, this is not only for quality control and regulatory enforcement, but also as a tool for new product development, such as the better understanding of flavour and colour generation through food processing, such as through the Maillard reaction.

4.3 Maillard browning of foods

Louis Camille Maillard (1912) published a landmark paper on the reaction of amino acids with sugars upon gentle heating in water to form a yellow-brown colour that he identified as melanoidins. Melanoidins are brown pigments and are major contributors to the colour of foods like coffee, bread and honey. Maillard's paper and later reports on his eponymous reaction were largely ignored until the 1940s, when the Maillard reaction became recognized as responsible for non-enzymatic browning (as opposed to enzymatic browning of fresh fruit and vegetables due to enzymes present in foods that become active due to exposure to oxygen) and loss of nutritive value in foods. It has since come to have enormous significance in food science, nutrition and food safety (Finot, 2006).

Renewed interest in the Maillard reaction emerged with the onset of World War II and the military need for mass production of foods with longer shelf-life stability. It was, therefore, of interest to gain better understanding of the chemical stability of foods and reactions that may impact on food quality, among which the Maillard reaction was identified as being key. However, it took several years to establish a better understanding of the effects and mechanism of the complex Maillard reaction.

Research in milk technology made a large step in that direction. Researchers from the National Institute for Research in Dairying at the University of Reading, the Low Temperature Station for Research in Biochemisty (Cambridge), and the Hannah Dairy Research Institute published an extensive paper on the 'deterioration on storage of dried skim milk' (Henry *et al.*, 1948). This reported the influence of various storage conditions of skim milk powder (moisture content, oxygen absorption, soluble nitrogen, temperature, time) on its stability, flavour, and nutritive value. Its observations related to the Maillard reaction and particularly noted the loss of the nutritionally essential amino acid lysine, possibly through reaction with sugars. Subsequent research has established that lysine is particularly susceptible to the Maillard reaction.

The American chemist, John Hodge, established a scheme for the Maillard reaction and published what became widely known as the 'Hodge Scheme' for Maillard reactions (Hodge, 1953). The Hodge Scheme became very important as it summarized the complex chemistry underlying the Maillard reaction, which encompasses a network of interlinked reactions leading to various end products influencing colour, aroma and taste formation. This knowledge enabled research to focus on better understanding of the means of controlling Maillard reactions through manipulation of time, temperature, pH and water activity, which has been of enormous benefit to food manufacturers to establish processing conditions most beneficial to generating optimum colour and flavour, while preserving nutritional quality.

However, while the Maillard reaction is key to generating many desired end products in food, there are some very undesirable products, too. Two noteworthy examples are the probable carcinogenic 5-hydroxymethylfurfural (HMF) and acrylamide. Acrylamide came to attention with a report from Swedish environmental chemists of its formation in heated foodstuffs (Tareke *et al.*, 2002). This discovery arose somewhat by chance. A construction team using polyacrylamide in a project to repair a tunnel became ill, which sparked an investigation of the workers' exposure to acrylamide. Acrylamide levels in healthy local subjects were measured as a control, but it was found that they too had high levels of acrylamide. Concurrently, another group was conducting a study of acrylamide levels in wild animals and domesticated pets, and had found high levels of acrylamide in pets. This was deduced as being due to consumption of pet foods and led to the hypothesis that the high levels in humans could also be due to diet.

The proof of this hypothesis was an urgent issue for the food industry. It was soon established by Mottram *et al.* (2002) at the Universities of Reading and Leeds that acrylamide was formed in the Maillard reaction originating from asparagine present as a major amino acid in potatoes and cereals. This link to the Maillard reaction was key as it enabled research to be commissioned, and strategies devised, to suggest means to minimize or eradicate acrylamide from processed foods, including using the enzyme asparaginase to breakdown asparagine and eliminate it from the Maillard reaction (Zyzak *et al.*, 2003), using process control to favour other reaction pathways from asparagine other than those leading to acrylamide (Parker *et al.*, 2012), or plant breeding to select varieties that are less prone to acrylamide formation (Postles *et al.*, 2013). Research has established that acrylamide occurs particularly during baking or frying, and is as likely to occur during home cooking as it is during commercial food processing. However, it is unclear now whether acrylamide intake from food poses any significant health risk (Food Standards Agency, 2014).

In both the advantageous and unwelcome aspects of the Maillard reaction, the food industry has worked closely with researchers to better understand the implications for the production of nutritious, tasty and safe food.

4.4 Sweet serendipity

Uncovering the potential risk of acrylamide was not an isolated example of discoveries being made more by accident than through careful execution of hypothesis-led laboratory experiments. Other notable examples are the discoveries of the most commercially successful and well-known artificial sweeteners: saccharin, aspartame and sucralose.

Constantin Fahlberg discovered saccharin in 1878 while working in the laboratory of Ira Remsen at John Hopkins University on coal tar derivatives (Tarbell and Tarbell, 1978). It is disputed whether it was Fahlberg or Remsen, but the story goes that one of the two contaminated his hands in the laboratory and later found that food (or the end of a pencil) he had handled carried a sweet taste. Again, either Fahlberg or Remsen fortunately connected this with samples in the laboratory and then, rather dangerously, set about tasting everything on the lab bench in search of the sweet taste. Controversially, although Fahlberg and Remsen published the discovery of saccharin together, Fahlberg went on to pursue commercial avenues for its application as a sugar substitute without acknowledging Remsen. A lucky and sweet discovery led to a very bitter relationship, and saccharin has since had its ups and downs in the eyes of consumers. Saccharin first established widespread use as a sugar substitute during First World War sugar shortages. In the 1960s and 1970s, saccharin became a commercial success as diets based on counting calories became widespread in Western countries since it sweetens with zero calories. Around the same time, it became the focus of cancer scares based on experiments with rats, which did not produce equivalent evidence from that found in human epidemiology studies (National Cancer Institute, 2009). Indeed, some countries did ban saccharin, but have since restored the compound as a safe product for use in foodstuffs.

Aspartame was accidently discovered by James Schlatter in 1965 when he licked his contaminated finger and noted a sweet taste while working in the laboratory of G.D. Searle on the synthesis of a molecule the company was working on intended for testing drugs for the treatment of gastric ulcers (Mazur, 1984). Aspartame is a methyl ester of the dipeptide of two natural amino acids, namely aspartic acid and phenylalanine, and is about 200 times sweeter than sugar. It was later approved for use as a non-nutritive sweetener and marketed as NutraSweet. In 1976, researchers in Leslie Hough's lab at Queen Elizabeth College, were investigating sucrose derivatives. A student was asked to 'test' one particular compound, sucralose, but misheard this as an instruction to 'taste' it. On tasting, he found it was incredibly sweet; indeed, sucralose is reportedly 600 times sweeter than sugar (Hough and Khan, 1989). The sponsors of this research, Tate & Lyle, now market sucralose under the name Splenda, which has the advantage over aspartame that it is stable during thermal processing and is hence applicable to, for example, baked products (Barndt and Jackson, 1990).

Artificial sweeteners can be produced more cheaply than sugar and have benefits for combating obesity through reduction of calorie intake and for diabetics to satisfy their natural craving for sweet food. However, there has always been concern from consumers about them being artificial additives. In this respect, there has long been the search for

non-calorific alternatives to sugar that are natural. Therefore, it is of little surprise that Stevia, which is naturally sourced, has no calories, no carbohydrates, and does not raise blood sugar levels, has attracted recent widespread attention (Heyden, 2013). Stevia is a glucoside (a molecule containing glucose bound to another functional group) isolated from the leaves of the plant *Stevia rebaudiana* (Kohda *et al.*, 1978), which is naturally sweet (300 times sweeter than sugar) and has recently gained regulatory approval from the European Food Safety Authority (EFSA).

Stevia is now available on UK supermarket shelves under several brand names as a tabletop sweetener and in an expanding variety of beverages, usually as a partial replacement of sugar (sucrose), to achieve a reduction in total sugar and calorie intake. Alternatives to sucrose are of topical interest. However, while the main purpose of sucrose in food is its sweet taste, it also has other functions in food including as a preservative, texture modifier and bulking agent. These various roles of sucrose are based on its physical and chemical properties other than sweet taste and make its replacement by alternative sweeteners difficult if their sweetness intensity values or physical and chemical properties differ greatly from those of sucrose.

4.5 Ensuring food safety and extended shelf life through packaging and processing

Methods to detect food contamination with, for example, bacterial toxins can ensure that the consumer is protected from unsafe foods, but it is far better to have in place preventative measures. Today we take it for granted that canned foods and packaged products can be safely stored for extended periods. However, early attempts at canning and associated thermal processing were crude. This had dangerous implications, including widespread outbreaks of botulism, and research began in earnest during the 1920s and 1930s to find an underpinning scientific basis for safe thermal processing of canned foods. This required deep understanding of the application of microbial inactivation kinetics to thermal processing of canned foods.

The principles of thermal death time and logarithmic (non-linear decrease by orders of magnitude) nature of thermal death time curves were described by researchers at the USA based National Canners Association (Bigelow and Esty, 1920; Bigelow, 1921). These were critical steps to allow determination of the amount of heat needed to destroy a given number of organisms at a chosen temperature. They also established the role of pH in controlling microorganisms, observing that bacteria did not survive as well in more strongly acidic foods as they did in less acidic foods. These findings were extended by the work of Charles Olin Ball, also at the National Canners Association, who published the mathematical principles and formulae for calculating the amount of heat put into, and removed from, a can undergoing various process treatments to achieve commercial sterility (Ball, 1928). From these foundations, the modern canning industry can ensure the safety of canned foods that we now rely on. This allows us to keep a supply of store cupboard staples in the home that go far beyond dry products such as flour and rice.

Other processes have been developed to allow safe storage of foods for extended shelf lives. These include the development of quick-freezing processes, first patented for seafood products by Birdseye (1924). Clarence Birdseye discovered that very rapid freezing only incurred minimal damage such that the defrosted product was nearly identical to the fresh product. With the concurrent developments of refrigeration and freezer technology for domestic use came frozen foods. This, together with development of microwave cooking technology through to widespread home use in the late-1970s allowed for convenience frozen meals to be developed.

