

ANNEX E1

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

Public Sector Research Establishments
(PSREs) in Agrochemicals, Seeds and Plant
Biotechnology: Overview

Annex E 1

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

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January 2001

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.

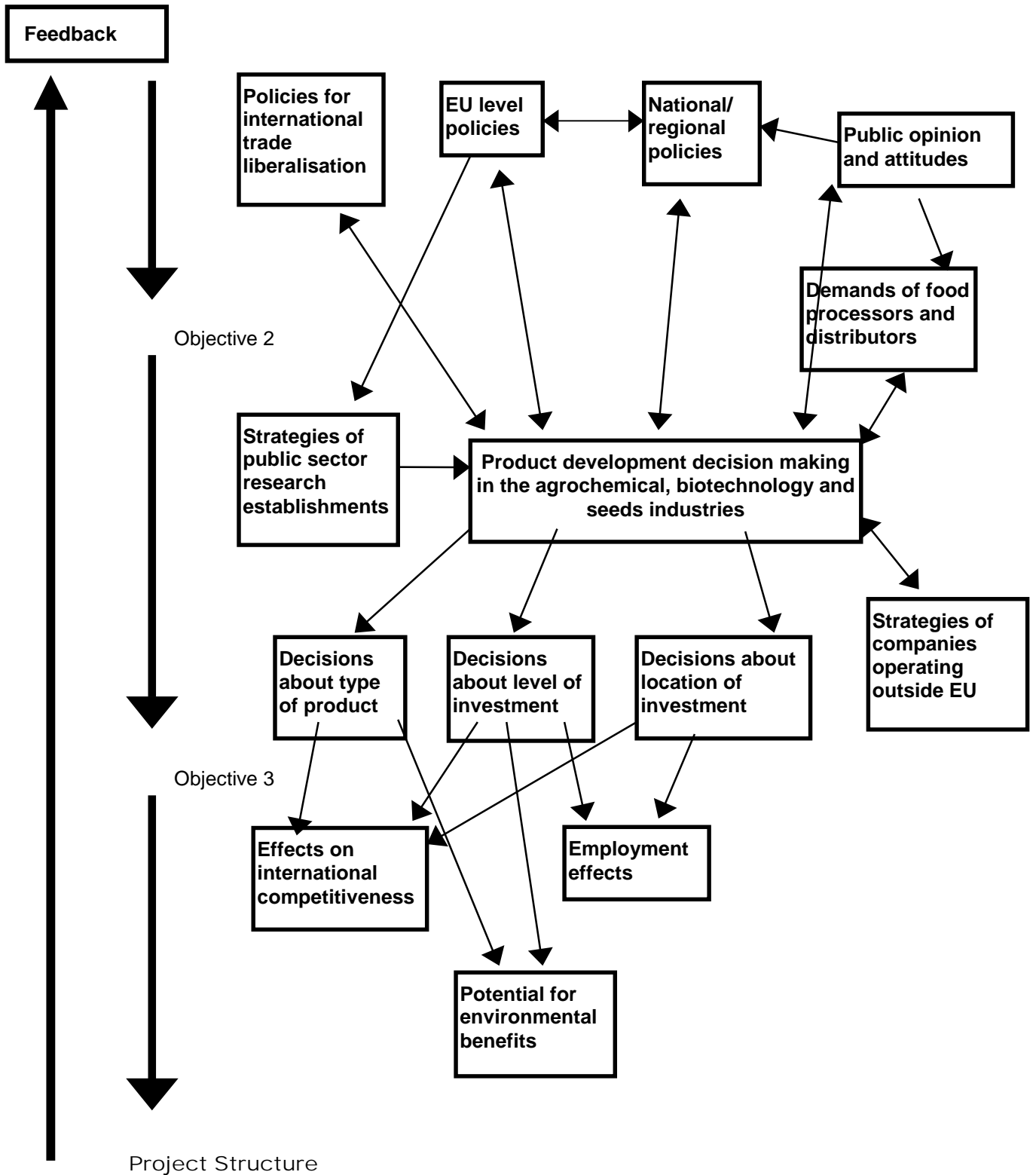
The range of policies and other influences studied includes:

- 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



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1. Introduction

The aim of the present report is to analyse how public policies and market-related factors influence the roles and innovation strategies of Public Sector Research Establishments (PSREs). The report is part of the wider European Commission funded PITA project, PITA being an abbreviation of Policy Influences on Technology for Agriculture. The overall aim of the PITA project is to study how public policy and market-related factors affect innovation in seeds, agrochemicals and biotechnology.

Four research questions are central to the present analysis. First, what are the roles of PSREs in the national systems of (agricultural) innovation in the countries studied? Second, how are these institutes funded, and what changes are taking place (or have taken place) in the funding? Thirdly, how do they manage their dual roles of supplying industry with useful techniques and knowledge on the one hand, and providing government agencies with independent expertise on the other hand? And fourthly, how do these research institutes take sustainable agriculture and environmental issues into account in their research agenda?

The present report draws extensively on national reports for Spain, France, UK, The Netherlands and Denmark. Moreover, information from the German Report (Annex E4) has been included. Section 2 below brings together excerpts from these national reports. It stands out very clearly from these reports that the roles of public sector research establishments are changing significantly. The national reports suggest that these changes are motivated mainly by a perceived need to improve their efficiency. Thus, efforts are being made:

- to strengthen the overall coordination of research,
- to build up stronger and more powerful research institutions,
- to define more clearly the roles of public versus private research, and – not least:
- to make PSREs more alert to recipients' needs.

To achieve these ends, PSREs are being reorganised, their activities are becoming more focused, in many cases they are being privatised, and various forms of research cooperation are being developed – both among PSREs and between PSREs and industrial partners.

Section 3 compares these developments and discusses their possible merits and demerits. The word 'discusses' is central here, for in most cases an empirical assessment of advantages and disadvantages would be premature. This is partly due to the fact that developments within the PSRE sector should be seen in the light of significant changes in their political environment, such as the reorganisation of relevant ministries.

Finally, Section 4 summarises the arguments and considers the changing roles of PSREs in relation to issues of public opinion and consumer safety – issues which seem to be of growing importance in the EU.

