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DESIGN OF A STATISTICAL SYSTEM FOR MEASURING FOOD QUALITY AND FOOD SAFETY IN THE PERSPECTIVE OF CONSUMER NEEDS

Invited paper submitted by Department for Environment, Food, and Rural Affairs (Defra), United Kingdom**

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* Due to the late submission of this paper, it could neither be translated nor reproduced.

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1. Introduction

1.1 This paper considers the measurement of a range of elements of food quality. It start by providing details of a method used to estimate the nutritional content of food consumed in the United Kingdom, also providing a selection of results to illustrate trends.

1.2 The paper then considers other dimensions of food quality, in particular methods of production, food safety and public perception. Finally the paper provides an example of how indicators of food fit within a wider framework of indicators that is being developed to monitor progress with the United Kingdom Government's Sustainable Farming and Food Strategy.

2. Nutritional quality of food

Methodology to measure nutritional content

2.1 The following section describes a methodology for calculating the nutritional content of food consumed in the United Kingdom. The Expenditure and Food Survey is a survey of around 7,000 private households. This survey was introduced in April 2001 and was formed by the merger of the National Food Survey (run by Defra) and the Family Expenditure Survey (run by the Office for National Statistics). Individuals within participating households complete a diary over a two week period of all purchases made over the period. For food items purchased and brought home they also record the weight of the item. This information is then used to estimate the quantities consumed for a range of food items.

2.2 A methodology is then used to convert the estimates of food consumption into nutrient intakes by estimating the nutrient content for a range of nutrients for each of the food types. Examples are given in the following table of nutrient factors (the quantity of nutrient per unit of food item) for two food items (milk and minced beef) and 9 nutrients. In total the different factors are applied for 47 nutrients for 260 food items, giving a total of over 12,000 factors.

Food item	nutrient	unit	nutrient factor
Pasteurised whole milk	Animal Protein	g	0.034056
	Fat	g	0.042622
	Saturates	g	0.028277
	Mono-unsaturates	g	0.011868
	Poly-unsaturates	g	0.001445
	Carbohydrate	g	0.052632
	Energy - Kcal	kcal	0.709758
	Calcium	mg	1.29
	Iron	mg	0.000413
…			
Minced beef			
	Animal Protein	g	0.202683
	Fat	g	0.141603
	Saturates	g	0.062781
	Mono-unsaturates	g	0.062916
	Poly-unsaturates	g	0.004521
	Carbohydrate	g	0
	Energy - Kcal	kcal	2.085156
	Calcium	mg	0.086026
	Iron	mg	0.014891
…			

2.3 The factors are derived by nutritional analysis of a range of different brands and food products within each food code. This is not exhaustive with only the more prevalent brands and products within each code being analysed. Each food code is defined to be as homogenous as possible from a nutritional perspective, whilst retaining a balance with the overall number of codes and the level of detail that can reasonably be sought from survey respondents. A sample of the diaries completed by respondents is analysed in more detail to derive weightings for individual brands and products within each food code. The weightings are then applied to derive factors for the food code as a whole.

2.4 These factors do change through time through changes in food preparation (e.g. the level of fat in meat at retail) or through the introduction of new branded products onto the market or changes to existing products. Consequently the analysis of nutrient content needs to be updated periodically. Bearing in mind the large number of food codes and wide range of different food products, this process is targeted based on external knowledge of change (e.g. market intelligence) and likely level of significance.

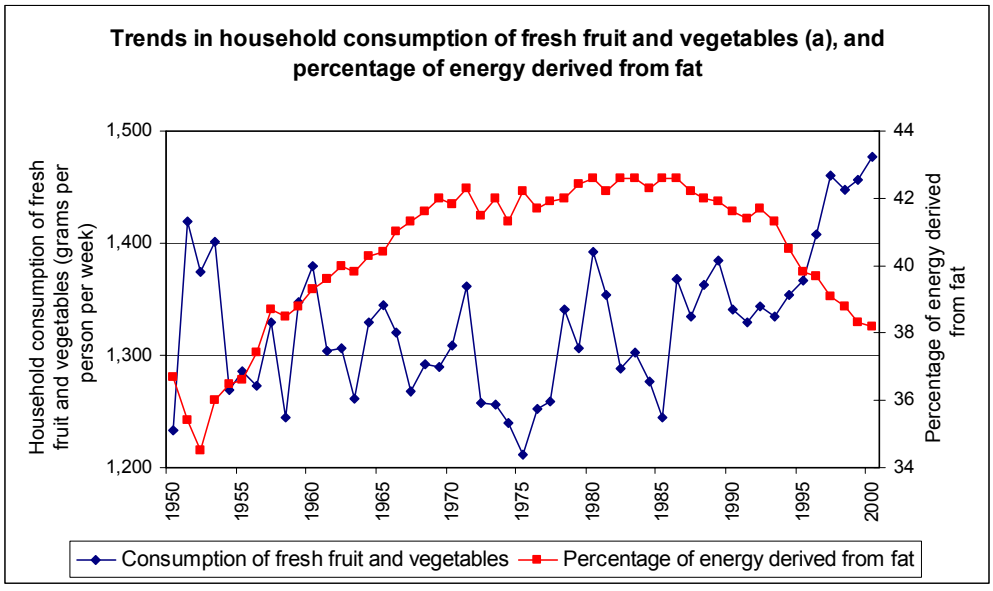
2.5 In a small number of cases the factors also allow for seasonal changes in the nutrient content of food items through the year.