During the 1960s, commercial scale freeze-drying came into existence which brought instant coffee and freeze-dried foods for astronauts. Also in the 1960s, aseptic packaging was developed, familiar to us now as Tetra Pak. Aseptic food processing uses flash heating to sterilize products before filling in sterile packaging, which seal the product against contamination and degradation. Often ultra-high temperature (UHT) treatment is used to sterilize food by heating for 1-2 seconds at temperatures in excess of 135°C.

By the 1980s, controlled- and modified-atmosphere packaging of fresh foods was being widely used to improve shelf lives of fresh produce like lettuce. More recently, irradiation and high-pressure processing of foods have been studied as alternatives to thermal processing. A current focus in food engineering research is to achieve food safety and quality with lower resource inputs, such as consumption of water and energy, to make food processes more sustainable.

4.6 The best thing since sliced bread?

In 1958, the British Baking Industries Research Association (BBIRA) now part of Campden BRI, based in Chorleywood, began to study the mechanical development of bread dough in batch systems. Their interest stemmed from the politically driven need to develop a bread process that enabled UK grown wheat to be used in the baking of sandwich loaves in place of imported North American and Australian wheat. The Government wanted to reduce imports in view of potential entry to the European Economic Community and better use of UK grown wheat in bread was an important goal. However, the difficulty with this was the lower protein content of UK wheat, which generally led to poor baking performance.

By 1961, the BBIRA had found the 'Chorleywood process', which revolutionised the way bread was produced in the UK. This process used high-speed batch mixing coupled with addition of ascorbic acid to the flour as an oxidising agent to eliminate the need for bulk fermentation of dough. Strictly speaking, ascorbic acid is not an oxidising agent, but during dough mixing it rapidly is oxidised by endogenous enzymes to form dehydroascorbic acid, which is an oxidising agent.

The advantage of the Chorleywood process, aside from its influence on the balance of trade in grade, was to produce cheaper bread, with softer texture and with longer shelf life than existing processes. The retention of soft texture over longer periods adds convenience as it helped facilitate the 'weekly shop' at the supermarket to replace a daily

trip to the baker for fresh bread. Some may lament this, but it is undeniable that consumers have embraced cheap, soft and long-lasting Chorleywood-processed bread.

4.7 Technologies for the reduction of salt but not saltiness

From a food technology perspective, salt reduction through reformulation is a major challenge, as it not only impacts food quality in terms of flavour, but also impacts on texture and preservation of food products (Durack et al., 2008). Salt reduces water activity in foods, which is an important parameter with respect to the ability of pathogens or spoilage microorganisms to grow and, hence, is key to preserving the shelf life of foods. Added to this essential role, the complex formulation of processed ready meals means that salt may be present in any number of ingredients other than as a primary ingredient, particularly as salt is able to enhance other flavours apart from imparting saltiness.

As well as the strategies of reformulation and substitution of sodium chloride salt with low-sodium alternatives, the modification of the physical structure of salt has been shown to give the possibility for lower levels of salt to be added to food products without loss of taste. However, this is only likely to be an effective approach where salt is added primarily for flavour rather than for its other functional attributes. Reduction of the particle size of salt has been explored in commercial products made from micron-sized sodium chloride particles that dissolve more rapidly than normal salt to give enhanced perception at lower quantity, or made of hollow microspheres of salt.

4.8 Using science toward a sustainable future for food production?

Looking toward the future, perhaps the most contentious issue relating to our food is that of genetic modification (GM) of food. This is a complex and emotive debate, but one that features astonishing advances in science, not least the story of DNA from the discovery of its structure by Watson and Crick (1953).

In essence, GM foods are foods produced from plants that have had changes made to their DNA by methods known as genetic engineering. These changes intend to introduce new traits, for example disease or drought resistance, in order to improve the quality or yield output of the plant as a crop. Prior to genetic engineering, the genetic make-up of plants and animals could only be manipulated by selective breeding to arrive at breeds or crossbreeds or plant varieties (cultivars) or hybrids with particular traits. GM technology affords greater control than these traditional approaches, and its exploitation is widespread, particularly for crops like soybean and maize.

The first GM foods were tomatoes, grown in the USA in 1994 and marketed as 'Flavr Savr' by the company Calgene (James and Krattiger, 1996). This tomato was engineered to be slower ripening, allowing it to retain texture, colour and flavour for longer than conventional varieties. In the UK, Zeneca Seeds (now part of Syngenta) produced a tomato purée based on research by Don Grierson at the University of Nottingham for major retailers including Sainsbury's and Safeway that was made with GM tomatoes that had improved processing characteristics for production of purées. The tomatoes were

modified to have reduced enzyme activity with respect to those involved in softening of the fruit during ripening. This gave production cost reductions since fewer tomatoes were lost through transport damage and there was a reduced need for heat treatment to reduce enzyme activity during processing. In addition, the modified tomatoes contained less water, so less energy was needed to concentrate the purée before canning. The reduced heat treatment also provided better retention of natural flavour compounds. At first, consumers, not least in the case of the Zeneca Seeds tomato purée because they were cheaper than existing products, welcomed these products, but latterly some concerns about potential health effects of GM foods were reported, despite no convincing evidence to support this idea (Key *et al.*, 2008). This is unfortunate in light of the considerable benefits of GM tomatoes, particularly with respect to processing efficiency.

Environmental groups are also concerned about the impact of GM crops on ecosystems. This is particularly in relation to altered DNA passing into the environment to be taken up by microorganisms or other plants (Dale *et al.*, 2002). For example, herbicide resistance could be passed onto weeds, leading to problems with weed control. However, such questions have rarely been posed with regard to conventional breeding, from which transmission of DNA is equally possible.

For some, the science of GM food is essential to deal with the food security challenges of feeding an increasing global population from less land and water, coupled with unpredictability of climate. GM crops can give higher yields from poorer soils using less water, nutrients and pesticides. With respect to food manufacture, the raw material input is of course important, but other challenges can be addressed also. Processing of food typically requires inputs of energy and water, which leads to a need for more efficient processing methods that make lighter use of these precious resources. Food waste is another key issue, for which improvements to raw material quality can be important, as can be the effective utilization of food preservation and packaging techniques to enhance shelf life and product safety.

An additional layer of complexity in the GM debate is the different regulatory environments facing potential developers and users of GM technology globally. The EU's agricultural and food industries currently operate in a very restrictive GM environment which is argued, by the pro-GM lobby, to be detrimental to industry competitiveness and long-term consumer and environmental interests.

Centre Spread

Continuity and change: some product and brand profiles

CS1. Introduction

Here we profile several manufactured food and drink products that many readers will recognise. We look at *Warburtons'* bread and *Princes'* canned salmon (products familiar to our forebears in the 1910s, but refreshed for the modern consumer); *Nestlé's Nescafé*, a brand that was first marketed in 1938, but which has since undergone considerable product development; *McCain's* frozen Oven Chips where new technology has totally changed the way a traditional item of the British diet is presented and prepared; *Tropicana's Trop50* reduced sugar fruit drink, and *Walkers* crisps and savoury snacks, both of which have been reformulated to meet the dietary expectations of today's consumers; and, finally, *apetito's* texture-modified range of meals for people with chewing and swallowing difficulties (dysphagia).

These profiles, based on information provided by the companies themselves, illustrate some of the ways in which the industry has used science and technology, and our better understanding of nutrition, to increase the range, quality, affordability, convenience and healthiness of products available to the British consumer, whilst reflecting the more recent concern of reducing their environmental impact. Profit, of course, is an underlying industry imperative: but the supplier of a branded product can only obtain repeat purchases, and survive in a competitive market, if its product meets the consumer's expectation of a safe, nutritious, affordable and tasty product that their household will enjoy.

CS2. Bread

In 1913 bread was an important component of the average family's diet, and accounted for a large share of working class households' expenditure on food. With growing affluence and a more varied diet, that pivotal role has declined. Nonetheless, bread remains a cheap, nutritious and convenient way of feeding the family, either in the home or from the lunch box, and accounts for about 4% of our expenditure on food and non-alcoholic drink[23]. About 80% (by volume) of our bread is baked by plant bakeries (mainly producing wrapped breads on a large scale), 17% is produced by in-store bakeries in supermarkets (either baking from scratch, or from part-baked and frozen products), and the remaining 3% (although 5% by value) is baked by craft bakeries. An increasing proportion is used for the sandwiches we buy outside the home: 5-10% is thought to be sold to the food service sector. The three largest plant bakeries, accounting for about 75% of all bread sold, are Allied Bakeries (Kingsmill), Premier Foods (Hovis) and Warburtons. Warburtons has greatly expanded its market share over the last decade[24]

[23] According to The Federation of Bakers (undated) UK expenditure on the bakery sector amounts to about £3.6 billion: http://www.bakersfederation.org.uk/the-bread-industry/about-the-bread-industry.html

[24] Source: The Nielsen Company, Total Coverage, Unit and Value Sales, 52 w/e 04.01.14

Warburtons' bread

Warburtons was established in 1876 when Thomas and Ellen Warburton started baking bread in their grocery shop in Bolton. The aim was simple - to make affordable and nutritious bread, with freshness and quality customers can really taste. More than 100 years later, and now run by the 5th generation of the Warburton family, the founding principles on which the business was built still remain the same.

Today, Warburtons employs around 4,500 people in 12 bakeries and 14 depots across the UK and sells over two million bakery products each week. It is the UK's largest bakery brand and the third biggest grocery brand in the UK: more than 25% of all bakery products consumed in the UK are produced by the company.

As the business has grown from a grocery shop to a national brand, the way in which it makes bread has also evolved. Over 50 years ago Warburtons' bakeries started using the Chorleywood Breadmaking Process. This ground-breaking process enabled Warburtons to increase the number of loaves produced, whilst at the same time keeping the bread fresh, nutritious and, importantly for families across the UK, affordable.

As consumers' lifestyles have changed, so too have their taste buds and Warburtons has listened and responded to this by introducing new products which cater for a range of taste and meal occasions. Innovation has continued throughout the years and in the last decade alone, Warburtons has invested more than £400 million in infrastructure to ensure it can make the best quality and variety of products. Today the business offers over 100 different products, including sliced bread, crumpets, pancakes, thins, wraps, muffins and teacakes.