2. An overview of PSREs in the countries studied

A fuller account of PSREs in individual countries is given in the national monographs underlying the present synthesis. The excerpts presented below are mainly intended to facilitate comparisons between countries.

2.1 Spain¹

The public system of research (PSR) in Spain comprises 49 universities, which share about 32% of total national expenditure of R&D and about 42% of personnel, the research institutes, which represent 12% of R&D expenditure and 9% of personnel, and other government laboratories representing about 10% of the R&D expenditure and about 15% of personnel.

The main characteristics of the structure, organisation and nature of Spanish public sector research (PSR) are as follows (Muñoz, Santesteban and Espinosa de los Monteros, 1999):

- Research organisations and funding sources are highly varied and the degree of coordination between different bodies is quite low;
- PSR seems to function independently from other systems, in particular the economic and productive systems;
- There are continuous conflicts between sectoral, national and regional policies in relation to R&D;
- There are difficulties in defining priorities for PSR in Spain, and there is limited experience of forecasting and evaluation;
- Spanish industry has played a very limited role in defining priorities and in technology forecasting. PSR operates from the "supply side" with scarcely any involvement from the "demand side", except in the case of some very specific activities and in the solution to some problems of very limited scope.

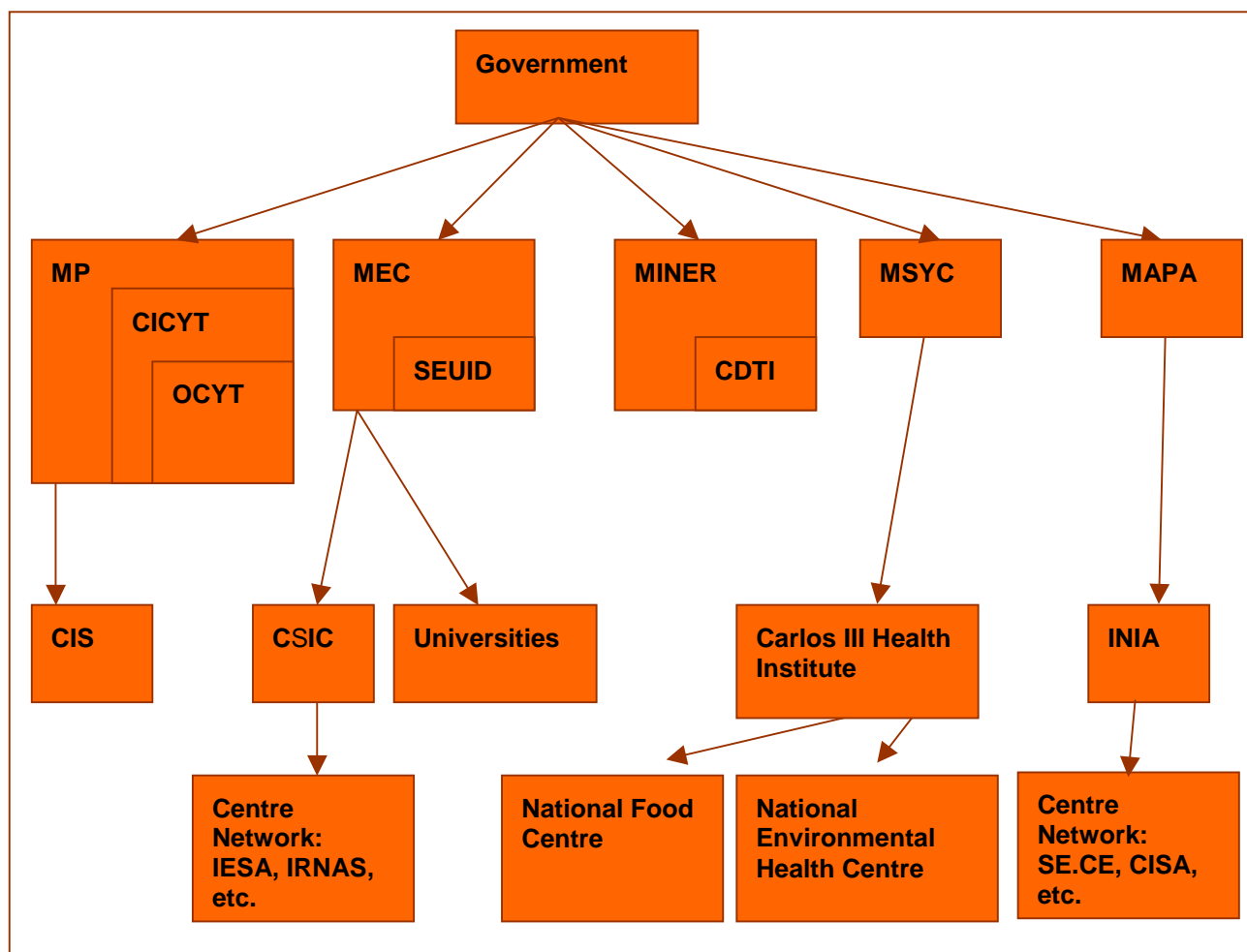
Since the Law of University Reform of 1983 and the Law of Promotion and General Coordination of Scientific Research of 1986 (named the Science Law) came into force, the Spanish public research system has undergone an important change. These two laws reinforced research activities in universities and were intended to coordinate the actions of R&D centres within the different ministries by means of the Comisión Interministerial de Ciencia y Tecnología (Inter-ministry Commission of Science and Technology - CICYT). The launching of the R&D National Plan (1988-1991, and subsequent versions) implemented these laws. The most recent attempt to consolidate the coordination of different research bodies has been the creation of the Office for Science and Technology (OCYT) in January 1998, directly attached to the Presidency of the Spanish Government. The OCYT constitutes the support unit of the CICYT for the planning, co-ordination, monitoring and evaluation of the science and technology activities of the relevant Ministerial Departments and public bodies. It is also entrusted with the co-ordination with the Regional Governments of the Autonomous Communities and with the co-ordination and follow-up of the international programmes with Spanish participation.

The National R&D Plan is the main instrument in Spanish R&D policy. In November 1999 the government approved the Fourth National Scientific Research, Development and Technological Innovation Plan (2000-2003) which is going to be the reference for Spain for the next four years.

