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Review

Innovation in the food industry

M.D. Earle

Innovation in the food industry combines technological innovation with social and cultural innovation. It occurs throughout the entire food system, including production, harvesting, primary and secondary processing, manufacturing and distribution. The ultimate innovation is a new or improved consumer product and service. Innovations can be focused in one area of food technology, for example process engineering, product formulation, food qualities or consumer needs; but ripples spread causing changes in other parts of the food system, in consumer eating patterns and in general social and cultural areas. Food industry innovation strategies need to be based on the total technology in the food system and concerned not only with the technological changes but also with the social and environmental changes, so as to produce food that satisfies the nutritional, personal and social needs and wants of all communities.

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Food product innovation can be a novelty, an improvement or a fundamental change. The novelty is the small, fashion change, for example a new flavoured chocolate bar. The improvement is the continuing change in a food with time, for example the incremental improvement of instant soup: improving the solubility, introducing new varieties, redesigning the package to make it more attractive, decreasing the calories. The fundamental change is the step-jump, for example the development of quick-frozen products. Such product changes are caused by innovations in technology and by social changes, and are realized by food companies. There are two prerequisites for successful innovation in the food industry: an innovation-oriented company, and a positively reactive environment.

Innovation development builds on the industry's past innovations, but also incorporates predicted technological and social trends. Strategies for innovation in the food industry and in a company are developed from these predictions.

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What is innovation?

'Innovation' has many meanings. For example, the *Shorter Oxford Dictionary* lists six definitions, which can be related to the types of people involved in innovation:

- introduction of novelties – marketers;
- change in the nature of fashion – designers;
- novel practice or method – engineers;
- something newly introduced – buyers;
- substitution of a new obligation for the old – consumers;
- alteration of what is established by the introduction of new elements – society.

This is simplistic, but there are three important principles to note:

- an innovation is new in the eye of the beholder;
- an innovation is a technological change and a social change;
- an innovation involves a wide range of people from designers to society.

These basic principles are very important and should be taken into account by management when considering innovation strategies.

In 1962, Rogers[1] said 'An innovation is an idea perceived as new by the individual. It really matters little, as far as human behaviour is concerned, whether or not an idea is objectively new as measured by the amount of time elapsed since its first use or discovery'. But innovation in industry is more than an idea; it is the process that is used to develop the idea and also the new product or service that is recognized as new by consumers[2].

Innovations can be grouped as social and technological, but these are seldom separate and often interrelated. Technological innovations can lead to social innovations and vice versa. A radical technological innovation causes a social or cultural change for consumers, communities and organizations in the food system. The innovations of gas, electric and then microwave heating revolutionized kitchens and cooking methods and also changed the food industry. The innovation of the supermarket changed food manufacturing and marketing, and the shopping habits of consumers. The innovations in baking methods and distribution resulted in the closure of many small bakeries, the formation of a few large bakeries, and changes in the consumers' buying of bread. However, social and political changes can also bring about technological change. The development of a vegetable oil industry in France based on locally grown materials was triggered by an import–export political controversy between France and the USA[3].

This interrelationship has been somewhat ignored during the past 30 years. Innovations in food companies have been fuelled by food technologists or marketers; top management has had little direct influence on innovation, unless their functional speciality was closely aligned with the innovations or they had strategic management skills[4]. Companies did not have the resources to identify either the consequences of the innovation on consumers and society, or the effects of societal changes on the food industry.

Another relationship that is sometimes ignored in innovation development is that between buyer and supplier. Innovation in the food system is often a complex mix of product and service innovation, particularly in the industrial and foodservice markets. Not only is the relationship between the product and the buyer important but also that between the supplier and the buyer.

The climate for innovation

For innovation to occur, an encouraging climate must exist both inside the company and in the environment surrounding the company; product innovation relates to both environments (Fig. 1).

A lively environment is important. For example, the food industry innovations that occurred in the UK during the 19th and 20th centuries[5] were interwoven with increased industrialization and urban growth, consumer needs and political emphasis on cheap food, but also with the development of steamships and motorized vans, mechanical and chemical engineering, new agricultural methods and larger companies. The rapid growth of the food industry initially in southeast Asia and Korea and now in China[6] shows how rapidly food technology can expand given the right climate for change, just as the slow spread in other countries underlines low-technology infrastructure, poor economic status, and perhaps a lack of social and political will[7].

