Economic impact of the Institute of Food Research

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Executive Summary

The Institute of Food Research (IFR) is a not-for-profit organisation sponsored by the Biotechnology and Biological Sciences Research Council (BBSRC).

IFR commissioned DTZ to undertake a statement of its economic impact in 2008. However, given the scale and breadth of IFR's work, it does not represent a comprehensive assessment, rather a snapshot.

IFR addresses a range of 'market failures' that provide the rationale for its support from Government. These failures are summarised in the following table.

Summary of market failures addressed by IFR		
IFR key activity	**Funding justification (Key market failure)**	**Nature of failure**
Strategic food research (food safety, microbial modelling, health and quality)	Externalities	Fundamental research is time consuming and uncertain in its outcomes. The food industry deals in bulk and short-term horizons and may not invest, reducing the availability of improved quality, safe food products. A central, high quality repository of food safety data is desirable.
Advice to Government Consumer and Social Science	Public good Information failure	Little incentive for any individual to bear the cost of food improvement / health promotion as this leads to a free-rider problem: those who don't pay still enjoy the benefits. Consumers may lack the skill to understand the risks of certain purchases, and lack the capacity to gather this information individually and independently.

The activities of IFR have a financial impact and provide benefits to the economy via its operating impact, final market impacts and wider qualitative benefits.

Operating Impacts

Summary of IFR operating impacts, UK level				
Impact type	**Output £ Million**	**Employment FTEs**	**Income £ Million**	**GVA £ Million**
Direct	£17.1	247	£9.9	£9.9
Indirect	£12.4	121	£3.4	£5.5
Induced	£13.2	157	£3.4	£6.8
Total	**£42.7**	**525**	**£16.7**	**£22.3**

Final Market Impacts

The calculations of final impacts for IFR are set out below under four headings:

Food Safety

- The added value of IFR work supporting UK processed chilled products is estimated to be £22.8 million per annum.
- If ComBase, a predictive microbiology tool, saves the EU food sector even 1% of its R&D budget, this is worth £22 million per annum.
- Extending the shelf life of products through IFR's work saves UK consumer wastage valued at £24.6m per annum.
- The potential value of reducing personal food-borne bacterial poisoning in the UK is some £60 million per annum

Food Health and Quality

- IFR has demonstrated organoleptic/nutritional benefits worth £6.8 million per annum to the UK eggs and broccoli markets.
- IFR has potential to demonstrate a further £100m of potential global benefits per annum from research into healthy gut and allergy work.

Social impacts

There is consumer evidence to show the high value that UK consumers attach to official advice on food safety which is underpinned by IFR science.

Cross Cutting Impacts

- Income from commercial sources to IFR is estimated to generate an additional £5.5 million GVA in the economy per annum.
- IFR receives £111k per year of royalty income.
- IFR supported commercialisation of Botulinum toxin which could be valued at £12.6 million for the company concerned.

1.0 Introduction

RCUK wishes all research councils to have institutes prepare statements of their economic impact by end of March 2008. These statements will be used to justify the UK government spend on science and technology and to inform where best value for money is being achieved.

The Institute of Food Research (IFR) is a not-for-profit organisation sponsored by the Biotechnology and Biological Sciences Research Council (BBSRC).

The BBSRC's delivery plan 2008 – 2011: "Delivering Excellence with Impact" outlines the priority areas for the current funding period. These are summarised as:

1. Ensuring the continued health and international competitiveness of UK biosciences;
2. Driving a step-change in the economic and social impact of funding;
3. Providing the skilled people upon which the science base and bio-industries depend;
4. Tackling major policy and societal long-term and multidisciplinary challenges; and
5. Securing national research capability and unique facilities in key strategic areas.

To this end, it is increasingly important to understand the benefits and market impacts generated through each of the funded research institutes.

IFR commissioned DTZ to undertake the work necessary to help produce a statement of its economic impact.

The activities of IFR have a financial impact and provide benefits to the economy via a number of routes:

- **The operating impact:** this occurs as IFR's income contributes to national GDP, expenditure is incurred with suppliers, staff are employed and salaries earned. This impact is achieved regardless of the level of research success.
- **Final market impacts:** these occur as the outcomes of IFR's research are applied in the market, through use of products or implementation of strategic advice. This can capture new positive impacts (such as improved sales) and avoidance of negative impacts (such as food wastage).
- The work of IFR generates a number of **wider social and environmental benefits** that are intangible, and difficult to quantify in terms of additional turnover or jobs.

This report highlights and quantifies the range of economic impacts generated around the UK through the on-going research of IFR. It also describes key achievements of the institute since its inception and identifies a range of non-quantifiable benefits attributable to IFR.

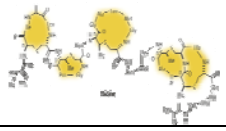
2.0 Background to the Institute

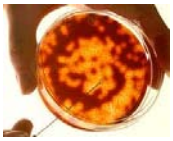
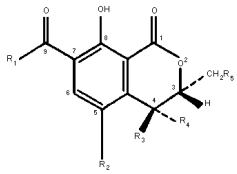
The predecessor to IFR was first set up and sponsored by the Government in 1917 to undertake organised food research to avoid the perceived risk of starvation due to post-harvest losses. Since then its role has evolved to provide impartial multidisciplinary science of international status, focusing research across a range of food and nutrition-related disciplines with the goal of providing evidence for how food can be a means of improving the health of individuals and of preventing or reducing the risk of food-related diseases.

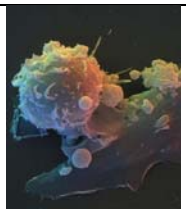
IFR has its roots in a number of organisations:

- The DSIR Low Temperature Research Station, Cambridge
- The Ditton Laboratory (specialising in fruit transport)
- The National Institute for Research in Dairying (later the Institute of Food Research, Reading Laboratory)
- The Food Research Institute (later the Institute of Food Research, Norwich Laboratory)
- The Meat Research Institute (later the Institute of Food Research, Bristol Laboratory)
- The Long Ashton Research Station (for example research on cider and perry, the Total Diet Study)

The following timeline summarises a selection of IFR's key achievements since it's foundation:

YEAR	Overview of Achievements	
1930s		Pioneering work to support the concept of controlled storage e.g. transport of fruit, meat to the UK; UK storage of field crops, fruit and meat.
1944		FIRST description by NIRD of nisin (Nature **3913** p 551) – a highly profitable commercialised food preservative. Platform for lantibiotic discovery and application.
Late 1960s		Work at the Institute demonstrated that chemicals used to treat timber were causing wood shavings to contaminate poultry stocks. Once the difficulty was understood and wood shavings were not used, the off-odours disappeared.
1970s		Prominent role in the development of the technique of Modified Atmosphere Packaging.
1979-1981		The Institute developed an alternative method for sterilising packaging before filling with UHT liquids, that was safer and more environmentally-friendly.

1980s		Collection of data on the growth and death of bacterial pathogens at the Institute served as the base on which the FIRST validated, commercialised predictive package, Food MicroModel was built.
1970s to 90s		Prominent role in the development of UK policy on dietary fibre.
Late 1980s		IFR examined the effect of Oat beta-glucans on the physical properties of gastrointestinal contents, which supported the evidence-base for Quaker Oats' 1996 application to FDA – the FIRST legitimised health claim on a food.
1980s to 90s		The FIRST quantitative immunoassay for the trace analyte, ochratoxin A, to be given Official First Action Status by AOAC International developed at IFR. Also an antibody-based ELISA assay for peanut marketed by a leading diagnostic company for industry use, with far higher sensitivity of detection than previously.
1998		Underpinning science to inform policy on the 5-a-day advice and promotional campaign.
1999		Underpinning science to inform policy on polyunsaturated fatty acid consumption
1990s	ALIZYME	IFR science was crucial in the development of a targeted device for drug release in the colon. Alizyme's COLAL® technology is currently being exploited for targeted delivery of an established anti-inflammatory steroid for local action at the site of disease.
1980s to 2000s		Underpinning science to inform policy development on mineral nutrition, and on risks:benefits of folic acid supplementation.

