Food and health:

A report on research and development activity in the United States, European Commission and the United Kingdom

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Research team

Katy Cooper
Ioannis Hodges-Mameltzis

Scientific writer

Allison Thorpe

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Executive summary

The relationship between food and health is complex. Food can both support good human health and enhance health potential, and yet can also be a key factor influencing ill health.

Great progress has been made in describing some of the inter-relationships between health, nutrition and social context. Malnutrition – both over- and under-consumption, and lack of access to basic nutrients – remains a key risk factor in the fight to improve the health and wellbeing of the global population. In some parts of the world, food insecurity remains the greatest threat – but increasingly there is concern about the impact of nutrition on the epidemic of chronic non-communicable diseases (NCDs). Today, more than 60% of global deaths can be attributed to NCDs; 80% of these deaths are in low- and middle-income countries.

Food and nutrition remain key modifiable risk factors in this epidemic, and basic and applied research into human nutrition and food products are central in shaping an effective strategic policy response to it. But this response needs to be based on the best available, up-to-date and sound research evidence.

The following report provides an insight into the current research agenda for food and health related research, through an exploration of the budgetary data on research and development (R&D) within the United States, the European Commission and the United Kingdom.

Key findings include:

- the lack of a working definition of 'food' in most financial and research strategy reports;
- navigation of the funding landscape is made more difficult by the lack of coherent systems and databases on annual R&D expenditure for food and health;
- difficulties in making year-on-year comparisons between agencies was often compounded by a lack of distinction between current (unadjusted) figures and constant (adjusted for inflation) figures within reported data by some agencies;
- the lack of transparency of data on funding allocations. Many of the systems did not differentiate between prevention, treatment and basic research;
- a fragmented and complex funding environment, with an apparent lack of an over-arching strategic framework governing research allocations; and
- evidence of under-investment in this critical area of research.

This report is not intended to be, and should not be seen as, a definitive statement on the state of investment in this arena. Rather, it is the beginning of a dialogue that C3 Collaborating for Health hopes will support efforts to improve the strategic approach to investment, and make it more transparent. In turn, this will support the development of an enabling environment for future innovation and progress within the field of food and health research.

Abbreviations

ARS	Agricultural Research Service
BBSRC	Biotechnology and Biological Sciences Research Council
BIS	Department of Business, Innovation and Skills
CBO	Congressional Budget Office
CDC	Centers for Disease Control and Prevention
CFSAN	Centre for Food Safety and Applied Nutrition
CIIA	Confederation of the food and drink industry of the EU
CORDIS	Community Research and Development Information Service
DARD	Department of Agriculture and Rural Development [Northern Ireland]
Defra	Department for the Environment, Food and Rural Affairs
DFID	Department for International Development
DH	Department of Health
DHHS	Department of Health and Human Services
DNRC	Division of Nutrition Research Co-ordination
EEA	European Economic Area
EC	European Commission
EPSRC	Engineering and Physical Sciences Research Council
ESRC	Economic and Social Research Council
EU	European Union
FAHRE	Food and Health Research in Europe
FDA	Food and Drug Administration
FP7	European Commission Seventh Framework Programme
FSA	Food Standards Agency
FY	fiscal year
HNRIM	Human Nutrition Research Information Management system
MRC	Medical Research Council
NIH	National Institutes of Health
NCD	non-communicable disease
NCI	National Cancer Institute
NERC	National Environment Research Council
NHLBI	National Heart, Lung and Blood Institute
NIDDK	National Institute of Diabetes and Digestive and Kidney Diseases
NINDS	National Institute of Neurological Disorders and Stroke
ODS	Office of Dietary Supplements
RCDC	Research, Condition and Disease Categorisation reports
RePORT	Research Portfolio Online Reporting Tools
USDA	United States Department of Agriculture
WHO	World Health Organization

Introduction

Around 2,500 years ago, Hippocrates suggested *Let food by thy medicine, and medicine be thy food'* – but the relationship between food and health is more complex than this quote would suggest. Food can both support human health and enhance health potential, and yet also be a significant risk factor influencing ill health.

In many parts of the world, access to food and good nutrition is scarce. Approximately 1 billion people, the majority of whom live in developing countries, are plagued by under nutrition and food insecurity.[1] Easy-to-remedy nutritional deficiencies are one of the factors responsible for ensuring that 1 in 38 newborns living in low-income countries will never reach their fifth birthdays.[2] Yet conversely, worldwide, overweight and obesity cause more deaths than underweight.

According to World Health Organization (WHO) data, 1.5 billion people over the age of 20 were overweight in 2008, with more than 200 million men and 300 million women obese. By 2015, this figure is projected to rise to 2.3 billion adults who will be overweight and more than 700 million who will be obese. Nearly 43 million children under the age of five were overweight globally in 2010.[3] The global risk of overweight and obesity and its health consequences is a serious concern. It is one of the leading risk factors for non-communicable diseases (NCDs), causing 4.8% of global deaths, with 44% of the diabetes burden, 23% of the ischaemic heart disease burden and 7–41% of certain cancer burdens attributable to overweight and obesity.

The links between NCDs and nutrition are not restricted to over-consumption. Insufficient intake of fruit and vegetables is estimated to cause around 14% of gastrointestinal cancer deaths, about 11% of ischaemic heart disease deaths and about 9% of stroke deaths worldwide,[2] and overconsumption of sodium (salt) is a major cause of hypertension. NCDs are a leading threat to human health, responsible for 60% of the world's mortality[4] and, contrary to popular perception, 80% of these deaths are in low- and middle-income countries.[5]

Food and nutrition are modifiable risk factors. There is an increasing push in many countries, reflected in the actions of some food companies, to reduce consumption of saturated fat, sugar and salt. This can be achieved by switching to healthier products, and also by reformulating existing products. Functional foods[1] can offer benefits beyond basic nutrition, offering opportunities to reduce disease risk and maximise health with minimal professional involvement.[6] Enrichment of foods, such as through the addition of folic acid, has been successfully carried out for many years, with beneficial health impact.[7, 8] However, despite the increasing popularity of such approaches, there remain gaps in our understanding of the evidence around such foods,[9] and we know little about the long-term effects and interactions between such foods and the drugs that are developed to address the same targets.[10] A strategic and coherent approach to research is essential to address these fundamental challenges, and implement a sound evidence-based approach to a pressing public-health problem.

Research has already made a key contribution to the understanding of the complex relationship between nutrition and health. But, as the statistics so vividly demonstrate, there is no room for complacency. A strategic research agenda is essential to ensure that public-health policy to address these significant challenges is informed by the most relevant, up-to-date and sound research possible.

[1] The US Agricultural Research Service definition of functional food is food 'designed to have physiological benefits and/or reduce the risk of chronic disease beyond basic nutritional functions, and may be similar in appearance to conventional food and consumed as part of a regular diet' .

This report summarises the findings of a research project that aimed to provide an insight into publically funded research and development investment in the United States, Europe, and in particular the European Commission (EC) Seventh Framework Programme (FP7) and the United Kingdom (UK). It summarises the findings of Phase 1 of the project, which focused on the UK, and identified **significant underinvestment** in this critical area of research,[11] and provides feedback from Phase 2 of the project, which extended the analysis to cover the USA and the EC FP7. The report provides an insight into the **complex funding landscape** for food-and-health-related research, suggesting that this hinders effective and comprehensive analysis of activity within this critical area. **A transparent and co-ordinated research agenda is an essential element of effective prevention and control.**[5] However, as this report demonstrates, for this critical area of research, navigating the funding landscape can be a significant hurdle. Funding allocations are challenging to identify, often spread across multiple departments and databases, with some duplication of activity, and robust information on current research trends globally is obscured by **lack of common terminology**. In order to guide the future of research at the interface between food and health, a more transparent picture of how funding is allocated by governments is essential.

This report is not intended to be, and should not be seen as, a definitive statement on the state of investment in this arena. Rather, it is the beginning of a dialogue that C3 hopes will support efforts to improve the strategic approach to investment, and make it more transparent. In turn, this will support the development of an enabling environment for future innovation and progress within the field of food and health research.

Purpose of the report

This report aims to:

- provide an insight into the landscape for public spending in the United States, Europe, and in particular the European Commission FP7 and the United Kingdom on food and health research and development;
- examine and compare R&D expenditure on 'functional food'; and
- review major journals and conferences on obesity to provide an insight into the relative balance between treatment and prevention.

Whilst recognising that industry is increasingly a major funder of research and development in this area, this area has not been considered within this report.

Geographical profile

The project focused on the USA, Europe, and in particular the EC FP7, and in particular the work of the European Commission, and the UK.

Methodology

This project was designed primarily to bring an insight into the funding landscape for food and health research. The methodology utilised was based on accessing publically available data, supplemented by bringing together existing knowledge and expertise from key opinion formers. It has utilised a variety of sources for the data presented within the report, including:

- email/face-to-face interviews with leading researchers and others, to refine the parameters of the project and to draw up lists of relevant statistics, sources and current knowledge;
- email/face-to-face interviews and internet searches to identify national agencies undertaking research and development activities within the field of food and nutrition research;

- desk research to identify the key statistics on, recipients of and stakeholders in research on food composition and other aspects of research into preventing/treating the diseases resulting from poor nutrition;
- data was collected through the review of publically available data on the online databases, budget summaries and financial reports identified through the desk research and by the interviews. The FP7 data presented in this report is based on budgets, while the US data utilised was specifically focused on disbursements/commitments (for an overview of the databases mined, see Annex A);
- where necessary, emails were sent to funding agencies to clarify the data collected, however as not all agencies have as yet responded, there should be some caution in interpreting data[2]; and
- desk research, using keywords, to identify relevant conferences and journal articles on obesity, to provide an insight into the balance between treatment and prevention in research, as evidenced by abstracts.

Limitations

Identifying funding allocations by topic area and financial year proved to be a complex process. Up-to-date budget data was not always publicly available and, where data was available, the categories used to classify funding were not consistent across funding agencies, and the ways in which data was reported was not always consistent. In effect, this means that it has not been possible to do a robust, year-on-year comparison of funding across agencies.

Additional common challenges across databases included use of inconsistent terminology, limited (and often overlapping) pre-set categories provided to interrogate databases, and a failure to distinguish between treatment and prevention as the overall focus of research.

[2] For example, the NIH's RePORT system makes a distinction between current (unadjusted) versus constant (adjusted for inflation) dollars within its own reported data; other agencies do not particularly make this distinction.

Results

Aim 1: Insights into the funding landscape

In general terms, relevant investment fell into five categories: Medical/human health; prevention; nutrition; food; and food and human health. Table 1 provides an insight into the expenditure across the areas considered by this study, within these five categories. The data given is for FY 2010, unless otherwise stated.

	US	**EC FP7**	**UK**
Medical/human health research	$31.2 billion (NIH)	€857 million[3] [≈ $1.2b]	£1.7 billion [≈ $2.7b] (MRC/NIHR FY 2010)[12]
Prevention research	$6 billion (NIH)	€88 million [≈ $124m] (FY 2008); €64 million[4] [≈ $90m] (FY 2009)	£10 million [≈ $16m] over 5 years (NPRI)[13]
Nutrition research	$1.44 billion (NIH)	*	*[5]
Food research	$1.275 billion (USDA)	€1.9 billion[6] [≈ $2.7b]	£415 million [≈ $664m] (FY 08/09) £408 million [≈ $653m] (FY 07/08)
Food and human health research	$86 million (USDA/ARS)	*[7]	£17 million [≈ $27m] (MRC)

Table 1: Comparison table of research spending on food/health research (annual expenditure)

Where possible, data for multiple years has been included, demonstrating a slight overall year on year increase in relevant research funding. However, a key factor limiting robust interpretation of the data was the lack of clarity around whether figures have been adjusted for inflation. Data from the NIH RePORT system was explicit in stating that their figures were adjusted – the EC data did not make this distinction. Therefore, whilst this increase is evident in the absolute figures, caution must

[3] The FP 7 budget as reported by the European Commission is reported for the entire funding period (2007–13). The estimates presented in Table 1 were calculated by dividing the stated figures (i.e. €6 billion for medical/human health research) by 7.