The policy-making powers for scientific policies are currently scattered among ten different ministries. In addition to this, each Autonomous Community designs and implements its own

¹ This sub-section is an excerpt from Annex E6.

scientific policy. Figure 1 outlines the main agents involved in the scientific policy of the Spanish government.



Legend: MP: Ministry of the Presidency; CICYT: Inter-ministry Commission for Science and Technology; OCYT: Science and Technology Office; ANEP: National Prospective Agency; MEC: Ministry of Education and Culture; SEUID: Secretariat of State of Universities and Research and Development; MSYC: Ministry of Health and Consumers; MAPA: Ministry of Agriculture, Fisheries and Food; CIS: Sociological Research Centre; CSIC: Higher Council for Scientific Research; IESA: Advanced Social Studies Institute; IRNAS: Sustainable Resources Institute; INIA: National Institute for Agriculture and Food Research and Technology; SE.CE.: Head Office of R&D Units; CISA: Animal Health and Research Centre.

Figure 1 Agents Spanish PSR

Among the Spanish Public Sector Research Establishments, there are some with a marked sectoral character, which are normally ascribed to one ministry, and others with a multidisciplinary character that conduct research applicable to several sectors. There were 216 PSREs in 1995; 70 of them were ascribed to the national government and the remaining 130 to the autonomous governments. The largest and most important PSRE is the Higher Council of Scientific Research (CSIC), a multidisciplinary institution that depends on the Ministry of Education and Culture. The CSIC accounts for 50% of the financial and human resources of Spain's PSREs and for 6% of all researchers working in Spain. It produces 18% of all the scientific literature and holds 24.6% of the patents of the Spanish public system (COTEC, 1998).

Regarding agricultural research, PSREs are financed basically by the National R&D Plan and by the Agricultural R&D Sectoral Programme of the Ministry of Agriculture, Fisheries and Food. The National Institute for Agriculture and Food Research and Technology (INIA) is the

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body responsible for managing the latter programme, which finances the INIA's research centres as well as those ascribed to the Autonomous Communities. In November 1998 the INIA's policy making powers were extended and now cover national actions related to the register of seeds and nursery plants.

In 1997, the area of Life Sciences and Agrifood accounted for 29.6% (6791 million pesetas ≈ Euro 41 m) of the National Fund for R&D, which is the financial instrument of the National R&D Plan. This area is divided into three: Biotechnology, Food Technology and Agricultural R&D. Table 1 shows the breakdown of funds in 1997 between these modalities and types of projects.

Table 1 Breakdown of funds in 1997 from the National R&D Fund (million Euro)

Programmes	Training of research personnel	Compro mises previous years	Projects and Special Actions	Integrated projects between research groups and industry	Scientific and Technical Infrastruc ture	Other	Total
Agricultural R&D	1.9	2.0	2.4	2.5	0.8	0.4	10.0
Food technology	1.6	1.2	2.8	1.3	0.5	0.4	7.9
Biotechnology	1.3	1.3	3.3	2.1	1.0	0.3	9.4

Source: Memory of the National R&D Plan in 1997, CICYT, 1999.

Besides, the National R&D Programme of Environment and Energy includes a number of projects on risks and residues of pesticides in water and soil.

The Fourth National Scientific Research, Development and Technological Innovation Plan (2000-2003) changes the name of the Agriculture Sectoral R&D Programme. Now there are two areas of interest for the PITA project: The Scientific and Technological Area of Food-farming Resources and Technology and the Sectoral Area of Food. The first includes two strategic actions: Preservation of genetic resources with a food-farming interest, and Farming resources and technologies. The second includes three strategic actions, of which the one relevant to our study is the Control of food quality and security.

2.2 The Netherlands²

The Netherlands has traditionally had a large public research effort devoted to agriculture and food. This, of course, is directly related to the importance of the agricultural sector in the Dutch economy. As in many other countries, the government has played a major role in setting up, directing and funding agricultural research. The core of the public sector agricultural research is located at Wageningen University (formerly Wageningen Agricultural University) and the research institutes of the Agricultural Research Department (DLO). Together Wageningen University and DLO employed close to 6000 people in 1998.

Within the university and DLO, several departments and institutes are doing research relevant to agrochemicals, biotechnology and seeds. Within the university the Department of Plant Sciences is the most relevant to our study. For instance, fundamental and applied plant breeding research is carried out at the Laboratory for Plant Breeding. Within DLO, three institutes do most of the research on agrochemicals, biotechnology and seeds: the Centre for Plant Breeding and Reproduction Research (CPRO), the Research Institute for Agrobiology

² Annex E5.

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and Soil Fertility (AB), and the Research Institute for Plant Protection (IPO).³ In the Netherlands, the government accounts for about 40% of all R&D expenditure. Dutch public policy on science, research and technology is mainly a matter for the Ministry of Education, Culture and Science (OC&W) and the Ministry of Economic Affairs (EZ). Every ministry in the Dutch government has its own budget for science and technology, but more than 60% of the total government S&T expenditure is included in the budget of the Ministry of OC&W. In 1997, three departments (the Ministry of Education, Culture and Science, the Ministry of Economic Affairs and the Ministry of Agriculture) contributed 85.6% of the total government R&D budget (Diederens et al., 1999: 71) (see Table 2).

Table 2 Government R&D spending by the departments OC&W, EZ and LNV

Department	Expenditures 1997 (million Euro)
Education (OC&W)	1530
Economic Affairs (EZ)	415
Agriculture (LNV)	160

Sources: OC&W: Onderzoek in cijfers 1995 and Science Budget 1995.

For agricultural R&D, the Ministry of Agriculture is the main governmental funding agency. In 1999, the Ministry of Agriculture (LNV) spent some 600 million Euro on R&D, education and information dissemination (e.g. extension services). On R&D only, the Ministry spends 241 million Euro, with the Wageningen University and the DLO institutes as the main recipients (Table 3).

Table 3 LNV Budget for R&D expenditures (1999)

Receiving organisation	Funding (million Euro)
Wageningen University	94
DLO Institutes	114
Applied Research Institutes	21
Others	12
Total	241

Source: Ministerie van LNV, Directie Wetenschap en Kennisoverdracht, Kennis voor Kracht en Kwaliteit. "Sturen op interactie". Ontwerp uitvoeringsprogramma LNV-kennisbeleid 1999-2002, Den Haag, 1999, p. 67.