Company environment for innovation

Innovation process

In the company, innovation is the process of bringing new ideas into use[8]. It starts with the strategic goals[9], then develops through product development, process development, marketing development and organizational development, or combinations of them. In the market,

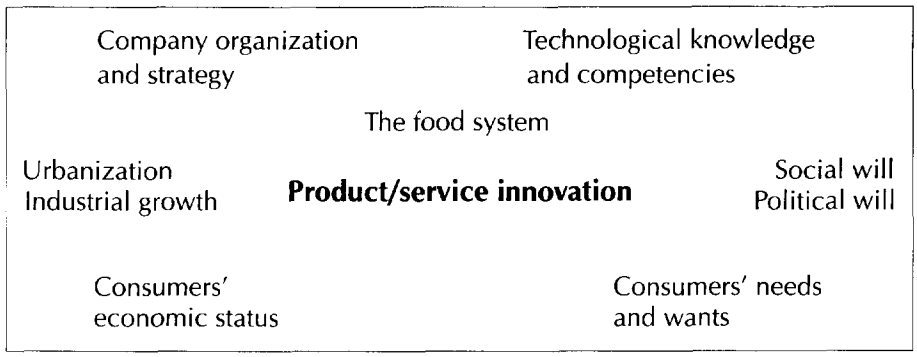

Fig. 1
The climate for product/service innovation.

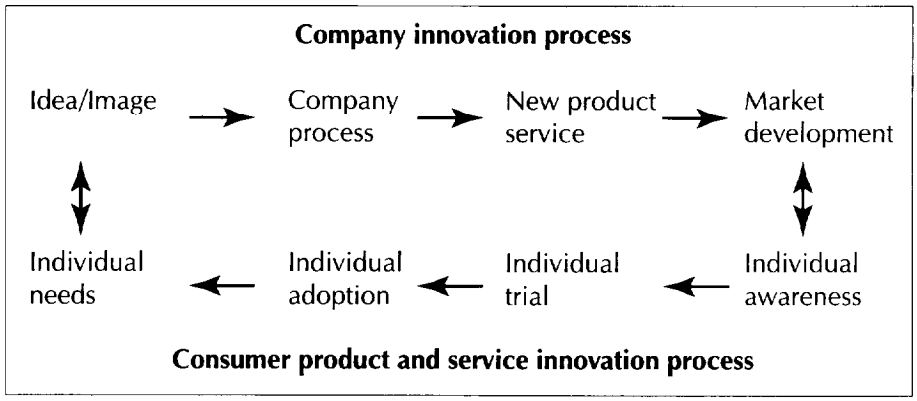

Fig. 2
The two innovation processes: company and consumer.

the new ideas are developed through the interrelationship of the company with the industrial and foodservice buyers or the retailers and consumers, using the methods of market development and market launch. The final stage of the innovation process is diffusion through the targeted sector of society to final adoption by the individual of the product, service or combined product and service innovation[10] (Fig. 2).

Although it is the consumer who adopts the new product and service, many other individuals and groups must adopt the innovation along the way. The actions and reactions of all these people affect the rate of diffusion of the innovation, indeed whether it becomes an innovation or not. People, companies and societies can be divided into: innovators, early adopters, early majority, late majority and laggards[1]. A company decides to which group it belongs, and which market to target.

Innovation-oriented company organization

'Innovation for a company means the creation of the future'[8]. A company decides to be an innovator; an improver, getting involved once the initial products have been developed; a 'me-too', copying what is already on the market; or a die-hard, ignoring the innovation completely. This decision determines its short-term and long-term development, as well as the whole company environment[11]. This decision is crucial because it relates to the success of the innovation, the product advantage, the competitive position and the market share[10,12]. Entrepreneurial vision and motives are important in innovation[13]. If the overall company strategy does not have some entrepreneurial vision, then it is difficult for anyone in the company to be entrepreneurial; the champion of innovation will likely be regarded as a nuisance and perhaps even foolish. Steiner[14] suggested that unconventional individuals, rather than conventional science or engineering, are central to innovation success.

In large companies, the first responsibility of management is often to keep the company viable in the short term. Thus, there is a lack of resources for long-term innovations, and an unwillingness to run the risk of possible failures. The company can organize product improvement and even new market development, because these allow economic analysis and provide a systematic innovation process. But a radical or discontinuous innovation is difficult to fit into the pragmatic philosophy of a company[15]. This has led to the hypothesis that radical innovation occurs in small companies; however, this does not occur as often in food technology as it does in information technology and biotechnology. In most sectors of the US food industry, large companies had higher innovation rates than smaller companies[16].

Within a company, the existence of a clearly defined new product development strategy, consumer focus in the product development process, and organization of the product development process are all important for the success of the product innovation[17,18].

Technological knowledge and competencies

A philosophy developed in the late 19th century believes that there is a straight-line relationship between scientific research and technological innovation:

scientific research → applied research → technology → engineering → innovation

However, modern technology is more complex than this step-wise procedure; it is a technology matrix[7,19], an interwoven pattern of knowledge, techniques and implementation. Technological knowledge includes intellectual, tacit and cultural knowledge. It is embodied not only in machines, processes, production and marketing, but also in people's brains, organizational structures and behavioural patterns[7,19]. It includes knowledge of consumer needs and behaviour, cultures, social systems and the general environment[8,10]. The technological knowledge, techniques and implementation methods are shown in Box 1.

