

ANNEX B11

PITA Project: Policy Influences on Technology for Agriculture:
Chemicals, Biotechnology and Seeds

EURO-FOOD: Pressures on R&D

Objective I Report

Annex B 11

TSER Programme
European Commission - DG XII
Project No. PL 97/1280
Contract No. SOE1-CT97-1068

Les Levidow

**Centre for Technology Strategy
Open University
United Kingdom**

November 2000

Introduction to the PITA Project

Technological innovation in the agrochemical, biotechnology and seeds industries and in associated public sector research establishments (PSREs) has the potential to deliver more socially and environmentally sustainable farming systems and to improve the quality of life of citizens in Europe. This is particularly true of farms on the most fertile land. However, although policies developed in different areas may all aim to improve the quality of life, in practice, in their influence on company and PSRE strategies, they frequently counteract one another and so attenuate the desired effect.

Market-related factors also influence decision making in industry and PSREs, the most important for this project being the policies of food processors and distributors and also public attitudes and opinion, which often set more demanding standards than those of national governments and the EU.

The PITA project (see Project Structure) is developing an integrated analysis of policies and market-related factors relevant to the agrochemical, biotechnology and seeds sectors. The core of the project is an investigation of the impact of these factors on the strategies and decision making of companies and PSREs and the downstream implications of these decisions on employment, international competitiveness and environmental benefits. The final outcome will be feedback of our conclusions to policy makers and company managers.

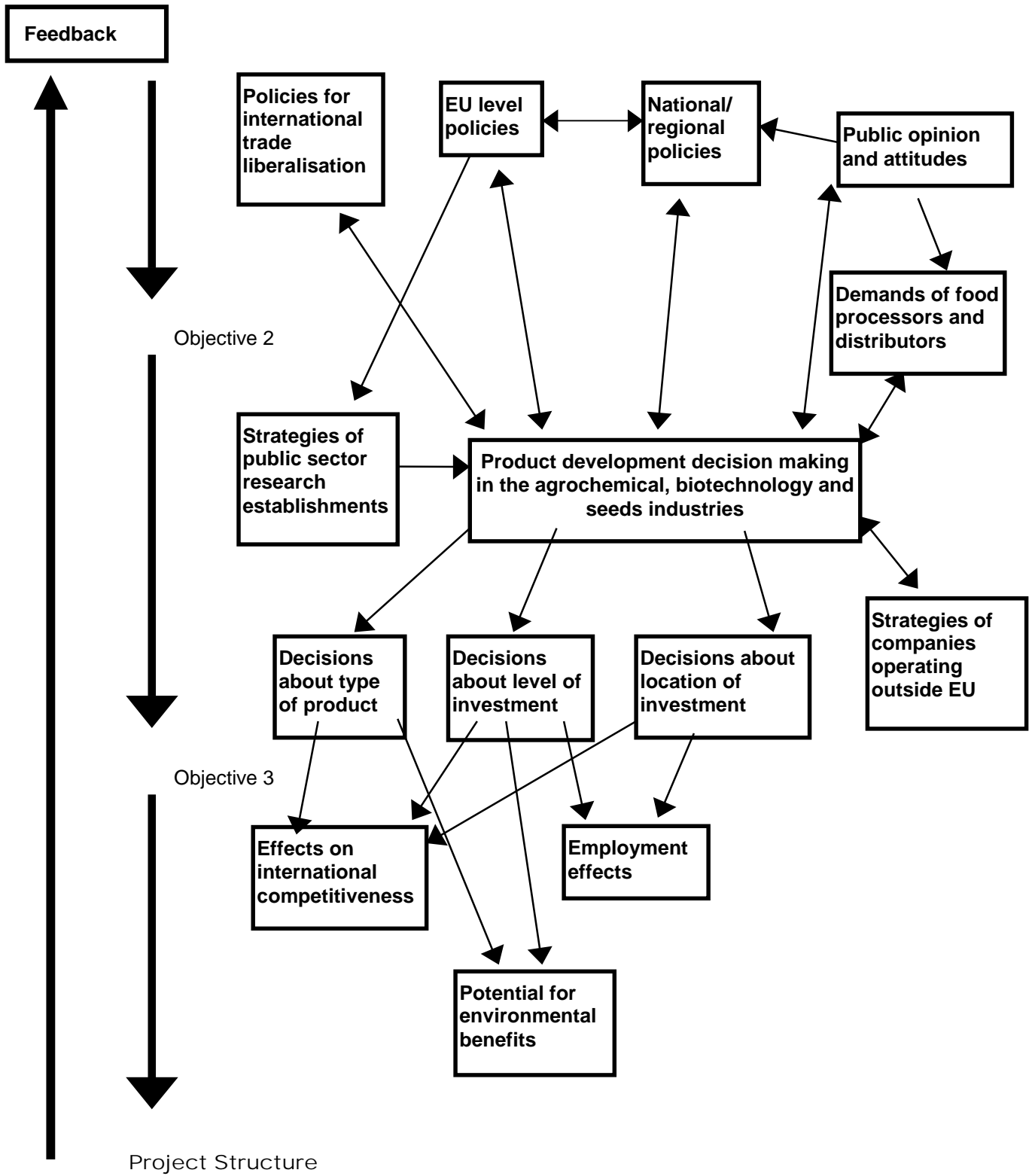
The range of policies and other influences studied includes:

- policies to stimulate innovation in the agrochemical, biotechnology and seeds industries;
- purchasing policies of food processors and distributors;
- policies for international trade liberalisation;
- policies for the regulation of industry and farming (for environmental protection and public health and safety, particularly for pesticides and biotechnology);
- agricultural and farming support policies, particularly for crop production;
- policies to promote environmental sustainability and wildlife biodiversity in arable farming areas;
- public opinion and attitudes.

The overall aim of the project is to contribute to the development of sustainable industrial and farming systems and an improved quality of life by encouraging the development and uptake of 'cleaner' technology for intensive agriculture. Its objectives are:

- to develop an integrated analysis of policies and market-related factors relevant to technological innovation in the agrochemical, biotechnology and seeds sectors, to study their interactions and to develop hypotheses about their impact on strategic decision making in industry and PSREs.
- to study the influence of policies and market-related factors on innovation strategies in the agrochemical, biotechnology and seeds industries and PSREs, and their impact on decisions about product development, levels of investment and location of investment.
- to study the outcomes of the industry decisions investigated under objective 2, in their effects on employment, on international competitiveness and on their potential to deliver environmental benefits.