[4] Prevention research was based on expenditure for 'public health' research for FP7 programmes.

[5] MRC Human Nutrition Research has been consulted for a budgetary breakdown of its activities.

[6] Based on 'Food, Agriculture and Fisheries, and Biotechnology' research theme of FP7.

[7] 'Farm to fork: Food, health and well being' is an area within the FP7s' 'Food, Agriculture and Fisheries, and Biotechnology' priority which includes 'Nutrition, diet-related diseases and disorders, including obesity and allergies; b] Health benefits of certain food and diets; and c] Innovative food and feed processing technologies, including packaging.' FP7 has been contacted to request a budget breakdown (by fiscal year).

be taken in interpreting this as evidence of increased investment, as the increase may not reflect an increase in real terms, if no control has been made for inflation and other external factors.

Investment in research on food and health was generally split across a number of divisions and departments, with research funded in the health, agricultural and food sectors (Table 2). Our research did not find any evidence of an explicit co-ordinating framework across these divisions/agencies, suggesting that within countries research direction may be autonomous within each division/agency rather than reflecting an overarching strategic vision across the landscape. Table 2 provides an overview of the country-specific agencies identified for inclusion within the project. A more detailed consideration of the reported spend by organisation is provided within the country-specific sections of this report.

Table 2: Overview of funding agencies included within the project

Funding agency[8]	**Sources of information**	**Reported spend by FY**
United States		
National Institutes of Health (NIH)[9]	RePORT (Research Portfolio Online Reporting Tool)	RePORT system: currently showing four projects on functional foods ($1,033,920); FY 2009 showed eight studies ($2 million); between 2000 and 2010, 27 projects identified, value estimated at $4,568,153.
	RCDC (Research, Condition and Disease Categorisation reports)	RCDC system: Funding for categories associated with food and health including nutrition increases from $1b to $1.435b from FY 2006–10.
	HNRIM (Human Nutrition Research Information Management system)	HNRIM system: growth from FY 1993–2002 from $373m to $917m. No data available after this date.
	Office of Dietary Supplements data	ODS system: budget of $29m for FY 2010, $21.7m of which was directly awarded to research projects.
Centers for Disease Control and Prevention (CDC)	2009 budget data from CDC	Total budget for 'nutrition, physical activity and obesity' – $40,590,000. FY 2010 request included $26,942,000 for food safety, and $62,780,000 for school health

[8] A brief overview of the funding agencies, and the relevant databases, is appended at Annex A.

[9] Some of the projects may be appearing on more than one system, and could be double counted; hence, direct comparison is not appropriate.

United States Department of Agriculture (USDA)	Agricultural Research Service (ARS) budget summaries	FY 2010 and FY 2011 – human nutrition research expenditure of $80m Proposed increase for FY 2011 of $6.4m for research on children's nutrition and health Basic research for the Human Nutrition Program in FY2010 received $10 million more than applied research
Food and Drug Administration (FDA)	Budget summaries for FY 08 for the FDA, Center for Food Safety and Applied Nutrition (CFSAN), the Joint Institute for Food Safety and Applied Nutrition, and the National Centre for Food Safety and Technology	FY 2010 – requested a budget of $3.2b, largely dedicated to food safety and inspection
Europe		
European Union	Eurostat Food and Health Research in Europe (FAHRE)	The Europe 2020 strategy calls for 3% of GDP to be invested in research. This is an overall call, not split by topic area
European Commission (Seventh Framework Programme)	Community Research and Development Information Service (CORDIS)	Overall budget of FP7 is circa €50.5b, of which €6b is annotated for health, €1.9b for food, agriculture, fisheries and technology. For FY 2011 the budget for health R&D is estimated at €682m
United Kingdom		
Department of Health (DH)(England)	UK Cross-Government Food Research and Innovation Strategy	The DH is responsible for the health of the population **in England only**. In both FYs 2007/8 and 2008/9 the total reported research spend on food-related projects was £9.27m
Department of Agriculture and Rural Development (DARD) (N. Ireland)	UK Cross-Government Food Research and Innovation Strategy	DARD is responsible for research into agri-food in Northern Ireland. In both FYs 2007/8 and 2008/9 the total reported research spend on food-related projects was £3.25m

Scottish Government	UK Cross-Government Food Research and Innovation Strategy	In FY 2007/8 the Scottish Government spend £52.23m. In FY 2008/9 the figure fell to £49.97m
Department for the Environment, Food and Rural Affairs (Defra)	UK Cross-Government Food Research and Innovation Strategy	Defra is the lead department responsible for agriculture and food. In FY 2007/8 Defra spent £66.9m on food-related research. In 2008/9 this fell to £66.42m.
Medical Research Council (MRC)	UK Cross-Government Food Research and Innovation Strategy	The MRC covers research into human nutritional requirements and the effects of food on health and disease. In FY 2007/8 and 2008/9 the MRC spent £17.3m
Biotechnology and Biological Sciences Research Council (BBSRC)	UK Cross-Government Food Research and Innovation Strategy	The BBSRC has a wide remit in relation to food, and is the research council with primary responsibility for agriculture and food. In FY 2007/8 it spent £184.50m. In 2008/9 this rose to £188.91m

Overview of spending by country and agency

1. US government expenditure on food research

Government spending in the United States is split across a number of departments: The NIH, the Office of Dietary Supplements (ODS), the CDC, the US Department of Agriculture and the FDA. The research team was unable to identify a single source to access comparative data across the funding agencies, and investigations suggested there was no shared definition of 'food' to guide identification of research and development spend and areas of activity.

National Institutes of Health (NIH)

Growing interest in nutritional research can be traced though government expenditure data presented on the DNRC's Human Nutrition Research Information Management System. Since 1993, there has been an increase in NIH funding for nutrition research and training funding from $373 million in FY 1993 to $917 million in FY 2002.[10]

This year-on-year growth appears to have been sustained in recent years, although further information would be needed to ensure that this increase reflects substantial real increases, or is just in line with inflation (Figure 1). Using the RCDC system, which has 218 pre-set categories,[11] provided an insight into the changes in funding disbursements for specific categories during the five-year period from 2006 to 2010. Whilst this demonstrated an absolute increase in funding over the study

[10] The report is available at http://hnrim.nih.gov/Report/Nih02_1rpt.pdf.

[11] Food was not a possible category.

period, there were a number of caveats to the data. In particular, it should be noted that the system allows individual research projects potentially to be included in multiple categories.

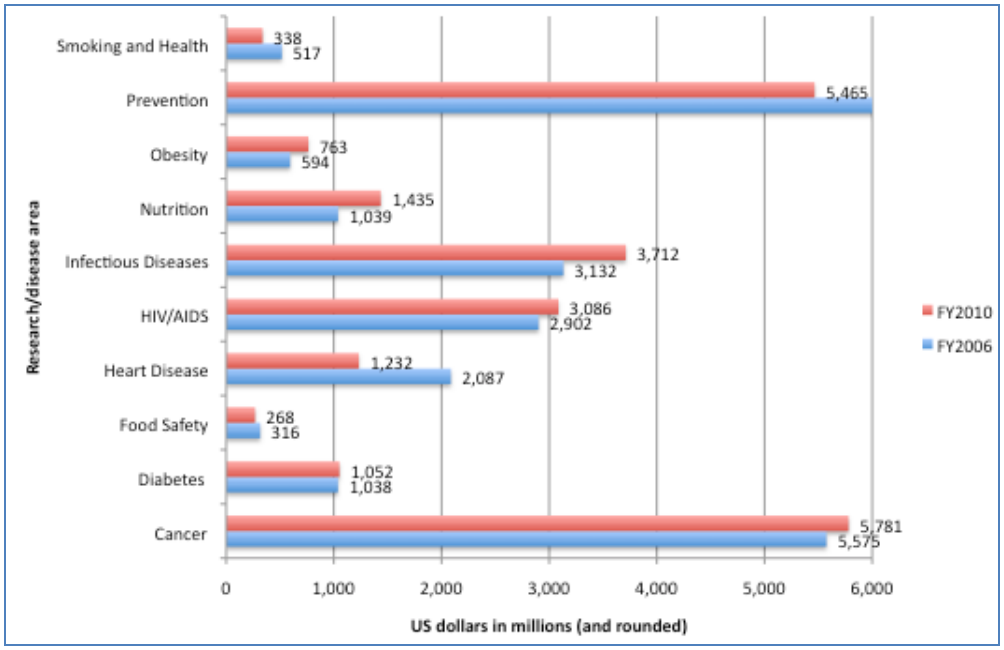

Figure1: NIH spending for fiscal years 2006 and 2010 on RCDC categories, selected for relevance to food and/or NCDs (HIV and infectious diseases were included for comparison)

The data showed that funding had increased from just over $1 billion to **$1.435 billion** from FY 2006 to 2010. However, it is noteworthy that, although there was a general increase in funding for most categories, a decrease in spending on prevention could be observed.

To get a better understanding of the types of projects which were being funded, the research team used the online RePORTER tool to investigate the breakdown of NIH funded projects by institute, using the categories of 'prevention', 'infectious diseases' and 'gene therapy'[12] (Figure 2 a–e). This showed that institutes tend to take a lead role, with different agencies focusing on different areas of research. For example:

- the National Institute of Diabetes and Digestive and Kidney Diseases [NIDDK] funded the majority of resources projects in nutrition (Figure 2a);
- the National Cancer Institute [NCI] and the National Heart, Lung and Blood Institute [NHLBI] funded the majority of prevention research (Figure 2b);
- the NCI funded the majority of gene research, followed by the National Institute of Neurological disorders and Stroke (NINDS).

[Continues on p. 15, after Figure 2a–e]

[12] As a substitute category for treatment.

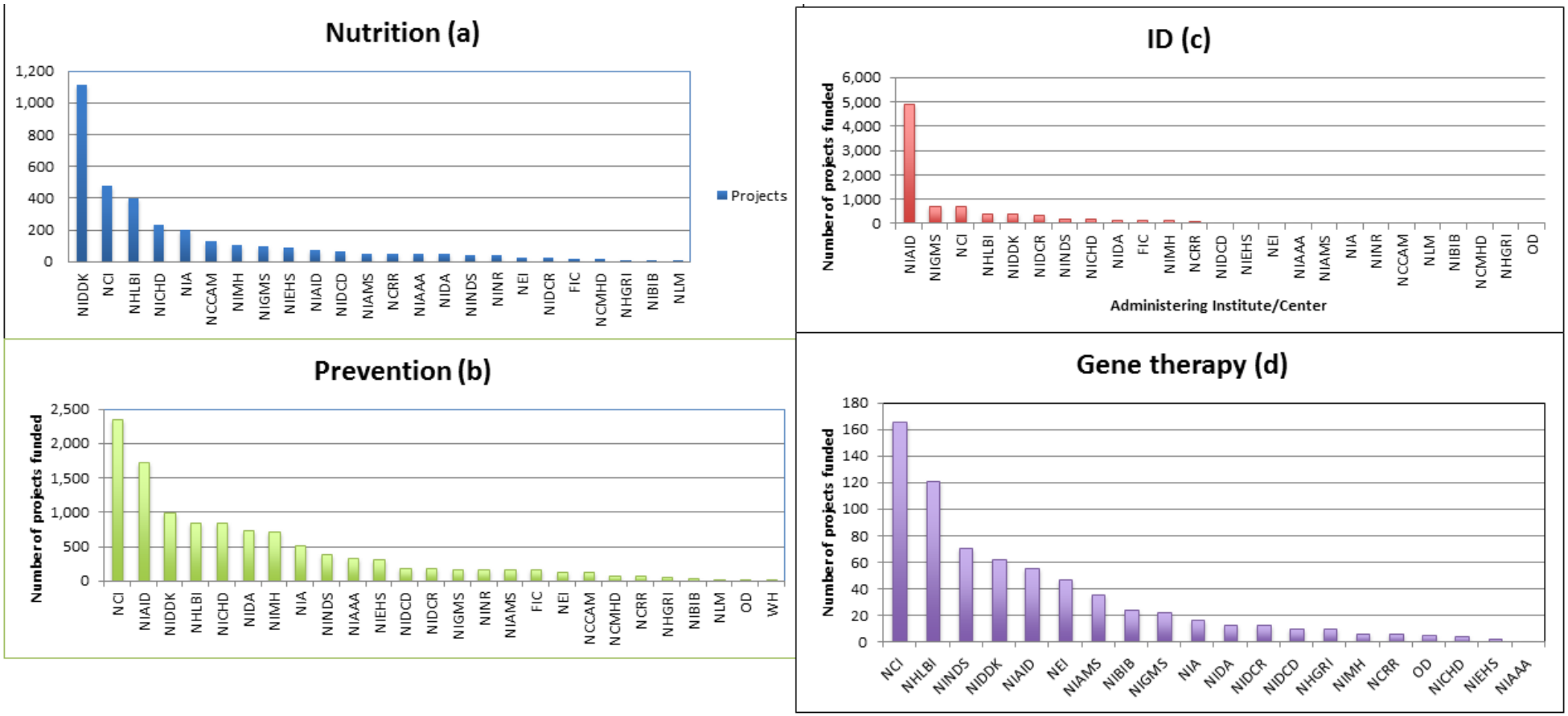

Figure 2a–e: NIH projects funded for FY 2008 (based on RePORTER tool)