In innovation, one part of the technology matrix is changed by the instigator or the champion of the new development, but the total technology matrix also shifts to produce long-term change. Usually this is a gradual change, because the company needs stability, but if the innovation is radical then the total technology matrix can change immediately.

The level of knowledge, the competencies in the techniques and the resources available for implementation determine the level of innovation occurring in a company[17]. The ability to conceptualize the innovation and the drive to implement it must exist. Patents may have been taken out in the area, and the physical products may have been designed and developed, but until this new total technology crystallizes it does not become an innovation. Assisted by modern communications, technological knowledge is now disseminating globally at an ever faster rate and the ability to apply it is becoming more widespread[19]. But implementation of the innovation needs the resources and the will to drive it to completion.

Technology is a vital source of competitive advantage for a company, but competition in the market selects the products that survive and gain economic importance[10,20]. Total innovation management, combining all aspects of innovation in the company and related to consumers and the market, will lead to improved innovation performance and competitive advantage[21].

External environment

The food system

It is important to include the entire food system when considering innovation strategies. An innovation in one area will affect other organizations in the food system. For example, a new fat-replacing ingredient needs the snack-food manufacturers to develop new frying methods; new methods of chilling fresh fish necessitate supermarkets to change their display methods.

The food system is a complex, dynamic organism with shifting vertical and horizontal relationships[22] – it is itself an area of continuous innovation, causing major product changes, particularly with regard to availability and variety. The most significant innovation in the food industry has been the growth in size of the companies in the industry. In Europe and the USA, amalgamations and takeovers produced large national companies, which became multinational enterprises and finally global empires. The development of an oligopoly structure of a few large companies, combined with a number of small companies, is occurring at every stage in the food system, from production to retailer and foodservice.

Vertical cooperation and integration can stimulate innovation by the increased knowledge of the food system and the opportunity to bring a wider range of abilities into the innovation process. Vertical integration occurs between different stages of the channels in the food system. For example, in the poultry industry, one company can control the breeding of chicks, feedstuff production, the growing companies, the processing plants and distribution to retailers. This type of innovation is rapidly spreading around the world and now even into China.

These innovations in the food system are affecting process and product innovations. A global philosophy and management are appearing in the design, development, production and marketing of foods. Instead of the technology and products emerging from the company headquarters, they are designed, developed and produced in the most suitable geographic area and then transferred to the other areas[23]. Rising product development costs and the need to design for different cultures can only increase this globalization of innovation[24,25].

Social and political wills

Food is an important part of the social structure and its activities; thus, the food industry is more tightly held in the societal and political web than other industries. Society wants cheap foods, so politicians encourage the provision of subsidies to farmers, control the prices of some basic foods, or encourage the cultivation of materials in cheaper areas of the world; society wants self-sufficiency, so home production is subsidized; society wants safety, so the government introduces food regulations; society wants the environment to be preserved, so the government introduces environmental restrictions. Food industry innovations are often directed by these social and governmental activities, whether they are aimed at developing import replacement products, following nutritional directions, or obeying food additive regulations.

Food innovations are also fuelled by wars because of the need for combatants who are well fed and can travel long distances; for example the Napoleonic wars led to the introduction of heat sterilization and canning[26], and their use dramatically increased during the 1914–1918 war; and the 1939–1945 war encouraged improvements in drying and quick-freezing methods. These preservation innovations developed faster during wartime because more resources were available.

Box 1. The basis of technology

1. Knowledge

Technology

- Scientific research
- Technical product qualities
- Processes and machines
- Marketing methods
- Distribution system

• Company

- Company knowledge
- Individual behaviour, needs, attitudes
- Company communication
- Company social system
- Company organization

Consumers and society

- Buyers' needs, wants, behaviour, attitudes
- Consumers' needs, wants, behaviour, attitudes
- Social, political, economic, cultural environment

2. Techniques

Business strategy and management

- Strategic planning
- Organizational planning
- Financial planning

Development techniques

- Raw material development
- Process development
- Product development
- Marketing development
- Distribution development

Planning techniques

- Production planning
- Total quality management
- Human resource planning
- Marketing strategy
- Financial analysis

3. Implementation

Top management decision making

- Business analysis
- Business planning

Production start-up

- Plant construction
- Plant commissioning
- Production
- Distribution

Market launch

- Marketing organization
- Sales organization
- Customer negotiations
- Promotion organization