Objective 1



Contents

1. 'QUALITY' CRITERIA AND INNOVATION: GENERAL PERSPECTIVES	5
2. POTENTIAL INFLUENCES ON R&D	6
2.1 MEANS OF INFLUENCING R&D	6
2.2 NOVEL SEEDS	7
2.3 PESTICIDE REDUCTION OR CHANGE	7
3. NOVEL SEEDS: FAVOURABLE AND UNFAVOURABLE PRESSURES	8
3.1 PEST & DISEASE RESISTANCE	8
3.2 GM CROPS: FIRST GENERATION	9
3.3 OUTPUT TRAITS	10
3.4 EXCLUSIVE ACCESS	11
3.5 NON-GM SUBSTITUTION: NATIONAL EXAMPLES	11
4. PESTICIDES: LOWER OR DIFFERENT USAGE	13
4.1 ORGANIC FARMING	14
4.2 GAP PROTOCOL	14
4.3 PESTICIDE REDUCTION: NATIONAL EXAMPLES	14
5. CONCLUSIONS: EURO-FOOD PRESSURES ON R&D	16
6. REFERENCES	18

1. 'Quality' criteria and innovation: general perspectives

Food companies seek to add and capture value on the basis of their claims for food quality. With the rise of own-brand labels [private-label products], retailers increasingly 'find themselves absorbing more responsibility and risk in the maintenance of food quality' (Flynn and Marsden, 1992). Such 'risk' links the potential for food scares, tangible harm to consumer health, competitive pressures and financial loss.

Much food is an industrial product, e.g. dependent upon industrial inputs. 'But it is also a socio-cultural symbol and a link between the human being and Nature' (Tozlani, 1998). Food companies seek to accommodate consumer concerns which go beyond biophysical characteristics -- encompassing food safety and quality, environmental sustainability and ethically appropriate methods of production. The latter concerns are specially evident for animal husbandry methods (Blandford and Fulponi, 1999).

Quality can encompass health, safety, special nutritional ingredients, 'naturalness' and environmental effects of crop cultivation (Morris and Young, 2000). These aspects often become linked, though 'natural' characteristics may conflict with novel ones. 'Quality' tends to denote a standard for all the products of a company, not just for special product lines. For characteristics other than taste, consumer judgements/appeal depend upon information from and trust in the company.

The symbols and criteria of quality are subject to competition. Quality can mean special provenance – e.g. links with local cultivation sites and production methods (Marsden *et al.*, 1999). For example, more and more French food is labelled as *terroir*, denoting its origin from specific peasant cultivators. Sometimes quality means special ingredients or processes which improve flavour or nutritional value. In some cases quality is defined to disfavour inputs, e.g. by minimizing pesticide usage.

Food companies accommodate public pressures to demonstrate that they minimize environmental pollution – e.g. energy usage, packaging, and agrochemical inputs by their suppliers. They conduct audits across the agro-food-distribution chain, in order to identify means of achieving those aims. Claims for environmental improvements generally promote the entire company's image and product range, rather than promote specific products as 'green'.

As compared to other industries, food processing companies devote relatively little funds to R&D and hold relatively few patents, which are concentrated in particular sectors. Unilever holds over half the patents in the edible oils and fats sector, and 7% of those relevant to the chocolate, confectionary and non-alcoholic drinks sector. Nestlé holds 7% of patents in the milk industry and 8% of those in the diversified foods sector (Rama, 1996). Patents are relatively less important than secrecy and first-mover advantage. Food innovation is stimulated by the relatively low ratio of R&D expenditure per innovation (Wilkinson, 1998).

Biotechnology poses both opportunities and difficulties for the food industry. On the one hand, it facilitates greater synergy with chemical processing, e.g. for convenience food or novel products. On the other hand, the greater importance of 'natural' quality may deter links between food and chemicals/pharmaceuticals (*ibid.*).

2. Potential influences on R&D

2.1 Means of influencing R&D

Retailers and food processors can potentially influence innovation in the PITA-related industries in several ways, as follows:

- Doing research themselves

Biotechnology R&D is done by some food processors, but mainly for microbial processes and enzymes. This emphasis has two main reasons: firstly, because the company inherently controls access, e.g. through patents and/or confinement in factories; and secondly, because the innovation flows into production under real-life processing conditions.

Apparently food companies do little research themselves on novel seeds, though some have bred varieties for pest-resistance, e.g. Koipe and Findus (see 3.1 below). Unilever funded research on GM wheat at its subsidiary, Plant Breeding International, but it divested PBI in 1998. Unilever breeds peas at its Crop Science Department in the Colworth research lab; these pea varieties are used by farmers supplying Birds Eye Walls. Unilever may still breed tomato varieties in the USA.

- Contracting out research

Research on lower-pesticide cultivation methods is funded by some food processors and retailers, e.g. Unilever and Sainsburys. It is unclear how this may stimulate new products. The Dutch sugar industry has its own applied research institute for sugar beet cultivation (see section 3.1).

- Shifting demand towards novel products from their suppliers

Pressure from food processors have given impetus to efforts at developing less harmful agrochemicals, e.g. an alternative agent to inhibit sprouting of potatoes (see section 4.3, Netherlands). Some food processors are developing novel products, and some biotechnology companies are developing GM seeds with special output traits, but there is little information on links between the two. Indeed, there may be a gap between them, e.g. because processors seek novel traits mainly in crops which have no lucrative seeds market. According to a Nestlé officer,

Food processors have relatively less interest in the most important field crops (soybean, corn, sugarbeet, rapeseed), yet plant breeding companies have focused their R&D on those crops, in order to reach the large-scale seeds market. Nestlé has explained to seed companies why their first- and second-generation priorities are wrong, but there was little response, except from one company (Petiard, 2000).

Of course, horticultural seed companies breed a wider range of plant varieties.

- Developing new products together with their suppliers

A food processor has been involved with a supplier in a breeding programme to develop disease-resistant potatoes (see 3.3 below). General Mills has agreed to form a joint venture with PTI, a Dupont subsidiary, with a preferential supply agreement for soy food (though its characteristics are not publicly known).