As Figure 2f clearly shows (combining Figures 2a–e), for many of the funding organisations, there are fewer projects funded within the categories of nutrition and prevention.

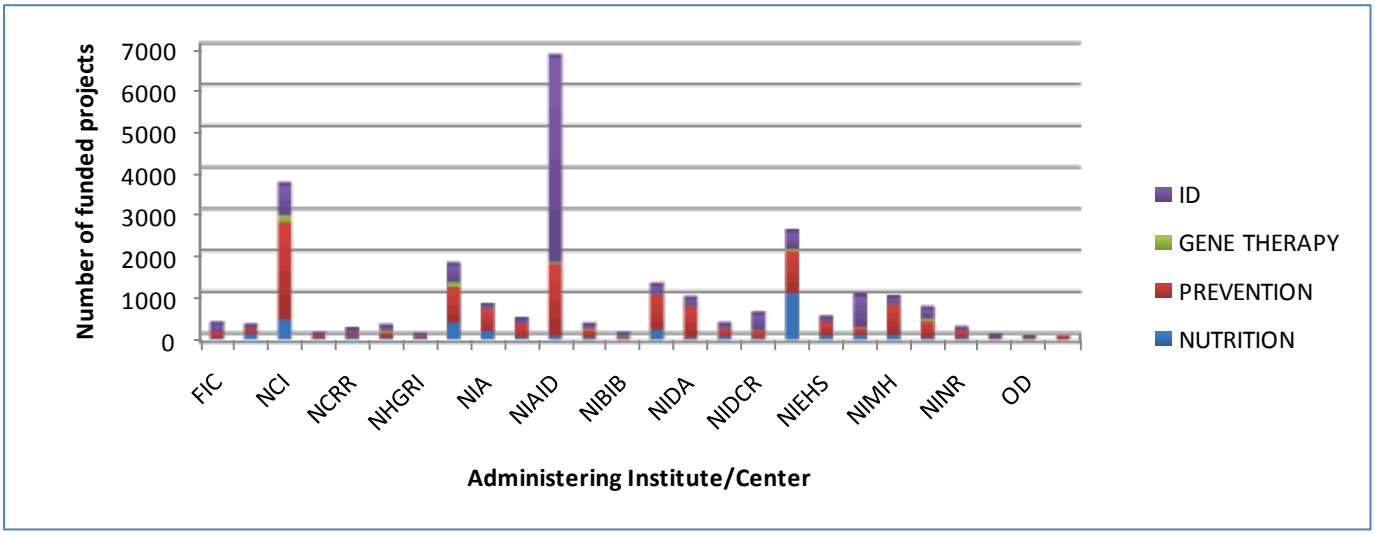

Figure 2f: NIH projects funded for FY 2008 (based on RePORTER tool)

Office of Dietary Supplements (ODS)

The ODS has also benefited from increased investment since 1998, although, as Figure 3 demonstrates, the rate of increase appears to have plateaued in recent years. The ODS had an overall budget of $29 million in FY 2010, $21.7 million of which was allocated for research. The ODS co-funded grants with nine NIH institutes and centres, and these partnerships are the main mechanism by which the ODS supports dietary supplement research in the United States. It allocates the largest proportion of its research budget towards botanical centres (Figure 4).

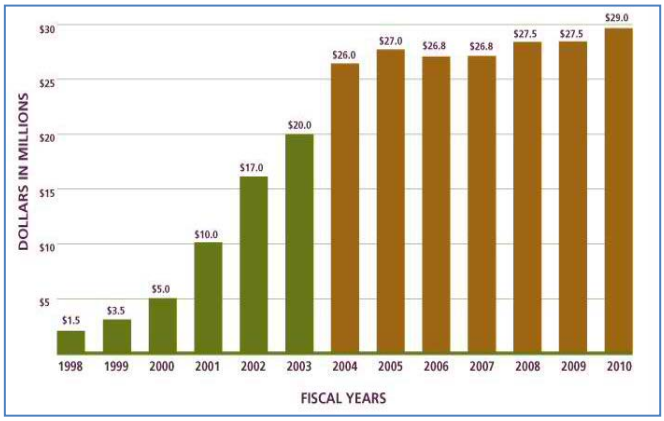

Figure 3: ODS Overall budget trend (1998–2010) (reproduced from ODS website)

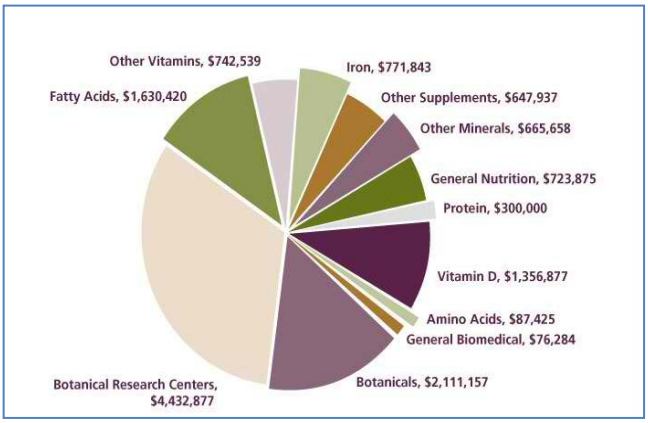

Figure 4: Category breakout of ODS co-funded grants in FY 2010. The total value of grants for this fiscal year was estimated at $13.5 million (reproduced from ODS website)

Examples of public-health nutrition projects being funded by ODS are shown in Table 3.

How are trends in vitamin consumption affecting the health of the population?
What are the upper safe limits for various vitamins and minerals?
Do these levels need to be adjusted for special populations, such as pregnant women, children, and people who are elderly or frail?
How safe and effective are the many botanicals found in dietary supplements?
How safe and effective are probiotics?

Table 3: Examples of public-health nutrition research questions funded by ODS

Centers for Disease Control and Prevention (CDC)

From 2009 budget data, it appears that the CDC has engaged in two key areas of food-related research:

- food-borne illnesses and general food safety (**$27,647,000**); and
- nutrition research, which is much more population-based/prevention-oriented in terms of assessing the nutritional status of the US population. In the area of 'Nutrition, physical activity, and obesity', the total CDC budget amounted to **$42,018,000**, of which **$6,936,000** (16.5 per cent) is allocated for micronutrient and malnutrition research.

The FY 2010 budget request included **$26,942,000** for food safety and **$62,780,000** for the School Health Programme, which seeks to build the capacity of schools and school districts to implement quality, cost-effective school-health programmes. There was no explicit statement that the Schools Program would incorporate a focus on food.

US Department of Agriculture (USDA)

Within the USDA, the principal research agency is the Agricultural Research Service [ARS]. This focuses on four specific national programme areas:

a) nutrition, food safety and quality;

b) animal production and protection;

c) natural resources and sustainable agricultural systems; and

d) crop production and protection.

As Table 4, which has a breakdown of all areas of research within the ARS, demonstrates, over $80 million of its overall budget was allocated towards human nutrition research expenditure (FY 2010 and 2011).

Budget Authority (Dollars in Millions)			
Program	2009 Enacted	2010 Estimate	2011 Budget
Discretionary:			
New Products/Product Quality/Value Added	$103	$105	$113
Livestock Production	80	81	85
Crop Production	199	208	220
Food Safety	106	108	114
Livestock Protection	75	79	83
Crop Protection	198	204	213
Human Nutrition	79	86	91
Environmental Stewardship	220	228	240
Total, Research Programs	1,060	1,099	1,159
National Agricultural Library	23	22	23
Repair and Maintenance of Facilities	17	17	18
Total, Ongoing Programs	1,100	1,138	1,200
Earmarked Projects	40	42	0
Total, Research and Information Activities	1,140	1,180	1,200
Buildings and Facilities	47	71	0
Total, Ongoing Discretionary Programs	1,187	1,251	1,200
Collaborative Research Program	3	0	0
Recovery Act:			
Buildings and Facilities	176	0	0
Total, Discretionary Programs	1,366	1,251	1,200
Mandatory:			
Trust Funds	24	24	24
Total, ARS	$1,390	$1,275	$1,224

Table 4. Breakdown of expenditure at the Agricultural Research Service (ARS) (2009–11)

According to the latest USDA budget report, the ARS Human Nutrition Program is focused on 'promoting food-based agricultural research, which can identify foods and diets, coupled with genetics and physical activity that will sustain and promote health throughout life'. The 2011 budget proposed an increase of **$6.4 million** for research on children's nutrition and health.[14] This accounts for approximately 8% of the total research budget (Figure 5).

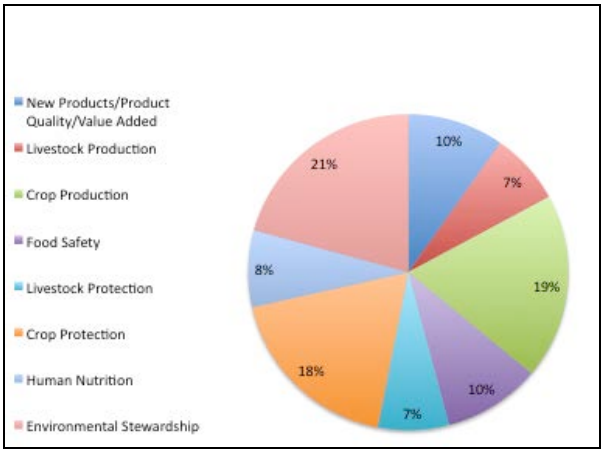

Figure 5: USDA ARS breakdown for FY 2011

(Figures 5–7 were created for this report using data available online (see Annex A for websites)

Basic research is generally thought to produce more fundamental scientific breakthroughs, as opposed to applied research, which has less spillover potential into other applications.[15] Tables 5 and 6 indicate the expenditure between the two types of research at the ARS and other sectors within the USDA [i.e. Forest Service, National Institute of Foods and Agriculture, Economic Research Service Area and the National Agricultural Statistics Service]. Notably, basic research for the Human Nutrition Program in FY 2010 received $10 million more than applied research.