Table 1. The innovation stages in the development of food ingredients

Development stage	Carbohydrates	Oils and fats	Proteins
Raw	Raw sugar, flour	Vegetable oils	Skim-milk powder
Purified	White sugar, white flour	Colourless oils	Milk protein
Separated	Glucose, starch	Fat fractions	Casein
Treated	Gelatinized starch	Hydrogenated fats	Caseinate
Replaced	Aspartame	Olearesins[a]	Soy proteins

[a]Fatty acid esters of sugars and sugar alcohols

Governments have always been involved in food research as well as in the discussion of the role of this research in food industry innovation[27,28]. National technology policies and government research will not by themselves bring about changes at the level of the company – the company must have the strategy and planning for innovation[29]. However, they can create a reactive environment for innovation so that food industry development can occur.

Consumers: needs, wants and economics

Consumers not only push food innovation by their 'behaviour' – increasing population, urbanization and pollution – but also pull the process by their wants and needs, and their knowledge growth from education and the media.

Consumers want a large variety and quantity of food that is easy to prepare, attractive to consume and cheap. Never has it been easier to obtain cheap food from supermarkets[30] or takeaways, but instead of eating what they need, many keep on consuming. Attitudes are changing as a result of increasing concern about obesity and its related diseases, and a significant majority is seeking improved nutrition[5]. Purchasing patterns are changing, with significant increases in cereal products and decreases in foods containing saturated fats[31,32].

Consumers can be divided into two groups in the global food system and indeed within many countries[33]:

- the over-fed affluent and comfortable;
- the poorly fed underclass.

In the main, product innovation during recent years has focused on the over-fed, despite the existence of a poorly fed underclass in every country and, in world comparisons, poorly fed countries, who need to increase their calorie intakes. This particular food innovation – providing nutritious food cheaply – appears to present food technologists and large global food companies with difficulties that relate more to commerce than to the nature of the problem.

Food innovation is affected by the economic status of a country. At the lowest levels, the populace cannot buy food and have to produce it themselves. As economic status rises, the quantity of food bought increases, and hence also the calorie intake; next, the protein intake starts to increase and both calorie and protein intakes rise quickly before levelling off; finally, both the calorie intake and quantity of food may decrease.

Technological innovation and economic change often appear to be in a 'chicken and egg' situation. For example, dried peas were originally sold in markets in the UK, then as people became more affluent they could afford to buy canned peas, which were more convenient, and finally they could afford frozen peas, which had a better flavour and texture. Today, consumers in the UK want 'fresh peas' year-round, and technology will try to achieve this. With a rise in per capita income, technology moves to develop production, processing and distribution technologies that are able to supply peoples' needs for foods. Thus, there is an interwoven pattern of rising per capita income and technological change.

Historical patterns and future trends in innovation in the food industry

There have been many innovations throughout all parts of the food system: new materials from the land and sea, new processes, new distribution methods, and a constant stream of new food products. Now two integrated innovation streams in the food system are being recognized:

- for ingredients and formulated foods,

  production → processing → manufacturing;

- for fresh foods,

  production → distribution.

Other important innovation areas in the food system are packaging and retailing. Innovations in food quality are being encouraged by consumer concerns and the development of quality measurement and management; this can only continue in the future[5,34].

Food ingredients and food processing

Fifty years ago, food processing companies produced basic carbohydrate, protein and fat materials; chemical companies produced simple food chemicals such as sodium bicarbonate and salt; and nutrient companies produced vitamins and minerals. With the aid of process engineering techniques, they started to develop new ingredients and caused major innovations in food manufacturing: from simple formulations using basic raw materials such as flour, yeast and salt in bread, or oil, eggs and vinegar in mayonnaise, to complex food formulations combining ingredients that are designed to give specific flavours, structures and nutrition.

Ingredient companies initiated a long series of major innovations, from the early purification of vegetable oils and raw sugar to the present-day development of low-calorie fat substitutes and sweeteners. Five stages in this development process are listed in Table 1.

Today, manufacturers can choose from thousands of ingredients[35]. The recent replacement of basic food materials by low-calorie ingredients could be opening up a

new era with respect to food ingredients. In contrast, in the case of food colours and flavours, which were originally extracted from plants and other sources, then synthesized using the techniques of organic chemistry, there is now a return to a preference for natural products[35-37].

The development of new ingredients has been underpinned by innovations in processing, based on process engineering knowledge[38,39]. Greater knowledge and control of the relationships between process variables and product qualities is forming the basis for an integrated approach to process and product development. The first aims of the ingredient industry were increased volumes and yields, reduced costs and energy use, and consistent product quality. The new aim is to increase the variety of ingredients, and tailor them to the individual requirements of food manufacturers. This is an area of innovation in which small companies can flourish, as described in Box 2 (Ref. 40).