Figure 2 presents the structure of public funding for PSREs relevant to seeds, agrochemicals and biotechnology. All PSREs receive funds from various public sources, as well as from private industry. In recent years, public spending has remained equal or has decreased, while the input from private industry has increased. Also, the character of public expenditure has changed, particularly the funds spent by the Ministry of Agriculture.

³ In 2000, CPRO, AB and IPO have merged into one institute: Plant Research International.

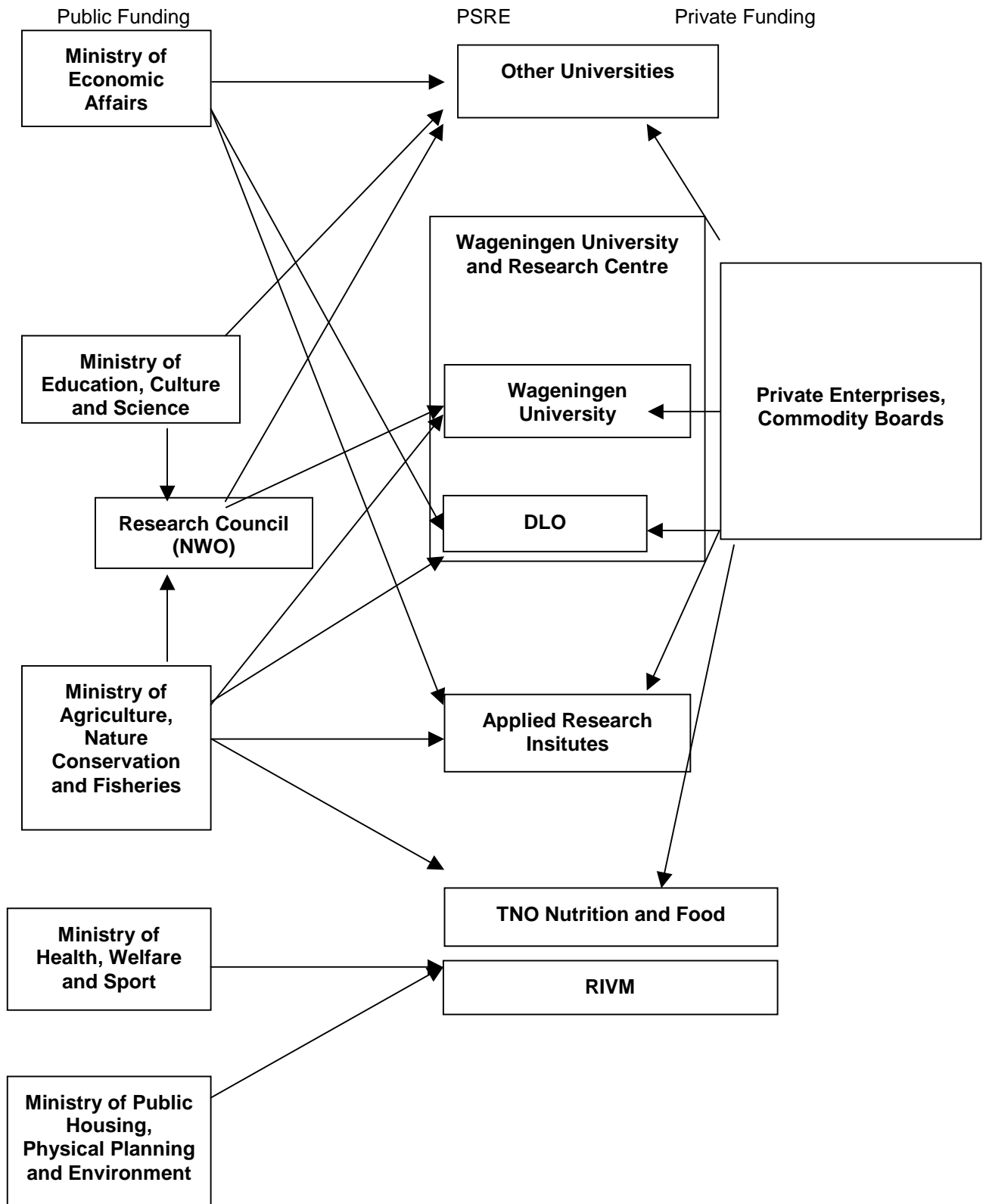


Figure 2 Funding structures of PSREs in the field of plant breeding, plant biotechnology and crop protection in the Netherlands

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Wageningen University (formerly Wageningen Agricultural University) receives 116 million Euro from the Ministry of Agriculture. Of this amount, 65 million is for education and 51 million is for research. Moreover, the University earned 45 million Euro in contract research. With this last figure, the university has the highest rate of contract research among all Dutch universities (Diederer, 1998).

Changes in the funding of Wageningen University are taking place or can be expected in the near future (Diederer, 1998; LNV, 1999). First, as the number of students has declined, the university will receive less funding for its education and research activities. Second, the Ministry of Agriculture in funding research is shifting from input financing to output financing. As a result, research projects will have to be more tuned towards the (policy) demands of LNV. Third, the Ministry of Agriculture, pressed by the Ministry of Finances, is looking more critically at the spending of research funds, urging recipients to increase their efficiency. Fourth, as other PSREs complain about unfair competition in contract research, because of cross subsidies from regular research funds, the university will have to charge full costs for its research activities. Fifth, within Wageningen UR, collaboration with DLO institutes will be promoted, or even forced. Sixth, the university has to give more room for multidisciplinary research, as questions from clients like LNV cannot be answered by unidisciplinary research. Seventh, LNV wants Wageningen University to be more aware of its societal responsibility. This means that societal questions and public or consumer concerns should be more pronounced in the list of research topics.

Until March 1999, DLO was part of the Ministry of LNV. During the 1990s, the character of funding of DLO research changed from input to output financing. This means that the funds received by the DLO institutes became conditional on delivery of specific outputs. Funding on the basis of results is major shift from the old system where the funding and the decision about spending the funds were mostly unrelated. While the Ministry of LNV supplied the money, decisions about research projects were made by the directors of the institutes together with an advisory board. This board consisted of representatives from the Ministry as well as from the farming and agribusiness community.