Research and Development:	FY 2010 Expense	FY 2009 Expense	FY 2008 Expense	FY 2007 Expense	FY 2006 Expense
Basic Research:					
Agricultural Research Service					
Human Nutrition	$ 45	$ 43	$ 42	$ 42	$ 41
Collaborative Research Program	-	2	2	2	3
Product Quality/Value Added	56	54	51	52	51
Livestock Production	44	43	42	42	41
Crop Production	119	102	99	99	97
Food Safety	53	53	51	51	50
Livestock Protection	45	42	40	41	43
Crop Protection	103	100	96	97	96
Environmental Stewardship	103	112	109	110	107
National Institute of Foods and Agriculture					
Land-grant University System	283	256	245	245	245
Forest Service	94	87	82	60	76
Economic Research Service					
Economic and Social Science	8	8	8	7	7
National Agricultural Statistics Service					
Statistical	3	3	3	3	2
Total Basic Research	$ 956	$ 905	$ 870	$ 851	$ 859

Table 5: Basic research spending for Agricultural Research Service (FY 2006–10) (US$ million)

Applied Research:					
Agricultural Research Service					
Human Nutrition	$ 35	$ 34	$ 35	$ 35	$ 36
Collaborative Research Program	-	1	2	1	4
Product Quality/Value Added	44	43	43	43	45
Livestock Production	35	34	35	35	36
Crop Production	96	82	82	83	84
Food Safety	43	42	43	43	44
Livestock Protection	36	33	34	34	38
Crop Protection	82	81	80	81	83
Environmental Stewardship	83	90	92	92	94
National Institute of Foods and Agriculture					
Land-grant University System	461	435	418	416	416
Forest Service	227	220	207	154	166
Economic Research Service					
Economic and Social Science	74	71	69	68	68
National Agricultural Statistics Service					
Statistical	4	5	5	3	3
Total Applied Research	$ 1,220	$ 1,171	$ 1,145	$ 1,088	$ 1,117

Table 6: Applied research spending for Agricultural Research Service (FY 2006–10) (US$ million)[16]

Food and Drug Administration (FDA)

The FDA budget request for FY 2010 was **$3.2 billion**. This was $511 million more than the previous fiscal year (a 19% increase). Although 2010 saw a significant increase in funding, the FDA's overall budget is small compared to other agencies (Figure 6).

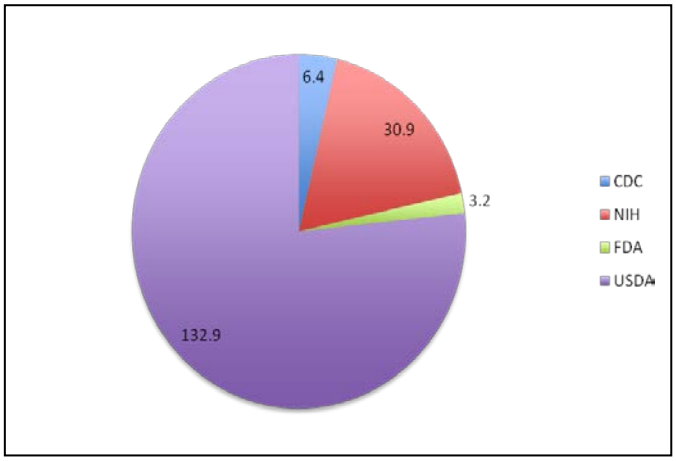

Figure 6: Overall budget of US federal agencies involved in food research and programming (FDA) (US$ million)

Although the FDA's Foods Program (totalling $1.37 billion) is largely dedicated to food safety and inspection, there appears to be a subsidiary interest in funding initiatives in nutrition, namely in package labelling ($19.8 million in 2011: http://www.fda.gov/downloads/AboutFDA/ReportsManualsForms/Reports/BudgetReports/UCM207338.pdf). The latest 'President's Fiscal Year 2011 Budget Request for FDA' prioritises prevention, but this is largely focused again on the prevention of food-borne illness instead of NCDs.

2. The European Commission

The Seventh Framework Programme for Research and Technological Development [FP7] is the European Commission's primary instrument for funding research across Europe for 2007–13. Its overall budget is approximately **€50.5 billion**[17], with four primary areas for funding:

a) cooperation (collaboration research);

b) ideas (European Research Council);

c) people (Marie Curie schemes); and

d) capacities (research capacities).

Within 'cooperation' (which has an overall budget of approximately **€32 billion**), the EU has invested €6 billion on health**, €**1.9 billion on 'food, agriculture and fisheries, and biotechnology'. For FY 2011, the budget for 'health' R&D has been estimated at **€682 million**.[18]

Seventy-eight projects focusing on food and health [ongoing and completed] were identified using the CIAA website (http://etp.ciaa.eu/asp/links/research_project.asp) (Figure 7).

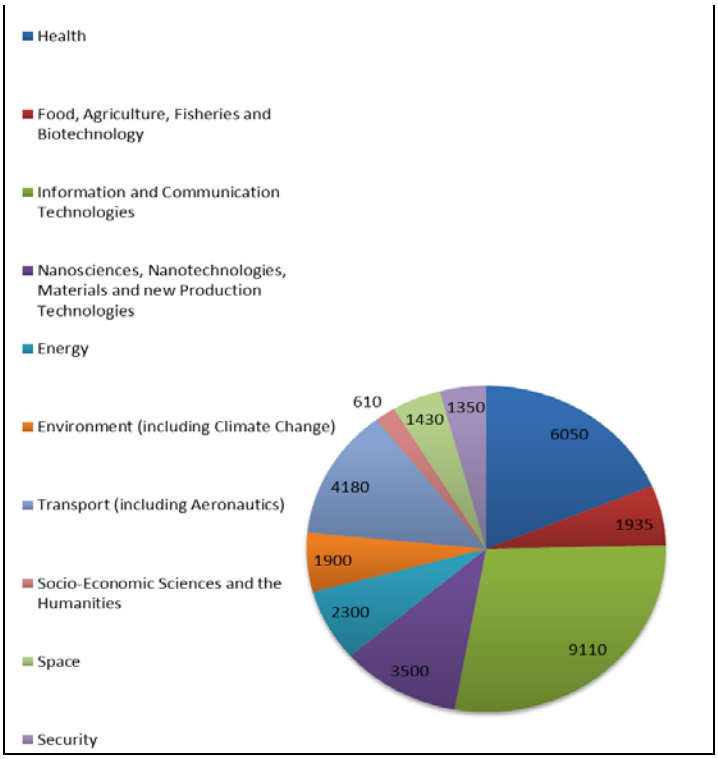

Figure 7: 10 themes supported by FP7's 'cooperation' funding mechanism (€ million)

One of the primary issues concerning the European Commission is the issue of food safety. In the previous framework programme [FP6], the EC invested €750 million in food quality and safety research.

3. United Kingdom

In 2006, the UK Clinical Research Collaboration published *UK Health Research Analysis,*[19] a major piece of research into research spending. This report found that only 2.5% of health-related research expenditure in 2004–5 by the 11 largest government and charity funders was dedicated to primary disease prevention or health promotion (see Figure 8). Of this, nutrition and chemoprevention accounted for 33% of prevention spending – which was less than 1% of the total expenditure on research. The majority of prevention spending was on infection (see Figure 9).

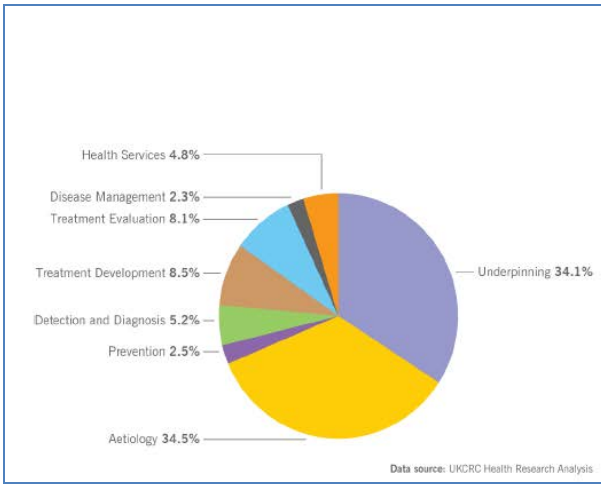

Figure 8: Proportion of combined total spend by research activity

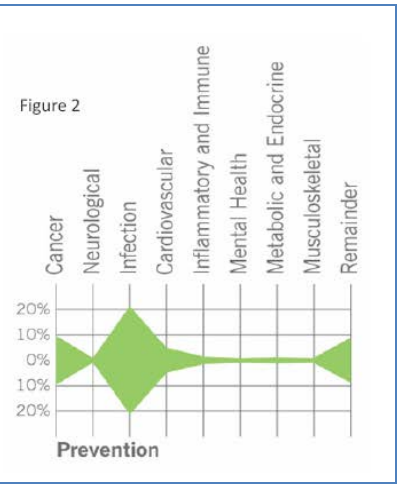

Figure 9: Distribution of prevention spend

In 2008/09, public investment in research and innovation across the UK amounted to some £400 million.[20]

The UK Cross-Government Food Research and Innovation Strategy,[20] published in January 2010, provides an overview of linkages between research communities and the labyrinthine way in which funding is devoted to food-related research (Figure 10).

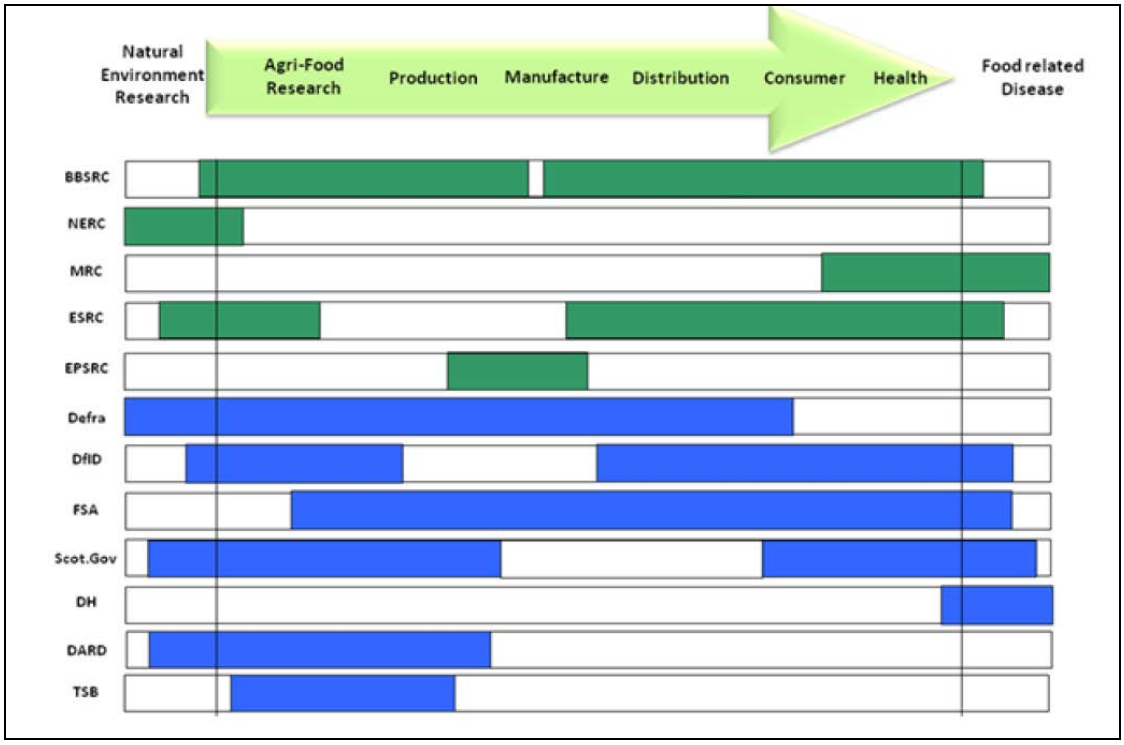

Figure 10 Food responsibilities across government, devolved administrations and research councils [20]

The report also presents a summarised breakdown of food research spending by the 11 major government organisations, cut both by category (for example, within the Biotechnology and Biological Sciences Research Council (BBSRC): animal health, soil science) and by programme (for example, within the Department for the Environment, Food and Rural Affairs (Defra): agriculture and climate change) (Figure 11).