2.6 A similar approach is adopted to measure the nutrient content of food eaten outside of the home (which accounts for around 10% of food intake). However, the quantities of food eaten out are estimated using standard portion sizes and the nutrient content of different food items is now derived from analysis of the household food items by matching with similar products.

Trends on diet and nutrition

2.7 Some of the results of the survey are now considered in assessing trends in diet and nutrition in the United Kingdom. Food consumption patterns are being shaped by increasingly affluent and informed consumers but current eating patterns, if continued, may also lead to a segmentation of society between the “disciplined” (who take into account health) and the “undisciplined”, leading to subsequent health and nutrition problems. For example, the British Heart Foundation has estimated that treating ill health caused by poor diet costs the National Health Service at least £2bn each year. Obesity has almost trebled in England since the early 1980s; 21% of women and 19% of men are now classified as obese with a further 33% of women and 44% of men classified as overweight. The National Audit Office has estimated that the costs of obesity across the economy as a whole run to £2.5bn a year.

2.8 Food choices are informed by knowledge of dietary recommendations, but also by factors such as taste, availability, price and social and cultural norms and are therefore shaped at every stage of the food chain. In more recent years food consumption patterns have become more favourable (see chart below). The consumption of fruit and vegetables has increased by 10% over the last ten years whilst the percentage of energy derived from fat has declined and now stands at 38.2% (by comparison with the target recommended in Dietary Reference Values of 35%).

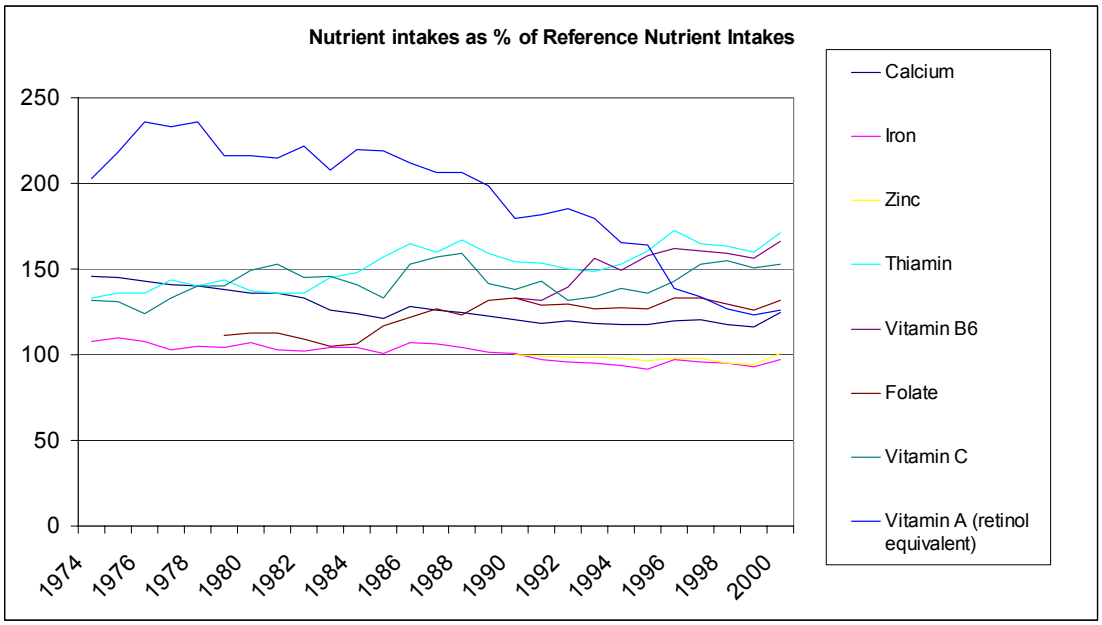


(a) includes only fresh fruit and fresh vegetables (excluding potatoes).
Juices, canned, frozen and other fruit and vegetable products are excluded.
Source: National Food Survey, DEFRA