Ingredient companies influence the development and production of agricultural and marine raw materials. It appears that one of their future innovative strategies will be to make as many changes as possible in the field, so that ingredients appear more natural. It is notable that several ingredient companies are leading the way in biotechnology research, but development may take some time because of consumer concerns and legal requirements[41].

Box 2. Small food processors can develop an innovation[a]

The revolutionary new process UltraRapid Concentration (URC™):

- concentrates fruit by as much as nine times in 1 min;
- retains much of the fresh fruit's original flavour and colour;
- allows the end product to be tailored exactly to the food manufacturer's needs, including its texture, water activity, sweetness, acidity and moisture barrier properties.

This process was developed by the research team at Taura Natural Food of Mount Maunganui, New Zealand, a small company that makes fruit beverages, fruit toppings, caramels, jams, fruit spreads, ketchups and sauces. The 22-member research team included food technologists, process engineers and market development specialists. The company built up a critical mass of professionally qualified people, both from within the company and externally, including universities, and developed a centre of excellence.

Most of the products that have been developed using this process are proprietary formulations that were developed by Taura exclusively for a single customer's use. The company exports its URC™ products to Australia, South Korea, Taiwan, Japan, Switzerland, the USA and Canada. The plant is now processing 10 000 t of fruit per year; a second plant has been built in Australia and joint-venture plants are being planned in North America and Europe. URC™ fruit are being used by food manufacturers in breakfast cereals, and bakery, confectionery and snack products. A leading Australian fruit juice company, Berrivale Orchards Ltd, now holds an 80% share of the company.

[a]Data taken from Ref. 40

Formulated foods and food manufacturing

In manufacturing, there was an early introduction of mechanical methods, which have been improved during the past 20 years; more recently, there have been some innovations in the application of process engineering principles. Materials science is growing; more knowledge is accumulating on the effects of process variables on three product qualities: food structures, sensory properties and nutritional values. This will lead to the design of new production methods, and food products with known and consistent product qualities that are relevant to the needs of consumers[42].

The five methods of food preservation – heat, cold, chemical, dehydration and mechanical – have improved as a result of new developments, and basic knowledge about them has increased. Hurdle technology, using an optimum combination of preservation methods, is increasing in importance[43]. However, there is scope for innovations in preservation methods. Other methods including the use of electric fields, magnetic fields, ultrasound, pulsed light and irradiation have yet to achieve widespread commercial success[44].

There is a movement of manufacturing to the retailers; already supermarkets are making fresh bread and other bakery products, and preparing meat, vegetables, parts of meals, and sometimes even complete meals[45]. Sloan[46] has predicted that this trend will increase because of the desire of consumers for fresh foods. It will be interesting to see how manufacturers innovate for this trend – by supplying fresh products daily, or by co-operative manufacturing with the supermarkets.

The main innovation in the manufacturing industry has been the development of a systematic product development process[18], which has combined consumer and technological research to develop many varieties of products that are relevant to consumer needs of convenience, variety, safety, nutrition, social relationships and value for money[46-48]. It is predicted that these needs will expand in the USA to include customization (fulfilling the individual needs and desires of consumers), fresh alternatives and more flavourful food. There appears to be a development from the rather bland mainstream foods of the past to flavour boosting and, for some growing parts of the market, spicy and hot foods[46].

Fresh foods and distribution

This innovation is based on control of the physiological and biochemical changes in a food so that it retains its original qualities for a significant period of time. The ultimate aim is to retain 'life' in the food, but the current practical aim is to extend the storage life of harvested food by improved atmospheric and temperature control during storage and transport, and new types of packaging. The extension of life is exemplified in the export distribution of live crayfish and mussels, and the sale of lettuces with roots in a supporting solution.

The aims are to increase the variety of fresh products by breeding, sometimes based on biotechnology, by utilizing global growing areas and by improving distribution processes, so that the foods can be available all year. Product innovations can be new types or new varieties. The growth in fresh foods will result in a growth of brands in this area and also an increasing need for ensuring and marketing food safety[46].

