Foresight for Food and Drink

Fruit and Vegetables

CONTENTS

Foresight For The Fruit And Vegetables Sector

The UK's Foresight programme was first announced in the 1993 White Paper *Realising our Potential*. Its aim is to create sustainable competitive advantage and enhance the quality of life, by bringing together business, the science base and Government to identify and respond to emerging opportunities in markets and technologies.

The Foresight programme is spearheaded by 16 panels set up to explore opportunities in different sectors of the economy. In 1995, the panels published their first reports following widespread consultation. These reports aimed to identify:

- the likely social, economic and market trends that will affect the UK in the medium to long term;
- the developments required in science, engineering and technology to best address future needs; and
- the implications for policy and infrastructure and for business investment strategies.

The Food and Drink panel has since looked in further detail at six sub-sectors:

- Alcoholic Drinks
- Cereals
- Dairy
- Fruit and Vegetables
- Meat
- Soft Drinks

The groups involved were asked to perform Foresight analyses for each of their sectors, to challenge the original panel findings and to make recommendations for further action aimed at involving industry and academia in debate about priorities for the future.

This report summarises the work of the Fruit and Vegetables sub-group of the Food and Drink panel.

Executive Summary

This report concentrates on the production end of the fruit and vegetables sector while highlighting the key influences from the consumer and retailer end of the food chain.

UK fruit and vegetable producers are successful and compete well with other countries in some crops. The value of home-produced sales is approximately £2 billion for vegetables and £325 million for fruit. Imports add a further £1.3 billion and £1.9 billion respectively to these figures. In the past, producers have not been export-focused, instead concentrating on domestic markets and this is reflected in the export sales of £203 and £144 million. Domestic production volumes tend to be cyclic and weather related.

The sector is well served by the UK research base with a range of organizations funding basic, strategic and applied research in the public and private sector.

Meeting the demands of an ever more discerning consumer will remain the main challenge to the sector. The acceptance of biotechnology and other new technologies for production and processing will depend on demonstrable benefits to the consumer (although these may be indirect benefits such as environmental friendly production methods).

Although the UK per capita consumption of many types of fruit and vegetables has been falling in recent years, there is an opportunity to reverse this trend due to the gain in awareness of 'healthy eating'.

High quality information about the latest techniques together with a well educated workforce will be key to future competitiveness. Production systems will continue to be driven by the need for greater efficiency and improved product quality at all stages.

The availability of water will be critical and the use of better prediction of weather changes together with decision support systems will be needed to help manage production and meet changes in demand.

Science and technology opportunities to help this sector exist in plant science and biotechnology, advanced agricultural engineering, crop protection and for each there have been examples, highlighted here, of UK research contributing to benefits to UK growers. The barriers to progress in some of these areas are also identified.

The sub-group's recommendations are:

- The major public and industry research sponsors should together maintain a medium to long term strategy (5-10 years) for research supporting the sector.

- Investment in the development of varieties of fruit and vegetables to benefit the UK should be maintained.

- A high priority is for research into the nutritional and disease-preventing benefits of fruit and vegetables and how these can be maximised with improved eating characteristics to encourage greater consumption in the UK.

- Companies in the sector should support an information retrieval and analysis service aimed at supplying up-to-date technical information on production practice world-wide to a large proportion of UK growers.

- The implications for the fruit and vegetables sector of future water availability and use should be widely discussed.

- A strategy for education and training of potential entrants to the fruit and vegetables sector should be drawn up.

- The vision for the future started with this report should be developed further involving all those with an interest in the sector.

Background To The Sector

1. The fruit and vegetables sector is defined here as that part of the food chain (from primary production to retailing) dealing with home produced or imported fresh or processed fruit and vegetables. This report focuses mainly on issues surrounding primary production.

Fruit and vegetable production

2. UK fruit and vegetable production is successful and competes well in some areas with the best in the world, for example in protected tomatoes and root and green vegetables, soft fruit, quick frozen vegetables and added value prepared salads and other vegetables. The structure of the primary production sector is currently fragmented with some very large but also many small growers. Apart from apples, there are few co-operatives in comparison with Holland, for example, although this situation is changing. In the past, the fragmentation mentioned above and the segmentation of added value has meant that a consolidated sector view on priorities has been difficult to obtain. This situation is changing, however, and the EU fruit and vegetables regime is likely to cause an amalgamation of growers giving more large companies.

3. Production volumes are weather related and tend to be cyclic - gluts and famines with associated price fluctuations. This allows the more entrepreneurial companies to fill niches or out of season slots in the market, but for the UK as a whole, this can be inefficient because of the excess production that may arise. In general, unpredictable over-supply causing artificially low prices is not wanted.

4. Producers have not been particularly export-focused in the past, instead relying on domestic markets.

5. Retailers have and will have a major influence by demanding increasing quality and greater continuity of supply; additionally, they often stimulate product innovation.