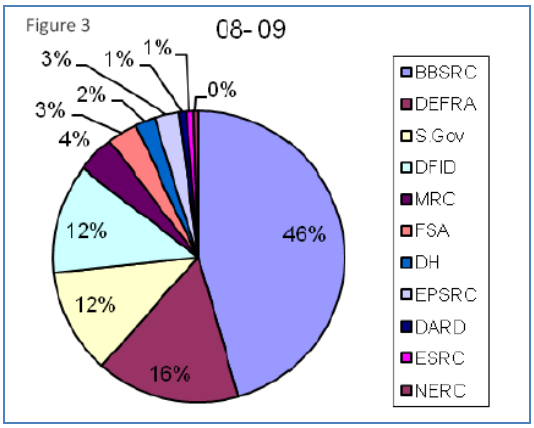

Figure 11: Food research and spending, UK government departments 2008–9 [20]

As Figure 11 shows, food research and innovation research spending was split across a number of funding organisations in 2008–9. The actual spend that underpins this distribution is shown in figure 12.

Total Food Research Spend

Funder	*07/08*	*% of Total*	*08/09*	*% of total*
BBSRC	184.50	45.22	188.91	45.52
DEFRA	66.90	16.40	66.42	16.00
Scottish Govt.	52.23	12.80	48.97	11.80
DFID	49.10	12.04	50.24	12.11
MRC	17.30	4.24	17.30	4.17
FSA	16.12	3.95	13.80	3.33
DH	9.27	2.27	9.27	2.23
EPSRC	3.50	0.86	11.52	2.78
DARD	3.25	0.80	3.25	0.78
ESRC	3.18	0.78	3.18	0.77
NERC	2.63	0.64	2.15	0.52
Total	**407.98**		**415.01**	

Figure 12: Total food research spend by organisation [20]

Biotechnology and Biological Sciences Research Council (BBSRC)

BBSRC programmes that relate to food can broadly be broken down into three strategic areas:

- research-led priorities;
- innovation-led activities;
- strategic business priorities for the institute.

BBSRC collaborates with a number of the other strategic funders, both in the United Kingdom and internationally.

It spent £12.2 million in 2008–9 on 'diet and health' (6.5% of the BBSRC total), which was a reduction in investment from the £14.1 million spent in this area in 2007–8 (Figure 13).

BBSRC

Category (title)	*07/08*	*08/09*
Plant & Crop Science	66.4	65.6
Animal Health	45.5	54.5
Studentships	18.9	18.6
Diet & Health	14.1	12.2
Food Safety	10.9	11.2
Agricultural Systems	7.2	4.0
Environmental Change and Agri-Systems	6.6	6.8
Soil Science	6.3	5.9
Food Manufacturing	5.3	4.6
Animal Welfare	2.2	3.9
Aquaculture	1.1	1.6
Total	**184.6**	**188.9**

Figure 13: Breakdown of research funding data for BBSRC[13] [20]

Department of the Environment, Food and Rural Affairs (Defra)

Defra's food-related programmes include research that contributes to sustainable farming and biodiversity, agriculture and climate change, water management, the resilience of the food chain and work that underpins GM-risk assessment and policy development (Figure 14).

Defra

Programme	*07/08*	*08/09*
Farming and Food science: Agriculture and climate change	5.25	5.61
Plant health and bee health	0.80	0.74
Research Efficient and Resilient food Chain (RERFC)	5.38	4.69
Water Quality and Use	3.47	4.41
Sustainable Farming systems and biodiversity	13.90	12.85
Genetically modified Organisms	0.38	0.40
Salmon and fisheries programme SF02	0.72	0.72
Livestock health/welfare programmes (related to food-excluding work on Crypto, pets and exotic viruses (£2M))	37.00	37.00
Total	**66.90**	**66.42**

Figure 14: Breakdown of DEFRA funding by programme area 2007–9[14] [20]

Department of Health

Health in the United Kingdom is a devolved function. The Department of Health only has responsibility for England. The health of the population in Northern Ireland, Wales and Scotland is separately administered through the devolved administrations.

[13] The data does not include overlaps in spend between programmes.

[14] Data does not include capital expenditure for the Veterinary Laboratories Agency or surveillance.

In England, the Department of Health's portfolio for food-related research in 20089 included research evidence for the policy groups developing and formulating policy for NHS, public health and adult social care, and investments in research on nutrition, diet and lifestyle (Figure 15).

Biomedical Research Centres (£468m – 12 centres – 5 years) in NHS and University partnerships provide NHS infrastructure for translational clinical research with patient benefit. Several Centres undertake research in nutrition and energy balance.

Biomedical Research Unit for Nutrition, Diet and Lifestyle (including Obesity) (£3.75m – 4 years) is a partnership between Southampton University Hospitals NHS Trust and Southampton University, enabling health researchers and clinicians to drive innovation in the prevention, diagnosis and treatment of ill-health related to nutrition, diet and lifestyle; and translate advances in medical research into benefits for patients.

Diabetes Clinical Research Network involves people with diabetes, carers and public in deciding research priorities, and generating a research portfolio by investigators from different disciplines, to encompass clinical studies with epidemiological studies and health services research, and interaction with basic, clinical science and translational research.

Programme Grants for Applied Research Scheme provides evidence to improve health outcomes, with a focus on research findings expected to impact on healthcare within a three to five year timescale. Diabetes was identified as a priority award (£7m - 5 years).

Health Technology Assessment Programme (HTA) supports independent research information on the effectiveness, costs and broader impact of healthcare treatments and tests for those who plan, provide or receive care in the NHS e.g. anti-obesity drugs in primary care, and themed calls with PHR for research on obesity.

Other Programmes that potentially include projects relating to nutrition include: Research for Innovation, Speculation and Creativity (RISC), Research for Patient Benefit (RfPB), and New and Emerging Applications of Technology.

Public Health Research (PHR) programme evaluates public health interventions, providing new knowledge on benefits, costs, acceptability and wider impacts of non-NHS interventions intended to improve health of the public and reduce inequalities in health.

Figure 15: Overview of DH investment in nutrition, diet and lifestyle in 2008-9 [20]

Medical Research Council (MRC)

The MRC's research focus in relation to food covers human nutritional requirements and the effects of food on health and diseases. In 2007/8 the MRC funded approximately £45 million of research into nutrition and related areas. Of this, approximately £17 million was directly relevant to 'food research' (Figures 16 and 17).

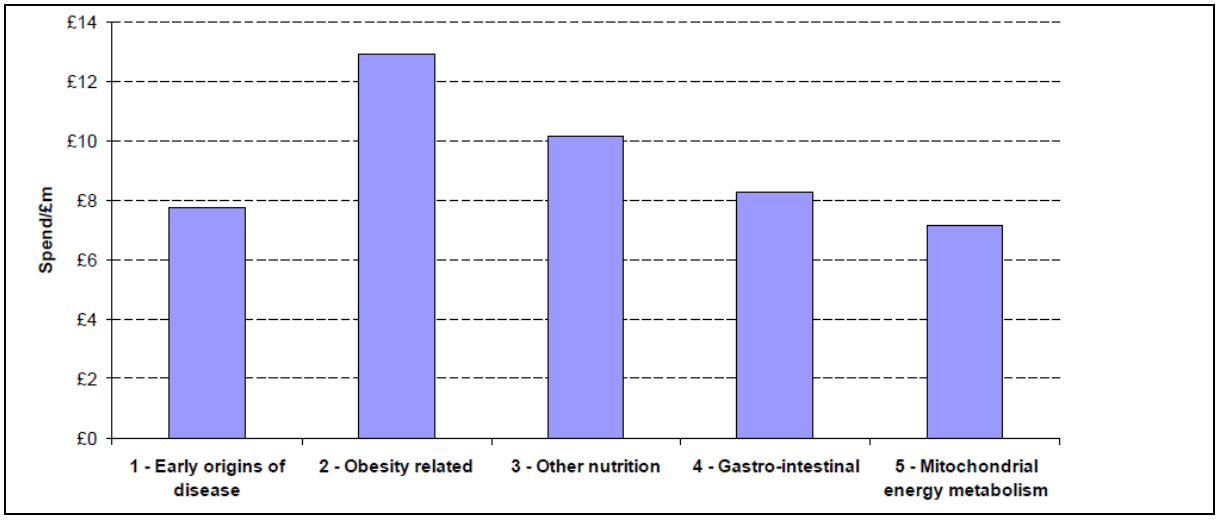

Figure 16: MRC spending distribution across scientific areas[20]

MRC

Programme	*07/08*	*08/09*
MRC Collaborative Centre for Human Nutrition Research	6.0	6.0
MRC International Nutrition Group	1.6	1.6
MRC Epidemiology Resource Centre	2.5	2.5
MRC Epidemiology Unit	6.1	6.1
MRC Social and Public Health Sciences Unit	3.5	3.5
Grant and fellowship funding (response mode) - early origins of disease	2.0	2.0
Grant and fellowship funding (response mode) - obesity related	3.0	3.0
Grant and fellowship funding (response mode) - gastrointestinal disease	1.4	1.4
Grant and fellowship funding (response mode) - other nutrition	2.1	2.1
Total	**28.2**	**28.2**

Figure 17: Breakdown of MRC food-related research funding 2007–9[20]

Aim 2: Functional foods

US government expenditure

Identifying reports or data on **total** US expenditure on functional foods research was challenging. A query in the RePORT database for functional foods as a search term for all currently active projects yielded four studies that were funded in 2010, totalling $1,033,920. A query for projects from FY 2009 yielded eight results, with funding for these projects estimated at almost $2 million. A second query for studies from FY 2000–10 yielded 27 results, with project funding estimated at $4,568.153 (Table 7).

NIH Spending Categorization	Project Title	Project Number	Project Start Date	Project End Date	FY	Total Cost	Funding IC
Clinical Research;Complementary and Alternative Medicine;Nutrition	MUSHROOM	5M01RR010732-15	01-Apr-09	31-Mar-10	2009	$8,320	
Aging;Cardiovascular;Diabetes;Heart Disease;Nutrition;Obesity;Prevention	ACT 2 PROJ 2 LONGEVITY FOODS AND OBESITY-ASSOCIATED INSULIN RESISTANCE	5G12RR003061-24	01-Aug-09	31-Jul-10	2009	$123,551	
Complementary and Alternative Medicine	SPECTROMETRIC VALIDATION OF BOTANICAL MATERIALS AND REFERENCE STANDARDS	5RC2AT005899-02	30-Sep-09	29-Sep-11	2010	$625,959	NCCAM
Complementary and Alternative Medicine	SPECTROMETRIC VALIDATION OF BOTANICAL MATERIALS AND REFERENCE STANDARDS	1RC2AT005899-01	30-Sep-09	29-Sep-11	2009	$605,846	NCCAM
Complementary and Alternative Medicine;Digestive Diseases;Liver Disease;Nutrition;Prevention	INHIBITION OF CHOLESTEROL SYNTHESIS BY GREEN AND BLACK TEA	5R21AT005235-02	01-Jul-09	30-Jun-11	2010	$215,961	NCCAM
Complementary and Alternative Medicine;Digestive Diseases;Liver Disease;Nutrition;Prevention	INHIBITION OF CHOLESTEROL SYNTHESIS BY GREEN AND BLACK TEA	5R21AT005235-02	01-Jul-09	30-Jun-11	2010		OD
Complementary and Alternative Medicine;Digestive Diseases;Liver Disease;Nutrition;Prevention	INHIBITION OF CHOLESTEROL SYNTHESIS BY GREEN AND BLACK TEA	1R21AT005235-01	01-Jul-09	30-Jun-11	2009	$181,406	NCCAM
Complementary and Alternative Medicine;Digestive Diseases;Liver Disease;Nutrition;Prevention	INHIBITION OF CHOLESTEROL SYNTHESIS BY GREEN AND BLACK TEA	1R21AT005235-01	01-Jul-09	30-Jun-11	2009		OD
Biotechnology;Complementary and Alternative Medicine;Infectious Diseases;Nutrition;Prevention	EVIDENCE BASED REVIEW: PROBIOTIC SAFETY	Y1AT9003-2-0-1			2010	$42,000	NCCAM
Biotechnology;Complementary and Alternative Medicine;Infectious Diseases;Nutrition;Prevention	EVIDENCE BASED REVIEW: PROBIOTIC SAFETY	Y1AT9003-1-0-1			2009	$150,000	NCCAM

Table 7: Search results from RePORT using keyword search term 'functional foods' for FY 2009 (10 NIH-funded projects were identified, with a total research cost estimated at $1,953,043)

Whilst this shows a substantial investment in functional foods, the data is partial. The USDA, through the ARS, is known to be a key funder of research in this area. However, identifying funding allocations by the ARS proved to be difficult.