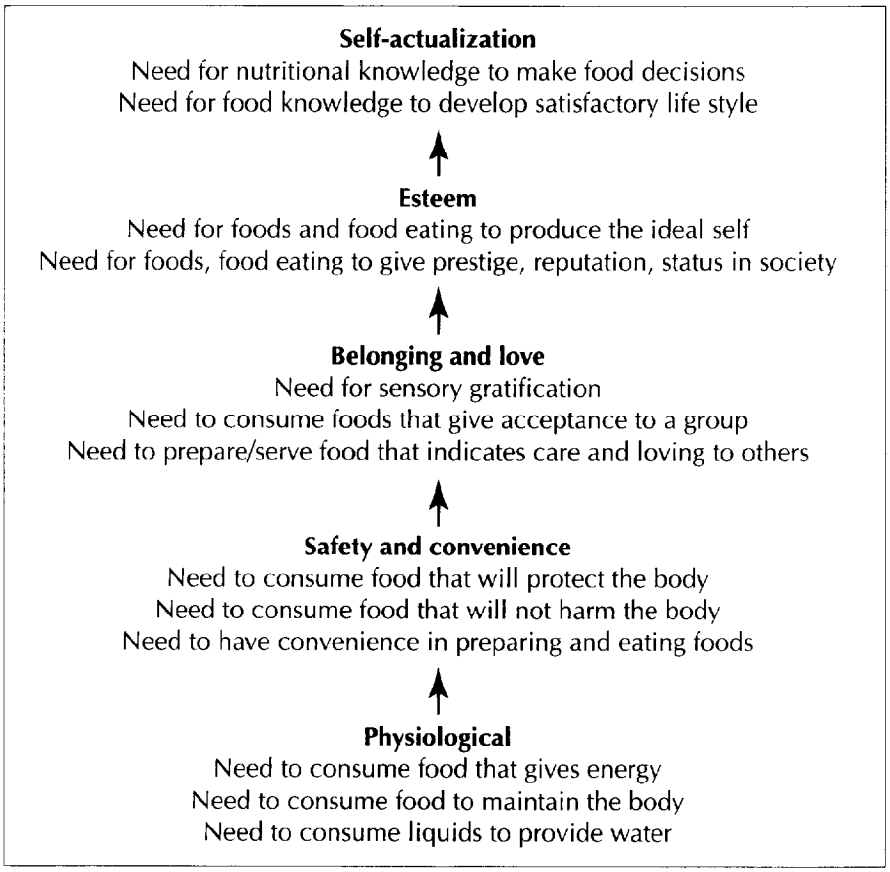

Fig. 3
Application of Maslow's need hierarchy to food behaviour (adapted from Ref. 57).

Packaging

Packaging has seen many innovations: from the early cellophane packs to the multi-walled packs, the soldered can to the tear-top aluminium can, and the thick glass bottle to the PET [poly(ethylene terephthalate)] bottle. Packaging innovations introduced more efficient packing methods, increased protection and storage life, and improved aesthetic presentation. Packaging innovations are driven by consumer desires, distribution needs and new materials[49]. Packaging is often integral with manufacturing, for example the use of the multi-walled cardboard cartons in combination with pasteurization and sterilization for milk, juices and other liquids[50].

Packaging innovations have been quickly accepted by food manufacturers, because of the reductions in production costs, and the need for attractiveness on the supermarket shelves. Environmental criticisms of packaging are pressuring changes to reduce waste and aid recycling. Although this will not reduce the amount of packaged foods, it is already reducing the amount of packaging materials used by encouraging the use of thinner films, less board in boxes and less dual packaging.

An important innovation was the development of identification markings on packages that allowed scanning and computer recording in supermarkets[51]. The use of these identification systems is now expanding in the food system, so that eventually the final consumer product will be identified with the manufacturer, the ingredient suppliers, and the farmers or fishers. This will take some time in the total global food system, but should be quickly achieved in a chain in which there is vertical integration.

Retailing

The major innovation in retailing was the move away from small stores to supermarkets, superstores and hypermarkets. However, in the USA a reverse trend is now predicted: a move away from supermarkets to convenience stores[46]. Grunert *et al.*[10] have predicted increased internationalization of retailers.

Retailer labels have increased; 20–50% of foods have retailer's-own labels, depending on the country and the company. In the UK, this is leading to retailer-driven vertical partnerships, as retailers seek to maintain and increase margins in a static market and minimize their exposure to food safety risks[52].

The changes that have occurred inside stores are the result of the interplay of consumers, technology, retailers and regulations. The development of scanners shows this interplay: barcode scanners, consumer card scanners, hand-held consumer scanners, instant coupon machines, self-scan checkouts, and now telephone interaction for home deliveries[30].

Foodservice has shown innovation in the global expansion of simple fast foods; McDonald's, the largest fast-food company, has >14 000 units in 68 countries[53]. The food is standardized throughout the world, but with some differences to satisfy the local culture, for example halal certification for Muslims and the addition of an egg for Australians.

Food qualities, including nutrition and safety

There is increasing knowledge of the relationships between consumer needs, the quantitative measurement of food qualities, and the effects of processing and storage on food qualities[5]. This will lead to a more controlled method of designing food products.