6. Data on the value of fruit and vegetable production(1) are given in table 1[Fig] and table 2 [Fig]. These figures underlie much larger ones for value added products made from the raw materials. For example, cider sales reach £1.3 billion annually.

(1) Data from MAFF and the Potato Marketing Board

Fruit and vegetable sales and consumption

7. Consumption data for the UK between 1975 and 1995(2) are given in Figures 1-3. These data indicate that, despite national campaigns and advice on the health benefits of eating fruit and vegetables, consumption of many types has fallen or remained static over the last twenty years. Those that have increased represent the great demand for convenience foods such as pre-packed salads.

(2) 1995 National Food Survey, MAFF, The Stationery Office, 1996 Potato consumption data are in 10g per person per week - data from the potato Marketing Board

Figure 1 : Household consumption of selected fresh green vegetables (grams per person per week) and potatoes (10 x grams per person per week)

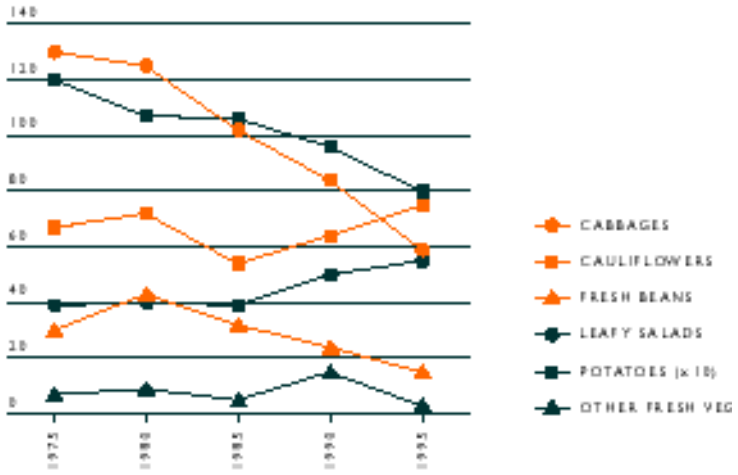


Figure 2 : Household consumption of frozen vegetables (grams per person per week)

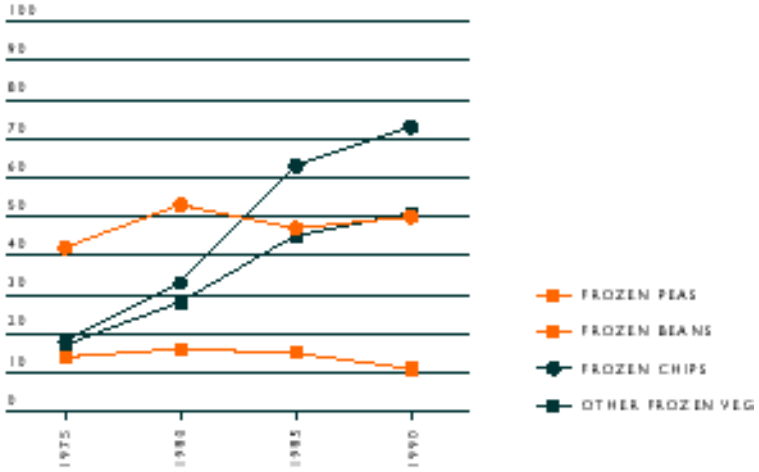
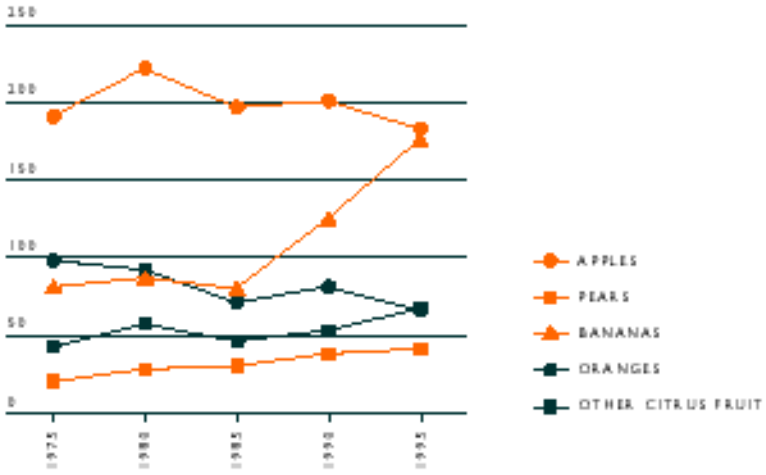


Figure 3 : Household consumption of fresh fruit (grams per person per week)



R&D

8. There has historically been a rapid uptake of new knowledge from the very strong base

of public sector basic and strategic research. However, the pivotal role played by research institutions and university departments has often not been recognised or acknowledged by growers. Levy bodies such as the Horticultural Development Council (HDC), the Apple and Pear Research Council (APRC) and the Potato Marketing Board (PMB) as well as other industry oriented bodies such as the East Malling Trustees (EMT; for fruit and hops) fund research which is primarily, although not exclusively, applied. They have been influential in bringing growers together to purchase R&D and to agree on priority problems. As part of European fruit and vegetable reforms, opportunities have opened up for growers to spend more on near-market research. In addition, in some areas, such as innovative growing techniques, agronomy and extended season growing, companies are increasingly solving their problems through in-house research or through private contracts with research organisations.