1980s to 2000s		Provided advice and research into the shelf-life of chilled foods to inform policy development and safe industry innovation.
2007		IFR scientists discover a vital molecule for resistance to food allergy, offering a potential target for therapy.

3.0 Why IFR receives funding

The HM-Treasury Green Book guidance states that there must be clear rationale for public sector interventions, and that:

"*This underlying rationale is usually founded either in market failure or where there are clear government distributional objectives that need to be met*"[1]

There is debate around the funding of research in the UK. For example, the Barnes Report,[2] classified agricultural and food R&D into two categories, a near market category (inappropriate for public funding) and fundamental research (which should receive public funding). On the other hand, a more recent 2004 DEFRA study[3] concluded that:

"the market failure concept continues to apply to the provision of near-market research in British Horticulture".

IFR's research is focused in both fundamental and strategic research, and its funding profile accordingly points to a mix of public and private sources. Commercial purchasers, and industry-focused research has led to a number of industrial co-operations, managed through the IFR Enterprises subsidiary.

This section looks at the key areas of IFR research and the rationale for public sector funding in each case.

[1] HM-Treasury, Green Book: Appraisal and Evaluation in Central Government, pp11
[2] *Report on a review of expenditure by the agricultural departments on research and dev*elopment C.J.A. Barnes for MAFF April 1988
[3] Report of the 2004 statutory review of the Horticultural Development Council, DEFRA July 2004

3.1 Research activities

IFR's core research areas have been, or are now broadly classified under the following headings:

Figure 2.1
Summary of IFR research activities

Research field	Workstreams	Research goals
Food Safety	▪ *Salmonella* ▪ *Clostridium botulinum* and *Clostridium perfringens* ▪ *Listeria* ▪ *Campylobacter* ▪ Combase (unified database)	▪ Increased product shelf life ▪ Waste reduction ▪ Downturn in incidence of food poisoning ▪ Advancement of safe REPFEDs products ▪ Advice to Government
Food & Health	▪ Lactic acid bacteria ▪ Microbiology and immunology of GI Tract ▪ Dietary fibre ▪ Folate fortification ▪ Phytochemicals (including super broccoli) ▪ Allergy / toxin testing ▪ Colal®	▪ Glycoalkaloids (anti-nutrients – e.g. safe potatoes) ▪ Health / diet improvement ▪ Preventative ▪ Pre/probiotic market ▪ ELISA tests (e.g. for mycotoxins) ▪ Advice to Government ▪ Encapsulation (pharma)
Food Quality	▪ Cold chain and low temperature storage ▪ Modified Atmosphere Packaging ▪ Taints in eggs/poultry ▪ Texture / freeze drying ▪ Food design ▪ Emulsifiers ▪ Colloids ▪ Acceptability	▪ Reduce wastage ▪ Fat reduction ▪ Food transport ▪ Improved look ▪ Encapsulation (nutriceuticals) ▪ Improved food properties
Social Impacts	▪ Consumer choice ▪ Risk communication ▪ Dealing with uncertainty ▪ Risk assessment	▪ Improved consumer understanding of products and risks ▪ Minimised risk of food-based bacterial infection

3.2 Addressing market failure

Market failure is when the market, by itself, has not and cannot be expected to deliver an efficient outcome. Thus, any research intervention must seek to redress this failure in the market. Market failures can be qualitatively applied to each area of activity within IFR, indicating the requirement for research regardless of the financial value of impacts.

There are a number of factors to consider in setting out the market failure relevant to government intervention in food research (and BBSRC sponsorship of IFR) and these are discussed below under the following headings:

- Externalities
- Public goods
- Information asymmetry

Externalities

"'Externalities' result when a particular activity produces benefits or costs for other activities that are not directly priced into the market. Externalities are associated with, for example, research and development spill-overs, and environmental impacts, such as pollution."[4]

In summary, the implied under-supply of food research in the absence of government intervention is due to the fact that the companies' private benefits from actions taken to produce more health and environmental benefits are smaller than the benefits to society as a whole.

Furthermore, there are externalities related to research and development (R&D), particularly fundamental research where ideas are difficult to patent so the financial return on research is lower than the total social return. Therefore, public funding is provided to address the market failure. The Barker Report into Food Poverty (2006) notes this in the context of nutrition research:

"*whilst the poorest consumers may have needs that differ from the average consumer, the market should still serve those needs. Our work indicates that communities continue to experience market failure in the provision of nutritious food*"[5]

It is widely recognised that any ground-breaking innovation introduced by one company will, in the absence of patent protection, readily be copied by other players. When it comes to food quality and safety, all members of society should benefit rather than those able to pay.

[4] *The Green Book – Appraisal and Evaluation in Central Government* HM Treasury, Crown copyright
[5] Food Poverty and the OFT's Consultation – referenced by HM-Treasury, available at: http://www.hm-treasury.gov.uk/media/A/A/barker2_interimResponse_FoodPoverty_85.5kb.pdf

Public goods

"The market may have difficulty supplying and allocating certain types of products and services, such as 'public goods'. Public goods are those that are 'non-rival' or 'non-excludable' when used or consumed. 'Non-rival' means that consumption of the good by one person does not prevent someone else using or consuming that good. 'Non-excludable' means that if a public good is made available to one consumer, it is effectively made available to everyone. Non-excludability can give rise to a problem known as 'free-riding'."[6]

Public goods are those that provide social benefits that are large in comparison to their private benefits. Government intervention is necessary to achieve public good investment in food research that may benefit all of industry through reduced disease, improved yield or improved understanding of productivity. IFR has an important role in providing scientific knowledge to organisations such as the Food Standards Agency. Without a solid scientific base, public good information relevant to food quality, safety and health will not be available and the FSA will not be able to function. This kind of knowledge is particularly important in relation to prevention or response to food scares.

Information Asymmetry

"Information is needed for a market to operate efficiently. Buyers need to know the quality of the good or service to judge the value of the benefit it can provide. Sellers, lenders and investors need to know the reliability of a buyer, borrower or entrepreneur. This information must be available fully to both sides of the market, and where it is not, market failure may result. This is known as 'asymmetry of information'."[7]

In addition to the issues described above relating to information asymmetry, which are related to the distribution of information, are issues concerning the overall level of information available in the market. In terms of information, there are often high costs of production but low costs of subsequently transmitting it that may dampen incentives to produce information given the difficulties of controlling its usage by other parties (limited excludability). This can ultimately lead to low levels of available information. The subsidising or funding of R&D activities by Government is one way of addressing these market tendencies.[8]

Combase (a joint venture by IFR, the UK Food Standards Agency and US Department of Agriculture) also addresses this failure by offering information on how bacteria behave in foods. The database brings together data generated by each of the parties, and other contributing organisations. It is freely available on the internet to manufacturers, producers and researchers with an interest in food safety. The system has become a vital tool to assure the safety of foods in international trade. The use of ComBase avoids unnecessary repetition of experiments, increases the efficiency of research efforts; improves food safety and quality; standardise the data sources for microbial risk assessors, which will reduce the potential for trade disputes.