Nutrition has been a strong force in innovation. Food companies have reacted by using new ingredients and formulations to reduce the levels of fat, sugar and salt in foods, but perhaps in the future they will be forced by consumers to consider the total nutritional value of their products and the effects they may have on the diets and health of consumers[48]. Although the effects of processing on nutritional value have been studied for many years, the research effort has been small and few companies have the knowledge and perhaps the will to design their processing methods to control their products' nutritional value. There is little knowledge of the effects of new foods in the diet; any research that has been carried out has usually been done after the introduction of the new products. For example, there is limited information

on the effects of fat replacement on food choice and energy balances[54].

Food safety is another area of consumer concern about which the industry lacks knowledge. Foodborne diseases appear to be occurring more frequently[55], and these have had major effects on some industries and some types of foods: BSE (bovine spongiform encephalopathy) on the beef industry, algal toxins on the shellfish industry, *Escherichia coli* O157:H7 on prepared meats and *Listeria monocytogenes* on delicatessen foods. Such outbreaks are now quickly reported around the world and can affect distant markets. The hazard analysis and critical control points (HACCP) approach was originally used as a process tool to ensure food safety, identifying critical points in the process, studying the variables related to food safety and then controlling the variables to ensure a safe food. The application of the HACCP approach is now being extended to ensure official certification standards for products in particular markets, animal welfare standards and the company's product quality standards.

The combination of total quality management (TQM) with HACCP, quality ISO 9000 standards and environmental ISO 1400 standards is going to represent a major product quality innovation that will transform the food industry. These safety and quality systems are being coordinated from the growing of food, through harvesting, processing, manufacturing, distribution and preparation for consumption. This will cause vertical integration of the entire food system for food quality guarantees, emphasizing the need for more research on the relationship between processing variables and food qualities[56].

Innovation strategies for the future

Technology has moved from the production age to the service age and recently to the information age. What does this mean for food technology? The foodservice sector has grown dramatically and still appears to be growing faster than the other sectors of the food industry. It is not so clear how the information age is affecting innovation in the food industry. It is important to understand the consumer in the information age, before developing new innovation strategies for the future.

The information age and the consumer

The information age will increase the consumers' knowledge about foods. Affluent and comfortable consumers in Western and Asian countries have moved through all the levels of the Maslow's need hierarchy[57] as related to foods (Fig. 3), and have reached the self-actualization stage. There are consumers at each stage of need, and many consumers combine the needs of several stages.

Sloan[46] has predicted that consumers in the USA will have three groups of needs for the food industry to address in the future:

- to make it easier for consumers to ensure they have a healthy diet, and to provide products that aid disease prevention, maintain weight at the correct level, energize tired people and relieve stress;
- to provide entertainment, an opportunity to indulge, and a vehicle that offers both emotional and social reward;
- to provide food that is simple, easy and accessible.

Many consumers now seek knowledge through television and the Internet. Innovative food manufacturers will need to keep ahead of this knowledge so that their innovations satisfy consumers at the right time. Consumer interest in nutrition will promote innovation as it has done in the past, but manufacturers will need to keep ahead of consumers' knowledge and not just react when some nutritional research hits the media. Consumers are now going to question the nutritional innovations in products. Consumers have more knowledge of the food industry, its methods of processing and the qualities of the food products, and are demanding higher environmental and social standards. Currently, they gain this control through the political system, but can the food industry react more directly? A major innovative strategy for the 21st century could be the change from a regulatory-based industry to an ethical-based industry. Certainly, if functional foods or nutraceuticals are to increase, sectors of the food industry will need to attain the ethical standards of the pharmaceutical industry.

Consumer trends are spreading throughout the world[58] and this can only increase with the communication explosion. US citizens are afraid of colon cancer and suddenly consumers in Singapore are worried about lack of fibre. Information technology is creating global consumers, who accept food and knowledge from any country[59].

Culture intermingling is growing stronger in food eating. The ethnic foods trend is taking place in many countries, with products moving in different directions; for example, US foods to Thailand, Thai foods to the USA. Food products from one country are adapted for consumers in other countries, by blending with the traditional ethnic food profile and absorbing any religious or cultural needs. Global products will increasingly be designed as a standardized core product that needs minimal local adaptation[60,61]. Food innovations in products, production, processing and retailing spread around the world, and the rate of diffusion of these innovations appears to be quickening.

Future innovation strategies for the food industry

Whatever direction its innovation strategy may take, a company needs the knowledge and techniques to create, design and develop the innovation, as well as the resources and implementation skills to bring it to market. In the knowledge era, companies will increase their knowledge and global involvement. The knowledge-based organization will put increased emphasis on the relationship between technical product qualities and consumer needs and wants; this means that marketing personnel will need to be technically literate, and technical personnel will be required to become more people oriented. Such changes are already happening in industrial food marketing. The 'fresh' technology, because of its requirement to control conditions from production,

through harvesting to the consumer, is also developing this approach to innovation. There must be coordinated in-depth knowledge in a food company: total technology is the basis of innovation in the information age.