Key Drivers

Consumers and markets

- Choice, cost, quality (including taste, appearance and texture), safety, convenience, availability, service, novelty and continuity of supply are and will remain predominant factors.

- There will be a greatly increased awareness of health issues, including the role of fruit and vegetables in protection against cancer and other diseases, leading to the opportunity to promote their nutritional benefits (there is also a need to define and declare them). This will also be the best opportunity to reverse declining consumption.

- Acceptance of new technologies, particularly biotechnology, will depend on demonstrable benefits to the customer, such as convenience, lower price or quality characteristics, and also on how they are perceived to affect the 'naturalness' and safety of food; antibiotic resistance markers in genetically modified plant material are a case where consumers are not likely to accept the technology. These perceptions will in turn depend on the extent of knowledge and understanding among consumers, careful communication about production methods by companies in the food chain and the public's views on issues surrounding the ethics of production.

- There will be greatly increased competition within domestic and export markets from overseas, particularly low labour cost countries. The ethics of production in these countries will come under increasing scrutiny as will the hidden costs in transporting goods long distances; local production will become more important.

- There will be more differentiation of fresh (as is already the case with apples) and processed products and retail/grower consortia will increasingly seek to obtain sole use of particular varieties.

- Convenience foods and niche (or 'micro') fruit and vegetable products will increase in importance.

- Fresh fruit sales will meet increasing competition from other snack foods.

- Integrated Crop Management (ICM), balancing economic production with environmental responsibility, will become the norm - demanded by consumers and retailers through tighter legislation and regulation including self-regulation.

Internal

Information supply and take-up

- Access to an efficient supply of high quality information to companies in the supply chain about the latest production techniques and new materials world-wide will be vital to the sector's future competitiveness. The levy and other trade organizations, the trade press and agro-industry consultants will have an important role to play.

- Information technology (IT) will play a central role in helping rapid decision-making e.g. for yield prediction

- A well educated and motivated workforce will be essential at all levels within companies.

Primary production

- Quality of fresh produce will continue to be the key for all sectors of the industry. Quality characteristics include, for fresh and prepared products: post-harvest quality and shelf-life; eating quality (flavour and texture); visual appearance, microbiological and chemical safety; and nutritional attributes. Irradiation may be re-examined for extending shelf life (it is already being used for strawberries in Holland and the USA).

- For processed fruit and vegetables important factors will be pre and post-harvest quality together with physical and chemical characteristics that affect processing procedures, for example to give a 'fresh' texture and taste. Faster and more efficient ways of freezing and thawing will be sought. The time taken from field to factory will be minimised. New, cost-effective methods of dehydrating fruit and vegetables will take advantage of improved fresh quality and will reduce transport costs. There will be a wider range of freeze-dried products. Short and long term storage will remain important for potatoes, fruit and root vegetables.

- Automation and robotics will play an increasingly important role. The whole production process from planting to packaging will be affected in order to reduce costs, to avoid repetitive strain and other over-use injuries among staff and to substitute for jobs which are arduous or tedious and/or could be hazardous. Personnel levels in the sector will be reduced as a result which may give savings in costs.

- Production costs from harvest product to the product sale to the consumer will remain a key factor in profitability. Driving these costs down will be critical for the sector's future competitiveness and yield will continue to be important.

Industry infrastructure

- The competitiveness of the sector will depend upon it becoming more attractive to new, better educated, career entrants.

- Information technology (IT) will have a major impact on vertical integration of companies in the food chain - it will become essential for Integrated Crop Management (ICM), traceability, supply and distribution.

- The growth and concentration of retailers and catering companies will continue at the expense of the wholesale markets and there will be further concentration and rationalization of companies in the sector.

- Increased exports of high value added fruit and vegetables will support volume production and economies of scale. UK retailers will expand their interests overseas and will play a major part in these exports.

External

- Technology will itself be a driver for change by giving opportunities for improved production methods.

- Biotechnology will play an increasingly important role in removing the genetic constraints within current genotypes and varieties. There will need to be clear benefits to the consumer, not just the producer, and absolute safety.

- The availability of water for irrigation will be critical. Long term changes in climate and the approach of water companies may cause problems for growers and supplies will need to be actively managed by users as well as providers.

- The ability to predict long, medium and short-term weather patterns, coupled with decision support systems and precision agriculture and horticulture will give great competitive advantage and should reduce gluts.

- The availability of agrochemicals for minor and major horticultural crops will continue to be limited particularly to combat pests and diseases new to the UK.