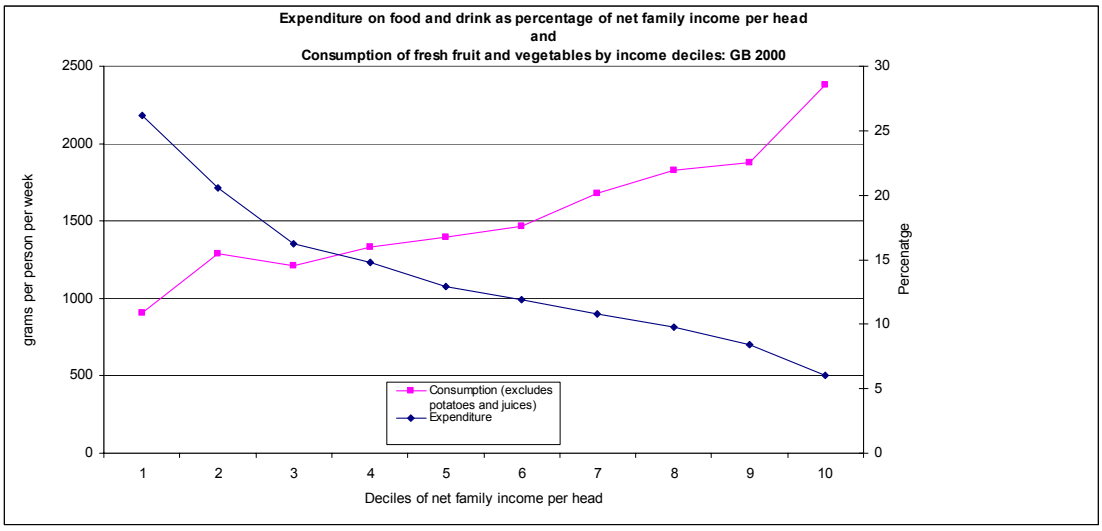
2.9 This chart also illustrates the way in which the quality of diet can either be monitored through the measurement of nutrient intakes (in this case fat consumption expressed as a % of total energy intake) or through the measurement of specific food items which themselves act as indicators of the wider quality of diet (i.e. fruit and vegetable consumption in the chart above).

Both approaches are valid and the selection of which approach to use will in part need to take into account the knowledge and expertise of the audience.

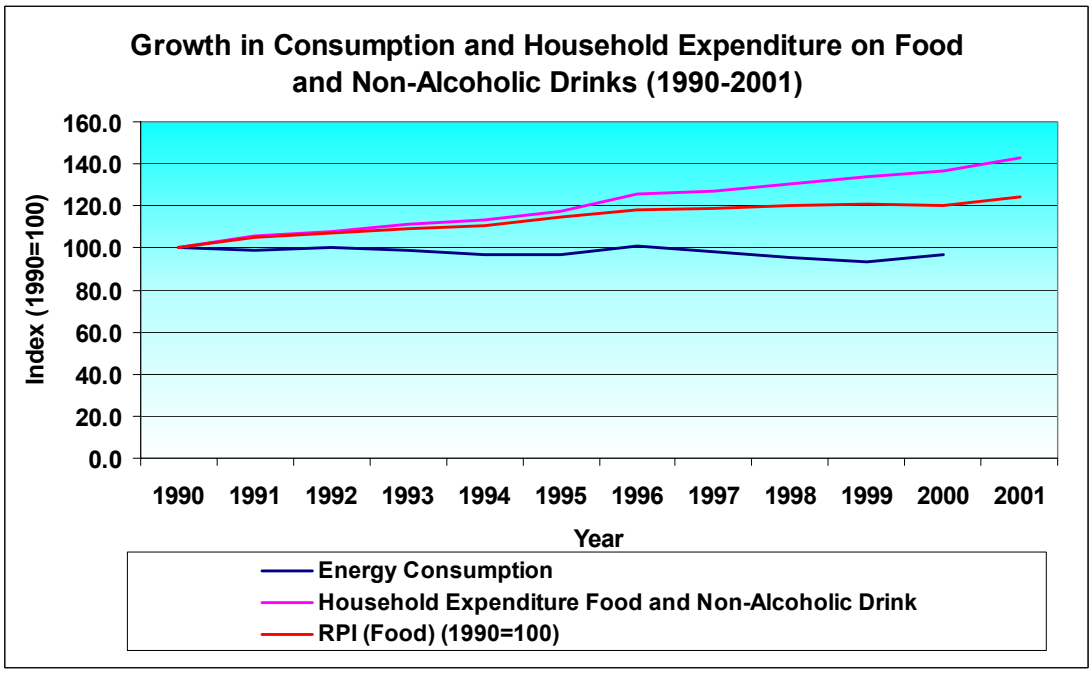
2.10 The following chart provides trends in the level of a wider range of nutrients derived from the survey expressed as a percentage of the recommended Reference Nutrient Intake.