2.2 Novel seeds

Each category of novel seeds has its own dynamics:

- Pest resistance in general: Pressures to minimize pesticide usage provide an incentive for developing new seed varieties which can better protect themselves from pests. In at least one case, processors have helped to develop pest-resistant seeds (see section 3.1 below).
- First-generation genetically modified (GM) crops with agronomic traits, e.g. Bt insect-resistance or herbicide tolerance: There is increasing pressure to exclude these GM ingredients from food products, and even from animal feed in some countries. 'Organic' food is officially defined as excluding GM ingredients in several European countries, (e.g. DK, NL, UK, ES), or even as excluding any 'contamination' by GM pollen (e.g. UK), so this criterion acts as political-economic pressure against cultivating GM crops near other crops. When Deutsche Bank (1999) said that 'GMOs are dead', this well describes food prospects for the first-generation GM crops, but the outcome is still open for animal feed uses of those crops (see sections 3.2 and 3.5 below).
- Second-generation GM crops with 'output' traits, e.g. better nutritional qualities (Ebbert, 1998): There is little sign that retailers are requesting such ingredients; relevant information is not available from public sources. Food processors state that they foresee consumer benefits from GM-based foods, but they say little about their own research funding along these lines or any specific plans to market such products. Their reticence has at least two reasons: consumer distrust of GM-based foods, and commercial confidentiality (see 3.3 and 3.4 below).
- Processing traits: Some biotechnology companies emphasize the benefits of present or future products for food processing. For example, Zeneca/Calgene's Flavr-Savr tomato has lower water content and so requires less energy for turning into paste. However, such traits are not readily translated into benefits for food processors. According to a Nestlé officer:

Benefits are elusive because 'efficiency' gains may not materialize when the process is scaled up, or because such gains may depend upon a technical change. The slow-ripening tomato, for example, has a relatively lower water content, which has been promoted as a benefit for food processing companies. For all such companies, however, there is a problem in the concentration step at the end of the process. We could certainly decrease the concentration temperature, but then we would increase the duration of the concentration step and thereby decrease the factory yield. Basically the question is: should we build a new factory for a new tomato – or a better tomato for existing factories? (Petiard, 2000)

2.3 Pesticide reduction or change

During the 1990s pesticide-reduction guidelines were being implemented and publicized by some major food companies (van der Grijp and den Hond, 2000). For example in 1997 Birds Eye Wall's, a UK Unilever subsidiary producing frozen foods, started a Sustainable Agriculture Project with its pea growers. The project aims to reduce the environmental impact of pea growing through changes in crop-protection methods, crop rotation, soil condition and energy use. Consequently farmers reduced the total amount of agrochemicals; moreover, they were permitted to use only approx. 10-12 products that had relatively less polluting active ingredients, as selected by Unilever (Brouwer and Bijman, 2000).

These pressures have become more formalized. According to Nestlé (n.d.), the company attempts to obtain raw materials 'produced by environmentally sound farming methods' and gives farmers 'recommendations for the conservation of natural resources'. According to Unilever, it has developed guidelines for the growing of vegetables and tomatoes:

These cover issues such as the types of fertilisers and pesticides allowed and how they should be applied, as well as directions on harvesting and transport. We buy our key crops, such as spinach and peas, from farmers who work under contract to us and follow our guidelines. About 90% of the tomato paste we process comes from tomatoes grown in this way. (Unilever, 1998: 18)

The food industry funds some research on pesticide-reduction methods, which can influence the types of agrochemical inputs as well as the quantity used. European food processors have also stimulated an agrochemical supplier to develop a less harmful agent which inhibits sprouting in potatoes (see section 4.3 below).

Recently retailers too have exerted greater pressure to reduce pesticide usage, especially by requiring farmers to adopt various measures for reducing pesticide usage. As codified by the major European retailers, the Good Agricultural Practice [GAP] Protocol asks farmers to select seeds which minimize dependence on agrochemicals. It makes distinctions among crop-protection methods:

seed treatments are preferred to foliar sprays; and biological or mechanical methods are preferred to chemicals (EUREP, 1999).

Although those preferences may reduce environmental harm, it is unclear how they stimulate novel inputs. Many seed treatments use an active substance similar to foliar sprays.

Seed treatments are a key element of crop-protection strategy for Bayer, which emphasizes the efficiency and safety benefits (Bayer, 1997: 77-78). However, Bayer's seed-treatment product *Gaucha* has been blamed for harm to bee populations; the French Ministry of Agriculture has asked the company for a risk-assessment study of that pesticide. This case has focused the attention of the mass media and honey producers on the environmental impacts of seed treatments in general.

For many small and medium enterprises (SMEs) in the seeds sector, environmental pressures from the agro-food industry have been as important as those from regulation. In response they have strengthened their R&D investments, especially by targeting pest- and disease-resistant varieties (Grávalos and García, 2000).

3. Novel Seeds: favourable and unfavourable pressures

3.1 Pest & disease resistance

Organic seeds

Plant breeding has always involved a trade-off between pest resistance and yield. With the advent of the 'pesticide umbrella', less emphasis was given to pest resistance. Recently the latter has drawn renewed interest from the rise of the organic food sector. 'More than conventional farmers, organic farmers greatly value variety characteristics that contribute substantially to weed reduction, a broad resistance to diseases and pests, and improved taste and shelf life' (Den Nijs and Lammerts van Bueren, 1999: 64). GM pest-resistant seeds are excluded from organic agriculture by the decision of national organic organizations and EU regulations along similar lines.

When the main lobby group for organic farming outlined research priorities to the European Commission, it did not mention novel seeds (IFOAM, 1999). 'Certified organic seeds are not bred for better pest resistance, which has nothing to do with certification requirements' (personal communication, IFOAM, 25.01.00). In France, organic farmers rarely use special 'organic' seeds, which are expensive.

Nevertheless organic research institutes are attempting to develop pest-resistant seeds. They state a preference for pest tolerance over resistance (FiBL, 1999). In the case of potato fungus, for example, 'Resistance breeding has mainly focused on monogenetic absolute resistance', whose durability may be limited by the great capacity of the fungus to overcome the resistance. Polygenetic tolerance is more durable over time. In the Netherlands some research institutes have been searching for alternative sources. Marker Assisted Breeding may be a useful tool to accelerate research on polygenetic tolerance (Den Nijs and Lammerts van Bueren, 1999: 67).

Other examples

Beyond the organic sector, plant breeding for (non-GM) pest-resistant seeds has been conducted by some food processors, e.g. by Findus, a subsidiary of Nestlé. Koipe, a subsidiary of Eridiana Béghin-Say, carries out R&D on pest-resistant and better-quality oil sunflower seeds. According to Unilever, 'We aim to maintain the highest standards at our sites and in the products we sell. Our intention is to produce superior varieties that contain natural resistance to pests and diseases, which reduces the need for agrochemicals' (Unilever, n.d.).

The Dutch potato processor Aviko has been involved in a potato breeding programme of a primary supplier companies – Agrico – to develop potatoes with better disease resistance. These potatoes would need less pesticide. This initiative was started in response to the growing public concern over the environment impact of pesticide use in potato production in the 1980s. In Spain some companies are developing seeds which have greater resistance to pests, to avoid or minimize dependence upon agrochemicals; the R&D uses assisted breeding techniques, not genetic modification.

Dutch sugar industry has its own applied research institute for sugar beet cultivation. This institute carries out research projects on reducing pesticide use and on ICM/IPM. The sugar beet processors (in the Netherlands, among other countries) decide which varieties suppliers can grow and so influence the development of new varieties.

3.2 GM crops: first generation

'GM' labelling has been led by European retail chains. Through cooperative efforts, they have sought standard rules which could gain public trust, and they have established common supplies of non-GM sources. Thus they avoided competing against each other for 'non-GM' products.