Legislation

- Overall, there is likely to be an increase in legislation driven by consumer pressure, for example on environmental issues such as effluent and waste packaging disposal and the use of recyclable packaging, on the hidden costs of transporting goods long distances, on health and safety and on providing more product information. The influence of domestic legislation will decrease in comparison with EU legislation/regulation (a current example is on nitrate levels).

- European legislation on minimum wages and the 48 hour week are likely to have a significant effect on the profitability of the sector.

Scientific Opportunities And Barriers To Progress

9. Academic and industry plant science in the UK is already making a significant contribution to the fruit and vegetables sector. Notable successes include:

- Studies on the influences of temperature on different stages of insect pest life cycles together with new, computer-based approaches to handling this information has resulted in decision-support systems being available allowing better targeted use of insecticides in vegetables and apples.

- Integrated pest management has been widely practised by top-fruit growers for many years. The more recent Gro-Act standards for integrated crop management in apples and pears have been adopted by over 80% of growers.

- Research on the action of Bacillus thuringiensis toxin, its toxicity to different insect pests and the use of plasmid transfer techniques has led to new insecticides coming onto the market.

- Based on fundamental studies in immunology and plant pathology, diagnostic tests for viral, bacterial and fungal diseases in planting material (e.g. the EMLA scheme for fruit trees), soil and on seeds are now in routine use.

- Collaborative academic/industry research on tomato fruit cell wall-degrading enzymes together with the application of anti-sense and transformation technology has resulted in UK-held patents for the production of tomato cultivars with improved quality for paste production. The end-products of this collaboration are on sale in British supermarkets and have been accepted by consumers - opportunities for UK-grown crops could follow.

- Research on controlled environment storage has made a significant impact on the keeping qualities of apples and pears. This information together with annual trials with fruit from different orchards is used to provide annual advice to growers about the conditions and length of storage.

- Studies on crop photosynthesis and assimilate partitioning have contributed to a 20% increase over the last five years in the marketable yield of protected tomatoes.

Plant science and biotechnology

10. The potential for further innovation and for large improvements in the efficiency of production will depend on the ability to change key processes within the plant - to increase

or decrease the expression of particular genes. The molecular tools to do this are rapidly becoming available as is basic genetic information in the form of DNA sequences. Traditional breeding can be made more efficient and quicker by the identification and exploitation of molecular markers linked to important agronomic traits.

11. The potential to produce better crops is huge. Potential targets include:

- dramatically improving yields while maintaining consistently high quality (i.e. increasing the efficiency of production);
- removing the need for rootstocks for stone and top-fruit production;
- slower ripening/senescence for improved shelf life (such as used in the FlavrSavr tomato);
- completely new varieties using previously untried natural genetic variation;
- functional foods with boosted vitamins, beneficial nutrients, fibre or pharmaceuticals;
- smart plants which advertise when they are at peak maturity or under stress;
- better processing characteristics including the shear strengths of cell walls and toughness of fibres;
- reduction of bruising and discoloration by blocking the action of the 'browning' enzyme;
- overcoming seasonal constraints on production;
- stress resistance e.g. drought tolerance.

12. Research in these areas is also likely to have spin-offs into other crops. For example, research into the biology and chemistry of cell walls and how they are joined in different tissues will help understand, and ultimately modify, texture properties in both fruit and vegetables.

13. Barriers to the successful exploitation of these opportunities are:

- A worrying lack of expertise in some important disciplines, for example in plant biochemistry and physiology. The large injection of resources into plant molecular biology in the early 1980s allowed the UK to remain at the forefront of this area but there was at the same time some diversion of resources away from other disciplines which is now proving costly in terms of being able to link advances in knowledge at the gene level to processes in the whole plant.
- An often negative public reaction to new technologies, particularly genetic modification. The sub-group sees an independent (not industry or Government) source of advice and information for the as the best way of overcoming such reactions. Where food safety is concerned, this role is the basis of the remit of the

new Food Standards Agency

- An increasing concentration of the intellectual property rights (IPR) to molecular information within a few companies may lead to less information being available for use in fruit and vegetable crops. It is essential, for example, that gene sequence data continues to be put into the public domain.

- A decline in support for publicly funded horticultural crop breeding in the UK hinders the development of new varieties of crops which would benefit UK growers (for example by being tailored to the UK's market requirements or climatic conditions). Crop values in the UK are often insufficiently large for multinational seed companies focused on international markets for their products to invest in research and development specifically with UK interest in mind. For fruit crops, there is negligible activity in genetic improvement in the private sector and advances can only be sustained by public sector investment.

- Threats to funding of the UK's national fruit and vegetable gene banks which supply germplasm for developing new varieties.