Warburtons is also committed to ensuring that everyone can enjoy its products, including those with food intolerances and allergies. As such, in 2011 it became the first branded baker in the UK to enter into the 'free-from' bread category. The revolutionary move by the business to diversify its offer now means that these groups of consumers can enjoy the same standard of quality and freshness that families across the UK enjoy.

For Warburtons, a bakery is not just about baking. It's about managing the whole supply chain and constantly reviewing it to ensure quality bread reaches retailers' shelves, and thus consumers' plates, as quickly and efficiently as possible. In January 2014, Warburtons introduced new tracking software to allow it to effectively plan deliveries from its 25 sites across the UK to various locations using a fleet of 800 vehicles. The system allows Warburtons to deliver to 20,000 retail outlets across the UK in the least time possible, providing 2.2 million fresh loaves of bread to the public every day. Over the years, the business has also invested in its fleet of vehicles and today it is one of the largest in the UK.

Quality is key and, by establishing long-term relationships with farmers in the UK and Canada over 15 years, Warburtons can ensure the quality of ingredients it uses remains consistently high. It sources all its ingredients to ensure the highest ethical and quality standards and regularly checks and inspects all suppliers.

Alongside quality and choice, Warburtons has taken its duty of care to consumers very seriously from day one. Bread provides a wide range of nutrients and is a nutritious staple as part of the everyday diet. The business helps consumers make informed choices when purchasing products by including full nutritional information on pack. What's more, Warburtons constantly reviews the ingredients it uses. In recent years it made a substantial investment to meet the Government's voluntary salt reduction targets ahead of time, and all products now have salt levels of 0.4g of sodium per 100g or below.

Families have always been, and always will be, at the heart of the Warburtons business and every modification to the bread making process over the last 100 years has been driven by them and for their benefit – 'From our Family to Yours'.

CS3. Canned salmon

In the early 19th Century, it was found that if food was heated to a sufficiently high temperature in an airtight container it would not spoil, although nobody knew exactly why then. By 1813, Bryan Dorkin and John Hall had set up the first commercial canning factory in England, supplying the army. Canning was, however, a primitive technique at the time. Each of the cans was individually handmade from three pieces of iron sheet that had been dipped in molten tin. One piece was curved around to form the body of the can, with separate top and bottom pieces. A skilled worker could make perhaps 6 cans an hour. Today's sophisticated production lines can produce over 1,500 cans a minute. Over the decades, with improved technologies, cans have become much safer and stronger, and better able to preserve the quality and nutrient content of the food. Cans today weigh over 30% less than those produced 20 years ago, using fewer raw materials; they are, of course, eminently recyclable.

Although originally of most interest to the military, by the late 19th Century - with new transport technologies and the opening-up of the Americas - canned goods were widening the food choices of ordinary consumers in Europe. The great salmon fisheries of California, Canada, and later Alaska, were soon exploited, and salmon canneries were established at the mouth of almost every river on the Pacific coast. Huge quantities were exported to Britain, and the Empire, enriching the diet of Victorian households who could not afford fresh salmon. In the 1923 General Election, the Liberals played on canned salmon's image as the people's food. Indeed, Harold Wilson, Labour's prime minister from 1968-1976, may well have been consciously associating himself with this vision when he told the *Observer* in November 1962: 'I don't do much socialising and my tastes are simple. If I had the choice between smoked salmon and tinned salmon, I'd have it tinned' (Coates, 2006). Several companies imported canned salmon and other fish: one of them, established in 1880 in Liverpool by Simpson and Roberts, began selling its products under the *Princes* brand and created *Princes Pure Foods* in 1900.

Princes' canned salmon

Princes operated simply as an importing company until 1946, when it began a process of diversification with its first venture into food manufacturing. Since 1989, it has been a wholly-owned subsidiary of the Mitsubishi Corporation. It is one of the leading companies and brands in the European canned fish market, reflecting its origins.

Most of the canned salmon imported into the UK and the rest of Europe is from Alaska (USA) and British Colombia (Canada) and comes from wild Pacific Salmon. Although there were hundreds of canneries in Alaska and British Columbia in the early 20th Century, there are less than 25 today, owned by 6 main producers.

Alaska restricts the number of licenses it issues for commercial salmon fishing, and is the only state in the USA whose constitution explicitly mandates that all fish shall be utilized, developed, and maintained on a sustainable basis.

Traditional pack canned salmon contains only two ingredients: fresh salmon and salt. The canned salmon includes skin and delicate, edible bones that are rich in calcium and magnesium. Pressure-cooked in the can, they are so soft they can be easily blended into the salmon with a few swishes of a fork, adding extra nutrients and flavour. Pink Salmon has a light colour and mild flavour, while Red (or Sockeye) Salmon has a richer more intense flavour and colour.

The long shelf life of canned foods not only saves on energy that otherwise would be used for refrigeration or freezing foods, but helps reduce food waste as well. For over 100 years they have provided a quick, affordable, healthy option.

CS4. Instant coffee

Coffee is a beverage of choice for many Britons, and the coffee shop has become a fixture on the High Street of most of our towns and cities. In the home, as well as preparing 'real' coffee from ground coffee beans, many kitchens will have at least one jar of instant coffee powder or granules. Today's instant coffees are a 20th Century development. A century ago, however, instant coffees in liquid and powder forms were also available. The Nestlé and Anglo-Swiss Condensed Milk Company, for example, made Nestlé's Milkmaid Brand Café au Lait at its Aylesbury Factory, alongside its condensed milk. Strong black coffee was brewed, mixed with milk and then condensed (M.B., 1918).

Milkmaid Café au Lait was widely promoted during World War I, for its convenience, quality and affordability. An advertisement from 1915, for example, declared that there is 'nothing that is more appreciated in the trenches' (Anon., 1915): 'If you have a friend at the Front, send him a few tins, *and try a tin yourself*. It is most economical - you simply add boiling water to produce, cup by cup, as required, the most delicious coffee, as served in France - no trouble - no waste. A $10^1/_2$d. tin makes from 16 to 20 cups ...'. That would be about £2.75p a tin at 2010 prices using *MeasuringWorth*'s retail price index, or about 15p per cup. Much of the advertising played on the sophisticated tastes of the potential consumer. One from 1919 for example - see below - at the time of the Treaty of Versailles, depicted the American President (Woodrow Wilson), and the French Prime Minister (Georges Benjamin Clemenceau) enjoying a cup of coffee in a smart café.

Nestlé's Nescafé

So how did Café au Lait become Nescafé? In 1929, Louis Dapples, then Nestlé Chairman, was presented with an interesting task by his former employer, the Banque Française et Italienne pour l'Amérique du Sud. Following the Wall Street Crash, and the collapse of coffee prices, the bank had a lot of coffee unsold in warehouses in Brazil. Nestlé was asked whether these stocks could be turned into a 'soluble coffee cube' for sale. Dr Max Morgenthaler, a chemist, joined the company to help its researchers find a solution. After three years they discovered that Café au Lait converted into powder kept its flavour for longer than was the case with a powder made from black coffee. But the Café au Lait powder was not easily soluble, and the milk and sugar caused production challenges. Moreover, the coffee taste and aroma were better preserved in sweetened milk coffee rather than unsweetened. Dr Morgenthaler concluded that the secret of preserving the coffee aroma lay in creating a soluble coffee with a soluble carbohydrate. This was new and went against original thinking. Later he used a specific technique to produce a powder that did this, and presented it to the Nestlé Executive Board as drinkable soluble coffee samples.

On 1 April 1938, the soluble coffee product, named Nescafé, was launched in Switzerland. Nestlé set up a large-scale production line to extract the soluble components from roast and ground coffee beans to produce a new product called Nescafé at its factory in the Swiss town of Orbe. This brand was rolled out in the UK in June 1938 and in the USA in 1939.

In 1952, the Nescafé factory in St Menet, France, produced a new innovation - a product that didn't need added carbohydrates. During the 1960s this was re-launched in glass containers in Europe and Japan to help preserve freshness. And then, in 1965, the brand unveiled another innovation, freeze-dried soluble coffee, Nescafé Gold Blend.

Over the decades Nescafé expanded its soluble coffee range, creating other varieties: Nescafé Decaffeinated; Nescafé Gold Espresso; Nescafé Frappé; Nescafé Cappuccino; and Nescafé Ready-to-Drink. In the 1990s, researchers developed a proprietary self-foaming solution to improve the texture of milk froth, which is now used in Nescafé Cappuccino. Nestlé went further in its innovations with the launch of its Dolce Gusto coffee making machines in Switzerland, Germany and the UK in 2006. These 'coffee shop-at-home' machines can switch from hot to cold drinks. These are sold in individual pods, or capsules, which regulate the pressure that the machine applies, so ensuring coffee shop quality in every cup.

CS5. Frozen chipped potatoes

Potatoes are an important part of the British diet being a valuable source of dietary fibre, particularly in and around the skin, and a significant source of vitamins C (depending on type and method of cooking) and B6. Although we carry less fresh potatoes home, this has been offset by our increased consumption of processed products. Indeed, processed potato products now account for over half the potatoes (raw weight) sold retail or to the catering trades. Crisps are an important part of this; but nearly 40% of *all* potato sales (raw weight) are of frozen or chilled products (Potato Council, 2012). Frozen oven-ready chips, perhaps, epitomise this development: for some critics they are seen as an expensive way to buy potatoes but, in many British kitchens, they are a convenient and versatile food. Given that chip pan fires are responsible for 20% of all accidental household fires dealt with by Fire and Rescue Services[25], it might be claimed that oven-ready chips are safer too! One of the biggest suppliers of oven-ready chips is McCain Foods (GB) Ltd.

McCain's frozen potato products

McCain Foods originated in Canada in 1957, and in the UK in 1968. Its oven ready chips were launched in 1979: previously chips were either prepared at home or deep fried from frozen. It is now the largest chip producer in the world, with almost 33% of the market, operating in 51 locations worldwide. In the UK it works closely with the 300 or so farmers that supply it with potatoes, providing them with seed potatoes and with agronomic advice. In total, it buys about 12% of the national potato crop. It supplies a range of frozen potato products, not just chips, for the retail, fast food, and other catering trades.