Under public pressure, and in lieu of clear EU rules, the European food industry adopted tentative measures for voluntarily labelling GM products in 1998. These measures were product-based, i.e. dependent upon the detectability of GM ingredients. Eventually the EU rules standardized the detectability criteria (EC, 1998b).

Nevertheless, some major companies adopted even more stringent processed-based criteria; they voluntarily labelled GM-derived additives and even oils, in which no GM ingredients would be detectable. Thus more and more companies went beyond EU requirements. In Germany and Austria, the entire industry has moved towards negative labelling, e.g. 'GM-free' food. (For more detail, see BPG, 1999, section 4 on Labelling Practices.)

These various labelling measures in turn deterred companies from using GM ingredients in their own-brand products, to avoid labelling them as 'GM'. At least in northern Europe, most retailers have excluded GM grain from their own-brand products; some have given public undertakings to do so. They charge no premium price for non-GM food.

Increasingly the exclusion policy is process-based, i.e. independent of detectability. Such a policy requires a documentary control system, e.g. as developed by the Danish food industry. Nevertheless most non-GM products are sold at no extra price. Some companies promote 'organic' meat as a way for customers to avoid GM animal feed.

Alternative supply networks have institutionalized the commercial blockage of GM grain, i.e. soybean and maize (ENDS, 1999). Major retailers established a consortium to obtain non-GM grain; consortium members include Sainsbury, Marks & Spencer (UK), Carrefour-Promodes (FR), Efelunga (IT), Migros (CH), Delhaize (BE), Superquinn (IR). During 1999 efforts to exclude GM grain were made by major processors too, e.g. Unilever, Nestlé, Eridiana Béghin-Say, Gerber (subsidiary of Novartis), Frito-Lay (subsidiary of Pepsico). According to Nestlé, the largest food manufacturer in Europe, it undertook to exclude GM-derived ingredients as far as practically possible, where the public demanded it; but the company did not list in which countries this policy operated (FoEE survey, 05.00).

Unilever announced that it would no longer use GM ingredients in its European production in May 2000. It left open such options for the future: 'We are continuing to research the use of biotechnology and genetic modification in the development of new products.' The company will retain the capability to include GM-derived ingredients 'if these are shown to be safe, approved by the relevant authorities and are wanted by consumers on a fully transparent basis' (Unilever, 2000).

Animal feed is the major use of soya and maize, so far more grain would be needed overall for non-GM animal feed than for non-GM food. Segregation is more difficult for these larger quantities (Wrong, 1999). Some retailers have undertaken to sell meat only from suppliers which exclude GM-based animal feed. Others say they will attempt to do likewise, but there are uncertainties about how to guarantee adequate supplies. So far, non-GM animal feed has been established mainly in the UK and France.

3.3 Output traits

'Functional foods' denote special nutritional qualities. At present such products are derived mainly from changes in processing techniques or from additional ingredients, rather than from novel seeds. For example stanols, which lower blood cholesterol, are extracted from plants through an innovation in food processing (Anon, 1999). Some dairy products are enriched with vitamins and calcium. Some functional foods involve no change at all; for example, Danone promotes some products as a healthful 'Mediterranean diet' (*Le Monde*, 29.06.95).

Although functional foods currently have a \$14bn market in Europe, there is uncertainty about how this sector could be expanded. Some companies have withdrawn their advertising campaigns or even the products because of poor sales. The European public is sceptical of novel foods (*FT*, 12.02.00). According to a UK survey, 4/5 of people disbelieve health claims made by food manufacturers, while most regard organic food as more healthful. And some functional foods are more expensive; Benecol has four times the price of the normal spread (Finch, 2000).

With a view towards functional foods, seeds are being modified for nutritional qualities by many companies, e.g. Cosun, Seminis Vegetable Seeds, Advanta and Monsanto. Together with biologists of the University of Utrecht and the seed company Advanta, Cosun has developed a special chicory variety that contains a high inuline content. Inuline can be used in the food industry as a low-caloric fat substitute. Another example is Swiss research which developed rice varieties producing a metabolic precursor of Vitamin A; Zeneca has obtained the patent on the relevant genes, while Monsanto has a patent on a specific techniques used to obtain the GM variety.

More generally, bulk commodity crops are being decommoitized. As foreseen by Monsanto (1997), decommoitization in R&D will move the product range beyond bulk-commodity crops (i.e. beyond the early GM crops), towards differentiated varieties with specific qualities or end-uses. Crops have been genetically modified for changes in output or processing characteristics, corresponding to various potential uses. According to a recent survey (Dibb and Mayer, 2000), GM seeds include the following changes:

Genetic modification	Potential uses
Greater level of micronutrients	'Functional foods'; alternative sources of ingredients
Lowered fatty acids	More stable oils for cooking; substitute oils; therapeutic uses
Lowered starch/sugar	Industrial starch production; low-calorie sugar
Lowered protein/amino acids	Animal feed, baking, nutraceuticals, infant formula
Removal of anti-nutritionals	Reduced-allergen food, animal feed, formula
Colour enhancement	Sweeter-tasting crops, alternative sources of sweeteners

Through differentiation, 'Food processing companies seek ways to improve consumer quality for all its products or for new products. But functional foods are problematic because they fall into a grey area with pharmaceuticals', according to Nestlé. The company funds seeds

ANNEX B11

research specially for its drinks business, though not for nutritional purposes; there is little market for coffee seeds and so little incentive for plant breeding companies to do the R&D.

We are mainly working on coffee, cacao, and chicory. These can be considered as orphan crops, in the sense that the agro-seed industry is not really interested in them. Coffee is a good candidate for consumer benefits, e.g. by improving taste. Chicory granules are hygroscopic: once a jar is opened, the granules form clumps. We can search for less hygroscopic strains in existing varieties. (Nestlé interview)

In sum, there is considerable investment in modifying crops for consumer-quality traits and other food or feed uses, but there is no clear sign that food companies intend to use such ingredients.

3.4 Exclusive access

Food processing companies seek exclusive access to novel seeds to gain a competitive advantage. This criterion may conflict with Plant Variety Registration (PVR), the rules under which an EU member state authorizes each new seed variety for general sale (EEC, 1970; EC, 1998a). It is unclear how one company could gain exclusive access to the novel seed or to its benefits under the PVR rules. Questions have been posed by a Nestlé officer:

- If an ingredient is freely available on the open market, then how to ensure its exclusive use for a high-value product? (perhaps in parallel with its general use for a lower-value product).
- For example, could we have exclusive rights to use an improved corn for breakfast cereals, even if it is freely available for use for animal feed or another usage?
- If a seed variety is registered, then it is available to anyone, e.g. to a grower who has been contracted by a competitor of the variety's owner.
- If it is not registered, then can a food company give the seed to its contracted farmers?
- If a company patents a seed variety, can it control use of the harvest? PVR rules are unclear (Petiard, 2000).