[6] *The Green Book – Appraisal and Evaluation in Central Government* HM Treasury, Crown copyright
[7] *The Green Book – Appraisal and Evaluation in Central Government* HM Treasury, Crown copyright
[8] *Economics of regulation, charging and other policy instruments with particular reference to farming, food and the agri-environment – A supporting document for Partners for success – a farm regulation and charging strategy* Tim Keyworth and George Yarrow, Regulatory Policy Institute, Oxford for Defra, October 2005

Summary of failures addressed by IFR

Figure 2.3 - Summary of market failures addressed by IFR		
IFR key activity	**Funding justification (Key market failure)**	**Nature of failure**
Strategic food research (food safety, microbial modelling, health and quality)	Externalities	Fundamental research is time consuming and uncertain in its outcomes. The food industry deals in bulk and short-term horizons and may not invest, reducing the availability of improved quality, safe food products. A central, high quality repository of food safety data is desirable.
Advice to Government Consumer and Social Science	Public good Information failure	Little incentive for any individual to bear the cost of food improvement / health promotion as this leads to a free-rider problem: those who don't pay still enjoy the benefits. Consumers may lack the skill to understand the risks/benefits of certain purchases and behaviours, and lack the capacity to gather this information individually and independently.

4.0 Operating impact of IFR

4.1 Modelling approach

The economic impact of operating IFR measures both the activity relating to the on-site running of the Institute, such as expenditure incurred and staff employed, and also the knock-on effects as these expenditures ripple through the UK economy and support further activities. The total economic impact of operating IFR therefore encompasses three distinct elements:

1. **Direct impact:** output generated and persons employed in the day-to-day operation of the Institute, on-site in Norwich:

2. **Indirect impact:** output and employment created in the businesses which supply the inputs or materials used by the Institute; and

3. **Induced impact:** output and employment created when workers employed directly or indirectly spend their incomes in the local economy.

Direct impact

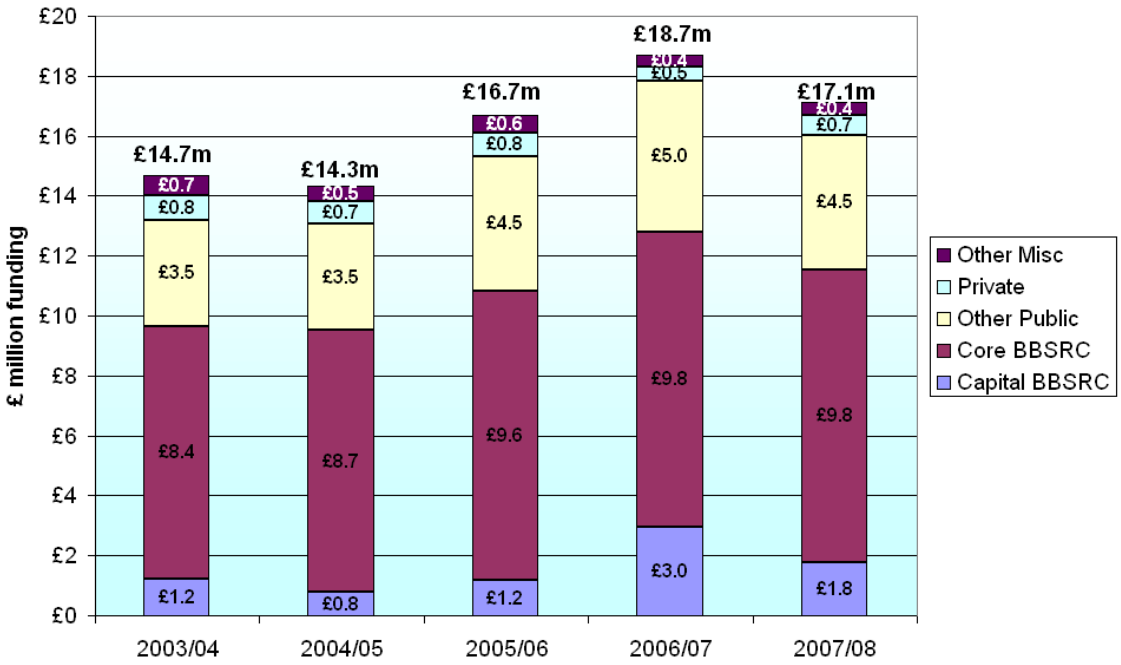
IFR employs **247 FTE staff** (full time equivalents) and had an income of **£17.1 million** in 2007/08. Output per head is therefore some £69,300 for IFR staff: a common indicator of productivity. As IFR operates as a not-for-profit organisation it is not suprising that this is below the UK average for natural science research activities (£116,600 in 2006[9]), and this difference can largely be explained by the profit margins generated by private sector research.

In addition, in 2007, IFR had 29 PhD students (two joint with UEA Institute of Health) and an average of 20 occasional visiting scientists. These students receive a stipend which varies according to the sponsor. Visiting scientists are supported by their host institutions, or by EU funding for training purposes.

Figure 4.1 illustrates IFR's income by source over the last 4 years. Between 2003/04 and 2007/08, total income has grown by some £3.4 million, driven by increases in core and other public funding. The total level and share of private and other funding has broadly decreased year-on-year. This suggests that IFR has reduced its focus on strategic research, and is increasingly concentrating on fundamental research. Thus, it is increasingly reliant on continued public support to address the market failures associated with fundamental research.

[9] ONS, 2006 Annual Business Inquiry, Crown Copyright

Figure 4.1 – IFR income by source, 2004-07

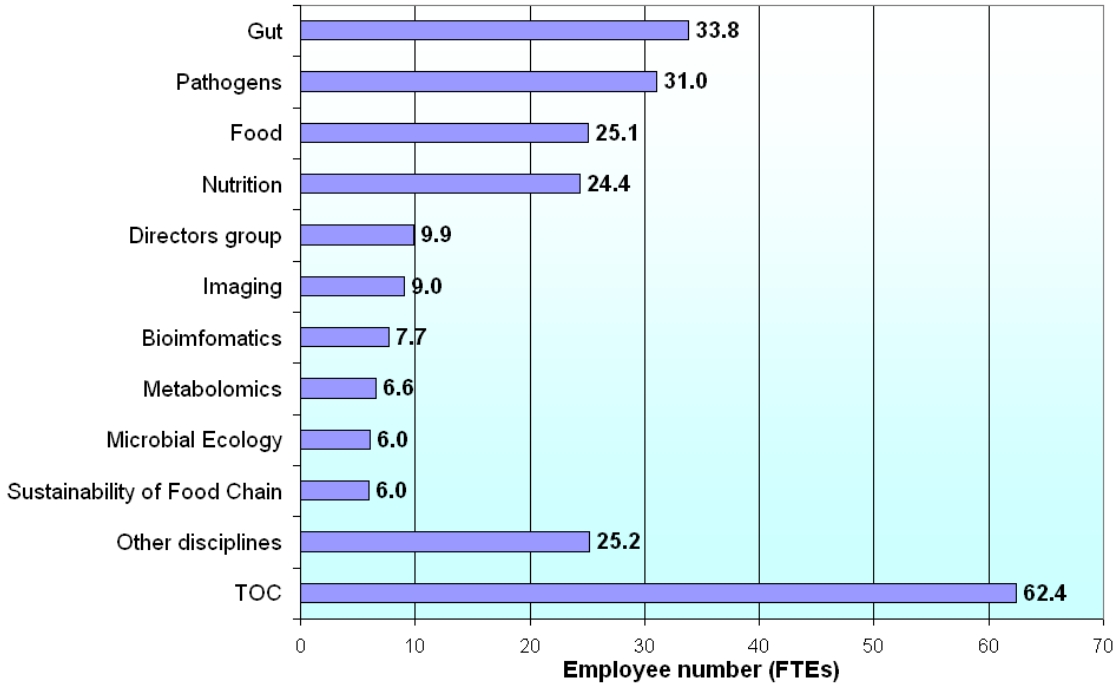


The 247 FTE staff number comprises 185 within science-based departments and 62 from TOC central services. TOC is a shared service between IFR and the neighbouring John Innes Centre, with IFR being allocated a 4/11 share. Over the last 3 years, scientific staff numbers have fallen by 24 FTEs, from 209 in 2005 to the current level of 185. Staff numbers within central services have also decreased over the period (-11 FTEs). This decrease has been achieved through sharing services with JIC.