Since 2006, all its potato products have been pre-cooked in sunflower rather than palm oil, reducing saturated fats by 70% across its product range. In 2001 it began reducing added salt across its products and has now achieved a 22% reduction: there is none in oven chips. New products have had a healthier profile. Rustic Oven Chips, launched in 2007, have 3% fat (0.5% saturated) and retain the potato skin for added fibre. It was one of the first UK manufacturers to introduce traffic light labelling indicating whether the product has high, medium or low amounts of fat, saturated fat, sugars and salt.

McCain shares the FDF's Five Fold Ambition to send zero food and packaging waste to landfill by 2015. Soil arriving at the plant on the potato is returned to agricultural land or composted. A biogas facility at their Whittlesey factory ferments potato solids contained in wastewater, powering a gas turbine engine to generate electricity.

[25] Fire Service, *Chip Pan Safety Advice*, http://www.fireservice.co.uk/safety/chip-pans

CS6. Fruit juice drinks

Fruit juice is popular with consumers both because of its taste and its health benefits. However, concerns have been expressed about the intake of fruit sugars and, in recent years, this sector has seen no market growth. Consequently, in December 2011, *Tropicana* (owned by PepsiCo UK and Ireland) embarked on an extensive consumer research project among UK consumers. An unpublished study for Tropicana by Millward Brown in 2011 found that 66% of consumers were concerned about the level of sugar in fruit juice: 41% had reduced their juice consumption owing to sugar concerns; and a further 5% had stopped consuming juice altogether for the same reason. This was the background to the launch of Trop50.

Tropicana's Trop50 range of fruit drinks

Tropicana has been blending premium juice for 65 years and has used this expertise to develop Trop50.

Following an initial survey, Tropicana invested in a full consumer research programme to help understand what consumers would find most appealing with regard to sugar and calorie content. Feedback from over 8000 respondents indicated that having both 50% fewer calories and 50% less sugar had the most appeal. This directly led to Trop50's unique '50% less' proposition.

Research had also uncovered the importance of an extract from the naturally-occurring Stevia leaf (the sweetener 'steviol glycosides') - the real innovation behind Trop50 - which consumers said was a reassuring ingredient providing sweetness without the calories (see Section 4.4).

The Trop50 concept was for a blend of Tropicana Pure Premium, not-from-concentrate, juice and water, sweetened with steviol glycosides, but research had indicated that consumers were not prepared to compromise taste for health. Multiple iterations of the product were trialled. Consumer flavour testing helped determine the best range of flavours that would work with the sweetness of the Stevia leaf extract

Trop50 was the UK's first not-from-concentrate reduced calorie and sugar juice drink, with both 50% less sugar and calories than regular juice. It is healthier, and yet still tastes good: each 200ml glass of Trop50 contains all of a consumer's daily vitamin C and contains around 47 calories a glass.

CS7. Snacks with reduced salt content

An important public health message is that most consumers need to limit their salt intake and, as we saw in Chapter 3, the food industry is collaborating with the Government, under the *Public Health Responsibility Deal*, to reduce the salt content of manufactured products. One of the many companies committed to the salt reduction pledge is PepsiCo UK & Ireland, makers of *Walkers* crisps and other savoury snacks.

Walkers crisps and snacks

The major source of sodium in crisps and snack products is common salt (sodium chloride) which has many functions:

- for potato-based crisps, salt is important in the overall flavour profile since it not only adds flavour but also enhances many of the other flavourings used;
- salt also assists in the distribution of other ingredients such as flavours, colours and antioxidants on the surface of the potato crisp;
- in extruded snacks, salt regulates expansion of the product to generate light and crispy texture and is, therefore, an important component in the dough matrix before expansion; and
- during the manufacturing process, salt makes the dough easier to shape as well as creating the characteristic crunchy texture of snacks.

The sodium reduction strategy for crisps and potato snacks was multi-faceted. The first reformulations back in the early 2000s involved reductions in the amount of salt applied directly to savoury snacks. This was quite a challenge as each snack flavour is unique, with significant and sensitive consumer appeal: therefore each seasoning required individual reformulation. Various techniques were employed to replace sodium whilst not reducing consumer acceptability. Examples were: use of alternative food ingredients with flavour enhancing properties; incorporation of salt replacers (e.g. potassium chloride); recipe adjustment; and reductions in the sodium chloride particle size (see Section 4.7).

Between 2003 and 2005 there were reductions of up to 20% in the sodium content of the core range of *Walkers* crisps (Ready Salted, Cheese & Onion and Salt & Vinegar), and then a further reduction of approximately 40% since 2006 across its standard range. Similar reductions of approximately 50% in the salt content of savoury snacks since 2006 have been achieved. Moreover, the amount of saturated fat in *Walkers* crisps and savoury snacks was reduced by 70-80%. By the end of 2012, 94% of *Walkers* crisps and savoury snacks sold met the Public Health Responsibility Deal targets for salt reduction.

CS8. Food for those with swallowing difficulties

Over a million people in the UK have problems chewing and swallowing food (dysphagia), associated with dementia, stroke, cancers, head injury and neurological conditions such as Parkinson's. Mealtimes can be challenging - both for the sufferer and those catering for them. The main condition where dysphagia is prevalent is dementia with 800,000 people in the UK currently having dementia. Some 30% over the age of 65 will develop dementia and, as we know, this age profile is set to rise (Alzheimer's Society, 2013). One company that specialises in supplying this market is apetito Ltd.

apetito's range of texture modified meals for dysphagia sufferers

apetito is a leading provider of prepared meals for care homes, hospitals and local authorities. Through its Wiltshire Farm Foods franchise, it delivers frozen meals, or a daily hot meal, to private homes. Its new range, introduced in January 2010, consists of 77 texture-modified main meals, snacks and hot desserts that cover nationally recognised texture-categories C, D and E. Category C is a thick purée for a dysphagia diet. What is particularly innovative about apetito's Category C range is that while meals are frozen into the shape of a mould, they retain this shape on heating, rather than reverting to a liquidised state. This has been achieved using a complex blend of starches and plant extracts, so that their texture-modified products look like normal meals after cooking. Puréed peas look like peas, while roast beef boasts slices of meat and piped mashed potato to look like the real thing, rather than traditional options resembling baby food or 'dollops' on a plate.

Another pioneering development is nine Category C hot desserts. Previously, dessert options for dysphagia sufferers were limited to mousses and yoghurts, but the introduction of dishes such as Sticky Toffee Pudding, Bakewell Sponge, and Apple Pie were firsts for the industry.

For those with dementia, being presented with food that they can recognise and that engages their senses of taste and smell can help avoid potential confusion that could detract from enjoyment of mealtimes. As unintentional weight loss and dysphagia typically go hand-in-hand, it is especially important for sufferers to receive optimal intake of nutrients and energy. However, if they don't have access to food that looks appetising, has an enticing aroma and tastes good, it is difficult to encourage them to eat. The range caters to all appetites, with all meals and snacks nutrient and calorie-dense, enabling customers to 'Dine with Dignity'.

5. Food quality and safety - meeting consumer and society's needs

5.1 Introduction

The prime motive of the food industry in the UK has been to provide a consistent supply of products to the retail market and, by successfully meeting consumers' needs and wants, to make a return on their investment. As has been demonstrated in Chapter 2, many food companies in the UK have achieved this and have survived, grown and evolved to meet the changing needs of the consumer and the evolving political and economic circumstances.

A major element over the last 100 years has been the evolution of a significant role for the Government and public bodies in the protection of consumers from foods which might be harmful or which might fail to match their expectation of quality - whether their own perception of quality or that defined by the information provided by the seller (for example by labelling or advertising).

In this Chapter we look at the way the UK food industry has been involved in this evolution. We consider how changing circumstances created the need for improved controls on safety and quality, how the industry reacted to the imposition of legislation, how it participated in the process and how it has developed quality systems which, in many cases, far exceed the demands imposed by the legislation.

5.2 1860-1913: Establishing responsibility for food quality: early legal moves

A key incident which is linked to the introduction of food safety legislation was a chemical food poisoning outbreak in Bradford in 1858; 20 people died and about 200 became ill having eaten sweets contaminated with arsenic obtained in error from a pharmacy. Along with other incidents, this led to the start of a modern framework for UK food and drug legislation and the passage of the 1860 Act for Preventing the Adulteration of Food or Drink. This allowed for the use of 'Analysts' (subsequently 'Public Analysts') to determine the purity of food. The chemical and physical examination of foods was at this time rapidly expanding and identifying adulteration was becoming much easier. However, this first Act needed modification to make it more effective. Amongst others, there were significant improvements adopted in 1875 and 1899. Looking back on these developments, on the centenary of the 1860 Act, it was stated that 'as a result of this wonderful pioneer work and of the Food and Drugs Act of 1875 in which many of the earlier legal difficulties had been removed, it may fairly be said that by the early 20th Century the grosser forms of food adulteration had disappeared and the lesser ones were kept under control' (Hamence, 1960).

Another change which can be noted during these early days was that prior to the adoption of the 1860 Act, the food industry had been largely opposed to the imposition of a criminal framework on food production. However, by the start of the 20th Century, many reputable food manufacturers were able to see the benefit of legal controls in that

they reduced the competition from traders who had been able to profit from the sale of adulterated or poor quality foods. The legislation was being seen as providing the responsible food industry with protection and helped to cement their reputation.

Whilst the work of scientists had demonstrated that food adulteration was a significant problem needing control, the resulting legislation also led to some food companies employing their own chemists as analysts as a defensive strategy. The subsequent contribution of these scientists has been well documented by Horrocks (1994). However, as she states: 'Firms soon learnt that chemical expertise had uses beyond the simply defensive need to avoid prosecution'.

By the start of the 20th Century, there had also been progress on understanding the microbiological nature of much food deterioration. The 'germ theory of fermentation' had been demonstrated by Louis Pasteur in 1862 and led to the development of heat treatment processes such as pasteurisation. The connection between microbiological contamination, poor hygiene and product deterioration was understood. However, in the absence of commercial refrigeration processes, the use of chemical preservatives such as formaldehyde and borax was commonplace.