Given those scenarios and questions, the take-up of some novel seeds may depend upon clarifying or changing intellectual property rights vis à vis the PVR rules.

3.5 Non-GM substitution: national examples

Pressures to exclude GM ingredients operate across Europe for many reasons, e.g. because many food companies anticipate consumer pressures in advance, they use common sources of food materials, and they have Europe-wide markets. For the first-generation GM crops, European markets have declined, except perhaps for animal feed uses. For grain- and meat-based products, 'organic' lines compete with other non-GM lines. A five-country survey illustrates those trends.

DENMARK

There is a voluntary agreement among the major supermarkets to label all GM-derived food, regardless of detectability. Impetus for the agreement came from the Federation of Danish Consumer Co-operatives, which has 1/3 of the domestic retail market for food. Such labelling has encouraged the development of a non-GM market; it is difficult to find any product labelled as 'GM'. The Danish food industry was the first in Europe to devise a documentary control system for obtaining non-GM soya. Some companies promote 'organic' meat as a means to avoid GM animal feed.

FRANCE

Domestic and foreign pressure has discouraged the use of GM grain in France. German food retailers indicated that they would not buy GM maize from French farmers (*Cultivar Actualité*,

ANNEX B11

05.05.99). In France retail and processing companies have found substitutes for GM soya or maize, e.g. non-GM or other grains (*L'Usine Nouvelle*, 27.05.99).

In particular some food producers have stimulated the cultivation of *soya de pays*, locally produced non-GM soya, for which the suppliers receive a 10% premium price. The largest producer of animal feed in France (Glon-Sanders), as well as a Europe-wide producer of poultry (Bourgoin), have declared that they exclude GM grain. Bourgoin is also a partner of the retail chains which import non-GM soya from the USA and Brazil. The non-GM soya meal is mainly used to feed poultry for meat and eggs. Most of the products are 'quality' oriented; the retailers' specifications (*cahier des charges*) may prohibit GM-derived feed (*Le Monde*, 02.09.99).

NETHERLANDS

Food: In 1999 the food retailers (represented by CBL) decided to label all 'GM' products, i.e. all products in which GM ingredients can be detected (including additives, flavourings, etc.). In mid-1999 the largest retailers (Albert Heijn and Laurus) asked the suppliers of their own-brand products to label the presence of any GM ingredient. As a result, most producers changed their recipes to exclude any GM ingredients.

Representing food retailers, the CBL have expressed concern about a lack of guarantees for GM-free organic produce. When the Dutch Consumer Union conducted a general public survey in spring 1999, half the respondents mentioned GM products as an important issue. Yet the Netherlands has little organized protest against GM food.

Feed: The Dutch Dairy Organisation (NZO), the interest organisation for the dairy processing industry, has made clear that it determines whether GM feed crops for dairy cows will be grown in the Netherlands. Among other considerations, 'consumer acceptance in foreign markets are important signals for the Dutch dairy industry'. In particular, it has rejected Advanta's herbicide-tolerant maize as an ingredient in animal feed; this was one reason why Advanta sold its herbicide-tolerant maize variety to AgrEvo.

SPAIN

When retailers first took measures to avoid GM ingredients in Spain in 1998, they were responding not to any direct public criticism in Spain, but rather to a general uncertainty about future pressures there. Some Spanish retailers demanded that their suppliers provide certificates guaranteeing the non-GM origin; at least one conducted a survey to trace the origin of the ingredients of all of their own-brand products. A multinational food company operating in Spain asked the soya processors to guarantee that their soya oil was GM-free. The soya processors replied that such a guarantee was impossible because all the soya imports were mixtures. The food company decided to change its production line to other oils (Todt and Luján, 1999). Initially this change did not affect the soya market very much because only 30% of soya is used for food; most of the rest is used for animal feed

Three of the largest retail chains in Spain are owned or co-owned by French retailers, which have extended their own non-GM policy into the Spanish market. Pryça, with 95 retail outlets in Spain, decided to follow its parent company Carrefour and eliminate any GM food from its own-brand products. Spanish-affiliated foreign companies (Marks & Spencer, Unilever and Nestlé) have also followed the non-GM policy of their parent companies. In 1999 Alcampo did not intend to eliminate GM ingredients from their own-brand products because it 'has not detected them' (interview with Alcampo Spain, *El País*, 10.05.99). The most important Spanish retailer, El Corte Inglés, made no public statement about biotechnology or environmental issues; when asked, it replies that the company tries to exclude GM ingredients.

By early 2000 Spanish food retailers adopted a policy of excluding GM ingredients from food. The Spanish association of corn food starch producers, Humaiz, declared that it would no longer purchase GM maize because of consumer objections. Moreover Humaiz asked the Spanish government to prohibit the cultivation of GM maize because it carries the risk of contaminating other maize crops (*El País*, 17.04.00). In 1998-99 Spain had the greatest

cultivation of GM maize in Europe, but this was expected to decline in the year 2000. Its use is limited to animal feed.

UK

The UK food industry adopted product-based measures for voluntarily labelling GM products in 1998. One by one, major companies then adopted process-based criteria. This policy, combined with public protest, acted as a deterrent against GM food. By 1999 they all undertook to exclude GM ingredients from their own-brand products. Such companies include Iceland, Sainsburys, Safeways, Asda, etc.

Animal feed has come under similar pressure. An extreme case is the UK's largest user of fresh produce, Tesco, which has undertaken to use only non-GM animal feed (and even to use no crops grown on sites used previously for R&D trials of GM crops). A retailer reputed for high quality, Marks & Spencer, introduced a range of meat and eggs derived from livestock raised on non-GM diets. Sainsburys is seeking suppliers of meat not derived from GM grain.

According to Sainsburys, 'We support the responsible use of GM providing it is legal, safe, environmentally responsible and has clear consumer benefit', but no UK company has stated what would count as such products or their benefits. One beneficial product is an exception which proves the rule about the obstacles to GM ingredients. Based on a slow-ripening GM tomato from Zeneca, similar to Calgene's Flavr-Savr in the USA, a tomato paste was marketed exclusively by Sainsbury's UK in 1997, at a lower-price than comparable non-GM products. Clearly labelled 'GM' from the start, the product drew no criticism, even after Monsanto's GM soybean became a target of protest. Nevertheless the tomato paste was withdrawn when Sainsbury's moved to exclude GM ingredients from all its own-brand products in 1999. Apparently the GM tomato paste became a casualty of larger-scale decisions.

4. Pesticides: lower or different usage

Amongst efforts to reduce pesticide usage, there are three main approaches:

Organic or bio:

This uses only biopesticides or no pesticides at all. It depends upon farmers' knowledge of methods and alternative inputs which help to avoid pest problems. Generally it has a higher price, though some UK retailers have undertaken to sell organic food at a comparable price.