Advanced agricultural engineering

14. Advanced engineering includes both automation, for example of repetitive, essentially similar tasks, and robotics; a robot is a machine that can be programmed to interact in response to its environment. Automation has been increasingly applied in the fruit and vegetable sector, for example in vegetable and fruit grading, vegetable trimming and pruning. Although robotics has been in use in heavy manufacturing industries for years, it is just beginning to find application in fruit and vegetables, for example for picking delicate crops such as mushrooms. The UK has a strong academic base in advanced agricultural engineering.

15. There are opportunities to deliver benefits throughout the fruit and vegetable sector. These include:

- improving the health and safety of employees by relieving them of potentially injurious tasks involving, for instance, repeated stretching and handling operations, and reducing the exposure to uncomfortable environments;

- reducing production costs by using automation instead of manual labour which can amount to 30 to 50% of production costs;

- optimising quality of the end product through a combination of better crop husbandry, robotic harvesting and sensors with image analysis for inspection and grading;

- greater protection of the environment and the consumer through precision application of pesticides and on-line detection of residues;

16. Obstacles to be overcome to realise these opportunities include;

- solving the quite severe technical difficulties while keeping the solutions cheap enough to be affordable by growers

- finding funding for the multidisciplinary approaches to R&D which are often needed but which are expensive to support;

- finding engineering companies willing and able to develop innovative equipment - there is currently only a small UK industrial sector and overseas companies are sometimes reluctant to get involved with the particular needs of the UK sector (and of individual crops) unless there are also generic benefits to be gained for wider markets. The development of systems that could be built on-farm may be a partial solution.

- the difficulty of transferring suitable technology from other highly profitable industrial sectors such as the car industry (robotics) or telecommunications (sensing and communication technologies) to the fruit and vegetable sector which works on significantly lower levels of profit margin;

- the development of modelling techniques to handle the enormous datasets generated by satellite and other remote sensing systems.

Crop protection

17. To deliver the very high standards of presentation and freedom from damage that are demanded by the retailers and their customers, the UK fruit and vegetable sector relies on effective crop protection agrochemicals, the use of biological control, particularly for insect pests of fruit and protected crops and the deployment of pest and disease resistant cultivars (available only for a few crops. There is a niche for organic production, and bio-control methods such as those to influence predator/prey relationships will grow in importance. Integrated Crop Management will play a significant role. However, the sub-group considers that for most crops, a combination of genetic resistance with chemical intervention will be necessary for the foreseeable future. UK growers have historically been very successful in supplying high quality produce and have been very quick to take up new techniques and improved chemicals.

18. The tomato is an example where breeding programmes over many years have produced varieties with high levels of disease resistance such that integrated crop management techniques employing a combination of reduced dosage of agrochemicals and biocontrol agents have been able to be routinely applied albeit at an increase cost to the producer. There have also been successes in soft fruit, potatoes and a few vegetable crops. However, elevated genetic resistance to widespread and damaging pests and diseases of major horticultural crops (e.g. apples and brassicas) where control relies on pesticide use, would give great benefit.

19. Recent research has shown that there are considerable similarities in the organisation of genes in related species. For example, genes identified in the model crucifer, Arabidopsis, can be used to locate and isolate genes of comparable function in the closely related brassicas. Research indicates that it may be possible to extend this approach to more distantly related plant species. For example, several genes controlling resistance to diseases caused by fungi bacteria and viruses have now been isolated from a number of species and the proteins they code for show remarkable similarity. UK scientists are in the forefront of this research and its potential application to future crop protection strategies.

20. These advances combined with those in plant science described above should allow lengthy breeding programmes to be circumvented and may result in disease resistance

being transferred into a range of fruit and vegetable crops. Together with bio-control methods and careful use of chemical treatments this should extend the use of Integrated Pest Management (IPM).

21. Better knowledge of the molecular basis for microbial pathogenicity and the mechanisms of plant resistance should lead to the identification of new targets for crop protection agents, for example, routes to stimulate the plant's natural defence mechanisms. Agrochemicals which stimulate the plant's natural defence mechanisms or which are derived from naturally occurring materials are examples of new developments and future opportunities.

22. The main barriers to improving UK crop protection systems are:

- The cost of research to isolate the genes involved in particular species, particularly for the minor crops. Agrochemical and agricultural biotechnology companies are involved in this type of research in the UK but they have to make business decisions about how much of the basic/strategic research they can support. The sub-group considers that continued public sector support for research to confer genetic resistance to fruit and vegetable crops is essential.

- The reducing number of agrochemicals available for the so-called minor crops, including many fruits and vegetables. Cost factors deter agrochemical companies from developing new chemicals specifically for such crops as the markets are small compared to soya, rice and cereals. There is a successful UK system for Specific Off-Label Approvals (SOLAs) for agrochemicals for horticulture which is funded by growers through the HDC. However, many older chemicals are likely to be removed from the market place due to the cost of generating the data required following EU reviews.

- The emergence of new, or the recurrence of older pest and disease problems is a certainty for the future. However, the infrastructure to maintain the necessary skills to tackle these problems is threatened by short term changes in the direction of research funding.