The invention of automatic bottle-making machines in 1910 provided a means to ensure the delivery of milk in hygienic containers which could be sealed easily (Paine, 1960). This led rapidly to the introduction of milk deliveries in reusable glass bottles and the need for chemical preservatives in milk was reduced. Pressure for the introduction of more general controls on preservatives had also been increasing with analysts and medical specialists arguing that consumers were at risk from the use of these chemicals. The level of risk was unclear and it was strongly argued by industry bodies that the preservatives were important for maintaining the supply of food. However, as shown in Box 5.1, initial controls were introduced in 1912 which banned preservatives in milk and cream with a fat content below 35% (Anon, 1912).

Box 5.1. Extracts from the Regulations of Local Government Board: Public Health (Milk and Cream) Regulations 1912

Article III:

(1) No person shall add, or order or permit any other person to add, any preservative substance to milk intended for sale for human consumption.

Article IV:

(1) No person shall add, or order or permit any other person to add –

(a) any thickening substance to cream or prepared cream;

(b) any preservative substance to cream containing less than 35 per cent by weight of milk fat;

(c) to cream containing 35 per cent or more by weight of milk fat, any preservative substance other than –

(i) boric acid, borax or a mixture of these preservative substances, or

(ii) hydrogen peroxide

in any case in which the cream is intended for sale for human consumption.

Source: Anon (1912).

5.3 1913-1938: To regulate or not? That is the question

We therefore enter the century covered by this review with the very first dedicated regulation on additives barely three months old. By 1913 there had been major advances in understanding the scientific basis of food and the links to issues of safety and quality. These advances continued during the next 25 years.

However, first the country was faced with the outbreak of the First World War in 1914. Initially there appeared to be little impact on the food supply situation with imports continuing for about two years. There were difficulties though and, as the supply situation worsened, the Government created a Ministry of Food in 1916. Subsequently in 1917 it established an official 'Food Controller' with overall responsibility for food. Writing about this change, Beveridge (1928) states: 'The whole of the essential supplies imported or home-grown are bought or requisitioned by the Food Controller at fixed prices; the manufacturers, importers, and distributers become in various ways his agents on commission; they handle and distribute at fixed prices or fixed margins of profit under his direction'. Controls remained in place for some time after the end of the war in 1918. Progressively these were lifted and had effectively been removed by 1922.

Using data from the paper by Sally Horrocks (1994), the growing importance of science during the interwar years can be demonstrated. The largest laboratory in the food industry at this time was operated by Lyons which grew from its staff of just 4 in 1919 to 200 in 1939. The work of this central laboratory, led by the Chief Chemist Dr Lampitt, was a combination of scientific investigation and more routine quality control activities for the support of production. As Horrocks (1994) states:

> 'In most companies, chemists began by devoting most of their time to analytical work for control of quality of both raw materials and products. Initially, raw material received the most attention, but this extended to include the development of new analytical techniques and attention to production problems. Gradually, more functions were added, including investigating customer complaints, the examination and imitation of competitors' products, and profitable use of waste materials.'

The important task of maintaining a product's quality and the reputation of a brand was also recognised in this period. Horrocks quotes the example of Crosse and Blackwell's Branston Pickle which had first been sold in 1922. She states that: 'despite recipe changes and the adoption of new production techniques, the intention was to sell a product which appeared unchanged' (Horrocks, 1994).

The application of statistical methods to quality control can also be traced to this period. Walter H. Shewhart is seen as establishing the fundamentals of statistical process control; he was employed near Chicago by the Western Electric Company. He found that there can be natural variation in processes (chance cause) as well as changes due to failures or incorrect operation (assignable cause). By using control charts, he believed it would be possible to identify the likely presence of the second within the expected variation caused

by the first. He proposed this to the company in 1924 and the system is still used around the world to control production lines and bears his name in consequence.

The respective roles of Government and industry were though still a subject for debate. The growth in the numbers of scientists working both with the food industry and for the analytical services of Government (most notably the Public Analysts employed by local authorities) continued to increase the knowledge of the potential harm that might be caused by the consumption of chemicals added to foods. An early investigation into the potential toxicity of preservatives had been conducted by the Local Government Board which established a Departmental Committee in 1899. This did eventually result in the limited legal controls for milk and cream mentioned earlier but there was resistance from both Government and industry for more general controls. The pressure for more extensive regulation continued and the debate came to a head in the early 1920s.

As already mentioned, there had been extensive use of preservatives as a means of preventing food deterioration. Mounting medical evidence indicated that some of these preservatives were potentially harmful to people - formaldehyde was known to be particularly harmful as it also acted on the gut microflora preventing normal digestive processes. A detailed analysis of the arguments put forward at this time has been provided by French and Phillips (2000). The use of refrigerated cold stores had made it possible to store more foods for longer periods without resorting to the use of preservatives. However, major manufacturers claimed that it would be difficult to distribute their products around the country without them. In 1923 the Ministry of Health established a new Departmental Committee to look again at preservatives and also to consider the use of colours. A very detailed analysis of the workings of this Committee has been provided by French and Phillips (2000). Despite suggestions that industry should be involved, the membership of the Committee consisted of scientists and doctors. There was also a suggestion that there should be public meetings but 'both Ministry of Health officials and the food industry preferred closed sessions in order to obtain frank testimony without prompting adverse press comment' (French and Phillips, 2000). It is even recorded that in 1923 'a Ministry of Health official noted that food manufacturers would not attend open sessions, not because they are ashamed of their point of view, but on the ground that the Press are certain to garble their version and to pick out only disquieting items for scare purposes ...' (French and Phillips, 2000).

Although there was strong opposition to controls in some sectors of the food industry, there were some manufacturers who could see benefit in reducing reliance on preservatives. The Committee's report recommended banning the use of salicylic and boric acids and placing limits on the use of sulphur dioxide and benzoic acid and this was carried forward into the resulting regulations in 1925 (Anon, 1925).

The use of colours in food was also causing concern. It is claimed that 'in London around 1900, the addition of yellow colouring to milk was so common that housewives refused to buy uncoloured milk thinking it had been adulterated. The yellow tint was commonly added to prevent detection of skimmed or watered milk' (Deshpande, 2002). Rather than adopting a detailed set of controls similar to that provided for preservatives, the initial

regulation provided for a short list of prohibited colours known to be toxic. This was introduced in 1925 in the same regulations as those for preservatives (Anon, 1925).

During the 1930s there was further agitation for tighter regulation – in this case more generally on the composition of foods. The Government view at this time was that since this was not a health issue, any adulteration or fraud could be dealt with using the general powers of the Sale of Food and Drugs Act. However, in 1933 a Departmental Committee was tasked with investigating the potential role of food standards and sought evidence from a broad range of experts. Although the general industry view was that standards were not needed, one industry expert, Dr Lampitt, the Chief Chemist for Lyons 'suggested that standards could be introduced without raising prices and might be applied to tea, coffee, jam, cream and cheese to protect consumers' (French and Phillips, 2000). The resulting report was cautious, although it did suggest that there should be the legal power to adopt standards. After further delay, there was a consolidation of food and drugs law which led to the passage of the Food and Drugs Act 1938 (Anon, 1938). Although mostly consolidating, the Act gave new wider powers to the Minister of Health to control the composition and labelling of foods (see Box 5.2). Use of these new powers, however, was prevented by the outbreak of the war in 1939 and its provisions were suspended.

Box 5.2. Extract from the Food and Drugs Act 1938

Section 8

(1) The Minister of Health may, subject to the provisions of this section, make regulations for ...

(a) authorising measures to be taken for the prevention of danger to health from the importation, preparation, transport, storage, exposure for sale, and delivery of food of various kinds intended for sale of sold for human consumption;

(b) requiring wrappers or containers enclosing or containing food of various kinds to be labelled or marked in accordance with the regulations;

(c) prohibiting or restricting the addition of any substance to, and regulating generally the composition of, any food.

...

(4) Regulations shall not be made for any of the purposes mentioned in ... paragraph (c) unless they are expressed to be in the opinion of the Minister necessary or expedient for preventing danger to health or loss of nutritive value, or otherwise for protecting purchasers.

Source: Anon (1938).

5.4 1938-1955: Industry and Government working together to maintain the food supply

The outbreak of the Second World War again made it necessary to impose controls on the supply of food (rationing) and to regulate and reorganise manufacturing operations. Although in the first months after the declaration of war in September 1939, the country was still able to import foods, this situation changed more countries were occupied and, later, when Japan entered the war.

An official summary of the wartime circumstances was produced by the Ministry of Food (1946). Not only were there shortages of raw materials but shortages of petrol, transport, packing materials and labour had to be considered. The report also describes how there was a demand for factory space as the growing munitions industry needed more buildings. The food industry was therefore 'concentrated' with food manufacturing operations being transferred to factories which were either more efficient or were located in areas where there was still space. The report mentions that 'in the compound lard industry, for example, 30 out of 40 factories were closed, and in the edible fat melting industry 140 out of 200' (Ministry of Food, 1946). As well as concentrating production, fewer products were manufactured. An example quoted is that 'in the biscuit industry, the number of varieties produced by any one manufacturer was reduced from as many as 350 before the war to only 20'. In some cases, brand names were dropped for the duration of the War – in the soft drinks industry their manufacturers' association agreed to sell products under standardised designations and a similar policy was apparently adopted by margarine manufacturers.

During the War, stringent controls were introduced on most foods. In nearly every case there had been no previous controls and, for the first time, specific compositional and labelling controls were introduced to try to provide an equitable distribution of the limited food supply and to ensure the basic quality of the available foods (see Box 5.3). Strict rationing was introduced to ensure fair distribution, and manufacturers used ingenious means to keep the supply of foods flowing to consumers. It can be noted that the first general food labelling controls were contained in The Labelling of Food Order 1944 (Anon, 1944) which required, subject to exemptions, the provision of a business name and address, a product name and a listing of ingredients. Even when the War was over, supply did not quickly improve. The emergency controls continued for several years.

Box 5.3. Extract from the Ministry of Food publication

The Protection of the Consumer

When in 1941 milk and eggs began to become scarce, so called 'milk substitutes' and 'egg substitutes' appeared on the market. Some of these, though they had little nutritional value, possessed certain of the physical properties of the scarce food (e.g. the raising power of eggs in baking). Others were worthless. To protect the public from such products, a Food Substitutes (Control) Order was made. This prohibited the sale of any product as a substitute for a food, except under licence from the Ministry. In this way, control of the composition, price and description of all substitute foods was enforced.