Integrated agriculture, or agriculture intégrée:

This reduces the need for pesticide usage and can change the types used. It aims to keep pests under control so that they cause no economic damage, rather than try to eliminate them entirely. Like organic methods, integrated agriculture depends on farmers' knowledge (Perkins, 1982; NRC, 1987). In particular:

Integrated Crop Management (ICM) selects components of the farm system to avoid pests. These include soil management to enhance crop health, resistant cultivars, natural predators, limits on pesticide or mineral residues, etc.

Integrated Pest Management (IPM) is an earlier concept which has become part of ICM. IPM manages the cultivation system to control pests, e.g. through crop rotation, fertiliser application, soil preparation, time of sowing, etc.

'Precision' farming or agriculture raisonnée:

This lowers pesticide usage by using more precise methods (den Hond et al. 1999). For example, farmers decide more carefully what applications are really needed; they treat parts of a field separately, according to specific conditions there; and they replace high-volume products with more expensive, low-dose products. Using information technology, expert decision systems can replace farmers' judgements. The products carry a different label and a higher price in France. Although overlapping somewhat with ICM/IPM, 'precision' farming can be distinguished as an initiative from food processing and agrochemical companies.

4.1 Organic farming

In response to consumer demand, organic food lines are being expanded greatly by major food retailers; they are being extended to processed foods as well as fresh produce (e.g. in DK, NL, UK). Major food processors have entered the organic market, e.g. by establishing their own product lines or by acquiring a specialist organic company (van der Grijp and den Hond, 2000: 14). Organic farming still encompasses only 2% of European agricultural land, though a much higher percentage in northern Europe, and it may become a mainstream part of European agriculture (Padel et al., 1999).

Organic farming generates new knowledge of agronomic processes by farmers (Murdoch and Morgan, 2000). It also stimulates innovations in biopesticides. For example, research priorities include replacements for the copper-based salts currently used as pesticides by organic growers (IFOAM, 1999). The EU is banning their use for protecting grapes in 2002, so alternatives are being sought.

4.2 GAP Protocol

During the 1990s many retail chains developed pesticide-reduction guidelines for their suppliers. Building on such practices, the Euro-Retailer Produce Working Group adopted a Good Agricultural Practice Protocol in 1997 and revised it in 1999. The detailed guidelines emphasize ICM methods for avoiding pest problems (e.g. through resistant varieties, crop rotation, soil management) and for minimizing pesticide usage and its effects (e.g. through biological control, mechanical methods, regular crop monitoring, seed treatments rather than foliar sprays). 'Varieties should possess resistance/tolerance to commercially important pests and diseases' (EUREP, 1999).

The GAP Protocol affects competition among companies and farmers in several ways. On the one hand, it helps to avoid competition for sales on the basis of lower pesticide usage (apart from their 'organic' lines). On the other hand, all retailers come under pressure to join the scheme, and potentially all farmers come under pressure to follow the Protocol. In effect the earlier company guidelines are extended to the Europe-wide food industry and potentially beyond, to foreign suppliers. Contractors will validate compliance in each country. There is not yet public information on how the Protocol is implemented.

Food products derived from ICM/IPM methods are becoming a general standard rather than a specific market. They are generally sold at the same price as conventional products. IPM lacks any special recognition in food markets in many countries, e.g. UK, France, Denmark, and the Netherlands.

4.3 Pesticide reduction: national examples

Pressures to reduce pesticide usage operate across Europe, e.g. because farmers and companies sell their products across national boundaries.

DENMARK

Organic food is sold under a red Ø label; nearly 4% of agricultural land there is under organic cultivation. Some horticultural organizations have promoted a special label for 'environmental green' products, which result from integrated production (IP) methods, minimizing the use of agrochemicals. This effort succeeded in encompassing 70% of farm produce. However, the

ANNEX B11

label has not been very successful in promoting the products, which do not obtain a higher price than conventional ones.

FRANCE: three standards

Bio (organic) food bears an extra price of 25-50% in France. Sales doubled between 1998-99 but still comprised only 0.6% of the market; it is growing fast, especially for milk and dairy products. There is a strong traditional organic food chain, directly linking producers to consumers cooperatives and small specialised shops. The growth comes from the strategic commitment of the retailers and food industry to organic food production.

Agriculture intégrée (e.g. IPM) is the common term for strategies for reducing agrochemical inputs and production costs. This may become the new industry-wide standard, though with no premium price. The products have no label, so the extent of IPM crop production is difficult to quantify in France.

Agriculture raisonnée, a different approach, has been promoted by major food companies (e.g. Auchan, Carrefour and Danone), the chemical industry and major farmers' unions through a network of a hundred-odd farms. According to Danone, it must be 'the new standard of agriculture'; this company works with producers organisations to reduce pesticide applications on cereals. Moreover, it is promoted by agrochemical companies, which provide 70% of the budget for FARRE, the Forum de l'Agriculture Raisonnée Respectueuse de l'Environnement. There is no national certification system, so the proportion of *agriculture raisonnée* is not known (*Le Monde*, 01.03.99).

Quality-oriented retailers publicize the low-pesticide methods of their suppliers, while charging a 10% extra price (*L'Usine Nouvelle*, 11.03.99). Casino advertises such products with a special label, *terre et saveur*, while Auchan created a label, *agriculture raisonnée* (*Le Monde*, 05.03.00). Carrefour uses no special label.

Some retailers would like *agriculture raisonnée* to be adopted as a new conventional standard. When companies make contracts with farmers, the *cahier des charges* may specify the latter, or else *bio*. When buying food products, they may specify *agriculture intégrée*, along the lines of the GAP Protocol. Since 1993 Carrefour has implemented *agriculture raisonnée*, which encompasses 80% of apples, peaches and pears, 70% of carrots, 30% of leeks.

NETHERLANDS

Pesticide-reduction efforts had its origins in government policy, especially the 1991 Multi-Year Crop Protection Plan. A significant response came from Albert Heijn, which has approx. 1/4 of all food retail sales there. In 1997 it extended its ICM programme to its foreign suppliers, particularly from Spain, France, Israel and Italy. Albert Heijn aims to sell fresh produce only from ICM or organic cultivation practices (van der Grijp and den Hond, 2000). Consequently, by 1999 nearly all fresh produce of Dutch origin sold by Albert Heijn was produced under ICM standards. Albert Heijn also sells an increasing number and amount of organic food products; in 1998 it decided to offer a broad range of organic food products, most of them sold under an own-brand label (Albert Heijn, 1999).

Another company, HAK, has 300 contract growers. It started a quality control system across the agro-food chain and later added environmental criteria, in order to reduce pesticide and fertilizer use by suppliers. It set a combination of mandatory and voluntary guidelines for them.