Even though DLO is now an independent research organisation, three quarters of its income continues to come from LNV. For this reason, the Ministry still has a decisive influence on the establishment and design of research programmes. Gradually, research programmes are becoming more responsive to LNV policy goals, although some continuation of old programmes is guaranteed to prevent a loss of investments in human and physical capital. The determination of research programmes starts with the development of a policy proposal by LNV. Input is gathered from the research communities, prospective users and the National Council for Agricultural Research (NRLO). Once a draft proposal is written, reactions are invited from all kinds of stakeholders, most importantly from the main farmers' organisation LTO and the various commodity boards. Finally, a policy plan is submitted to Parliament as part of the yearly budget for the Ministry (Diederer et al., 1999).

In 1998, DLO received 116 million Euro from LNV, but this amount will diminish over the years (cf. Table 4 below). Some 10 percent of LNV financing of DLO is spent on research programmes targeted at crop protection and plant breeding and reproduction.

Table 4 Financial contribution of the Ministry of Agriculture to DLO (in million Euro)

	1998	1999	2000 (forecast)
Total	116	98	94
Crop protection	4.6	4.9	4.8

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Plant breeding and reproduction	5.6	5.4	5.2
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Source: LNV (1999), Rijksbegroting LNV 2000, Memorie van Toelichting - algemene deel.

Funding of applied research is 50% government (Ministry of Agriculture) and 50% private funds. The private funds mostly come from industry. For instance Commodity Boards funded 19 million Euro in applied research institutes in 1996 (Diederer, 1998). In 1999, LNV's contribution to applied research was about 26 million Euro⁴. Since 1998, LNV funding has no longer been in the form of input financing. In 1998, LNV shifted to programme financing, which means that it now finances on the basis of results. Government spending on applied research is now independent from private sector spending. The main reason for this shift is that LNV wants to have more influence on how its funds are being used. LNV's interests are not necessarily the same as private sector interests, and, in addition, government spending on applied research has become more difficult to legitimise politically (Diederer, 1998).

Following up on DLO becoming independent and on the formation of Wageningen UR, 10 institutes for applied research will merge into two new organisations: Applied Plant Research and Applied Animal Research. These new organisations will also be brought under the umbrella of Wageningen UR.

2.3 The United Kingdom⁵

2.3.1 Policy trends in public sector funding

PSREs linked to agriculture have faced considerable changes since the early 1980s. These were triggered by growing criticism of the Common Agricultural Policy, in terms of the cost of surplus production to the taxpayer and the impact of intensive agricultural production on the environment. Between 1994 and 1997, the conservative government conducted an extensive review of the potential for privatisation and rationalisation of public sector research (HRI, 1999: 20).

Research priorities were changed. Public funding for research to increase productivity was drastically cut. Funding for 'near market' research was redirected towards basic research of relevance to the whole food sector, not just agriculture, and towards addressing public concerns about food safety and the environment (Thirtle et al., 1997).

Some establishments were closed, amalgamated or privatised, and the public sector was expected to become less dependent than before on government funding. For example, the Glasshouse Crops Research Institute was sold for property development in the 1980s and some of its work transferred to Horticulture Research International. The Plant Breeding Institute, widely known for its work on cereals, was sold in the late 1980s to Unilever, who subsequently sold it on to Monsanto. In 1997, most of the work of the Agricultural Development and Advisory Service (ADAS) of the Ministry of Agriculture, Fisheries and Food was privatised.

The funding process became more open and competitive, with a wide range of institutions, both public and private, being invited to bid for funds for specific research topics (Thirtle et al., 1997). The public sector was encouraged to form links with industry, both to help compensate for the decline in government funding for research, and to stimulate more rapid commercial uptake of research ideas.

With the change to a Labour Government in 1997, pressures on the PSREs to commercialise their research have increased rather than decreased. A report on this subject commissioned by the Treasury recommended that the Government should seek 'to ensure that leadership in the PSREs is committed to drive commercialisation as an explicit part of their mission'. This

⁴ This is the 21 million mentioned in Table 3 with subsidies added for housing and equipment.

⁵ This sub-section presents excerpts from Annex E7.

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objective 'should be embodied in the job description and personal objectives of the PSRE chief executive and be seen as his or her personal responsibility. It should be cascaded through the personal objectives of senior management and scientific staff' (HM Treasury, 1999). The report, which was based on research on more than 40 PSREs, singled out the biosciences as a research area in which there is a strong industry demand or 'pull'. This is because the industry is characterised by large successful companies with the resources to seek out and exploit PSRE research, and because biomolecular science offers revolutionary, rather than incremental, advances in products and processes.

2.3.2 *Sources of public funding*

Public funding for crop-related research comes from research councils, central government departments and regional governments. An additional source of funding, which straddles the boundary between public and private sector, is that from the agricultural levy boards. The structure of crop-related research funding in the UK is shown in simplified form in Figure 3.

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(Source: Adapted from Martin, 1998: 10)

Of the research councils, the Biotechnology and Biological Sciences Research Council