Gut health and pathogen research are the largest single research areas in terms of scientist numbers. In total, 10 separate areas have more than 10 employees each, forming the majority of IFR activity. This pattern is summarised in Figure 4.2 (note: other disciplines comprises 9 areas[10], each area with <5 staff):

[10] Natl Col Yeast Cultures, Laboratory Attendants, Consumer Science, Science Operations, MRI, Model Gut, IFR Media Laboratory, Proteomics, Transcriptomics

Figure 4.2 – FTE Employee numbers by area, 2007

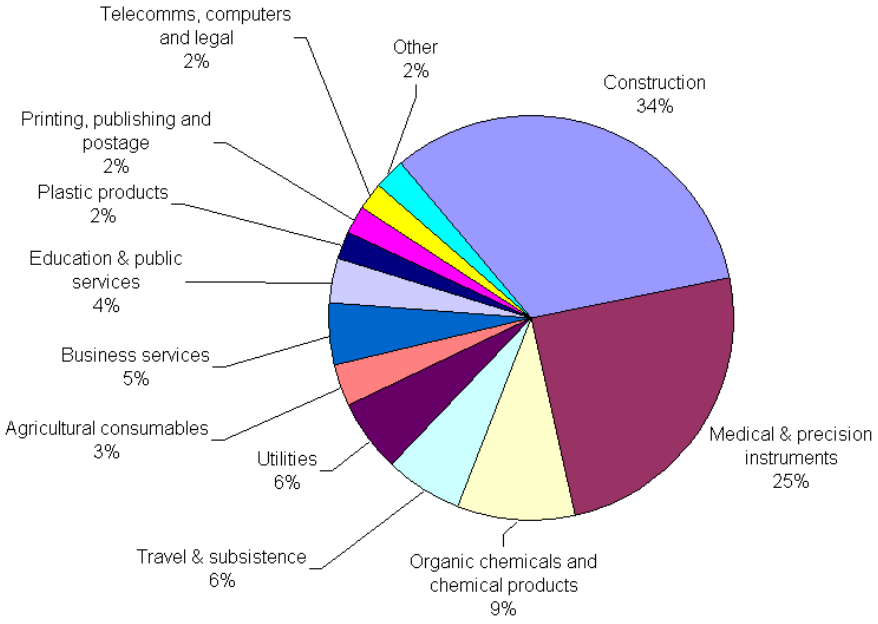


Source: Human Resources, Norwich BioScience Institutes

Indirect impact

IFR spent £7.1 million with suppliers in 2007, of which £6.8 million was with UK-based suppliers. This supplier expenditure forms the inputs for calculating the indirect operating impact of IFR. Figure 4.3 summarises the key areas of supplier expenditure by value.

Figure 4.3 – Components of IFR expenditure, 2007



In 2007, construction was the most significant component of expenditure, major redevelopment in the IFR1 building, and other more minor site-works. There was also significant investment in capital equipment (classified here together with medical and precision instruments). These investments boosted total supplier expenditure by c. £1.4 million from 2006. Consumables including chemicals, chemical products and plastic products are also a significant component of expenditure.

This profile of supplier expenditure supports output and employment amongst supplier industries, and their suppliers in turn. The extent of this impact can be estimated using the UK National Accounts published by the ONS, estimating the level of expenditure required to support an FTE job in each supplier, and their knock-on expenditure.

In total for 2007, IFR's supplier expenditure is estimated to **indirectly generate a total of £12.4 million output for UK industries, supporting 121 FTE jobs**. This comprises 70 FTEs in those UK companies directly supplying IFR, and a further 51 employed through further supply chain effects (i.e. as IFR's suppliers purchase inputs in-turn from their suppliers, which is still attributable to IFR's initial demand).

Induced impact

Total salaries paid to directly employed IFR staff amounted to £9.3 million for 2007, while salaries paid to those employed indirectly are estimated at £3.4 million. In total, this £12.7 million of direct and indirect salaries accrues to households and will then be spent on a profile of consumer goods and services, generating further economic activity in the UK. This forms the basis for IFR's induced impact.

In addition, the students working with IFR will earn and spend additional income in the area, which is not included within the above staff salaries. In 2007 there were 29 PhD students at the Institute. Assuming an income of £21,000 per annum for each student (comprising a £12,000 stipend and £9,000 University contribution), this gives total additional income of £609,000 per annum. This will also contribute to local induced impacts.

Modelling this household income using an average consumer profile across the UK, the **total induced impact of IFR operation amounts to output of £13.2 million, supporting a further 157 FTE positions with associated income of £3.4 million**. While these induced impacts can be attributed to IFR, they will largely occur in sectors out-with the profile of direct and indirect industries, occurring instead in consumer industries such as retail and recreational services.

4.2 Summary of operating impacts

Figure 4.4 summarises the above effects, estimating the total gross impact of the operation of IFR at £42.7m of output, supporting incomes of £16.7m amongst 525 FTEs per annum in the UK. GVA is a measure of productivity which captures the level of salary expenditure and operating profits generated throughout the economy – the operating impact of IFR is estimated to generate £22.3m per annum GVA for the UK economy.

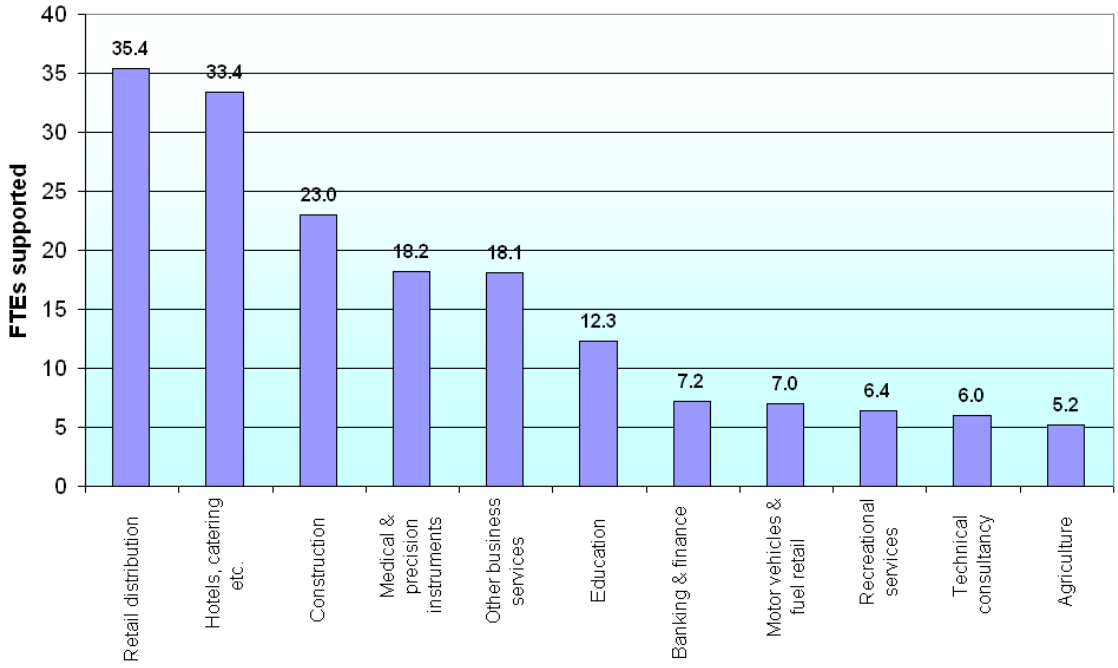
Multipliers illustrate the ratio of knock-on impacts to direct activity: the higher the multiplier, the more beneficial the impact. IFR's multipliers are broadly in-line with the UK R&D industry averages (which includes private sector research). At the margin, IFR has a higher than average output and GVA impact, but a lower employment and income multiplier. This can be caused by a number of factors, but suggests that IFR's suppliers are comparatively more productive than their counterparts elsewhere in the industry.