Recommendations

23. This report identifies many opportunities to benefit the fruit and vegetables sector and all those involved in the sector are encouraged to consider where they can help in realising these opportunities. For its part, the Foresight sub-group will continue to develop a vision for the future (see below) but there are some actions which it believes should be taken now. These are:

Research and development

- The major research sponsors (MAFF, BBSRC, SOAEFD, DANI, HDC, APRC, EMT and PMB) should together maintain a medium to long term strategy (5-10 years) for research supporting the UK fruit and vegetables sector taking into consideration the conclusions and priorities identified in this report in plant science, advanced agricultural engineering and crop protection.

- These sponsors, in collaboration with national and multinational plant breeders, should support the development of varieties of fruit and vegetables conferring particular benefits to UK producers and consumers.

- A high priority is for research into the nutritional benefits of fruit and vegetables and how these can be maximised together with enhancing the flavour, texture and other properties to encourage greater consumption by the UK public. This should be supported by the medical and health research sponsors as well as those above.

Information technology

- Companies in the sector should support an information retrieval and analysis service aimed at supplying up-to-date technical information on production practice world-wide to a large proportion of UK growers.

Infrastructure

- The Agriculture, Horticulture & Forestry and Food & Drink Foresight panels should organise discussions with food chain industries, other panels, water suppliers and other interested parties on the future availability and use of water for the food chain industries and the implications for the UK's water resource management.

Education

- Education professionals and the private sector should collaborate in promoting education about the science, engineering and technology of food production aimed

at future consumers and at a potential future workforce. A strategy for education and training for potential entrants to the fruit and vegetables sector should be drawn up.

Further Work

24. During its consultations, the sub-group has heard the desire for a visionary approach to the future - a blueprint for the sorts of fruit and vegetable varieties, growing systems, skills and infrastructure the UK will need to meet the needs and preferences of consumers in the next century. The sub-group has made a start towards this in its work so far and will challenge scientists, research sponsors and practitioners in the food chain to come up with a shared vision of where the UK wants to be in the future. Elements of this approach include:

- Stimulating demand for fruit and vegetables by creating 'irresistible' products.
- The aim to supply world-wide markets with new products tailor-made for their particular consumer preferences (e.g. a 'super-Bramley' apple).
- Achieving more consistent yields allowing scheduling and possibly the development of a UK futures market - both to give predictable rates of return on investment.
- Developing better economic models of the profitability of the sector to demonstrate its value to corporate investment.
- Innovative presentation and marketing of new products containing fruit and vegetables.
- Making buying British fruit and vegetables the natural first choice.

Revisiting The Food And Drink Panel's Recommendations

26. The points made in this report reinforce and augment many of the conclusions in the panel's 1995 report, particularly that further investment was needed in R&D or changes in infrastructure in the following areas:

- A better understanding of the relationships between diet and health.
- Genetics and molecular biology of raw materials
- The sensory perception of product quality and the psychology of consumer choice.
- Information flow through the production chain
- Education and training for potential entrants to companies in the sector.

Appendix - Scenarios

The sub-group developed three scenarios or imaginary futures as an aid to lateral thinking. For each, the sub-group described its features and identified the scientific and market opportunities which would contribute to increasing the UK's competitiveness and quality of life.

Scenario 1 - 'Fortress UK'

- There are more attractive export markets than the UK. The UK has left the EU and established import controls to limit competition for domestic markets from overseas. The rest of the world has retaliated with their own import controls.
- Production is supremely tailored for the UK climate using genetic modification to give improved varieties for processing (including more 'fresh' taste), storage, stability of nutrients, all year round production and to replace crops that cannot be obtained (citrus, bananas etc.). There is all-year-round production for most crops.
- Crop protection is also adapted to cope with the UK environment - stress resistance, pest and disease control.
- Increasing amounts of land is being brought into production with more intensive systems, some non-soil based. Optimisation of water and energy use is a necessity.

Scenario 2 - All fruit and vegetables produced outside UK

- Rising labour costs and competition have grown to such an extent that fresh production in the UK has become uneconomic and all fruit and vegetables are sourced from overseas.
- Shelf life, storage, packaging and transport methods is critical. Ensuring food safety is paramount - non invasive QC methods are needed.
- UK expertise in procurement management, quality management and control is exported to producing countries.

Scenario 3 - 'Green scenario'

- In a very affluent society, concerns about environmental issues and a great interest in production methods have come to the fore. A dramatic increase in vegetarianism has raised demand for premium quality fruit and vegetables.

- Dramatically reduced (or zero) inputs of agrochemicals have given pressure for better varieties (although genetic modification is not acceptable) to maintain or increase nutritional and eating quality, yield and keep costs down. Biocontrol and sophisticated crop management systems linked to accurate local long-range weather and insect population forecasts, 1 m^2 resolution soil maps and precision agriculture are used for most UK production but are only available to the largest growers because of the very high fees charged by data providers.