A keyword search of a US governmental portal for nutrition information [www.nutrition.gov] identified a number of NIH-based funded projects (Table 8). Whilst this confirms the interest in this area, identifying the associated budgetary allocations and levels of funding that had been committed was not possible.

1. Plant polyphenol effects on glucose and insulin metabolism.
2. Increasing carotenoid and vitamin A levels in corn and tomato.
3. Blueberry influence on aging and cognition.
4. Developing new vegetable varieties [carrots and garlic] with increased carotenoid levels and bioavailability.
5. Absorption and metabolism of plant pigments by humans.
6. Determining the bioavailability of the anti- oxidant compound avenanthramide, found in oat grain,

and investigating whether avenanthramide can exert bioprotection against age- and exercise-related oxidative stress.
7. Modulation of immune function by phytochemicals and nutrients.
8. Developing high-folate potatoes.
9. Identifying and improving broccoli varieties for anti-cancer properties and carotenoids.
10. Influence of various dietary factors on bone health.
11. Prevention of heart disease and cancer in animal and cell models.
12. Determining natural antioxidants and antioxidant capacity of dark-coloured bran rice.

Table 8: Topics of functional foods research undertaken at the ARS

It is also known that ARS research has yielded new and improved technologies leading to new food products; however, the absolute investment that resulted in the development of these technologies was also not possible to identify (Table 9).

1. Lactose-reduced dairy products (Lactaid).
2. Low-fat mozzarella cheese used in the National School Lunch Program.
3. Whey-based texturised foods
4. Quality and shelf-life extension of fresh-cut fruits and vegetables.
5. 100-percent-fruit bars.
6. Fruit and vegetable wraps for various foods.
7. Vitamin D-enhanced mushrooms.
8. Sunbutter, a sunflower-based alternative to peanut butter for people with peanut allergies.
9. A series of grain-based technologies [Oatrim, Nutrim, Z-trim, and Calorie Trim] yielding food ingredients that can replace fats in food and/or deliver dietary fibre.
10. A low-glycemic sweetener [sucromalt].
11. Low-oil-uptake, rice-based batters.

Table 9: Pertinent ARS technologies adopted and commercialised by research partners[21]

Europe

The EC has a long history of investing in functional foods research (Table 10)[22]. Approximately 10–20% of the research budget in the field of food and nutrition in the EC FP7 is allocated to functional food.

Framework programme [FP]	Funding period	Total budget (€m)	Functional food budget (€m)	No. of functional food projects
FP6: Food quality and safety	2002–6	753	73	15

FP5: Key Action 1 'Food, nutrition, and health'	1998–2002	204	51	33
FP4: Agriculture and fisheries incl. agro-industry (FAIR)	1994–8	110	12	12
FP3: Agro-industrial research (AIR)	1991–4	62	5	5
FP2: Food-linked agro-industrial research (FLAIR)	1989–94	25	2	4

Table 10: EC FP2–FP6 research funding on functional food projects[22]

In the early 1990s, fibres, pro-, pre- and synbiotics were the subjects more commonly studied in functional foods research. The range has been broadened to antioxidative effects, vitamins, phyto-oestrogens, the use of new bioactive ingredients, and the emerging field of nutritional genomics.[23]

This interest is not restricted to the EC Framework Programmes, as Figure 18 demonstrates: functional food is a key topic of research for many of the EU member states. Germany and the United Kingdom lead the other EU member states in the total number of research facilities devoted to functional foods research. Furthermore, an increasing number of research institutes in both the public and private sectors are engaged in R&D for functional foods.

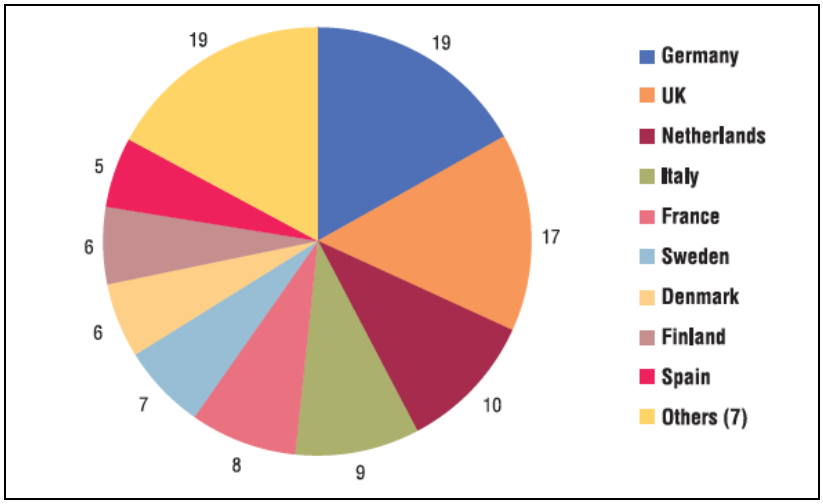

Figure 18: Number of research facilities in the EU active in the field of functional food

Aim 3: Review of journals and conferences on obesity

The final aim of the project was to provide an insight into the relative balance between treatment and prevention, as evidenced by the scientific programmes and abstracts of recent conferences, and through a keyword search of the published literature.

Two conferences were identified as being particularly relevant: the 2010 annual obesity conference held in San Diego organised by the Obesity Society,[15] and the International Obesity conference in Stockholm. A keyword search of the official conference websites, the scientific programmes and the abstract booklets found:

- in San Diego, there were zero oral abstracts on 'prevention', 18 poster abstracts on 'prevention' and 23 poster abstracts on 'treatment'[16];
- in Stockholm, there were three abstracts submitted in the 'epidemiology, diet, activity and behaviour' track on the topic of 'food environment'. There were three talks in this area, namely: a) *policy links to jointly tackle obesity and global warming*; b) *understanding and changing the retail environment for obesity prevention*; and c] *hard evidence that the food industry can change.* There was no evident discrepancy in treatment versus prevention for oral abstracts.[17]

Whilst these were the two major international conferences on obesity within 2010, the limited sample size precludes any definitive conclusions on the general balance between treatment and prevention activity in conferences. Differences in the emphasis placed on treatment versus prevention could reflect the strategic intent behind the conferences, the interests of the scientific committees, and the over-arching strategic direction of sponsorship bodies, as opposed to demonstrating a preference for treatment over prevention.

However, a similar key word search was performed using the primary medical research database, (PubMED – www.pubmed.org), to provide an insight into the range of articles which have been published within this field (Table 11), demonstrating that, in general terms, more articles are published on treatment-related topics than on prevention-related topics.

Keyword	Number of results (hits)
Food-related research health	184
Food-related research	675
Food prevention	60,382
Food treatment	191,294
Chronic disease prevention	33,226
Chronic disease treatment	239,646
Obesity prevention	20,752
Obesity treatment	67,856

Table 11: Pubmed results from keyword search (January 2011)

[15] The Obesity Society is one of the 'leading scientific society dedicated to the study of obesity. Since 1982, the Obesity Society has been committed to encouraging research on the causes and treatment of obesity, and to keeping the medical community and public informed of new advances' (http://www.obesity.org/).

[16] Online website for the 2010 Conference is no longer available. The data was accessed in November 2010.

[17] There was no access to the abstract book for the poster presentations.

Discussion

Why is this field of research important?

The inter-relationships between food and health are complex and varied. Malnutrition – both over- and under-consumption of food, and nutritional deficiencies – is a key factor influencing health outcomes globally. Poor nutrition can lead to lower immunity, increasing susceptibility to illnesses. Conversely, good nutrition can have a protective effect.

There is a rich evidence base looking at the impact of human nutrition on NCDs, and more specifically looking at the inter-relationship between obesity and diabetes. A large body of work in both developed and developing countries has demonstrated both the current and projected burdens of NCDs on populations. For instance, a study by Alwan and colleagues[24] recently estimated that NCDs were responsible for 23.4 million deaths in the 23 low-income and middle-income countries analysed. This was 64% of the total deaths in these countries. An estimated 47% of the deaths occurred in people who were younger than 70 years. The authors indicated that obesity was one of the most significant contributors to mortality, but that 'cost-effective interventions' to reduce its burden at a population level remained inadequate.

These findings are supported by a study in SE Asia, which reported that NCDs accounted for 60% of mortality in that region.[25] In sub-Saharan Africa, rates of age-specific mortality from NCDs are in fact higher than all other regions of the world, for both men and women.[26] In terms of the global burden of NCDs in the coming decades, projections of mortality and burden of disease have estimated that the proportion of deaths due to NCDs will rise to 69% in 2030 (from a baseline of 59% in 2002).[27]

The extent to which food research [as in new technologies or in methods to reduce salt, fats, and sugar contents of particular foods] can reduce the global burden of NCDs, however, remains less clear.

Economic context of investment

Although there are concerns that the global financial/economic downturn may have a detrimental impact on budgets, one avenue where progress could potentially be made is around the mobilisation of a broad range of stakeholders in order to increase monetary support for NCD-related research, building particularly on the momentum around the UN High-Level Meeting on NCDs (September 2011). The broadening of the stakeholder base has resulted in an increased funding base for research and development in other areas. For example, the success of HIV/AIDS advocacy [i.e. Global Fund on AIDS, increasing antiretroviral access to sub-Saharan Africa, vaccine funding] could be considered as a model approach for encouraging and supporting effective investment through a coherent approach to advocacy for NCD funding.

With the UK government's huge budget deficit, public-spending cuts by the government are felt to be inevitable – and research organisations are already gearing up for what they expect to be swingeing cuts in funding. One particularly worrying trend that can be observed in the Food Innovation and Strategy report[20] is that in 2009 there was a fall in the spend by the BBSRC on diet and health from £14.1 million to £12.2 million, and funding for another key category – food manufacturing – also fell from £5.3 million to £4.6 million. Given that these figures predate the robust cost containment measures anticipated by the new government, this is a significant cause for concern.

Food research as an investment priority

Global R&D investment forecasts suggest that slow growth is expected for research and development generally,[28, 29] following a period of recession. Understanding the impact of the recession and the future prospects for growth within this sector is crucial to inform a strategic approach to research and development.

Phase one of this project examined expenditure in this sector in the United Kingdom and provided evidence for significant under-investment by UK government agencies. In the broad context of 'food research', the research team concluded that only a small proportion of funding by the UK government went specifically towards health and nutrition, with the overarching emphasis instead on sustainability (in the context of environment and food security), with £65.6 million spent on 'plant and crop science' in 2008–9, which was five times the expenditure on 'diet and health'. This echoes the priorities in the government's *Food 2030* report, [30] whose vision for a 'sustainable and secure food system' does not mention human health.

Phase two of the study extended this analysis to consider Europe (and in particular the EC FP7) and the United States. This demonstrated that US federal agencies' investment was relatively higher for food research that the FP7 funding mechanism in the EC. However, research in the United States showed a similarly limited focus on human health to that found in the United Kingdom, with the majority of federal food research funding allocated towards food security/safety.