Figure 4.4
Summary of IFR operating impacts, UK level

Impact type	Output £ Million	Employment FTEs	Income £ Million	GVA £ Million
Direct	£17.1	247	£9.9	£9.9
Indirect	£12.4	121	£3.4	£5.5
Induced	£13.2	157	£3.4	£6.8
Total	**£42.7**	**525**	**£16.7**	**£22.3**
Multipliers				
Implied IFR multiplier	2.50	2.13	1.69	2.25
UK average multiplier	2.32	2.28	1.76	2.21

Figure 4.5 illustrates the profile of those off-site industries that proportionately gain the most from the operation of IFR. Results are presented for each industry in which more the 5 FTEs are supported through indirect and induced effects. The main beneficiaries are the retail and hotels/catering industries (through wage expenditure), followed by construction and manufacture/maintenance of medical instruments.

Figure 4.5 – Summary of FTE employment supported in core supply chain industries



5.0 Measuring the impact of IFR research

When measuring the impacts of IFR research, we need to understand the routes to market – the ways in which the research is used by producers or consumers to generate value for them. The range of IFR research is broad, and it is not possible to fully map the user profile in each case.

This report therefore focuses on known and likely impacts of the research. This approach offers the most robust impact measurement, but may under-estimate the full value of the research. Any missed financial impacts are therefore assumed to be captured by the further qualitative analyses in the subsequent section.

When attributing a value to these effects, the HM-Treasury's guidance offers the following definitions:

- **Market value**: the price at which a commodity can be bought or sold, determined through the interaction of buyers and sellers in the market.

- **Shadow price**: The opportunity cost to society of participating in some form of activity. It is applied in circumstances where actual prices cannot be charged, or where prices do not reflect the true scarcity value of a good. This approach is used to value non-market impacts (willingness to pay)

Real market prices can measure the strategic value-added to the UK economy through the use of IFR's research. These prices can take the form of new sales, avoidance of wastage, or sustaining activities that would otherwise diminish. This approach is not a "shadow" value, but related to actual impacts and GDP growth experienced at the national level. Using market prices will give an estimate of the actual impact of IFR in monetary terms, reflected in national accounting systems, while the further welfare benefits are recognised through qualitative research.

By contrast, the BERR (formerly DTI) proposes a system of shadow pricing when calculating the impact of speculative research. This involves the estimation of the value of proxy indicators associated with the outputs of research. This method allows research institutes to lay claim to a proportion of existing impacts, though by their nature these "shadows" do not relate to actual activity or economic growth, but a potential value of intangible welfare effects, such as health or environmental improvements.

This impact report attempts to capture both real market and shadow price effects to assess the full economic and social impact of IFR.

5.1 Final market impacts

The calculation of final impacts for IFR is set out below using the following headings:

- Food Safety
- Food Health and Quality
- Social Impacts
- Cross Cutting Impacts

5.1.1 Food Safety

Value for consumers through chilled foods advancement

Value is delivered for consumers or producers through any change in the cost of final products using IFR's contribution to chilled food technology.

For example, total sales of cook-chill ready-meal products in 2005 were £4bn, with an average pack price of £3[11].

It is difficult to separate the contribution of individual researchers in this field, however IFR estimates their contribution as a share of 1% of research. In actuality, sales of these products are absolute (all or nothing), and not achieved proportionately as research progresses. However, IFR contribution to the success of the research does offer a reasonable proxy to the attributable share of these total sales (1% * £4bn), equal to £40 million per annum.

However, it is also important to take displacement into account – sales of these products are not absolute new activity, but will be substitutes for sales of the same products, but with a lower degree of added-value processing. For example, sales of MAP and chilled chicken products are assumed to replace sales of fresh chickens.

Only the share of new value-added through chilled foods can be attributed to IFR (reflected in increased profit to producers, or saved cost for consumers). DEFRA industry estimates demonstrate that some 57% of total value of retail sales of meat products accrue to those providing advanced processing[12]. On this basis, **the added value of IFR work supporting processed chilled, ready-meal products is estimated to be £22.8 million per annum**.

Bagged salads did not exist before 1992. Now two thirds of households buy them regularly. The value of the UK salad vegetable market grew by 90 per cent between 1992 and 2002. By 2002 it was worth £1.25 billion[13]. IFR has made a significant contribution to the safety and quality of chilled salad products including cole slaw. Modified-atmosphere packaging (MAP) can extend the shelf life of prepared salad by more than 50 per cent and IFR was a leader in the underpinning science for this technology.

[11] Source: Eurostat/ Industry data presented in "*Clostridium Botulinum in VP and MAP chilled foods*
[12] Source: http://statistics.defra.gov.uk/esg/publications/auk/2006/table7-2.xls
[13] Source: Felicity Lawrence http://www.theecologist.org/archive_detail.asp?content_id=322

ComBase

The UK is a world-leader in predictive microbiology. IFR developed the database structure to pool available predictive microbiology data. ComBase is a combined database of microbial responses to food environments which brings together initiatives from both sides of the Atlantic, driven by IFR and funded by the US Department of Agriculture (USDA) and by the Food Standards Agency (FSA).

The FSA and USDA realised that it would be beneficial to incorporate data in IFR's common database. In 2006, the Ausralian Food Safety Centre of Excellence joined the Consortium. With EU funding the database was extended with reformatted data from European research institutions, and datasets from the scientific literature. This unified database is called ComBase.

A number of institutes/companies have joined the initiative as ComBase Associates: Food Research Department, University of Queretaro, Mexico; Safety and Environment Assurance Centre, Unilever Research, UK ; Department of Food Science and Technology, Agricultural University of Athens, Greece ; National Food Research Institute, Japan.

The system has become a vital tool to assure the safety of foods in international trade. The use of ComBase avoids unnecessary repetition of experiments, increases the efficiency of research efforts; improves food safety and quality; standardises the data sources for microbial risk assessors, which will reduce the potential for trade and liability disputes.

IFR has also developed various software tools (ComBase Predictor, Perfringens Predictor, DMFit), accompanying the database, to help users to asses benefits and limitations of predictive mathematical models. Both ComBase and GrowthPredictor have been designed to provide those involved in food safety (such as researchers, the food industry and those involved in public health) with easily accessible information to assist with design of challenge tests and risk assessment.

ComBase training is provided across the world in Europe, Asia and America. Over 375 people have been trained through 25 courses run since 2003. Each course has around 15 delegates from industry and academia attending.