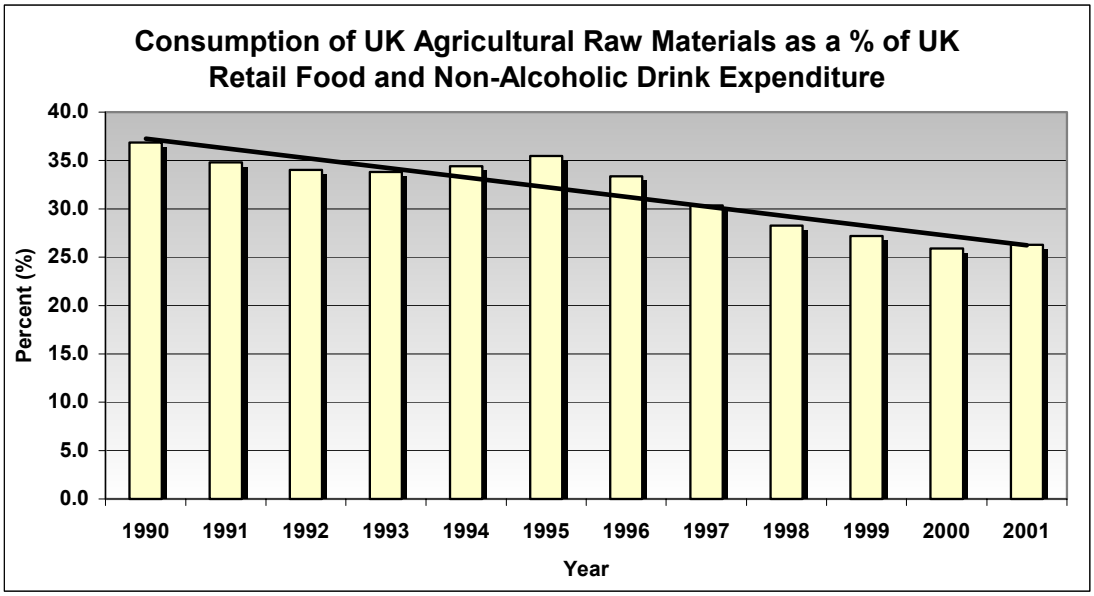
2.11 There are marked socio-economic differences; for example, the death rate from coronary heart disease is three times higher amongst the unskilled than amongst professionals, and this gap has widened over the latest 20 years for which figures are available. These differences are mirrored in the patterns of food consumption as measured by the survey. Expenditure on food and drink is much more significant in the budgets of lower income families (26% of net family income for the lowest decile) which makes it more difficult to pay any premium for healthy eating (see chart below). At the same time higher income households consume far more fruit and vegetables (with the highest decile 2.5 times the lowest decile) reflecting both higher spending power but also other household characteristics (e.g. more ready access to a source of supply) .



2.12 There are increasing trends in the level of consumption of more highly processed and prepared foods. The extent of these trends can be seen from the following chart. The first chart shows that whilst average energy consumption is showing a slight downward trend, household expenditure on food is increasing at about twice the rate of the increase in retail prices of food. This difference will largely reflect the continuing switch towards purchasing more processed products.



This trend towards consumption of processed foods is also leading to a decline in the farmgate share of retail expenditure on food as shown in the next chart. For the Unite Kingdom the farmgate share of retail expenditure is now at around 25% and is declining by around 1% point per year.



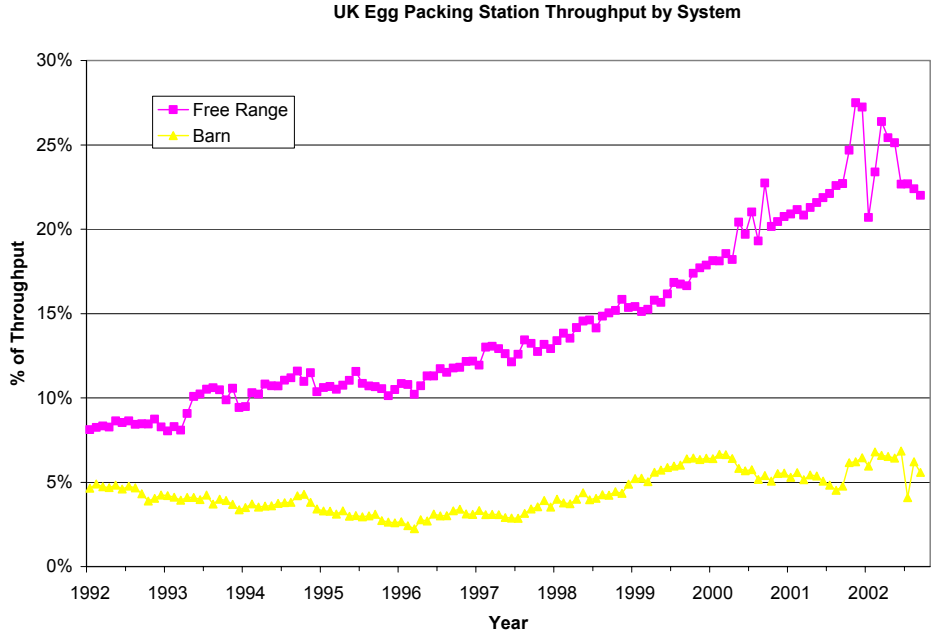
From a statistical measurement perspective, the trend towards consumption of more processed products creates increasing difficulty in measuring nutrient content due to the increasing range of such products and their increasing significance within the diet.

3. Methods of production

3.1 Another dimension of food quality is the method by which the food was produced, in particular farm production. Even when this does not have an impact on the final nutritional quality or safety of the finished product, it can be an important aspect of quality from the consumer's perspective. There are two main aspects to this dimension of quality; the environmental impact of production and animal health and welfare.

3.2 Measurement of this dimension of food quality can be made by direct measurement of different methods of production. It should be noted that measurement here will overlap with the development of agri-environment indicators and needs to be co-ordinated.

3.3 The following chart provides information on the trends in egg production of the more welfare friendly systems.



The production of free range eggs has increased from 8% in 1992 to around 22% currently. United Kingdom consumers of free range eggs are currently paying around twice the price of battery eggs, which gives a measure of their perception of their higher quality (mainly associated with animal welfare).