In developing innovation strategies for the global future, a company needs to consider its place in the food system: its size, competencies and knowledge; the resources available; the targeted consumer groups and their needs and wants; as well as its aims for the future and its business strategies to achieve these aims. It also needs to decide where it will fit in the innovation timetable from innovators to long-time followers, before it develops its innovation strategy.

Companies need to select their place in the growing global food system, whether it is in the fresh products channel or in the processed products channel, and whether it is at the production, ingredient processing, manufacturing, distribution or retail stage. Innovations are already occurring in the earlier stages of the food system and will continue; however, the major innovations in the manufacturing and distribution sectors are difficult to predict in this information age. There could be more specialization in food manufacturing companies – the large food manufacturer with an extremely diverse range of products might disappear. Because of the increasing depth of knowledge needed in food manufacturing, food manufacturers might be more successful in the future if they were to concentrate on particular product areas, just as beverage manufacturers do today.

The retail sector is a continuous area for innovation. There appears to be an increase in access problems, which will need creative, innovative distribution strategies to resolve them. Will there be a return to small local stores or a move towards direct buying by some method of telecommunications? These innovation strategies are under consideration. There is a growth of convenience stores in the USA, and also of food stores associated with petrol (gas) stations in many countries. Is this an indication of local stores replacing supermarkets? UK food retailers are placing emphasis on a high level of product quality for their own labels, a demand for quality standards from suppliers, a focus on the environment and higher margins. They have a high degree of own production and vertical integration; there is no room for manufacturers who are unable to meet their requirements. These retailers will be more closely involved in the manufacturers' innovation processes, from the selection of product ideas and the product design specifications, to the final decisions on launching and marketing. Food manufacturers are becoming caught between the food processors, who are pushing their innovation strategies by supplying ingredients, processes and even the target consumers, and the retailers, who are pushing them to develop innovations that are in agreement with the retailers' innovation strategy. What innovation strategy should a manufacturer with national brands develop to break out of this two-pronged control?

Some possible innovation strategies for the various stages in the food system are:

- Foodservice – The fast-food area will continue to develop globally, with international foods developing from the fusion of meals and snacks from different countries. In some countries, particularly the USA, fast-food companies could develop more fresh meals or part meals to take home.
- Retailers – New developments will start to occur in the USA to cater for changing consumer needs. There could be innovation in the types of stores, with fresh food markets, convenience stores and take-home meal outlets flourishing at the expense of the supermarkets that currently dominate.
- Manufacturers – In seeking 'total food technology', manufacturers could seek innovations in the retail sector, developing new retail outlets that they could own outright or in a joint venture with other manufacturers or retailers. Two possible innovations are:

  (1) marketing a specialized range of nutritionally designed products through nutrition boutiques;

  (2) cooperation with fast-food outlets to develop a new combined manufacturing and retail system to provide fresh meals or part meals to take home.
- Processors – Currently, this is an innovative sector and one can only see processors increasing their industrial marketing, developing cooperative programmes with their customers, both food manufacturers and foodservice, and increasingly involving farmers and fishers.
- Farmers and fishers – They could increasingly manage a 'fresh' chain from the farm or sea to the 'fresh' supermarket and foodservice outlet. There will be closer relationships with food processors in the breeding and production of new ingredients so that these are directly relevant to the needs of the processors. The farmers and fishing companies could consider ownership of the processors and even the manufacturers so that their development of new varieties and of more sustainable production methods is directly related to the needs of the consumer.

Innovations to feed the poorly fed

A strategy of innovation to feed the poorly fed starts with a few basic consumer products, made from low-cost raw materials, and an efficient manufacturing and distribution system. Although such an innovation is old in time, it will be new in the eyes of the poorly fed people. In the poorer areas of an affluent country, the innovation could be convenience stores that sell only a small product range and are owned by the food manufacturers themselves, giving a very simple distribution system. Supermarkets are often difficult for the poor to reach when they do not own cars and public transport is unavailable.

In the case of countries with a large proportion of poor people, the problem is more difficult but must be solved. This presents difficulties to large global food companies as the system needs to be profitable. The global food industry may have to be pushed by political will

and a subsidized agricultural production to develop this innovation. However, it is important for the global food system that this innovation is introduced and succeeds.

These are some examples to demonstrate that innovation should be directed to the needs of consumers: convenience, controlled nutritional composition, freshness, cheapness, safety and attractive sensory properties. An innovation may be from new materials, new equipment or new methods of organizing the food system, but in the end it is about delivering foods to the consumer. The greatest innovation will be the development of new food sub-systems within an integrated global food system. There is the opportunity to create a global food system that will provide adequate food for all, without causing the diseases of excess.

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