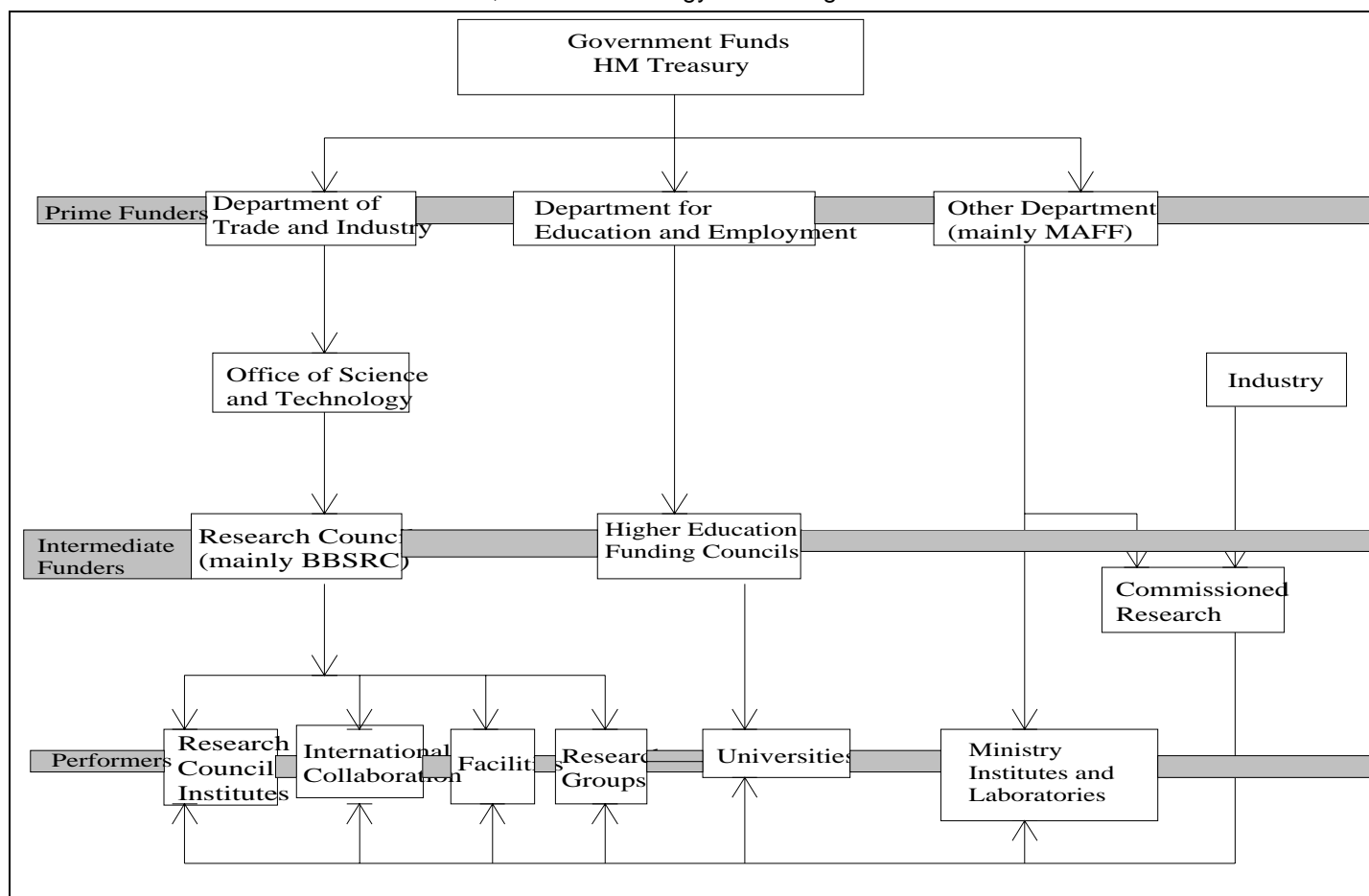


Figure 3 Simplified structure of crop-related research funding in the UK

(BBSRC) is the most significant (it spent 270 million ecu on research in 1997/98 - Martin, 1998: 3). It was created in 1994 from a merger between the Agricultural and Food Research Council and related parts of the Science and Engineering Research Council, because of a perceived lack of co-ordination between research councils.

Other research councils that fund a small number of research projects relating to crops and biotechnology are the Engineering and Physical Sciences Research Council (EPSRC), the Natural Environment Research Council (NERC) and the Social and Economic Research Council (SERC).

Of the central government departments that fund crop-related research, the most significant are the Ministry of Agriculture, Fisheries and Food (MAFF) and the Department of Trade and Industry (DTI). Small amounts of funding are provided by the Department of the Environment, Transport and the Regions (DETR) and the Department for International Development (DfID). MAFF has historically been the main government department promoting the UK agriculture and food industries. The DTI supports collaboration between UK industry and the research base through schemes such as LINK, EUREKA, SMART, the Teaching Company Scheme and ROPAs (Realising our Potential Awards). The DETR is the competent authority for the risk assessment of genetically-modified crops and funds risk assessment research to support this role. DfID funds research aimed at benefiting developing countries, often within the country concerned.

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Funding for agricultural research in Scotland is devolved to the Scottish Executive Rural Affairs Department (SERAD, formerly called the Scottish Office Agriculture, Environment and Fisheries Department, SOAEFD). In Northern Ireland, it is devolved to the Department of Agriculture for Northern Ireland (DANI).

Some funding for crop research in the public sector is provided by agricultural levy boards, in particular the Home Grown Cereals Authority (HGCA) and the British Sugar Corporation (BSC, part of Associated British Foods). These statutory bodies are legally empowered to impose mandatory levies on agricultural output, mainly to support 'near market' research for the industries they serve. The HGCA provides significant funding to the National Institute of Agricultural Botany, which conducts varietal trials and produces lists of recommended seeds. The BSC is a major source of funding for Broom's Barn Experimental Station, which conducts research on sugar beet.

Overall, BBSRC and MAFF are the main sources of funding for crop research. Each provides core funding for particular research institutes, as well as offering funding that is open to competitive bids. For example, BBSRC directly funds research in eight research institutes, including the John Innes Centre and the Institute of Arable Crops Research (see Table 5). MAFF's research institutes include Horticulture Research International.

The research councils, such as BBSRC, mainly fund basic and strategic research. Research councils have been encouraged to make their commitment to 'wealth creation and the quality of life' more explicit and to develop closer links with the communities that use their research, such as industry (UK Government, 1993). Much greater emphasis has been given to the involvement of industry in the design and management of research programmes.

Central and regional government departments, such as MAFF, focus on applied research to address specific policy problems. Since 1997, when the government changed from conservative to labour, changes in government priorities have led MAFF to place increased emphasis on research into food quality and safety, diet and health, protection of the environment and lower input crop production systems, including organic agriculture. However, MAFF's research budget, which used to be one of the largest among government departments, has been severely cut (by 10% since 1997, House of Common's Science and Technology Committee, 2000). The BBSRC has come under increasing pressure to help make up the shortfall, but says it lacks the flexibility to support an area of work when MAFF funding is withdrawn (Farrar, 2000).