- Authentication of production systems is rigorously applied using satellite monitoring.

- Because of high quality control, wastage has increased and requires environmentally friendly disposal/composting techniques.

- High energy taxes have dramatically increase glasshouse heating and transport costs. There has been a return to seasonality of production with more locally produced goods.

- Legume varieties have been improved for yield, protein composition and stress tolerance.

Scenario 4 - 'UK is the fruit and vegetables capital of Europe'

- Due to adverse climate changes in the Continental Europe, the UK has an enormous advantage in growing fruit and vegetables and is the main European supplier.

- The demands of the European consumer dominate UK production - high quality produce and tight control over production methods. Varieties have been customised for specific markets, many are entirely export markets. UK produce attracts a premium price.

- A small but highly trained workforce, in both production, communication and marketing skills, has been built up to meet these demands.

- Consumer concerns over new technologies have been alleviated to a large extent by a major programme of consultation and discussion at all levels of society involving scientists, retailers, manufacturers, growers, retailers, consumer organizations and the media.

- Highly sophisticated water management techniques, adapted from those in use in arid climates, are in routine use by UK growers.

- Production methods are highly automated - human workers are not used for any repetitive tasks.

Foresight Food & Drink Panel - Fruit And Vegetables Sub-Group

Chairman

Professor Ian Crute (Chair) HRI Wellesbourne

Members

Dr John Braunholtz	Horticultural Development Council
Henry Bryant	ENFRU Ltd
Angus Davison	Haygro Fruit
David Gregory	Marks & Spencer
Bob Hilborn	J Sainsbury plc
Rachel Holder	Van Heyningen Brothers Ltd
Cathy Knott	Processors and Growers Research Organization
David Martin	DMA Crop Consultants
Dr Steve Parry	Unilever Research
Dr Sue Popple	MAFF Chief Scientist's Group
Professor Susan Shaw	University of Strathclyde
Colin Wright	Birds Eye Wall's Ltd

October 1997.

Table 1 · Vegetables (including potatoes)

Value of production and sales (retail and processing) 1994 (£k)

	HOME PRODUCTION	IMPORTS FRESH	IMPORTS PROCESSED	TOTAL IMPORTS	TOTAL SUPPLY	% IMPORTS	FRESH PRODUCT SALES - HOME PRODUCED							IMPORTS	EXPORTS
							WHOLESALE	PREPACKERS	MULTIPLES	PROCESSING	DIRECT SALES	OTHER	SUB TOTAL		
Vegetables															
Beetroot	10,471	0	310	310	10,781	3	1,605	1,153	1,459	5,767	341	146	10,471	310	334
Carrots	98,854	10,192	1,273	11,465	110,319	10	33,046	20,323	23,316	11,704	10,281	184	98,854	11,465	4,019
Parsnips	22,395	0	0		22,395	0	8,688	3,446	7,888	1,390	952	31	22,395	0	0
Turnips and swedes	16,807	na	na		16,807	na	7,489	1,913	4,183	856	2,052	314	16,807	0	0
Potatoes	680,979	na	na	250,686	931,665	27			173,800		9,966		680,979	250,686	66,332
Bulb onions	44,222	46,320	0	46,320	90,542	51	39,374	9,084	31,621	5,263	3,005	303	44,222	46,320	1,893
Onions, Green	27,157	0	0		27,157	0	8,750	2,322	15,686	137	262	0	27,157	0	0
Brussels sprouts	29,305	1,359	239	1,598	30,903	5	10,868	6,999	7,970	1,208	2,261	0	29,305	1,598	378
Cabbage	77,243	2,398	6,047	8,445	85,688	10	34,011	10,156	28,625	6,785	4,743	170	77,243	8,445	1,199
Cauliflower	65,302	42,818	2,847	45,665	110,967	41	54,486	5,818	31,968	8,660	5,776	1,497	65,302	45,665	2,764
Calabrese	35,916	(a)	na		35,916	na	10,582	2,985	16,237	4,482	1,631	0	35,916	0	0
Broad beans	4,205	0	0		4,205	0	2,411	3,561	2,874	1,548	11,530	0	4,205	0	0
Runner and dwarf beans	18,338	na	na	14,540	32,878	44	7,950	3,396	8,160	7,864	5,508	0	18,338	14,540	0
Green peas	43,650	9,793	10,561	20,353	64,003	32	4,061	145	1,253	37,173	1,018	0	43,650	20,353	1,741
Dry peas and beans (c)	13,424	57,246	0	57,246	70,670	81	na	na	na	na	na	na	13,424	57,246	45,533
Asparagus	3,259	na	972	na	4,231	na	2,021	579	146	18	494	0	3,259	na	11
Outdoor celery	11,322	11,210	0	11,210	22,532	50	3,119	332	6,375	1,020	475	0	11,322	11,210	611