4. Food safety

4.1 The frequency of foodborne illnesses provides an important measure of food quality. However, measurement is far from easy. When people get an attack of diarrhoea and vomiting, they tend to think they are ill because of something they ate, but within the United Kingdom it is estimated that at least 50% of cases are not related to food. Even when a foodborne germ such as salmonella or *E. coli* O157 is found, it is not certain whether it has come from food that has been eaten. It may have come from someone else who was ill, a pet or other animal, or an environment contaminated with animal faeces, for example. This makes measurement of the levels of foodborne illnesses difficult.

4.2 Within the United Kingdom the Food Standards Agency has set itself a target to reduce foodborne illness by 20% over five years. This is to be measured on the basis of the number of cases confirmed by laboratory testing of the five main foodborne bacteria (salmonella, campylobacter, *E. coli* O157, listeria and *Clostridium perfringens*). In adopting this approach, it is recognised that the baseline figure will include only a small proportion of all the actual cases, since most are not confirmed by laboratory testing.

Foodborne illness cases confirmed by laboratory testing

All cases (including those from food eaten abroad)

	UK	England and Wales	Scotland	N. Ireland
Salmonella	16,987	14,844	1,723	420
Campylobacter	62,867	55,376	6,482	1,009
E.coli O157	1,147	896	197	54
Clostridium perf.	166	124	32	10
Listeria	113	98	11	4
Total	81,280	71,338	8,445	1,497

Cases not thought to have been acquired abroad

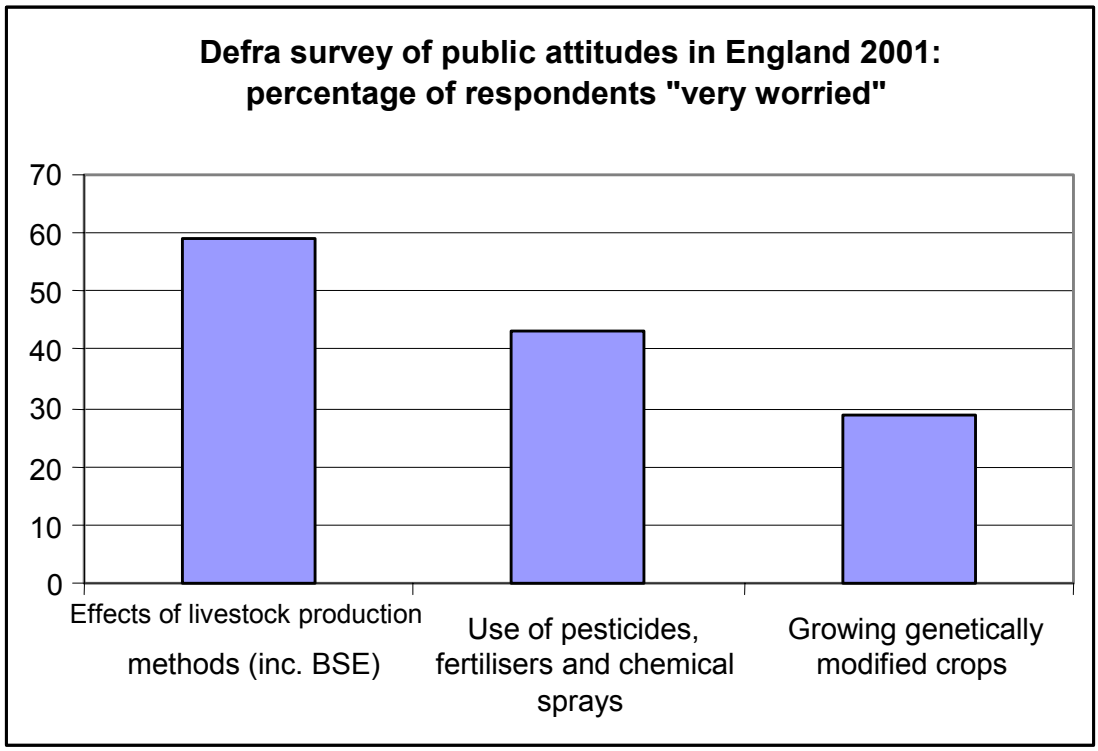
	UK	England and Wales	Scotland	N. Ireland
Salmonella	13,122	11,456	1,338	328
Campylobacter	50,773	43,415	6,359	999
E. coli O157	1,035	790	196	49
Clostridium perf.	166	124	32	10
Listeria	113	98	11	4
Total	65,209	55,883	7,936	1,390

Source: Food Standards Agency, UK

4.3 It is also possible to measure the prevalence of bacteria and toxins at different points in the food chain. Last year a survey conducted by the United Kingdom Food Standards Agency found campylobacter in around 50% of chicken on retail sale in the United Kingdom. In addition to the running of statistical surveys, this type of statistical information will often be derived from the regular and routine administrative testing regimes in place to prevent toxins, bacteria etc. from entering the food chain (e.g. pesticide residues, veterinary medicines residues, BSE testing) many of which operate in a wider international framework. Whilst providing statistical information as a by-product of the testing regimes, the administrative design of these systems may create problems in deriving consistent statistical series over time.