Until the 1990s profam (IPC) or chlorprofam (CIPC) were widely used to inhibit sprouting in stored potatoes. In the 1990s these chemicals came under negative pressure from food processors and from national bans in Europe. Funded partly by Cebeco, the AgroTechnological Institute (ATO) in Wageningen developed an alternative agent from an active ingredient extracted from caraway seed oil. It has been marketed by Luxan, a subsidiary of the Cebeco Group in the Netherlands and Switzerland since 1995 and is in the process of registration in other European countries.

SPAIN

Under pressure from retailers, farmers seek ways to reduce pesticide usage, run-off and residues. Commercial standards are becoming more stringent than legal requirements. In response, some companies are developing new pesticide formulas which have greater efficiency and thus lower doses of active ingredient. Some are developing biopesticides, e.g. based on foliar Bt.

The GAP Protocol guidelines are followed mainly by Spanish farmers who supply European retailers. Since 1998 some producers in Spain (e.g. Martinavarro) have participated in pilot trial projects to verify that the GAP Protocol is being implemented. There are no public data on the numbers of farms that have adopted ICM practices, though these practices are more widespread in horticulture than in arable crops. The number of organic farms has been increasing rapidly in Spain since 1996, reaching 8% of European organic farms by 1999, twice the 1997 figure (EC, 1999).

UK

Major retailers mention that they follow the GAP Protocol, which generalizes practices previously developed by Sainsburys. That company in particular is attempting to develop verification procedures for overseas suppliers, to complement the verification already being devised for European suppliers. ICM methods have been developed on Demonstration Farms by a programme called LEAF, 'Linking Environment and Farming'.

Organic food is distinguished by an authorized logo, e.g. 'Soil Association Organic Standard', among others. In 1997 the Soil Association decided that 'organic' products could not be derived from GM crops. Some companies promote 'organic' products as another way to avoid GM feed sources in animal products. The UK can produce enough organic food to fulfill only 30% (or less) of the demand, so the rest is imported.

Major retail chains play a relatively greater role in promoting organic food in the UK than in other European countries. For organic produce, some chains accept 'cosmetic imperfections' which they would not accept in conventional lines (Murdoch and Morgan, 2000). At least two retail chains have undertaken to sell organic food at no extra price.

5. Conclusions: Euro-food pressures on R&D

Facing public suspicion towards GM food and synthetic pesticides, the European food industry has accommodated these attitudes by favouring some types of farm inputs over others. These practices remain open to further public demands and industry strategy.

For their overall competitive advantage, European retail chains have built up own-brand product lines, designed to symbolize product quality. This role in turn has made retailers more vulnerable and responsive to consumer concerns. While they compete over distinctive aesthetic characteristics of products, they have decided to cooperate over standardizing some process characteristics which are less readily detectable to consumers, who therefore depend on company information.

In particular, retailers have developed common practices or criteria for non-GM grain and lower-pesticide methods. Such criteria apply to all product lines, not just to specialty products. This cooperative approach has several aims: to maintain consumer confidence in product quality, to establish Europe-wide supply chains which meet common or minimum standards, to make supplies interchangeable, and to avoid competition for 'non-GM' or 'low-pesticide' products defined in various ways.

Food processing companies too have accommodated such consumer pressures. For pesticide reduction, some companies have helped to fund research on pest-resistant seeds and alternative chemical agents; some have also promoted 'precision (rational) agriculture' methods, as distinct from IPM/ICM methods. At the same time, processors have relatively greater interest in differentiating their products from competitors' in other respects. Unlike

ANNEX B11

retailers, they research novel seeds which may provide consumer benefits and gain public acceptability, while seeking exclusive control over such products.

Seeds

Food retailers and processors have exerted pressure against the first-generation GM crops for use in food, even for use as animal feed in some countries. They may base future products upon other novel seeds, though such links may be difficult to make for several reasons:

- Food-processing advantages have been obtained and controlled more readily from microbial methods than from novel seeds. Likewise nutritional advantages have been obtained mainly from changes in processing methods.
- Food companies currently mention few such advantages which require novel seeds, even though some biotechnology-seed companies are modifying crops for output traits. Such products may pose problems of European public confidence -- e.g. because they blur the boundary between food and pharmaceuticals, because they are perceived as 'unnatural', or simply because they involve GM crops.
- The largest, most lucrative seed markets may not correspond to the crops for which food companies want novel seeds, e.g. coffee.
- A food company can gain a market advantage from a novel seed only if it has exclusive access, yet such an arrangement limits the prospective market for a plant breeding company. Such companies and farmers may not accept dependence upon just one purchaser.
- Pesticide-reduction may be achievable by changing the cultivation methods or the pesticidal agent, rather than the seed. On the other hand, some ICM/IPM methods depend upon pest-resistant seeds. Such breeding has focused on monogenetic absolute resistance, which may be overcome by pest adaptation, though organic breeders instead seek polygenetic tolerance to pests.

Pesticides

Food retailers and processors have exerted pressure upon farmers to reduce pesticide usage; verification procedures are being devised. Unlike the organic sector, these pressures potentially affect most of European agriculture. They may offer incentives for changing the type of pesticide used, and thus for R&D, though such links may be difficult to make for several reasons:

- Seed treatments are preferred to foliar sprays, but seed treatments may simply re-formulate the same active substance, and some have been criticized on environmental grounds.
- Biological methods are preferred to chemical ones, but the former offer less prospect of proprietary control and large markets for a pesticide company.
- As cultivation methods are redesigned to attract fewer pests, any success would reduce the need for pesticides.

Summary

The European food industry has sought to exclude GM ingredients and to minimize pesticide usage from their supplies, thus implicitly protecting the 'quality' reputation of their own-brand lines. Overall these pressures favour non-GM products which help reduce chemical pesticide sprays – e.g. pest-resistant seeds, seed treatments, or biopesticides – especially as components of ICM methods. Such pressures go beyond any statutory restrictions on GM products or pesticides.

The commercial pressures also go beyond national boundaries. Given the strong consumer signals in some countries, food companies have been changing their supply-chain practices throughout Europe. Likewise, farmers have come under pressures from food companies

based in other countries or marketing products there. In such ways, pressures on farm inputs become Europe-wide, for both companies and farmers.

6. References

This transversal report cites the most important sources which have a Europe-wide scope, rather than include all the references in the contributory reports on countries and companies.

Albert Heijn (1999) 'AH Informatief. Een bijlage over AH Biologisch', Allerhande, NL: Albert Heijn.

Anon (1999) 'Dysfunctional', *The Economist*, 11 September: 93-94.

Bayer AG (1997) *Perspective on Innovation '97*. Press Forum.

Blandford, D., and Fulponi, L. (1999) 'Emerging public concerns in agriculture', *European Review of Agricultural Economics* 26(3): 409-424.