Table 5 Principal agriculturally-related research institutes in the UK

MAFF's research institutes
• Directorate of Fisheries Research
• Central Science Laboratory
• Agricultural Development and Advisory Service
• Horticulture Research International
BBSRC-sponsored institutes
• Babraham Institute
• Institute of Arable Crops Research
• Institute of Animal Health
• Institute of Food Research
• Institute of Grasslands and Environmental Research
• John Innes Centre
• Roslin Institute
• Silsoe Research Institute

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Scottish agricultural and biological research institutes
• Scottish Crop Research Institute
• Hannah Research Institute
• Macaulay Land Use Research Institute
• Moredun Research Institute
• Rowett Research Institute

There is little direct funding of industry research by government except through schemes that promote co-operation between the public and private sector such as the LINK programme, which is run by the Department of Trade and Industry and supports long-term, 'enabling' and 'generic' research in areas of strategic importance to the national economy (Martin, 1998: 9). Other government schemes that encourage public-private sector cooperation include the Teaching Company Scheme (which involves joint supervision by academics and company managers of young graduates working in companies), awards for PhD research jointly supervised by an academic department and a company, and ROPAs (Realising our Potential Awards) to academic researchers who have received significant industrial research contracts.

Although the direct funding of industry research by government is limited, government supports industry indirectly by encouraging industry involvement in guiding public sector research priorities, through industry representation on management boards and research councils, and through jointly-funded projects. In addition, the research councils have had to take account of the research priorities established by the Office of Science and Technology's Foresight Programme, whose panels include industry people.

Martin (1998: 57-58), referring specifically to biotechnology, includes the following as distinctive aspects of the UK's funding system for research in the public sector:

- (i) the system is pluralistic but highly concentrated (there are several different funding organisations but BBSRC is by far the most significant one)
- (ii) the funding is science oriented (most research council funding goes to basic and strategic, rather than applied, research; a strong science base is seen as the main way of encouraging technological innovation)
- (iii) a significant proportion of the funding for agriculturally-related research is directed (by comparison with funding for medical research, which for the most part is non-directed); priorities are to a large extent set by the funding organisations, especially for the research institutes; however, for universities, funding is not usually directed
- (iv) there is a high level of involvement of the private sector in management boards, councils and committees of the funding organisations
- (v) considerable emphasis is placed on the commercial exploitation of research.

2.3.3 *PSREs in crop-related research*

In the UK, publicly-funded research relating to agriculture occurs mainly in specialist research institutes and, to a much lesser extent, in universities. The principal research institutes working on crops, and their sources of funding, are shown in Table 6.

Table 6 Principal research institutes working on crops, and their sources of funding, 1998-99

	Total income (£ million)	Funding as % of total					
		BBSRC-csg	BBSRC-ca	MAFF/SOAEFD	Industry	EU	Other
IACR	26	30	11	26	15	10	8
JIC	21.5	45	11	6	5	11	22
HRI	30.4	13		61	na	na	27
SCRI	12.4	na	na	68	na	na	32

IACR = Institute of Arable Crops Research; JIC = John Innes Centre; HRI = Horticulture Research International; SCRI = Scottish Crop Research Institute; BBSRC = Biotechnology and Biological Sciences Research Council; csg = competitive strategic grant; ca = competitive award; MAFF = Ministry of Agriculture, Fisheries and Food; SOAEFD = Scottish Office Agriculture, Environment and Fisheries Department; na = breakdown not available.

Sources: IACR, <http://www.iacr.bbsrc.ac.uk/iacr/ffunding.html> (accessed 19/02/00); JIC, JIC (1999) Governors' Report and Financial Statements, 31 March, p. 13 (excludes £ 3 million income of the Sainsbury Laboratory); HRI, Finance Department Statement of Financial Activities, 31 March 1999 (personal communication 04/07/00); SCRI, Annual Report 1998/99, p. 204.

The universities that have received the most funding for non-medical biological sciences from the BBSRC and MAFF are Cambridge, Edinburgh, Oxford, University College London, Nottingham, Birmingham and Sheffield (Martin, 1998, p. 62).

2.3.4 *Links between the public and private sector*

In an analysis of public-private knowledge flows in agricultural research, Senker and Faulkner (1999) note that at the beginning of the twentieth century there was considerable interaction between universities and industries involved in science and engineering, but that this interaction declined when industries established their own research laboratories. Now there is a revival of public-private sector interactions, which Senker and Faulkner consider is due to a number of factors:

- (i) the large number of scientifically literate graduates, who continue to develop their skills when they leave university for industry and are able to understand and assess the value of the work university researchers are doing
- (ii) intense competition among companies in technology-based industries, so that they are continually searching for new ideas and shorter development cycles
- (iii) the tendency for innovation to arise at the interface between disciplines, so being more likely to occur in universities than in companies whose employees are from a limited set of disciplines
- (iv) reduced government funding for research, which forces public sector scientists to seek private sector funding
- (v) the poor economic performance of the country in the late 1970s and early 1980s, which led governments to promote 'technology transfer'.

Senker and Faulkner say that, for the private sector, innovative research in the public sector provides a source of 'leading edge' and underpinning knowledge, new experimental techniques and instrumentation, and expert interpretation of results. However, companies need internal expertise in order to understand and use public sector research. Cohen and Levinthal (1990) refer to this as a company's 'absorptive capacity'.

According to Senker and Faulkner, factors encouraging public-private sector interaction stem from the technology as well as from the public and private sectors. Technology-related factors include the character of the technology and the age and dynamism of the research

field. Interaction is likely to be greater when the technology has application as a research tool, as genetic engineering does in biotechnology. Links with the public sector are more likely in new fields or in fields where the industry has no existing capability, so links tend to be intense in biotechnology because new knowledge and techniques are emerging all the time. Public-sector related factors include the availability of expertise in the public sector and the public policy context. In the case of biotechnology, the underpinning discipline of molecular biology developed entirely in the public sector and is comparatively well funded. Public policy supports public-private sector collaboration. Private-sector related factors include the size of the company, its existing knowledge base, and its propensity to network. Large companies have budgets that allow them to fund formal linkages. They tend to use these links for speculative and exploratory research for which they lack in-house expertise. They may second a member of staff to work alongside an academic researcher, or recruit an academic researcher to collaborate on a project. They may form links to gain access to expensive instrumentation and to have the results interpreted by experts. Some companies have a greater propensity to form links than others; they are more 'extrovert' and encourage their staff to network informally by attending conferences and seminars.