5. Public perception

5.1 It can be argued that public perception provides a further dimension of the quality of food. Whilst public perception of quality will be largely determined by the other dimensions of quality described above, it can also be measured directly in its own right. The following chart provides some results from a survey conducted by Defra of public attitudes to environmental and quality of life issues. These provide details on the proportion of the public who are ‘very worried’ about specific farming issues.

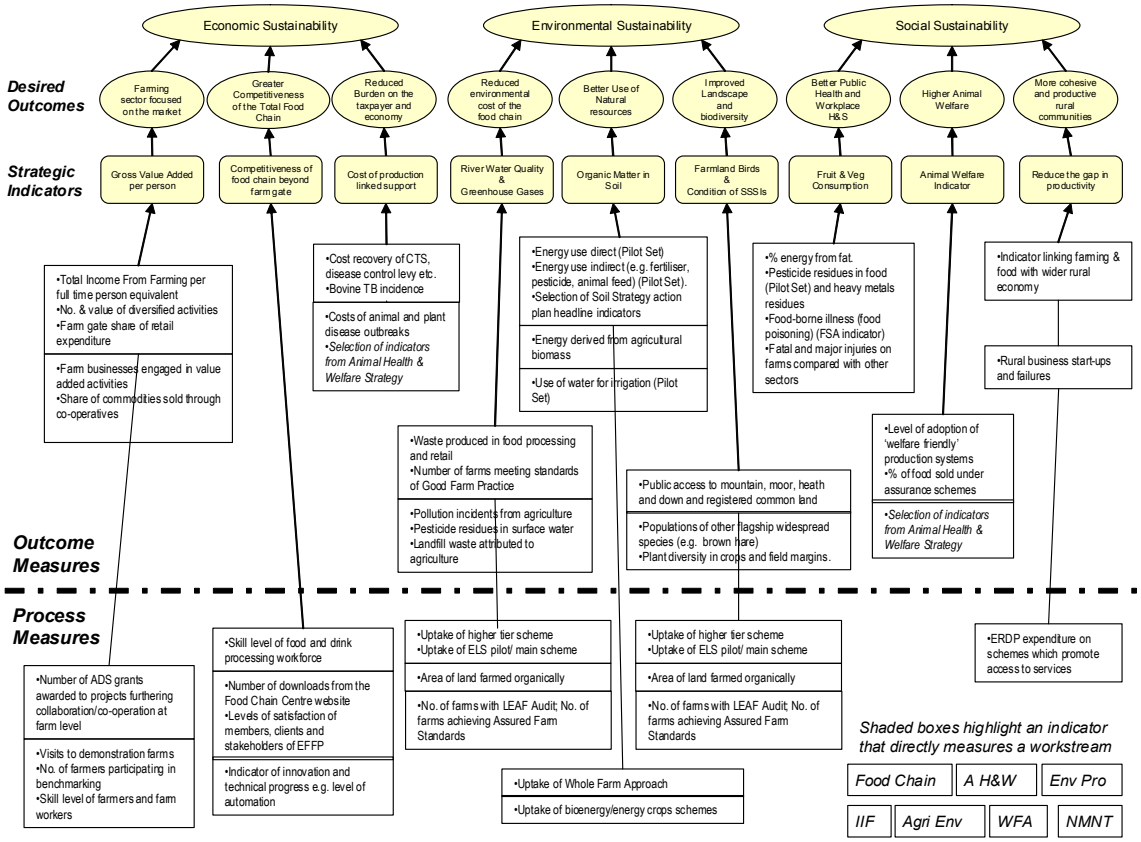


The high proportion of the public worried about livestock production methods (59%) largely reflects the impact of the foot and mouth outbreak in the United Kingdom at the time of the survey. This is nearly double the level from when the survey was previously run in 1996, which itself followed the main impact of BSE (when a possible link between BSE and vCJD was announced).

6. Sustainable Farming and Food Strategy – range of indicators

6.1 The following section considers the development of indicators of food quality within the development of a wider set of indicators of sustainability of the food chain.

6.2 Defra is currently implementing a Sustainable Farming and Food Strategy. The following diagram provides the latest thinking on the range of indicators to use to monitor progress with the strategy. The first two rows of the diagram illustrate the 9 outcomes sought by the strategy and how these link to the 3 pillars of sustainability (economic, environmental and social). Below this are the various indicators which are to be used to monitor progress with the strategy (strategic indicators and supporting indicators which are split into outcome and process measures) a number of which cover aspects of food quality.



6.3 Food quality is a cross-cutting element within the strategy. Whilst food quality is an important component of the social dimension of sustainability (e.g. through its impact on public health through diet and relationship with animal welfare), it will also be a part of the economic dimension (e.g. reflecting the improved returns to farmers more focussed on the quality requirements of consumers) and the environmental dimension (e.g. organic production).