BPG (1999) EU-level report on 'Safety Regulation of Transgenic Crops: Completing the Internal Market?', Biotechnology Policy Group (BPG), Open University, available at <<http://www-tec.open.ac.uk/cts/bpg.htm>>, also at <<http://cordis.lu/elsa/home.html>>

Brouwer, F. and Bijman, J. (2000) *Dynamics in Crop Protection, Agriculture and the Food Chain in Europe*. The Hague: Agricultural Economics Research Institute.

CEC (1999) *Agriculture, Environment, Rural Development: Facts and Figures - A Challenge for Agriculture*, <http://europa.eu.int/comm/dg06/envir/report/en/index.htm>, Brussels: Commission of the European Communities.

Den Hond, F., Groenewegen, P., and Vorley, W.T. (1999) 'Reduction of pesticide usage in the Netherlands: what leverage for policy?', *European Environment* 7: 126-32.

Den Nijs, T. and Lammerts van Bueren, E. (1999) 'Breeding for organic agriculture: cross pollination between conventional breeders and organic farmers', *Prophyta*, June: 64-68.

Deutsche Bank (1999) 'GMOs are dead', 12 July, <<http://www.biotech-info.net/Deutsche.html>>

Dibb, S. and Mayer, S. (2000) *The Next Generation: Good for Whose Health?* London: Food Commission.

Ebbertt, J. (1998) 'The impacts of biotechnology on the grain processing industry', *AgBioForum* 1(2): 78-80, <<http://www.agbioforum.missouri.edu>>.

EEC (1970) Directive du Conseil 70/457/CEE concernant le catalogue commun des variétés des espèces de plantes agricoles, *J.O. des Communautés européennes*, L225, 12 octobre: 1-6.

EC (1998a) Council Directive 98/95 amending [previous directives] on the common catalogue of varieties of agricultural plant species, *Official Journal of the European Communities*, 1 February, L 25.

EC (1998b) Council Regulation 1139/98 concerning the compulsory indication on the labelling of certain foodstuffs produced from genetically modified organisms..., *Official Journal of the European Communities*, 3 June, L 159: 4.

ENDS (1999) 'Unilever, Nestle to drop GM ingredients from food products', *ENDS Report* 291: 30.

EUREP (1999) *Good Agricultural Practice [GAP] Protocol*. Euro-Retailer Produce Working Group, <<http://www.eurep.org>>

FiBL (1999) Statement of 'International Conference on Biodiversity and Organic Plant Breeding', Research Institute for Organic Agriculture/Forschungsinstitut für biologischen Landbau (FiBL), <<http://www.www.fibl.ch>>

Finch, J. (2000) 'Mr Del Monte says yes to cholesterol lowering juice', *The Guardian* 20 April.

Flynn, A. and Marsden, T. (1992) 'Food regulation in a period of agricultural retreat: the British experience', *GeoForum* 23: 85-93.

ANNEX B11

- Grávalos, E. and García, A. (2000) 'Small and Medium Enterprises in the Field of Plant Biotechnology, Seeds and Agrochemicals: Transversal Analysis', Seville: Institute for Regional Development; research report for Policy Influences on Technology for Agriculture: Chemicals, Biotechnology and Seeds (coordinated by Open University).
- IFOAM (1999) 'Main Priorities in R&D for Organic Food Production', *Ecology & Farming* 20: 20-21 [submitted as policy advice to European Commission]. Tholey-Theley, Germany: International Federation of Organic Agriculture Movements, <<http://ecoweb.dk/ifoam>>
- Lammerts van Bueren, E. et al. (1999) *Sustainable Organic Plant Breeding. Final report: a vision, choices, consequences and steps*. Driebergen: Louis Bolk Institute, info@louisbolk.nl
- Marsden, T., Murdoch, J. and Morgan, K. (1999) 'Sustainable agriculture, food supply chains and regional development', *International Planning Studies* 4(3): 295-302.
- Monsanto (1997) *1997 Annual Report*.
- Morris, C. and Young, C. (2000) "'Seed to shelf", "teat to table", "barley to beer", and "womb to tomb": discourses of food quality and quality assurance schemes in the UK', *Journal of Rural Studies* 16: 103-115.
- Murdoch, J. and Morgan, K. (2000) 'Organic vs. conventional agriculture: knowledge, power and innovation in the food chain', *Geoforum* 31: 159-73.
- National Research Council (1987) *Alternative Agriculture*. Washington, D.C.: National Academy Press.
- Nestlé (n.d.) Agricultural Raw Materials, <http://www.nestle.com>
- Padel, S., Lampkin, N. and Foster, C. (1999) 'Influence of policy support on the development of organic farming in the European Union', *International Planning Studies* 4(3): 303-16.
- Perkins, J.H. (1982) *Insects, Experts and the Insecticide Crisis*. New York: Plenum Press.
- Petiard, V. (2000) 'Value-enhanced crops: the role and attitudes of food processors and retailers', talk by Nestlé R&D officer at 'New Frontiers in Plant Science and Plant Biotechnology', March, Toulouse; supplemented by an interview.
- Rama, R. (1996) 'Les multinationales et l'innovation', *ÉconomieRurale* 231, janvier/fevrier.
- Rama, R. (1998) 'Productive inertia and technological flows in food and drink processing', *Intl Jnl of Technology Management* 16(7): 689-709.
- Tozlani, S. (1998) 'Capital concentration among the food multinational enterprises and development of the world's agro-food system', *Intl Jnl of Technology Management* 16(7): 695-710.
- Todt, O. and Luján, J.L. (1999) 'Spain: Commercialisation of GM foods drives public debate as well as precaution', national report for 'Safety Regulation of Transgenic Crops: Completing the Internal Market?', funded by the European Commission, DG XII/E5, available at <<http://www-tec.open.ac.uk/cts/bpg.htm>>, also at <<http://cordis.lu/elsa/home.html>>
- Unilever (1998) *Environment Report 1998: Making Progress*.
- Unilever (n.d.) 'How We Manage Our Impact on the Environment', <<http://www.unilever.com>>
- Unilever (2000) 'Genetically Modified Organisms', <<http://www.unilever.com>>
- van der Grijp, N.M., and den Hond, F. (2000) *Green Supply Chain Initiatives in the European Food and Retailing Industry*, Amsterdam: Vrije Universiteit, Instituut voor Milieuvraagstukken (Institute for Environmental Studies, Report No. R-99/07), <<http://www.vu.nl/ivm>>
- Wilkinson, J. (1998) 'R&D priorities of the leading food firms and long-term innovation in the agrofood system', *Intl Jnl of Technology Management* 16(7): 711-20.
- Wrong, M. (1999) 'Fodder for the gm debate', *Financial Times* 18 November.