However, as this study has shown, the data must be interpreted with caution. In the United States, some of the projects – in particular those appearing in the NIH data for more generic categories – may be appearing on more than one system, and could be double counted. Without a clear system available or way to analyse the data to control for this, it is not possible to make direct comparisons of the data, or to analyse the figures with the appropriate degree of academic rigour.[18] However, despite this apparent shortfall in the system, the fact that there is a system in place for deconstructing spending in this area is laudable, and should be extended to other funders. As this report shows, this area of research and development funding is characterised by inconsistencies in the mechanisms employed to collate and present data, and an apparent lack of transparency. Deconstructing funding allocations with any degree of rigour can be at best a convoluted process, at worst practically impossible.

Strategies such as the Europe 2020 strategy, which puts research and innovation at the heart of the political agenda for the EC, with a proposal that 3% of GDP should be invested in research and innovation, [31] show the key role research has to play in tackling today's social and industrial problems. Yet without sustained and significant investment, it is unlikely that progress will be made. With the latest findings from the recently released UNESCO *Science Report 2010*[32] demonstrating that China's research capacity for science R&D is growing steadily, there is both an economic and a political imperative to ensure that any efforts to increase the appreciation of the importance of food-related research for health are inclusive of as many stakeholders as possible.

Functional foods

Food and nutrition are recognised to be modifiable risk factors. In recent years, there has been an increasing interest in the development of functional foods, namely foods 'designed to have physiological benefits and/or reduce the risk of chronic disease beyond basic nutritional functions, and may be similar in appearance to conventional food and consumed as part of a regular diet' (ARS definition).

Such foods can offer benefits beyond basic nutrition, offering opportunities to reduce disease risk and maximise health with minimal professional involvement. [6] In recent years, there has been an increasing focus on the public-health potential of switching to healthier products and reformulating existing products, with a key focus in recent years being on the push to reduce consumption of saturated fat, sugar and salt. This work builds on previous experience of modifying food for population health benefit, such as the enrichment of foods with folic acid, which has been successfully carried out for many years, with beneficial health impact.[7, 8] However, despite the

[18] It should be noted that there was general non-crossover between NIH, CDC and USDA data.

increasing popularity of such approaches, there remain gaps in understanding of the evidence around such foods,[9] and little is known about the long-term effects and interactions between such foods and the drugs which are developed to address the same targets.[10]

Multivitamin/mineral supplements

A systematic and comprehensive review by Huang and colleagues[33] at Johns Hopkins University in 2006 examined the efficacy of multivitamin/mineral supplements and certain single-nutrient supplements in the primary prevention of chronic diseases in adults. They concluded that 'supplement use may prevent cancer in individuals with poor or suboptimal nutritional status'. The authors also concluded that multivitamin/mineral supplements 'conferred no benefit in preventing cardiovascular disease or cataract, and may prevent advanced age-related macular degeneration only in high-risk individuals'. The take-home message from this review was that there is the need and opportunity for more rigorous science in supplements research. A parallel recommendation and case can be made for research into functional foods.

Role of industry

Whilst this report has not looked at the scale of investment from industry in the area of food and health research, the food industry remains one of the major stakeholders, with a huge potential to have an impact on this area. For example, although promotion of healthier food options is important in curbing the burden of NCDs, one of the understudied and underinvested areas is in how processed foods can have greater nutritional content – and how such processed foods could impact morbidity and mortality across populations.[19]

An initial position paper on food and health R&D by Cooper and colleagues at C3 Collaborating for Health referred to a list of food-industry actions recommended by Brownell and Warner,[34] which could potentially prevent the food industry being compared to the tobacco industry ('Big Tobacco'). A critical recommendation called for lobbying governments to increase funding for scientific research. The rationale for this recommendation is that scientists (i.e. academics) would rely less on monetary support from industry stakeholders. Ensuring that robust conflict of interest guidelines, such as those proposed by Rowe and colleagues, [35] are in place is essential to protect the integrity and credibility of the scientific record, particularly with respect to health, nutrition, and food-safety science. Such guidelines provide an important framework for companies that are taking a lead in addressing nutrition within their product portfolio.

Public–private investment, such as that undertaken in Ireland as part of its response to the emerging potential market for functional foods, can have a huge impact. In Ireland, the government has established a €4 million functional food and beverage centre in Dublin,[36] as well as developing a series of partnerships with major dairy processing companies and four public research agencies. Such projects demonstrate ways in which industrial partners and government research bodies can work together to undertake research. However, a detailed analysis of the strengths and weaknesses of this approach, or of the level of funding committed to this area is beyond the scope of this report.

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[19] Modelling the impact of processed foods on morbidity and mortality could be based on the modelling used in a study by the British Heart Foundation Health Promotion Research Group at the University of Oxford. In this study, Scarborough and colleagues concluded that if people in the United Kingdom consumed less meat, 32,000 deaths would be averted/delayed annually, with the majority (26,000) of these averted deaths for cardiovascular disease (http://www.publichealth.ox.ac.uk/bhfhprg/publicationsandreports/publications/bhfhprgpublished/friendsoftheearthreport).

Health gains

This paper has shown that food and health is clearly not a major priority for government-funded research. If it is to become a greater priority, there needs to be clear evidence of the benefits that can accrue from food-based interventions on health, so that the case can be made more clearly. If it is obvious that there are major benefits to be had, the question of why there is so little spending in this area will become more pertinent.

There are a number of reports that have begun to estimate the health gains – with a number of different approaches taken. For example, in 2006, the independent regulator and competition authority for the UK communications industries [Ofcom] undertook a consultation[37] and subsequently published an 'Impact assessment consultation on television advertising of food and drink to children', which includes a DH assessment of the health benefits of dietary changes. This was summarised by the Strategy Unit's report *Food: An Analysis of the Issues* in 2008 (Table 12).[38]

	Premature mortality avoided	Quality-adjusted life years gained
Increase fruit and vegetable intake by 136g/day	42,000	411,000
Reduce daily salt intake from average 9g to 6g	20,000	170,000
Cut saturated fat intake by 2.5% of energy	3,500	33,000
Cut added sugar intake by 1.75% of energy	3,500	49,000

Table 12: The health benefits of dietary change[38]

Other studies have suggested:

- collaborating with industry to decrease average sodium intake in the United States by 9.5% would avert over 500,000 strokes and save $32.1 billion in medical costs[39];
- estimating the impact on energy intake – and, hence, on overweight – of increased prices of taxing selected foods and beverages [particularly soda and pizza].[40]

Each of these studies is individually interesting, but they do not negate the need for a comprehensive strategic approach to identifying, assessing and validating the benefits that can accrue from food-based interventions on health.

Recommendations

The current landscape, which reflects the broad range of activity within the topic area, is complex, making it difficult for researchers, policy-makers and industry to understand the scope and routes of entry to identify information, research foci and potential partners. This undermines the coherence of the research agenda, and consideration needs to be given to how best to make these arrangements more transparent and accessible.

Navigation of the complex and fragmented funding landscape is made more difficult by the lack of an openly accessible over-arching strategic framework giving transparency to research foci and allocations, supported by coherent systems and databases on annual R&D expenditure for food and health. This could support the development of a more focused strategic research agenda for food and health, and would potentially encourage more research funders into the field, if roles, responsibilities and focal areas were more clearly delineated.

It is important that any efforts to increase the appreciation of the importance of food related research for health are inclusive of as many stakeholders as possible.

Areas that should be considered are:

- whether the development of an agreed working definition of 'food' which can be utilised across sectors, would be helpful;
- how support could be mobilised to secure a coherent approach to advocacy to ensure that the importance of food and health as a research priority is recognised;
- what action could be taken forward to facilitate and support greater transparency of data on funding allocations, differentiating between prevention, treatment and basic research;
- how to promote greater and more transparent investment in this critical area of research;
- one area that could be considered would be the development of an annual survey, along the lines of the G Finder survey, which tracks research and development investment for the neglected tropical diseases, so that changes in investment can be tracked.

Conclusion

One of the key challenges faced by the project team was defining the scope of the research and accessing appropriate, relevant and timely data. Working definitions of 'food' were generally lacking in most of the reports and sources reviewed for this report. Similarly, identifying and accessing up-to-date expenditure data and user-friendly breakdowns of funded projects was a complex process, resulting in data that was not comparable across funding streams. Without a more systematic, coherent approach to collect, collate, analyse and publicise the existing research agenda and opportunities for accessing funding and collaborating with other agencies, navigating and exploring the dynamic interface between food and health will remain a complex challenge, with attempts to guide future strategic investment hampered by a lack of knowledge of existing investment strategies, interests and commitments.

By providing an insight into the existing budgetary allocations for research on the interface between food and health, this project has provided a firm baseline for future discussions. However, our research did not find any evidence of an explicit co-ordinating framework across these divisions/agencies, suggesting that within countries research direction may be autonomous within each division/agency rather than reflecting an overarching strategic vision. This is a significant risk factor, and consideration needs to be given to how best to address this and support greater transparency across the landscape.

There are, as this report has demonstrated, significant challenges to be addressed – not least the apparent under-investment in this critical area of research. Research can and will make a contribution to the development of an understanding of the complex inter-relationship between food and health. But without sustained commitment, it is likely to be impossible to establish a coherent and strategic research agenda. The health statistics make a compelling case – complacency is neither justified, nor affordable.

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Further links of interest

CDC Budget 2010: http://www.cdc.gov/fmo/topic/Budget%20Information/appropriations_budget_form_pdf/FY2010_CDC_CJ_Final.pdf

Clinicaltrials.gov – Dietary supplements: http://clinicaltrials.gov/ct2/search/browse?brwse=diet_cat

Datamonitor: http://about.datamonitor.com/media/archives/645

European Functional Foods: Challenges beyond the Regulatory Milestone: http://www.foodlinkforum.com/publications/FH_15_EuropeanFunctionalFoods_ChallengesBeyondRegulatoryMilestone.pdf

EU R&D on functional foods: http://www.functionalfoodnet.eu/asp/default.asp?p=6

FAHRE (Food and Health Research in Europe): http://www2.spi.pt/fahre/

Federal R&D summaries (US: http://www.osti.gov/fedrnd/

Functional food in Europe Union report: http://www.functionalfoodnet.eu/asp/default.asp?p=6

'Functional foods: an ecologic perspective': http://www.ajcn.org/content/71/6/1728S.full.pdf

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Health at a Glance: Europe 2010 (OECD) Report: http://sup.kathimerini.gr/xtra/media/files/var/health_europe.pdf

Human Nutrition Research Information Management at the NIH: http://hnrim.nih.gov/

International Scientific Conference on Nutraceuticals and Functional Foods: http://www.foodandfunction.com/

'Nestlé: The unrepentant chocolatier: The world's biggest food company is betting on an emerging class of health and nutrition products to spur its growth. But risks abound': http://www.economist.com/node/14744982

NIH's ODS Strategic Plan: http://ods.od.nih.gov/pubs/strategicplan/StrategicPlan2010-2014.pdf

NIDDK (National Institute of Diabetes and Digestive and Kidney Disease): http://www2.niddk.nih.gov/

US FDA Budgets: http://www.fda.gov/AboutFDA/ReportsManualsForms/Reports/BudgetReports/default.htm

US Nutritional Policy Research (Mathematica, Inc.): http://www.mathematica-mpr.com/nutrition/

Webinar on evaluation of EU Diet, Physical Activity and Health platform: http://www.eufic.org/page/en/page/MEDIACENTRE/fftid/Webinar_on_evaluation_of_EU_platform/

'WIC food package should be based on science: foods with new functional ingredients should be provided only if they deliver health or nutritional benefits?' (Center on Budget and Policy Priorities): http://www.cbpp.org/cms/index.cfm?fa=view&id=3201

Annex A: Brief overview of funding agencies and relevant databases

United States of America

National Institutes of Health (NIH)

The National Institutes of Health (NIH) is the federal biomedical research agency in the United States, consisting of 27 institutes and centres, and is a component of the US Department of Health and Human Services (DHHS). It remains the primary federal agency that conducts, supports and promotes basic, clinical and translational medical research.