Annex

Food items covered by Expenditure and Food Survey

Food items	UNIT
UHT milk	ml
Sterilised	ml
Pasteurised/ homogenised	ml
school milk	ml
welfare milk	ml
Condensed or evaporated milk	ml
Infant or baby milks - ready to drink	ml
Infant or baby milks - dried	ml
Instant dried milk	ml
Yoghurt	ml
Fromage frais	ml
Fully skimmed milk	ml
Semi-skimmed milk	ml
Dairy desserts - not frozen	ml
Dried milk products	ml
Milk drinks & other milks	ml
Cream	ml
Hard cheese - Cheddar type	grams
Hard cheese - Other United Kingdom or foreign equivalent	grams
Hard cheese - Edam or other foreign	grams
Cottage cheese	grams
Soft natural cheese	grams
Processed cheese	grams
Beef joints - incl on the bone	grams
Beef joints - boned	grams
Beef steak - less expensive	grams
Beef steak - more expensive	grams
Minced beef	grams
All other beef and veal	grams
Mutton	grams
Lamb joints	grams
Lamb chops	grams
All other lamb	grams
Pork joints	grams
Pork chops	grams
Pork fillets & steaks	grams
All other pork	grams
Ox liver	grams
Lambs liver	grams
Pigs liver	grams
All other liver	grams
All offal other than liver	grams
Bacon and ham joints, uncooked	grams

Bacon and ham rashers, uncooked	grams
Ham and bacon	grams
Cooked chicken & turkey	grams
Takeaway chicken	grams
Corned beef - canned or sliced	grams
Other cooked meat	grams
Other canned meat & canned meat products	grams
Chicken - whole or part	grams
Turkey - whole or part	grams
Poultry other than chicken or turkey	grams
Other fresh/chilled/frozen meat	grams
Sausages, uncooked - pork	grams
Sausages, uncooked - beef	grams
Meat pies - ready to eat	grams
Sausage rolls - ready to eat	grams
Meat pies, pasties & puddings - frozen or not frozen	grams
Burgers - frozen or not frozen	grams
Complete meat-based ready meals - frozen of not frozen	grams
Other convenience meat products - frozen of not frozen	grams
Pate	grams
Delicatessen type sausages	grams
Meat pastes & spreads	grams
Takeaway meat pies & pasties	grams
Takeaway burger & bun	grams
Takeaway kebabs	grams
Takeaway sausages & saveloys	grams
Takeaway meat based meals	grams
Takeaway miscellaneous meats	grams
White fish, fresh or chilled	grams
White fish, frozen	grams
Herrings & other blue fish, fresh or chilled	grams
Herrings & other blue fish, frozen	grams
Salmon, fresh or chilled	grams
Salmon, frozen	grams
Blue fish, dried or salted or smoked	grams
White fish, dried or salted or smoked	grams
Shellfish, fresh or chilled	grams
Shellfish, frozen	grams
Takeaway fish	grams
Tinned salmon	grams
Other tinned or bottled fish	grams
Ready meals & other fish products - frozen or not frozen	grams
Takeaway fish products	grams
Takeaway fish based meals	grams
Eggs	number
Butter	grams
Soft margarine	grams
Other margarine	grams

Lard, cooking fat	grams
Olive Oil	ml
Other vegetable & salad oils	ml
Reduced fat spreads	grams
Low fat spreads	grams
Suet & dripping	grams
Imitatation cream	grams
Sugar	grams
Jams & fruit curds	grams
Marmalade	grams
Syrup, treacle	grams
Honey	grams
Potatoes - bought Jan-Aug, previous years crop	grams
Potatoes - bought Jan-Aug, this years crop	grams
Potatoes - bought Sep-Dec, this years crop or new imported	grams
Cabbages, fresh	grams
Brussels sprouts, fresh	grams
Cauliflower, fresh	grams
Lettuce & leafy salads	grams
Prepared lettuce salads	grams
Peas, fresh	grams
Beans, fresh	grams
Other fresh green vegetables	grams
Carrots, fresh	grams
Turnips & swede, fresh	grams
Other root vegetable, fresh	grams
Onions, leeks, shallots, fresh	grams
Cucumbers, fresh	grams
Mushrooms, fresh	grams
Tomatoes, fresh	grams
Stewpack, stirfry pack, pack of mixed vegetables	grams
Stem vegetables	grams
Marrow, courgettes, aubergine, pumpkin and other fresh vegetables	grams
Fresh herbs	grams
Tomatoes, canned or bottled	grams
Peas, canned	grams
Baked beans in sauce	grams
Other canned beans & pulses	grams
Other canned vegetables	grams
Dried pulses other than air-dried	grams
Air-dried vegetables	grams
Tomato puree and vegetable purees	ml
Vegetable juices eg tomato juice, carrot juice	ml
Chips - frozen or not frozen	grams
Takeaway chips	grams
Instant potato	grams
Canned potatoes	grams