Food companies participating in ComBase workshops include Del Monte Fresh Produce (UK) Ltd, the Co-operative Group, Nestle, Unilever, Uniq, Brindisi, United Biscuits (now Nabisco), Danish Meat Research FRES.CO s.r.l, and Istituto Zooprofalittico Sperimentale, Italy

Of about 1000 downloads of ComBase or predictive microbiology programs in a year more than half were from food industry. We can estimate the value of ComBase to the global food sector through willingness to pay to attend training and estimated savings in research effort.
Willingness to pay: 375 trainees for one day each
The average output per head of the UK food processing sector is £188,390[14], equivalent to £516 per day. This figure can be used as a proxy for output foregone to attend training. On this basis, 375 trainee days equates to £193,500.

[14] ONS, National Accounts

Savings in research effort by industry[15]: The top 15 food producers in the EU spent £2.2 billion on R&D in 2004. Food producers are consistently among the lowest spenders on R&D among all industry sectors. **If ComBase saves the food sector even 1% of its R&D budget, this is worth £22 million per annum.**

Wastage reduction

IFR's research into the preservation of food can also have market impacts through the reduction or prevention of current consumer waste levels, thus safeguarding food value for buyers. For example, innovations aimed at safely extending the shelf life of products by a week will avoid wastage due to food passing its 'use by' date.

Research by WRAP in 2007 illustrates that food wasted in the UK is valued at £8bn per annum. Of this total, 16% (or £1.3bn) was edible meat and fish. In the majority of cases, consumers stated that they had thrown out edible meat because of concerns over use by or best before dates. Therefore, safely extending shelf life by a week (or 2% of a year) could avoid that share of wastage. In this case, **extending the shelf life saves consumer wastage valued at £24.6m per annum**.

5.1.2 Food Health and Quality

Increased value generated through nutrition improvement

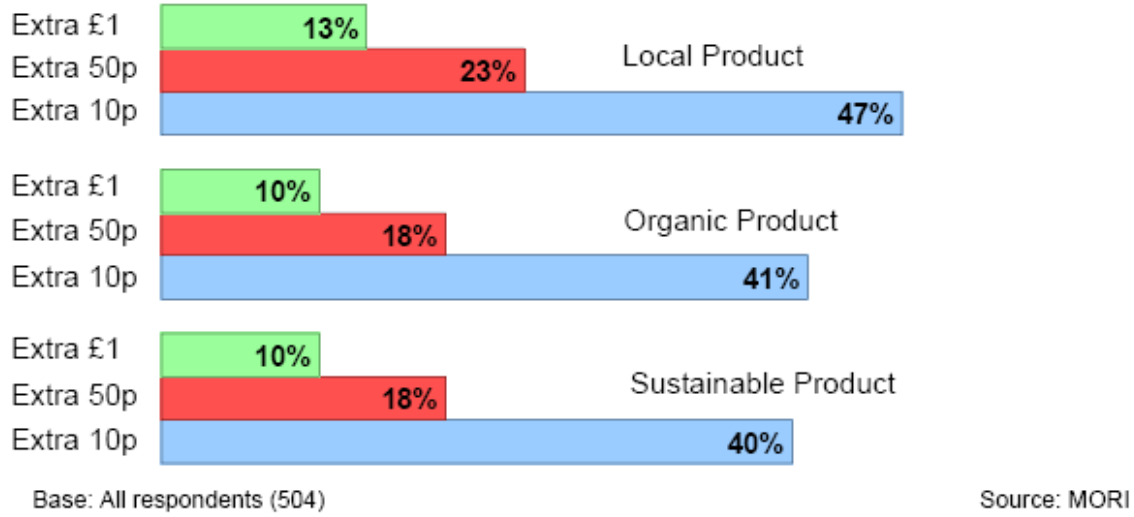
IFR's research into nutrition improvement across a number of food groups also adds value for consumers. This is reflected in consumers' willingness to pay a premium for goods with a higher fibre or nutrient content, in recognition of their health benefits.

IFR has worked jointly with JIC to develop the nutrient quality of broccoli. The so-called 'super broccoli' with its high isothiocyanate content is potentially linked to reduced incidence of cancer, modelled under laboratory conditions, with patient interventions in progress.

Research by IGD (The International Food and Grocery Information Service), demonstrates through consumer surveys that 36% of shoppers are willing to pay a premium for more nutritious food. It is generally acknowledged that further research is required to estimate the exact rate that consumers are willing to pay for improved nutrition, but surveys offer a fairly consistent picture across other positively viewed attributes. For example, Figure 5.4 demonstrates the measured willingness to pay for local, organic and sustainable products that would normally cost £5, as measured by the Countryside Agency:

[15] http://www.confectionerynews.com/news/ng.asp?n=64500-unilever-nestle-research-and-development

Figure 5.4 – demonstrated willingness to pay for desirable food characteristics



On this basis, with 36% of consumers willing to pay more for nutrition, with an average mark up of 5% generally accepted for beneficial food attributes, this would allow a rate of 1.8% of the total value of any markets where IFR has significantly contributed to nutritional values to be attributed to the research. This offers a "shadow price" approach to measurement, given that markets may not actually be charging the full amount that consumers have stated they are willing to pay.

For example, on this basis **the impact of JIC's and IFR's broccoli nutrient enhancement is therefore estimated at £0.5 million per annum in the UK** alone, based on a market value of £30 million (source: Defra).

Applying this rate to selected markets where IFR has demonstrated, or has potential to demonstrate organoleptic/nutritional benefits gives the following results:

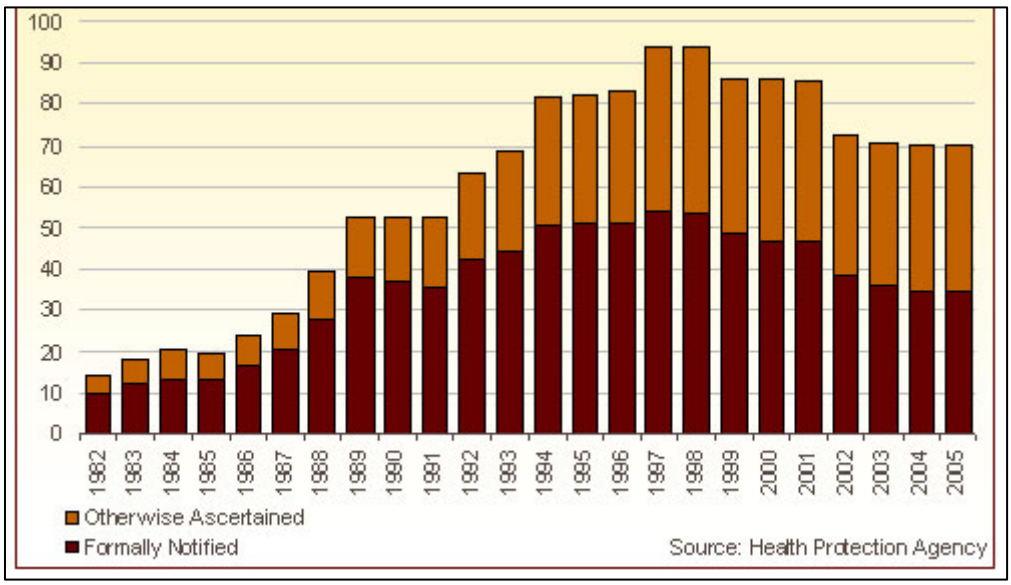
Food group	**Total UK market value[1] 2006 £ million**	**Premium attributable to IFR 2006 £ million**
Egg taints	£357	£6.2
Broccoli / other brassicas	£30	£0.5
Health proposition market	**Est. global market value[2] £ million**	**Potential premium attributable to IFR £ million**
Gut (probiotics / prebiotics / dietary fibre)	£3,080	£54.3
Immune (allergy research)	£2,525	£44.5
[1] Source: DEFRA, Agriculture in the UK 2006 [2] Source: Leatherhead		

Avoidance of the cost of food poisoning

IFR's food safety research into particular species such as *Salmonella, Campylobacter* and *Clostridium botulinum* is aimed at reducing the incidence of food poisoning, and as such offers potential avoidance of the associated costs.