RePORT (Research Portfolio Online Reporting Tools)

This website, developed by the NIH, is part of an overall NIH effort to enhance public accessibility to reports, data and analyses of the agency's research activities. It includes both NIH expenditure and the findings of NIH-supported research. This report made use of one of the tools available on the RePORT site – the RePORTER (RePORT Expenditures and Results) module. RePORTER is an electronic tool that enables users to search a repository of NIH-funded research projects and access publications and patents resulting from NIH funding (http://report.nih.gov/index.aspx).

In January 2009, the NIH also added the Research, Condition, and Disease Categorization (RCDC) reports to the RePORT website. The RCDC is a computerised process used by the NIH at the end of each fiscal year to sort and report the amount it funded in each of 218 reported categories of disease, condition or research area (http://report.nih.gov/rcdc/).

Division of Nutrition Research Coordination (DNRC)

The DNRC has been established to co-ordinate nutrition research and training initiatives across the institutes and centres of the NIH. This report used the Human Nutrition Research Information Management (HNRIM) system – a searchable online database of nutrition research and research training activities. In addition, research for this report covered a document entitled *Financial Report, FY 2007: NIH Program in Biomedical and Behavioral Nutrition Research and Training* (http://hnrim.nih.gov/Report/Reports.asp).

Office of Dietary Supplements (ODS)

The ODS at the NIH has been established to evaluate scientific data on dietary supplements and serves to support and disseminate research results (http://ods.od.nih.gov/About/Budget.aspx).

Centers for Disease Control and Prevention (CDC)

The CDC is a federal agency tasked with the protection of public health and safety by providing information to enhance health decisions (through research, policy and advocacy). The CDC develops and applies disease prevention and control, particularly in infectious diseases, environmental health, occupational safety and health, health promotion, injury prevention and education activities. In terms of food research and food-related initiatives, the CDC focuses on both food safety and nutrition. Budgetary data for the CDC was accessed at the Financial Management Office (http://www.cdc.gov/fmo/).

United States Department of Agriculture (USDA)

The USDA is the federal department responsible for the development and application of US federal government policy on farming, agriculture and food. It largely aims to meet the needs of food

producers (i.e. farmers and ranchers), support agricultural trade and production, promote food safety and develop nutrition policies. There is a strong research agenda within the USDA.

Agricultural Research Service (ARS) – Human Nutrition Program

The ARS is the principal in-house research agency of the USDA. One of the areas of research is in 'Human Nutrition', and the ARS maintains a network of six Human Nutrition Research Centers, and several other locations, that are working on the identification of phytochemicals (naturally occurring chemicals in plants) and other properties of foods that may confer a health benefit in humans (http://www.ars.usda.gov/research/programs/programs.htm?NP_CODE=107).

Food and Drug Administration (FDA)

The FDA is the federal agency that is primarily responsible for the regulation and supervision of food safety, tobacco products, dietary supplements, prescription, and over-the-counter pharmaceutical drugs (medications), vaccines, biopharmaceuticals, blood transfusions, medical devices, electromagnetic radiation-emitting devices, veterinary products and cosmetics. Budget summaries were accessed at http://www.fda.gov/AboutFDA/ReportsManualsForms/Reports/BudgetReports/default.htm.

Center for Food Safety and Applied Nutrition (CFSAN)

CFSAN is the FDA's branch that regulates food, dietary supplements and cosmetics. In addition, there are two main research groups outside the FDA that have a direct impact on the CFSAN – the Joint Institute for Food Safety and Applied Nutrition, and the National Center for Food Safety and Technology. A budget summary was accessed from FY 2008 at http://www.fda.gov/downloads/AboutFDA/ReportsManualsForms/Reports/BudgetReports/2008FDABudgetSummary/ucm122217.pdf

Congressional Budget Office (CBO)

The CBO is a federal, non-partisan agency within the legislative branch of the US government, which provides economic data to Congress. Expenditure data was accessed at http://www.cbo.gov. In addition, a June 2007 report on federal R&D spending was reviewed: http://www.cbo.gov/ftpdocs/82xx/doc8221/06-18-Research.pdf.

National Science Foundation (NSF)

The NSF is an independent US government agency responsible for promoting science and engineering through research programmes and education. For the purposes of this report, a report entitled *Federal Funds for Research and Development: Fiscal Years 2007–09*[20] was accessed and reviewed: http://www.nsf.gov/statistics/nsf10305/pdf/nsf10305.pdf.

European Economic Area

European Commission Seventh Framework Programme

The Seventh Framework Programme for Research and Technological Development (FP7) is the EU's primary instrument for funding research across Europe for 2007–13. FP7 is also designed to respond to Europe's employment needs, competitiveness and quality of life. Budget data for FP7 were identified in a report from the European Commission's website (http://ec.europa.eu/research/fp7/pdf/fp7-factsheets_en.pdf). The overall budget for FP7 is

[20]The NSF indicates that federal agencies have to report annually obligations or outlays incurred or expected to be incurred in that year, no matter when the agencies' funds were authorised, appropriated or received.

approximately **€50.5 billion**. FP7 is broken into four primary areas for funding; a) co-operation (collaboration research); b) ideas (European Research Council); c) people (Marie Curie schemes); and d) capacities (research capacities). Within 'co-operation' (with a budget of approximately **€32 billion**), the EU supports the so-called themes of 'health' (**€6 billion**), 'food, agriculture and fisheries, and biotechnology' (**€1.9 billion**) and others (see Figure 7). For FY 2011, the budget for 'health' R&D has been estimated at **€682 million**.[18]

The long-term objective of funding the 'food, agriculture and fisheries, and biotechnology' research theme is to build a European Knowledge Based Bio-Economy (KBBE). This theme is based on three primary activities: a) sustainable production and management of biological resources from land, forest and aquatic environments; b) fork to farm: food (including seafood), health and well-being; and c) life sciences, biotechnology and biochemistry for sustainable non-food products and processes.

The EC supports public/private partnerships called European Technology Platforms (ETPs), which are industry-led and focus on driving innovation in key European industry sectors. ETP Food for Life was created in 2005 to address how to foster innovation in the agri-food sector, currently the largest manufacturing sector within the EU. At the website of the CIIA (the Confederation of the food and drink Industry of the EU), there is a searchable research-project database (http://etp.ciaa.eu/asp/links/research_project.asp), with an option to search for 'food and health'. Seventy-eight projects (ongoing and completed) are currently included.

Eurostat

The online Eurostat system is the largest source of statistics on the European Union and candidate countries. One of the key objectives of Eurostat is to facilitate what it deems the 'harmonisation of statistical methods across the Member States of the EU, candidate countries, and European Free Trade Association (EFTA) countries'. The home page of Eurostat is http://epp.eurostat.ec.europa.eu/portal/page/portal/eurostat/home/.

A relevant report to this project is a publication on R&D expenditure across Europe that has a section entitled 'methodological notes', which is particularly useful: (http://epp.eurostat.ec.europa.eu/cache/ITY_OFFPUB/KS-SF-08-091/EN/KS-SF-08-091-EN.PDF).

Food and Health Research in Europe (FAHRE)

A recent initiative entitled Food and Health Research in Europe (FAHRE)[21] seeks to increase the structuring of food and health research and support. One of its primary aims is to create what it describes as a 'comprehensive map of food and health research funding and policy development in the European Economic Area'. As part of this initiative, FAHRE is working on identifying key stakeholders and processes involved at regional, national and transnational level, and also conducting an assessment of needs and capacities in food and health researchers. There are country-specific reports available at http://www2.spi.pt/fahre/.

Community Research and Development Information Service (CORDIS)

CORDIS is a comprehensive information resource for EU research and development activities. CORDIS serves as the official information source for publication of all calls for proposals under FP7. http://cordis.europa.eu/search/index.cfm?fuseaction=search.advanced.

[21] FAHRE and C3 Collaborating for Health are in the process of forging a partnership, given their mutual interest in chronic disease prevention.

United Kingdom

Department for the Environment, Food and Rural Affairs (Defra)

Defra is a Government Department in the United Kingdom. It makes policy and legislation and works with others to deliver policies in such areas as:

- the natural environment, biodiversity, plants and animals
- sustainable development and the green economy
- food, farming and fisheries
- animal health and welfare
- environmental protection and pollution control
- rural communities and issues

Defra is responsible for food labelling not related to food safety or nutrition in England.

Medical Research Council (MRC)

The MRC exists to improve human health through world-class medical research. To achieve this, it supports research across the biomedical spectrum, from fundamental lab-based science to clinical trials, and in all major disease areas. It works closely with the NHS and the UK Health Departments to deliver its mission, and gives a high priority to research that is likely to make a real difference to clinical practice and the health of the population. The MRC receives annual 'grant-in-aid' funding from Parliament through the Department for Business, Innovation and Skills (BIS). Although government-funded, the MRC is independent in its choice of which research to support.

Biotechnology and Biological Sciences Research Council (BBSRC)

BBSRC is one of seven Research Councils that work together as Research Councils UK (RCUK). It is funded from the Government's Department for Business, Innovation and Skills (BIS).

BBSRC's current budget is £470 million. It supports a total of around 1,600 scientists and 2,000 research students in universities and institutes in the United Kingdom. It has two key roles:

- to promote and support, by any means, high-quality basic, strategic and applied research and related postgraduate training relating to the understanding and exploitation of biological systems;
- to advance knowledge and technology (including the promotion and support of the exploitation of research outcomes), and provide trained scientists and engineers, which meet the needs of users and beneficiaries (including the agriculture, bioprocessing, chemical, food, healthcare, pharmaceutical and other biotechnological related industries), thereby contributing to the economic competitiveness of the United Kingdom and the quality of life.

Scottish Government

The devolved government for Scotland is responsible for most of the issues of day-to-day concern to the people of Scotland, including health, education, justice, rural affairs and transport. The Scottish Government was known as the Scottish Executive when it was established in 1999 following the first elections to the Scottish Parliament. The current administration was formed after elections in May 2007.

Food Standards Agency (FSA)

The Food Standards Agency is an independent government department set up by an Act of Parliament in 2000 to protect the public's health and consumer interests in relation to food. The

Food Standards Agency is responsible for food safety and food hygiene across the UK. It works with local authorities to enforce food safety rules and have staff who work in UK meat plants to ensure that the requirements of the regulations are being met. It also commissions research related to food safety.

Department of Health

The work of the Department of Health centres around three strategic objectives.

- **Better health and well-being for all**: helping people stay healthy and well; empowering people to live independently; and tackling health inequalities.
- **Better care for all**: the best possible health and social care that offers safe and effective care, when and where people need it; and empowering people in their choices.
- **Better value for all**: delivering affordable, efficient and sustainable services; contributing to the wider economy and the nation.

It is responsible for nutrition policy, including nutrition labelling, in England.

Engineering and Physical Sciences Research Council (EPSRC)

The EPSRC is the main UK government agency for funding research and training in engineering and the physical sciences, investing more than £850 million a year in a broad range of subjects – from mathematics to materials science, and from information technology to structural engineering.

Department of Agriculture and Rural Development (DARD)

The Department of Agriculture and Rural Development aims to promote sustainable economic growth and the development of the countryside in Northern Ireland. The Department assists the competitive development of the agri-food, fishing and forestry sectors of the Northern Ireland economy, having regard for the needs of consumers, the welfare of animals and the conservation and enhancement of the environment.

Economic and Social Research Council (ESRC)

The ESRC funds research and training in social and economic issues. It invested more than £211 million in 2009–10, funding over 2,500 world-leading social science researchers and supporting more than 3,000 postgraduate students. It is a non-departmental public body established by Royal Charter in 1965 and receives most of its funding through the Department for Business, Innovation and Skills.