In 1944, a Defence Regulation was made giving the Ministry of Food power to control the labelling and advertising of foods and, when desirable, to set up standards for foods. Detailed regulations were made prescribing the information to be given on the label and the claims that might be made about the vitamin or mineral content in advertising. Standards were laid down for a number of products such as baking powder, mustard and lard. All these measures helped the housewife in making an intelligent choice from the foods available.

Source: Ministry of Food (1946).

5.5 1955–1990: Developing quality standards in a changing world

As things slowly improved and rationing was relaxed and eventually removed, the food industry once again began to expand its product ranges. However, many of the detailed compositional standards introduced under the emergency powers were retained as it was considered they provided consumers with additional protection which, prior to the War, had not been considered appropriate. Initially these were introduced by amendments to the 1938 Act but eventually a fully updated and consolidated measure was passed as the Food and Drugs Act 1955.

Recognising that circumstances had changed, in 1947 the Minister of Food established a Food Standards Committee (FSC) to offer advice on such matters as the labelling, composition and marketing of foods in order to protect consumers in matters relating to health, nutrition or otherwise. This was initially linked to the Defence (Sale of Food) Regulations but subsequently for more standard food legislation. One task that needed more detailed consideration was the increasing range of additives that the food industry was using, or wished to use. Prior to the Second World War there were, as already described, limited controls on preservatives and colours. In 1951, the FSC appointed a Preservatives Sub-Committee with a remit to consider the Public Health (Preservatives etc., in Food) Regulations and to make recommendations. The first topic they considered was antioxidants since there was some legal uncertainty as to whether these substances were covered by the definition of preservative in the 1925 Regulations. Manufacturers had been avoiding using them although they had been permitted in certain other countries. The Sub-Committee submitted its findings to the FSC which then published the report (FSC, 1954). It was the first of a long series of reviews of the need and safety of food additives. These were largely accepted by Ministers, and implemented into law through a series of specific additive regulations.

From the 1950s into the 1970s, the Ministerial advisory committees became the main mechanism for assessing the need for and recommending the content of food regulations. As their work expanded, the committees evolved. The Preservatives Sub-Committee was renamed a Food Additives and Contaminants Sub-Committee which then, in 1964, was established as a separate entity and named the Food Additives and Contaminants Committee. This, in its turn, had links to a Pharmacological Sub-Committee.

What is important to note is that food industry employees actively served on these committees and contributed to the establishment of an effective regulatory system which protected consumers, but took into account manufacturing constraints - an example was Alan Turner, Chief Scientist at Cadburys, who chaired the FSC for several years. The committees were seen as a way of bringing together expertise from a broad spectrum of 'stakeholders'. The aim was to try to reach a consensus on the appropriate balance between detailed regulation, effective enforcement and industry practice. At this time, the contribution of individuals employed by the industry was seen as valuable and helped ensure that appropriate regard was given to the implications for industry of any possible control. The representation of 'consumers' on these committees was not considered necessary as there were enforcement officers appointed to the committees whose professional role was to ensure that consumers were protected.

An example of the type of issues examined at this time is that of the use of added water in food products such as the incorporation of water into ham and bacon in the 1970s which led to criticism from consumer groups and enforcement officers. The FSC considered the topic in its report on *Water in Food* in 1978 and again in its report on *Meat Products* in 1980. Whilst the specific labelling recommendations in the 1978 report were never implemented, the requirement to label water content on meat products was subsequently introduced in the revised meat products legislation in 1984.

A new dimension was added to the process when the UK joined the EEC in 1973 and started to participate in discussions on food law at an EEC level whilst at the same time incorporating European controls into UK law. At the time of joining, the EEC had already started harmonising standards and the UK, as part of the agreement to gain entry, had accepted most of the existing EEC legal requirements. One example of a significant change was that the EEC had implemented standardised procedures for the inspection of animal products and given a significant responsibility for this work to veterinarians. The UK had established a different system of meat inspection overseen by Environmental Health Officers. On joining, to the annoyance of the meat trade, this had to be replaced by official veterinary inspection. The EEC had also adopted standards for chocolate and related products - in this case the UK (and Ireland and Denmark who also joined in 1973) had been able to negotiate specific exemptions (a 'derogation') allowing the continued production of chocolate containing a small level of non-cocoa vegetable fat in the recipe.

More generally, two related changes in thinking led to a progressive shift in policy towards regulation. Consumers were becoming increasingly inquisitive about food and its components and were expressing concern at the chemicals being used. Also, as the range of products being manufactured increased, the use of rigid compositional standards became harder to maintain and enforce. The solution to these issues was to switch from a system based on compositional standards, to one based on informative labelling.

An example of changing attitudes can be illustrated by the discussions and development of open date marking of foods. The possible introduction of legal requirements to provide an open date mark for consumers was the cause of much debate (Turner, 1995). It was during the 1950s that Marks and Spencer had started to use sell-by date marks in its storerooms (Wright, 2009) but much of industry was opposed to open date marking. A conference speaker went so far as to state: 'You cannot expect to tell the public that an article of food was made on such-and-such a date and is expected to keep for so long; it would not be rational or helpful' (Hughes, 1960). A similar view was taken by the FSC in 1964 when considering whether the date of manufacture, packing or despatch should be indicated on labels they concluded that 'such a requirement is not practical, since so much depends not on the date the product was made but on the quality and freshness of the food from which it was prepared or on the conditions under which it is transported or stored' (FSC, 1964). By 1972, though, there had been a change of view and a subsequent review recommended the introduction of 'sell by' dates for short shelf-life foods (FSC, 1972). This was rapidly implemented by retailers and entered into common usage (and is still frequently mentioned even though it was replaced by 'use by' and 'best before' in a change in the legislation in 1991).

With the agreement by the EEC in 1979 of harmonised food labelling requirements, further changes were introduced. The most significant change for industry and consumers was the comprehensive introduction of full additive listing in ingredients lists. Prior to this, it had been accepted that a simple listing of the additive categories would be adequate for consumers. In addition to requiring the functional name, the new EU requirement was for the provision of the chemical name or the much shorter reference number - the 'E number'. The use of a numbering scheme had been introduced in the 1960s as a classification system in the legislation. Allowing this for labels was considered a helpful device to enable consumers to identify the substance should they be interested but also to demonstrate that it had been subject to toxicological assessment and given official 'European' approval. However, when it started to be used, the coding was seen as an attempt to hide the true nature of the chemicals. Consumer concerns rose rapidly and a bestselling book, *E for Additives,* claimed to provide additional information about the substances, the reasons for their use and, controversially, their possible adverse effects (Hanssen, 1984). Following consumer concern, it did not take long for most manufacturers to switch to providing the full chemical name rather than the E-number code and to consider reformulation to remove non-essential additives from the recipes.

Scientific advances were leading to the food industry increasingly using new chemicals and new processing methods. These were frequently subject to review and led to additional regulations. One such development was the potential for using ionising radiation as a means of extending the life of food. Scientific research was suggesting that this was safe and had potential. Another Government advisory committee, the Advisory Committee on Irradiated and Novel Foods, published a review of the evidence and recommended approving the process (Advisory Committee on Irradiated and Novel Foods, 1986). This was adopted into regulations (Anon, 1990a) but failed to be adopted by industry concerned that consumers, already aware of problems associated with radioactivity following the Chernobyl nuclear accident in 1986, would not be ready to accept the concept. It is worth noting that the relationship between food irradiation and radioactivity is limited to their common origin in nuclear science.

Developments within the European Community (as the EEC had become), were also opening up opportunities for UK food manufacturers. The early policy approach had been to adopt European measures to harmonise and replace national legislation. This approach was slow, and often unsuccessful, as national concepts of food quality varied. However, following a European Court of Justice ruling in the *Cassis de Dijon* case, a change occurred. Now the focus was to limit harmonisation to matters of food safety or control and to require Member States to allow trade in products legally manufactured in another Member State but which might not be legal under their own national rules. This approach, known as 'mutual recognition', was a major element in the 'Internal Market' programme which ran from 1985-1992. This approach, known as 'mutual recognition', was a major element in the 'Internal Market' programme which ran from 1985-1992 and was largely welcomed by UK manufacturers. There was, though, resistance in other Member States which is illustrated by the following extract from the FDF's Annual Report for 1990:

> 'There are still those in the Community who consider that mutual recognition will threaten their economic or political interests and who therefore attempt to undermine it principally through demands for a return to compositional or 'recipe' legislation. FDF has taken every opportunity to resist this approach which would segment markets, restrict new product developments and reduce consumer choice.' (Food and Drink Federation, 1991).

Concerns over the quality of British food rose dramatically when Bovine Spongiform Encephalopathy (BSE) appeared in cattle in 1986. Initially, there was no scientific evidence of a risk to human health. There was speculation, but no actual evidence. At this time, another crisis hit Government when the media became aware that there had been a significant rise in the number of cases of salmonella food poisoning and that a link to the consumption of raw eggs had been established. What was most damaging was that it was apparent Government had been aware of this but had only been discussing with egg producers what action was needed without making the public aware of the problem.

5.6 1990-2013: Crisis management and rebuilding trust in food quality

Although new primary legislation had been under consideration due to an agreement within Europe for enhanced food control arrangements, the Government brought forward a new Food Safety Act to build confidence in the food supply. This was passed in 1990 and remains in place to this day (Anon, 1990b).

From an industry perspective, the Act made two significant changes, both related to the defences available in the event that food failed to comply with legal requirements. One key was with regard to the responsibility of retailers and the resulting consequences were very significant. The former legislation allowed retailers of own-label products to obtain a written warranty from their suppliers indicating that the products were legal. The new Act removed this and required retailers to take more responsibility for the legality of the products sold under their brand. There was, therefore, an increase in the visits and checks performed by the retail technologist on the manufacturer to verify the overall safety and quality of the production. The other change was that a new defence of due diligence was introduced (see Box 5.4). This enabled companies to avoid prosecution if they could demonstrate that they had been applying appropriate controls at the time the food was produced. This required maintaining documentation and a much more systematic approach to quality management than had hitherto been applied.