Outdoor celery	11,322	11,210	0	11,210	22,532	50	3,119	332	6,375	1,020	475	0	11,322	11,210	611
Protected celery	4,586	(a)	na		4,586	na	1,368	0	2,829	0	263	127	4,586	0	0
Outdoor lettuce	83,832	72,810	0	72,810	156,642	46	50,122	10,422	83,332	4,206	5,572	0	83,832	72,810	2,988
Protected lettuce	21,335	(a)	0		21,335	na	8,243	211	11,731	0	1,150	0	21,335	0	0
Leeks	28,082	(b)	na		28,082	na	8,742	3,778	13,199	444	1,919	0	28,082	0	0
Rhubarb	11,808	na	na		11,808	0	5,476	134	4,197	1,147	854	0	11,808	0	0
Watercress	7,632	na	na		7,632	0	4,504	140	2,145	0	844	0	7,632	0	0
Tomatoes	67,001	162,736	153,195	315,931	382,932	83	153,040	80,701	123,472	0	18,227	0	67,001	315,931	7,492
Cucumbers	44,548	31,783	8,570	40,353	84,901	48	17,005	1,424	25,625	0	494	0	44,548	40,353	412
Peppers	4,402	64,593	4,587	69,180	73,582	94	2,727	0	1,383	0	292	0	4,402	69,180	229
Mushrooms	156,567	88,409	20,103	108,512	265,079	41	na	na	na	na	na	na	156,567	108,512	5,759
Other	140	1,207	195,569	196,776	196,917	100	na	na	na	na	na	na	140	196,776	61,858
Total	**2,003,589**	**602,874**	**404,273**	**1,271,401**	**3,275,962**		**629,562**	**208,853**	**766,696**	**121,703**	**110,366**	**4,158**	**2,003,589**	**1,271,401**	**203,553**

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Table 2 · Fruit

Value of production and sales (retail and processing) for 1994 (£k)

	HOME PRODUCTION	IMPORTS FRESH	IMPORTS PROCESSED	TOTAL IMPORTS	TOTAL SUPPLY	% IMPORTS	FRESH PRODUCT SALES - HOME PRODUCED							IMPORTS	EXPORTS
							WHOLESALE	PREPACKERS	MULTIPLES	PROCESSING	DIRECT SALES	OTHER	SUB TOTAL		
Fruit															
Total Desert apples	59,290	213,701	27,242	240,943	300,233	80	131,540	24,193	95,318	3,647	38,011	0	59,290	240,943	7,524
Total Culinary apples (a)	30,714	0	0	0	30,714	0	9,452	3,927	9,853	3,589	3,893	0	30,714	0	0
Cider apples and (b)(c)(e)	8,628	0	0	0	8,628	0	3,771	676	2,341	534	1,306	0	8,628	0	69
perry pears															
Total Pears	13,262	51,057	13,538	64,595	77,857	83	29,874	8,174	26,028	1,997	9,830	0	13,262	64,595	1,954
Total Plums	7,215	24,644	1,414	26,058	33,273	78	15,780	385	5,644	1,937	8,956	0	7,215	26,058	571
Cherries	2,188	12,993	23,558	36,551	38,739	94	1,590	0	462	0	135	0	2,188	36,551	3,137
Strawberries (f)	55,127	38,288	16,738	55,026	110,153	50	13,433	600	14,459	4,179	22,457	0	55,127	55,026	4,065
Raspberries	27,985	2,085	12,115	14,200	42,185	34	5,313	0	5,419	1,656	15,597	0	27,985	14,200	4,270
Blackcurrants	10,462	252	1,864	2,116	12,578	17	634	174	169	8,088	1,397	0	10,462	2,116	13
Citrus fruits (g)	0	230,309	145,260	375,569	375,569	100	na	na	na	na	na	na	0	375,569	18,252
Bananas	0	273,189	32,725	305,914	305,914	100	na	na	na	na	na	na	0	305,914	322
Melons	0	61,327	0	61,327	61,327	100	na	na	na	na	na	na	0	61,327	0
Peaches/nectarines	0	50,989	22,915	73,904	73,904	100	na	na	na	na	na	na	0	73,904	1,340
Grapes	0	125,805	8,941	134,746	134,746	100	na	na	na	na	na	na	0	134,746	3,161
Avocados	0	13,872	0	13,872	13,872	100	na	na	na	na	na	na	0	13,872	0
Pineapples	0	8,960	23,226	32,186	32,186	100	na	na	na	na	na	na	0	32,186	1,834
Kiwi fruit	0	17,944	0	17,944	17,944	100	na	na	na	na	na	na	0	17,944	0
Other fruit (d)	0	45,452	424,909	470,361	470,361	100	na	na	na	na	na	na	0	470,361	98,103
Total	266,062	1,170,867	754,445	1,925,312	2,191,374		255,811	48,721	195,264	30,423	116,679	0	325,352	1,925,312	144,614