Crisps & potato snacks	grams
Other potato products - frozen or not frozen	grams
Peas, frozen	grams
Beans, frozen	grams
Ready meals & other vegetable products - frozen or not frozen	grams
All vegetable takeaway products	grams
Other frozen vegetables	grams
Fresh oranges	grams
Other fresh citrus fruits	grams
Fresh apples	grams
Fresh pears	grams
Fresh stone fruit	grams
Fresh grapes	grams
Other fresh soft fruit	grams
Fresh bananas	grams
Fresh melons	grams
Other fresh fruit	grams
Tinned peaches, pears & pineapples	grams
All other tinned or bottled fruit	grams
Dried fruit	grams
Frozen strawberries, apple slices, peach halves, oranges and other frozen fruits	grams
Nuts & edible seeds	grams
Peanut butter	grams
Pure fruit juices	ml
White bread, standard, unsliced	grams
White bread, standard, sliced	grams
White bread, premium, sliced and unsliced	grams
White bread, soft grain, sliced and unsliced	grams
Brown bread, sliced and unsliced	grams
Wholemeal & granary bread, sliced and unsliced	grams
Rolls - white, brown or wholemeal	grams
Malt bread and fruit loaves	grams
Vienna & French bread	grams
Starch reduced bread & rolls	grams
Other breads	grams
Sandwiches	grams
Sandwiches from takeaway	grams
Takeaway breads	grams
Flour	grams
Buns, scones & teacakes	grams
Cakes & pastries , not frozen	grams
Takeaway pastries	grams
Crispbread	grams
Sweet biscuits (not chocolate) & cereal bars	grams
Cream crackers & other unsweetened biscuits	grams
Chocolate biscuits	grams
Oatmeal and oat products	grams

Muesli	grams
High fibre breakfast cereals	grams
Sweetened breakfast cereals	grams
Other breakfast cereals	grams
Canned or fresh carton custard	grams
All canned milk puddings	grams
Puddings	grams
Dried rice	grams
Cooked rice	grams
Takeaway rice	grams
Invalid foods, slimming foods and sports foods	grams
Infant cereal foods	grams
Cakes & pastries - frozen	grams
Canned pasta	grams
Dried and fresh pasta	grams
Takeaway pasta & noodles	grams
Pizzas - frozen and not frozen	grams
Takeaway pizza	grams
Cake, pudding & dessert mixes	grams
Cereal snacks	grams
Quiches & flans - frozen and not frozen	grams
Takeaway crisps, savoury snacks, popcorn, popadums, prawn crackers	grams
Other cereal foods- frozen and not frozen	grams
Other cereals	grams
Tea	grams
Coffee beans and ground coffee	grams
Instant coffee	grams
Coffee essences	ml
Tea and coffee from takeaway	ml
Cocoa and chocolate drinks	grams
Malt drinks & chocolate versions of malted drinks	grams
Mineral or spring waters	ml
Baby foods	grams
Soups - canned or cartons	grams
Soups - dehydrated or powdered	grams
Soups - from takeaway	grams
Other takeaway food brought home	grams
Meals on wheels - items not specified	ml
Salad dressings	grams
Other spreads & dresssings	grams
Pickles	grams
Sauces	grams
Takeaway sauces and mayonnnais	grams
Stock cubes and meat & yeast extracts	grams
Jelly squares or crystals	grams
Ice cream tub or block	ml
Ice cream cornets, choc-ices, lollies with ice cream	ml

Ice lollies, sorbet, frozen mousse, frozen yoghurt	ml
Takeaway ice cream, ice cream products, milkshakes	ml
Salt	grams
Artificial sweeteners	
Vinegar	
Spices and dried herbs	
Bisto, gravy granules, stuffing mix, baking powder, yeast	
Wine & beer making kits	
Fruit teas, instant tea, herbal tea, rosehip tea	
Payment for food, type not specified	
Soya & novel protein foods	grams
Soft drinks, concentrated, not low calorie	ml
Soft drinks, not concentrated, not low calorie	ml
Soft drinks, concentrated, low calorie	ml
Soft drinks, not concentrated, low calorie	ml
Chocolate bars - solid	grams
Chocolate bars - filled	grams
Chewing gum	grams
Mints	grams
Boiled sweets	grams
Fudges, toffees, caramels	grams
Takeaway confectionery	grams
Beers	ml
Lagers & continental beers	ml
Ciders & Perry	ml
Champagne, sparkling wines & wine with mixer	ml
Table wine	ml
Spirits with mixer	ml
Fortified wines	ml
Spirits	ml
Liqueurs & cocktails	ml
Alcopops	ml

Range of nutrients separately estimated by Expenditure and Food Survey

nutrient	unit
Vegetable Protein	g
Animal Protein	g
Fat	g
Saturates	g
Mono-unsaturates	g
Poly-unsaturates	g
Carbohydrate	g
Energy - Kcal	kcal
Energy - MJ	MJ
Calcium	mg
Iron	mg
Retinol	ug
Carotene	ug
Retinol equivalent	ug
Thiamin	mg
Riboflavin	mg
Nicotinic acid	mg
Tryptophan	mg
Niacin Equivalent	mg
Vitamin C	mg
Vitamin D	ug
FOLATE	ug
Sodium	mg
Starch	g
Glucose	g
Fructose	g
Sucrose	g
Maltose	g
Lactose	g
Other sugars	g
Total sugars	g
Non-milk extr sugars	g
Alcohol	g
Fibre:Southgate	g
Fibre:Englyst	g
Potassium	mg
Magnesium	mg
Copper	mg

Zinc	mg
Vitamin B6	mg
Vitamin B12	ug
Phosphorus	mg
Manganese	mg
Biotin	ug
Pantothenic acid	mg
Vitamin E	mg
Cholesterol	mg