Box 5.4. Food Safety Act 1990 – the defence of due diligence

Section 21(1)
In any proceedings for an offence under any of the preceding provisions of this Part (in this section referred to as 'the relevant provision'), it shall, subject to subsection (5) below, be a defence for the person charged to prove that he took all reasonable precautions and exercised all due diligence to avoid the commission of the offence by himself or by a person under his control.

Manufacturers now needed to be able to demonstrate a commitment to quality management and started to adopt formal documented approaches. At this time, the British Standards Institution's standard on quality systems, BS5750 (1979) had become important in the engineering industry as a systematic approach to demonstrating effective quality management in a way which could be certified against an official standard. Although not developed for use by the food industry, the concept was slowly applied and adopted with some major food manufacturers (Express Foods Group being one of the first) achieving certification.

With the increasing demands of retailers for manufacturers to comply with their individual company standards, the food manufacturing industry was becoming overwhelmed by competing demands and excessive audits. In response, the retailers developed a new standard under the auspices of the British Retail Consortium (1998). The system of documented quality management systems incorporating third party audits (replacing routine audits by retailers) had begun.

Another major development in the control of food quality had been quietly evolving within major food manufacturers. How could food manufacturers know their products were safe, in particular, that they were not microbiologically contaminated? Microbiologists could clearly demonstrate that testing of products at the end of the production line could not provide sufficient confidence. What was needed was a system to give confidence that the food had been manufactured correctly. Developed by Americans in the early 1970s, the Hazard Analysis Critical Control Point (HACCP) system was steadily adopted by major manufacturers as a systemic approach to the prevention of problems by establishing controls at the points where problems could lead to the production of unsafe foods. Working under the auspices of the Campden Food and Drink Association (better known now as Campden BRI), a group of key industry specialists (including Unilever, Princes Foods, RHM Research, S W Berisford (Food) Ltd and Express Foods) produced an influential guidelines document on the establishment of HACCP (Campden Food and Drink RA, 1987). Major manufacturers successfully applied the system and, in 1995, it was included in updated hygiene legislation (see Box 5.5). This was not immediately welcomed by all as small businesses found it difficult to understand and implement.

As mentioned above, BSE in cattle caused significant concerns amongst consumers and pressure on Government increased. It was in March 1996 that the Minister of Health announced that scientific evidence suggested that a new form of the human Creutzfeld Jakobs disease (CJD) was most likely caused by the consumption of infected beef. Distrust in the Government's management of food safety increased and, when the Labour Party came into power in 1997, their policy was to establish a new independent body to rebuild confidence in the management of the UK's food control system. The passage of the Food Standards Act 1999 (Anon, 1999) established the Food Standards Agency (FSA) as a new non-Ministerial Government department.

Food safety problems were not confined to the UK. A major contamination incident affected many animal products when animal feed contaminated with dioxin was used in

Belgium. Although the impact on the UK was limited, it led to further strengthening of food control systems across the EU. The resulting regulation incorporated modern concepts of risk management and risk assessment (EU Regulation, 2002). The assessment, using scientific evaluation was entrusted to a new EFSA. This Authority now plays a significant role in the development of EU, and hence UK, food law. One major task that it has recently been tackling is the assessment of scientific data linked to health claims for food. Food manufacturers are now required to have these approved, and approval is only granted if the scientific evidence is considered adequate by EFSA.

Box 5.5. HACCP and its implementation

The HACCP system provides an approach to food safety which focuses on the need to prevent hazards arising by ensuring effective control at those points where it is known that a failure to control will put consumers at risk. Put more simply, it prevents problems rather than reacting to them. It is structured around a set of 7 principles ranging from identifying hazards, to identifying the point where control is needed, through to implementing, verifying and documenting the controls.

Following its initial development in America, it rapidly spread to other countries. The international food standards organisation, the Codex Alimentarius Commission, included the HACCP system in updated recommended hygiene standards in 1993 (Codex Alimentarius Commission, 1993). Also in 1993, the EC incorporated 6 of the 7 HACCP principles into updated EU hygiene legislation (EU Directive, 1993). This Directive was implemented into UK law by the 1995 Food Hygiene Regulations. What can be noted here is that the EU version, cognisant of the implications of imposing additional documentation requirements on food businesses, only incorporated the first 6 HACCP principles into the legislation – the final element requiring the process to be documented was excluded. The actual wording of the legal requirement, from Regulation 4(3), is as follows (note that item (d) contains 2 of the 7 principles):

'A proprietor of a food business shall identify any step in the activities of the food business which is critical to ensuring food safety and ensure that adequate safety procedures are identified, implemented, maintained and reviewed on the basis of the following principles -

a) analysis of the potential food hazards in a food business operation;
b) identification of the points in those operations where food hazards may occur;
c) deciding which of the points identified are critical to ensuring food safety ('critical points');
d) identification and implementation of effective control and monitoring procedures at those critical points; and
e) review of the analysis of food hazards, the critical points and the control and monitoring procedures periodically, and whenever the food business's operations change.'

Source: Anon (1995).

The major food manufacturers of today continue to enhance their systems so as to build and maintain consumer confidence. The major companies are now global players and attempt to compete in the UK, within the EU and globally. In the modern competitive market, it is vital to protect a company's reputation for safety and quality. Investment in food quality management systems has been substantial and includes quality assurance, risk assessment and risk management, crisis management, horizon scanning, traceability systems, certification and auditing, allergen controls, and the development of segregated

high-risk production areas. These systems have been largely effective in rebuilding the consumer confidence in the food manufacturers from the low point of 1995.

Whilst clearly seeking to comply with the evolving legal framework, in many cases modern food manufacturing sets quality standards which far exceed the legal minimum. The example of traceability illustrates this. Legislation requires food businesses to have systems to identify their suppliers and their business customers. The actual implementation of modern traceability systems by the UK's major food manufacturers now allows the tracking of raw materials from the farmer through the complete supply chain and eventually to the consumer. A consumer complaint can rapidly be assessed and any similar products rapidly identified and, if necessary, withdrawn.

However, the food supply chain today can be a complex global network and even with sophisticated quality management systems there will always be weak points. The global food industry is made up of many thousands of companies from global players to micro-enterprises. Potential raw materials come from an even larger number of primary producers - farmers, fisheries, chemical manufacturers, packaging suppliers and water companies to list just a few. All these are run by individuals who may, or may not, have an appropriate commitment to safety and quality. Recognising the risk, most manufacturers seek to achieve greater pipeline visibility and will use 'approved suppliers'. However, there will always be opportunities for dishonest dealings and potential fraud. Constant vigilance is required to detect and prevent such fraud and there have been notable failures. The major product recall of processed foods in February 2005 was caused by illegal colours being used to enhance the colour of spices. In February 2013, there were further media headlines and extreme reporting when the presence of horsemeat in beef products was identified. All such incidents lead to additional consumer concerns and emphasise the importance of quality management systems combined with effective monitoring and surveillance. As a result, they lead to adjustments and a refocusing of priorities within food supply chains.

6. Past achievements; future challenges

6.1 Choice, affordability and convenience

The food and drink manufacturing sector continues to play a pivotal role in the food chain, linking the farmer via the distribution and catering trades through to the final consumer. Science and technology, and entrepreneurial skills, have been brought to bear on an industrial scale to tackle the age-old requirements of preserving seasonal food so it could be stored, keeping it safe from spoilage, and preparing palatable meals and snacks that consumers want to eat. With urbanisation, early in time some of these activities had already switched from the farm or cottage to local artisans who supplied the locality, for example, with bread. By the beginning of the 20th Century, however, in Britain at least, increasingly sophisticated food businesses were distributing their processed products across the country, and indeed to the far reaches of the Empire. Although cookery programmes on the television are very popular, and some households still bake their own bread, the reality for most British households is that much of the food and drink they consume has been prepared and packaged to a greater or lesser extent by the food industries. On most occasions, consumers seek to minimise the time spent preparing food in the home. Instead, reliance is placed on the food industry to supply convenience and understandably consumers want to know what it is they are buying and eating and how it was produced. They want to be assured that it is safe to eat; they need to be advised on how best it might be combined into a healthy diet; and parents want to ensure that they are not wasting money, but feeding their children nutritious and healthy food.

Food, for most British households, is more *affordable* now than it was 100 years ago. In part this is because of the overall rise in living standards, largely eradicating the grinding poverty that a significant part of the population once experienced (although a number of British families are reliant on food banks in the 2010s). Productivity improvements in agriculture, food manufacture and distribution, have largely kept pace with a massively expanded world population, which has increasingly adopted a western diet based on land-hungry livestock products. Whilst the food security of a wealthy country like the UK is not currently threatened, *globally* the food security of millions of marginalised households remains dire, and this is one of a complex of challenges that mankind faces as we progress through the 21st Century.

We now have greater *choice* over the foods we buy and consume, although choice is a multifaceted concept that requires some qualification. The revolution in transport and food preservation techniques has undoubtedly widened the range of food products available to British consumers. In 1913, canned fish and meats were already available to working families, at competitive prices. In Chapter 2, we mentioned frozen peas as an emblematic product that significantly changed the seasonality and range of vegetables from which we can compose our meals. The growth of global sourcing has also opened up a much larger range of ingredients and opportunities for manufacturers and consumers. But it might be protested that the emergence of large, industrial food processing concerns led to the disappearance of thousands of artisanal producers, thus reducing the range of individualistic products available. However, this multiplicity of products offered by local

producers gave the consumer very little effective choice: the number of bakers the shopper could frequent, for example, was severely constrained before the advent of mass transport.

Manufacturers eager to expand their market share, and capitalise on the image of their brand, offer another variant of choice in a proliferation of range extensions, copy-cat products, pack sizes, recipe variations, and the like: Heinz in the USA was marketing its products on the slogan *57 varieties* before the end of the 19th Century after all[26]. Whilst cynics might suggest that some of this 'choice' is more apparent than real, it is undoubtedly true that in most product categories the one-size-fits-all approach does not prevail. The supermarket revolution, and more latterly the growth in grocery sales through on-line shopping, has further expanded this concept of choice, for a modern superstore can stock many thousands of product lines, far in excess of what would be available in a local store. With the internet, a seemingly limitless range of products is available at the touch of our fingertips. But this concept of choice also needs qualification because, in addition to its own-label product, the superstore is unlikely to stock more than two leading brands, leaving the third ranking brand (and new entrants to the industry) struggling to obtain shelf-space from where they can attract the consumer's attention. Moreover, we should perhaps note that this concept of choice might be severely constrained for those on a tight budget, with no easy access to a large store, and struggling to feed a family with limited storage and cooking facilities.