The Health Protection Agency states that in 2005 there were around 70,000 cases of reported food poisoning in the UK, representing a 25% decline from the peak in 1998. This pattern is illustrated in Figure 5.5 below. The formation of the Food Standards Agency in 2000 may have had an impact on driving down food poisoning.

Figure 5.5 – UK incidence of Food Poisoning (thousand cases per annum)



The Food Standards Agency accepts that these numbers are an underestimate and suggests in its Corporate Plan 2010 that the likely number is **about 750,000** and the Health Protection Agency has estimated the true incidence to be **several million** cases per annum.

Campylobacter jejuni is the leading cause of human enteric disease worldwide and is a major public health and economic burden. Humans are commonly infected by eating undercooked poultry meat, which is contaminated during processing of the chickens. *Salmonella* is also a problem, as is *E. coli* O157.

The Food Standards Agency (FSA) estimates the cost per case of food poisoning at £80, after allowances are made for the associated health costs and lost productivity. On this basis, **the potential value of reducing personal food-borne bacterial poisoning in the UK is some £60 million per annum**, while there are clearly wider qualitative benefits associated with improved public health.

In the commercial sector, organisms such as *Salmonella* can have a devastating effect on the reputation of food companies. Following an outbreak in 2006, a major confectionary company lost 1.1% of its market share worth some £100m[16].

Botulism is a rare but potentially serious and economically damaging cause of food poisoning. IFR is a world-leader in work on mitigating the effects of botulism. IFR estimates that the cost per

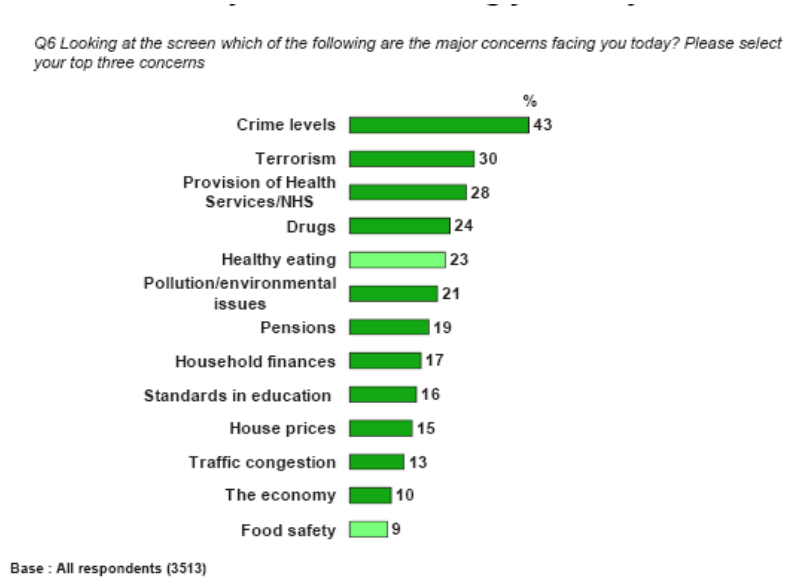
[16] http://www.citywire.co.uk/adviser/-/news/market-and-shares/content.aspx?ID=275399

case for a commercial outbreak is £20 million. Small outbreaks typically involve 20-30 cases. **If we assume that IFR's work prevented even one commercial outbreak of botulism the saving would be at least £400 million.**

5.1.3 Social Impacts

Consumers are offered free advice by Government through organisations such as the Food Standards Agency. IFR has an important role to play in ensuring that this advice is scientifically based. IFR therefore contributes to the welfare of UK society in general and there is evidence to support the value that consumers attach to this advice[17]. Figure 5.2 shows the level of concern that consumers have in relation to health eating.

Figure 5.2 Major Concerns Facing UK Consumers

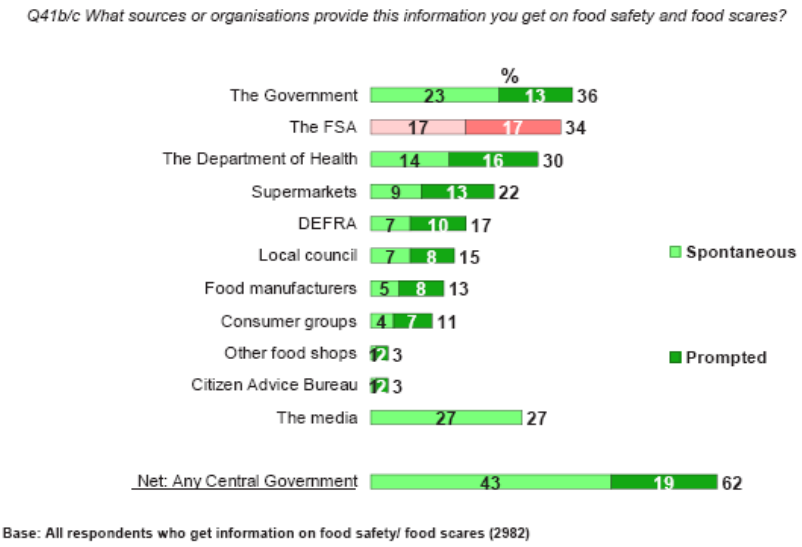


Source: FSA

The same survey also highlights the sources of information that consumers believe are important and trustworthy during food scares with the FSA featuring highly (see Figure 5.3 overleaf)

[17] FSA (2007) Consumer attitudes to Food Standards

Figure 5.3 Sources of information on food for consumers



Source: FSA

5.1.4 Cross Cutting Impacts

Known Commercial activity – Industrial income to IFR

We have used the Green Book method of "willingness to pay" to make some indicative estimates of the market impact of IFR activities, represented by increased incomes to private organisations. This recognises that IFR outputs are not all commodities for market sale, but intellectual property that forms the first step in a chain of intermediate suppliers before the final consumer purchase of food produce.

The "willingness to pay" method reflects the fact that private companies will only purchase IFR outputs if they feel that they are able to add value and thus make a profit themselves.

Thus, IFR incomes from private sector companies can be inflated to recognise the value added by each process before final market sale of food-based products. Inflation factors have been applied to each stage in the processing chain based on published UK national accounts for profitability in each sector in the chain, to give a prudent estimate of the total value added to the economy through exploitation of IFR near-market research. These linkages take the form of incomes through:

- **Bespoke research contracts** from private funders: It is assumed that the value paid into research is recaptured by the private sector through sale of final goods (with a mark up) – current private customers include major brand manufacturers.

- Further **industrial collaboration:** including those through the Link and EC partnerships.