The food and drink manufacturing industry also offers *convenience*. Products might be ready to eat, pre-assembled and ready for cooking, or only require heating. The range of raw materials and technologies the industry can access is far greater than that available to any household, greatly reducing the amount of time and effort that the individual would need to expend to produce a comparable product. This allows us to reduce the amount of time we spend preparing everyday food (if that is what we wish) and expands our range of food choices, as discussed above.

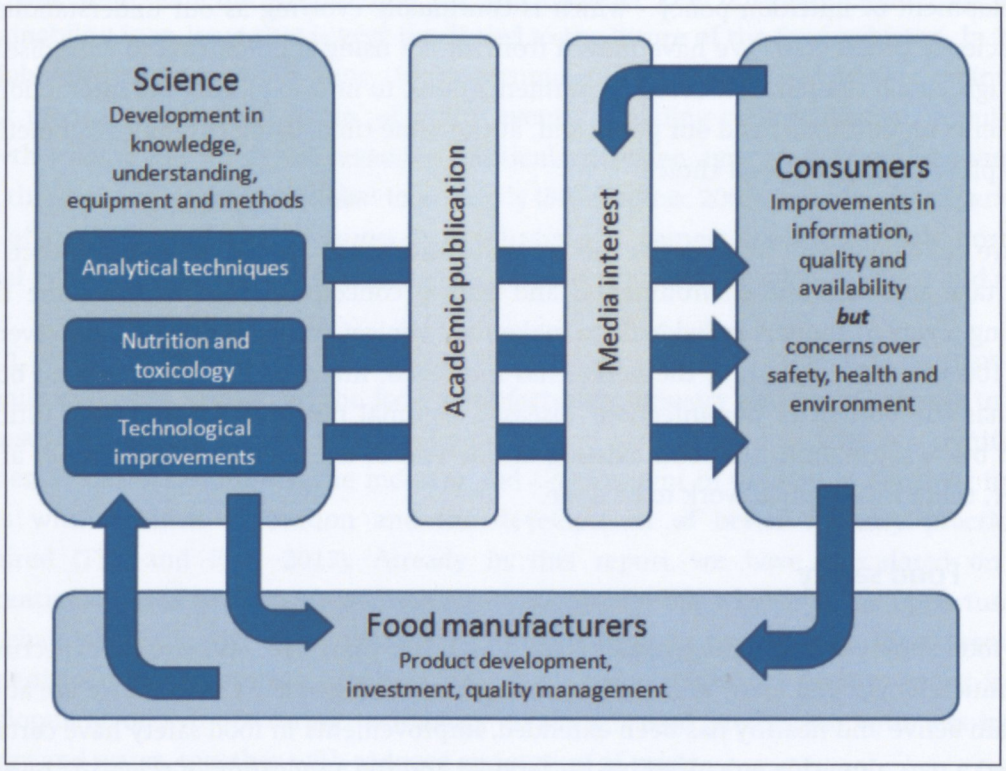
6.2 Developments in science

We have shown how the food industry has changed over the last 100 years. This is largely down to the huge advance in scientific knowledge and the application of that knowledge to develop technological solutions to problems. We have illustrated this by examples from analytical chemistry, from our understanding of micronutrients, from the development of food additives and an awareness of the range and toxicity of chemicals, to the role of genetics in both human nutrition and in modern plant breeding programmes.

Without the application of scientific knowledge, much of what has been achieved over the last 100 years would not have come about. There has, however, been a complex relationship between scientific advance and consumer perception of the safety and quality of the food supply which is illustrated in Figure 6.1 below.

[26] Apparently Henry Heinz coined the slogan in 1896 when the company was already manufacturing more than 60 products: http://www.heinz.com/our-company/press-room/trivia.aspx, last accessed 5 February 2014.

Figure 6.1. The inter-relationships between science, food manufacturers and consumers.



Publication of research results in the media can result in a wider dissemination providing consumers with an enhanced awareness of the characteristics of safe and wholesome food. It does, however, also lead to a greater awareness of the potential risks that foods pose. Whilst the industry might argue that in many cases the risks are small, the public perception is often that they are much greater. We sometimes think that the modern media is to blame but, as described in Chapter 5, even in the 1920s the industry was concerned about the manner in which the media might report a food story. The food industry does make direct use of the scientific advances in the products that it manufactures and the technology it uses to produce these foods. However, in a marketing-driven economy, the consumer has the ability to choose the products which match their requirements. Manufacturers will only prosper if they respond to these varied requirements. Scientists may consider that, based on our current knowledge, many food additives are safe and that GM foods pose no risk to human health. If consumers are doubtful, then manufacturers respond by removing additives and avoiding the use of GM ingredients. This then drives further research and the allocation of resource in a continuing effort to more deeply understand the nature of food components and their impact on human health.

6.3 Health/nutrition

The last 100 years has seen nutrition grow into an established science, with the UK at the forefront of research. At the turn of the 20th Century, the focus was on curing deficiency diseases, which led to the era of exploration of micronutrients (vitamins and minerals). The golden age of animal nutrition sowed the seeds for our understanding of macronutrient nutrition (fat, proteins and carbohydrates). The development of

epidemiology allowed scientists to examine diet-disease interactions, leading to the development of nutrition policy - which is continually evolving as our understanding of the science progresses. We have moved from an era using supplements to cure diseases, through blanket population based recommendations, to now exploring the interactions of nutrients on our brains and our genes and, at the same time, using psychological methods to explore reasons for food choice.

Future challenges will be to derive dietary guidelines underpinned by sound science that also take into account environmental and ethical concerns, whilst at the same time, finding a way to support individuals to make food choices consistent with them. Over the last 100 years, the health of the nation has improved, life expectancy has grown, but so too has the burden of non-infectious diseases. Optimal nutrition for all is the ultimate goal: but with malnutrition still existing at one end of the spectrum and obesity at the other, there is still much work to be done.

6.4 Food safety

Our food supply is undoubtedly safer than it was 100 years ago. We are all expecting to live much longer and many are. Retirement ages are rising as the time that we are able to remain active and healthy has been extended. Improvements in food safety have certainly played a part alongside enhanced health services and the application of scientific research to the control and eradication of disease.

The gross adulteration that had been pervasive in the 19th Century was being tackled 100 years ago and this has continued. Better control of food hygiene and the application of systematic quality management systems has created a food supply system that is vastly improved on what was provided to our grandparents and their parents. The ingredients that are used are regulated so that substances which show potential for harm are not permitted - at the start of the 20th Century, the need for such controls was still questioned.

Most of the food manufacturing industry recognises its responsibility to deliver safe food to the consumers - its customers. It has been deeply committed to supporting the development of an effective legislative control system whilst ensuring that its own internal controls meet, and often exceed, those requirements. As availability and choice have improved, customers have become more demanding about the various quality attributes of the foods they buy. Safety is regarded as fundamental. Consumers' perception of the level of risk does however vary and markets have been created in response: the growth of organic foods is a good example of this, as is the move to more 'natural' ingredients.

6.5 Sustainability and future challenges for the food industry of the 21st Century

There are conflicting opinions about the scope of the term 'sustainability'. In general terms, sustainability implies the use of natural resources, including water and fossil fuels,

at a rate that does not exceed that at which nature can replenish them. As such, sustainability is an issue that is very much tied to the future of the food industry. In 2009, Sir John Beddington, at the time the Government's Chief Scientific Adviser, painted a bleak picture of a 'perfect storm' of future events, including climate change, population growth leading to shortage of resources, particularly water, agricultural land and energy, that threaten the security of global food supply (Beddington, 2009). We already experience one of the effects of the pressures on food security, namely the increasingly unstable global price of food commodities, particularly protein-rich staples such as wheat and rice.

Much of the focus of ensuring a sustainable future supply of food has been on the agricultural sector. However, the food manufacturing industry also has a key role to play to ensure a safe, secure and healthy supply of food for the future. This is a significant challenge and has prompted the industry and Government in tandem to consider future areas within which innovation and the development of better industry practice is required (TSB and FDF, 2013). Already in this report we have speculated on the contentious role of GM food in addressing sustainability, but what of other opportunities and challenges? Clearly, there needs to be a major focus in developing a more resource-efficient food manufacturing supply chain, which encompasses the need to invest in the development of manufacturing technology to sustain food production with less use of energy and water, together with reduced generation of waste.

Despite the greater choice that comes from a global food supply system, there have been concerns that transporting food ingredients and manufactured foods around the world is no longer sustainable or may become so in the near future. There are though, valid reasons why some crops can be grown efficiently in one part of the world and transported for processing elsewhere. Economic factors are likely to dictate whether, or for how long, these practices continue. Increased transport costs may lead to a reduction in consumer choice; but improved preservation techniques could make cheaper (but slower) transport feasible. The balance between locally grown crops with local processing and efficient large-scale manufacturing with a global supply chain may shift, but a dynamic food industry will, no doubt, respond to the changed circumstances. Similar issues arise with products of animal origin, but here there are additional concerns over both animal welfare and the use of protein feeds for animals.

There are several key areas of research and development that could help in the development of sustainable food production, particularly waste minimisation, reduction in energy and water usage and exploitation of novel ingredients. Waste minimisation may be achievable through development of improved food packaging (including use of novel smart polymer materials that are responsive to environmental stimuli and materials from renewable sources) and processes for extension of product shelf-life, strategies for recycling of waste materials, and identification of methods for converting waste streams into valuable commodities. Greater efficiency, or significant reductions in the requirement for water and energy in food processing operations, including water recovery and the use of minimally refined ingredients, will require development of new process engineering approaches to food manufacture.

These are, of course, only a small selection of the areas where advances and innovations in science and technology are needed. As this report has illustrated, the UK food industry has demonstrated throughout its history an ability to adapt, change and innovate according to significant global events and challenges. No doubt these qualities will remain vital to the success of the UK food industry and in meeting consumers' interests.

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