Incomes from each of these groups are summarised in Figure 5.4:

Figure 5.4 Private sector activities, 2006/07		
Private income source	**Number of collaborations**	**Value to IFR**
Bespoke research contracts	5*	£291,821
Industrial collaboration – LINK	52	£306,881
Industrial collaboration – other	6	£177,400
Industrial collaboration – EU	20	£1,867,857
Total	**83**	**£2,643,959**
* individual value > £25,000		

Taking sales of processed food and drink as an example: UK processors add a mark-up of 29% on top of their input costs before sale. Then, when moving to retail, a further 60% mark up is added on average to final products. These mark-ups represent the Gross Value Added (GVA) facilitated by IFR investment, capturing the new wages and profits generated in the private sector.

Figure 5.5 summarises the additional GVA captured through the known exploitation of IFR's research, using weighted average mark-up rates across the sectors providing IFR income. In total, the £2.6 million **income from commercial sources to IFR is estimated to generate an additional £5.5 million GVA in the economy**, that will be recognised in national accounts.

Figure 5.5 – Estimated value added through commercial exploitation of research

Known Commercial activity – Licensing, patents and start-ups

IFR also receives incomes through licensing and royalty payments made towards existing IFR research. Figure 5.6 summarises the extent of these activities:

Figure 5.6 – Royalty income, patents, licences and start-ups 2006/07

	Total	New
Patents and plant breeders rights held by institute or collaborators	12	1
Licences / options arising from above	7	2
Number of start-ups	1	0
Royalty income	£111,400	

Botulism toxin therapeutics

Botulinum toxin is a neurotoxin protein produced by the bacterium *Clostridium botulinum*. It is the most poisonous naturally occurring substance in the world. Despite its toxicity. it is used in minute doses both to treat painful muscle spasms, and sold as a cosmetic treatment, for example under the brand names **Myobloc®**, **Botox®** and **Dysport®**. In 2003, it is estimated that 2.27 million cosmetic procedures were performed[18], and by 2007 Botox® alone was worth $1Billion to parent company Allergan[19].

IFR has worked with a company that makes a related product that it hopes to sell in the US market. By working with IFR, the company was able to submit an application for approval 3 months earlier than otherwise.

Conservatively assuming the market is worth $1Billion per annum, this equates to $83 million of sales per month. Three months worth of new sales are therefore worth $250 million. **Assuming the IFR supported company achieves a 10% market share, the 3 months of extra sales achieved are therefore valued at $25 million (equivalent to £12.6 million).** This represents new activity in the UK, achieved through IFR support. Although the market size may not grow in absolute terms with the introduction of new products, competitors are based outside the UK, and therefore this prevents a leakage of expenditure abroad, supporting the UK economy.

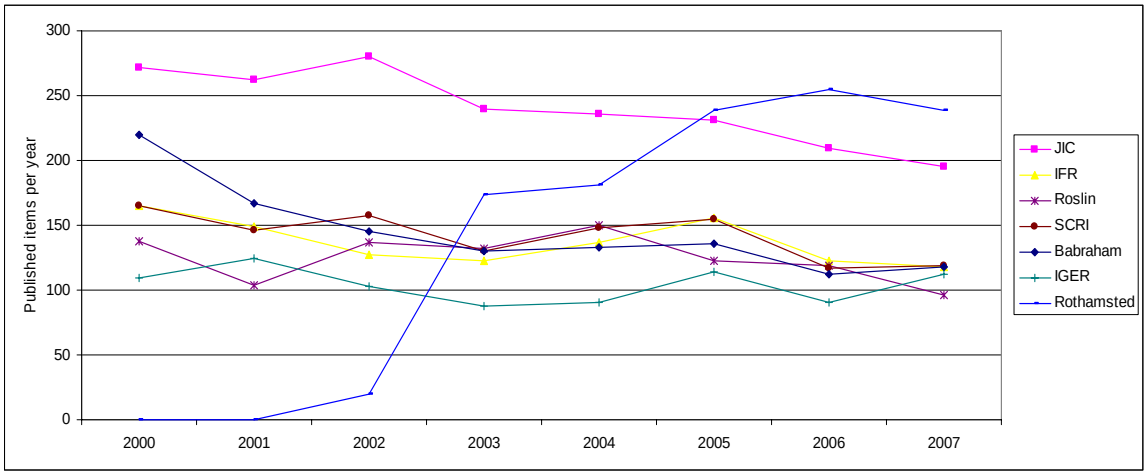
[18] American Society for Aesthetic Plastic Surgery
[19] Espicom Business Intelligence Ltd, Oct 2007

6.0 Wider qualitative impacts

Peer Reviewed Publications

In terms of publications, it can be seen that IFR performs on a par, or above, peer institutes producing 1,115 publications over the period 2000-2007. These data, however, do not take into account the numbers of principal investigators, or staff churn due to changing priorities.

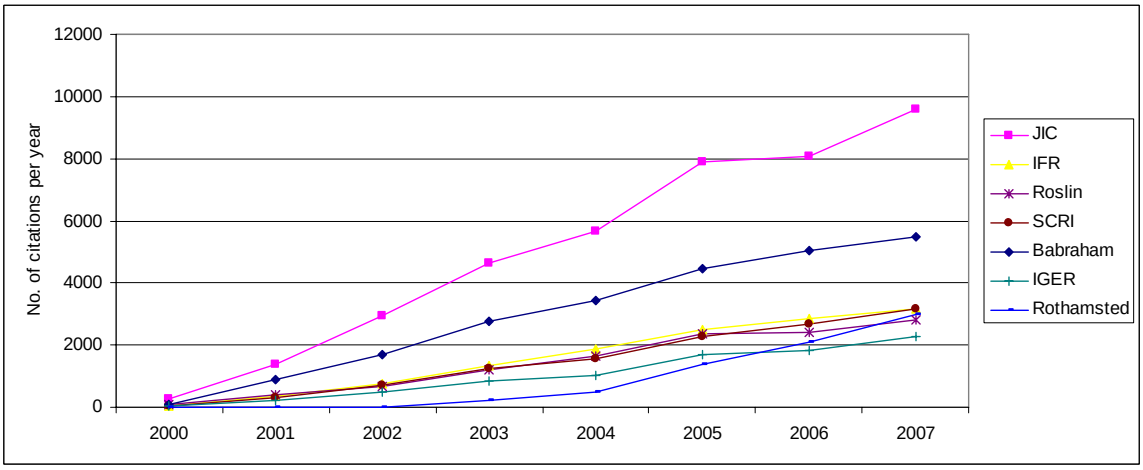
Figure 6.1 Number of publications produced by IFR and other institutes per annum



Source: Web of Science March 2008
Note: Rothamsted figures exclude publications from the Institute of Arable Crop Research

In terms of citations, it can be seen how the body of knowledge has grown over the period with IFR again performing on a par with other institutes.

Figure 6.2 Number of citations produced by IFR and other institutes, 2000 – 2007 totals



Source: Web of Science March 2008

Human Capital

In addition to its permanent staff, IFR has many visiting scientists and students who come for a short time to share knowledge and learn before moving on elsewhere. In particular IFR is reknowned as a centre of expertise in training for EU students.

In addition, scientists at IFR move on to other roles, for example, Professors of Food Science in the UK, senior researchers in EU-organisations, senior researchers in industry (USA, Switzerland, The Netherlands)

Growing the Economy

IFR has long pointed to the Campus effect of clustering scientific and related organisations together. The presence of JIC, The Sainsbury Laboratory and the University of East Anglia all create critical mass in science. Consideration is being given to a joint bio-incubator with JIC.

Outreach and engagement with stakeholders

IFR has a longstanding and active programme of activities in this area. It positively encourages and rewards staff to participate and senior scientists have provided high-level service to national and international bodies, government enquiries, and parliamentary discussions. One mechanism by which IFR communicates with its stakeholder base is via "Science + Innovation" magazine, published three times a year.