Barnes (1999) investigated reasons for public-private sector links in the agro-food industries from the perspective of the private sector. His findings support those of Senker and Faulkner in that the main reasons given for the links were to gain in-depth expertise and to compensate for a lack of company resources. A third reason was that the partners in the link had similar research programmes. Factors that discouraged links were company concerns over copyright and confidentiality, the length of time needed to negotiate contracts, research programmes too broad for a company's needs, and limited awareness of what the public sector might offer.

In his conclusions, Barnes raised a number of concerns about the impact of current government policies relating to public-sector research. One was that the damaging effect of cutbacks on a loss of public-sector expertise, valued by industry, might not be felt for some time because of the long-time lag (16 years and upwards) between expenditure and final output. Another was that the encouragement of industry links might discourage academic freedom, publication of results, and multi-disciplinary research.

Other authors have voiced some concerns about the increasing dependence of the public sector on private sector funding. For example, Senker and Faulkner (1999, p. 18-19) note: 'Current Government policy to privatise many MAFF research laboratories and extension services, as well as encouraging public sector researchers to seek contracts from industry makes it unclear where independent knowledge about the governance of technology now resides'. The numerous formal research links between the private and public research sectors 'raise doubts about the capability of PSR [public sector researchers] to act as independent advisers to Government on topics such as the regulation of genetically modified organisms'. In 1999, Friends of the Earth campaigned on just such an issue, pointing out that several members of the government's Advisory Committee on Releases to the Environment (ACRE) and Advisory Committee on Novel Foods and Processes had received funding from industry. As a result, all government committees involved in biotechnology now have to publish details of any commercial and other interests of their members (DETR, 1999, paragraph 26).

Similar concerns have been voiced, albeit more guardedly, by scientists within the public sector. For example, a report on research at the Scottish Crop Research Institute into gene flow from GM crops mentions 'the impartiality of the science and the scientists that are carrying out ecological risk assessment' as a significant factor in the public debate. It comments: 'while science must work with industry, it has to retain a degree of independence through public funding. Otherwise people will not believe its findings on these issues' (SCRI, 1999: 54).

2.4 France⁶

In the French system, research for agriculture is concentrated within three institutes:

- The Institut National de la Recherche Agronomique (INRA), which was created in 1946 and became a national public scientific and technological establishment in 1984, under the joint authority of the Ministries of Research and Agriculture. It has a threefold mission to:
 - guarantee consumers high-quality food and food safety
 - ensure that agricultural and agro-food companies are competitive
 - contribute to integrated land development and sustainable management of natural resources
- The Centre d'Etudes du Machinisme et du Génie Rural des Eaux et Forêts (CEMAGREF), which is devoted to engineering and which specialises in the areas of mechanic systems and water devices;
- The Centre de Coopération Internationale en Recherche Agronomique pour le Développement (CIRAD) which aims at developing research for the agricultural sector of developing countries.

Training is performed in specialised agronomic engineering national schools (Paris, Rennes, Montpellier, Toulouse, Nancy) which are under the authority of the Ministry of Agriculture. These engineering schools also have research activities, very often associated with INRA.

Public Sector Research for agriculture is also undertaken, although as a minor activity in some CNRS laboratories, primarily those focusing on plant biology. These laboratories are focused on basic research and generally work in close connection with INRA. The main University Centres with a high commitment in plant biology are generally associated with the CNRS and/or INRA. They include the Université d'Orsay, the Ecole Normale Supérieure de Lyon, the Université de Clermont- Ferrand, and the Université de Lille.

Given this situation and the scope of this study, we shall principally focus the study of PSREs in France on INRA.

2.4.1 Organisation of INRA

The National Institute for Agronomic Research (INRA) is responsible for ensuring high-quality nutrition, safeguarding competitiveness between agricultural and foodstuff companies and looking after the environment. Its main areas of competence are: natural resources; natural environments and territories; animal and plant species utilised for production purposes; the characterisation and transformation of products; companies, sectors, markets and exchanges; consumption.

INRA employs 8,587 people, including 3,771 research scientists and engineers. Its budget totals FF 3,363 million [\approx 513 m Euro]⁷.

Since 1998, INRA has adopted a new system for strategic management. This involves a distribution of the budget within seven strategic axes, whose content has been negotiated with the Ministries of Research and of Agriculture. The distribution of R&D budget according to the various strategic axes is shown in Table 7.

⁶ This sub-section is an excerpt from Annex E3.

⁷ 1998 Figures.

Table 7 The distribution of R&D expenditure

	%
Management of rural areas, environment protection and sustainable production	21.5
Improvement of human food and enhance public health	8.4
Diversify the products and enhance the productivity	24.4
Generic knowledge in life science and processing	22.7
Improve the adaptation of living organisms to changing conditions	17.6
Contribute to the decision of economic actors and diminish unemployment	3
Inform the citizen and contribute to public decision making	2.5

Since 1997, INRA has been organised in 17 Research Departments under five Scientific Directorates : (1) Environment, Forest and Agriculture, (2) Animal Production, (3) Plant Production, (4) Food, Nutrition and Health and (5) Society, Economy and Decision. This new structure reflects new trends in the definition of INRA strategies:

- growing importance of environmental issues: the Scientific Directorate “Environment, Forest and Agriculture” represents a third of INRA resources. It now includes the “Crop Protection” research department (Plant health) that was previously under the Scientific Directorate “Plant Production”⁸;
- growing importance of food security and human health with the appearance of the “Food, Nutrition and Health” Scientific Directorate;
- the importance of “traceability” and quality throughout the chain of production (“de la fourche à la fourchette” which stands for “from the seed to the store”) : this explains the disappearance of the “Food Industry” Scientific Directorate, the various Research Departments having been attached either to animal or to plant production, thus allowing a sharper focus on the vertical interdependencies of production.

The Scientific Directorates are no longer defined as a hierarchical level between the General Manager and the Heads of Research Departments. They now form a “college” around the General Manager and help define medium and long-term strategies and scientific management.

Importantly, 90% of the financial resources of INRA come from the government, through the Civil Budget for R&D, managed by the Ministry of Research. Of this budget, 80% is devoted to labour costs. Therefore the flexibility and margin for incentive/dedicated funds is limited, since the employees of INRA are Civil Servants⁹. Thus, the important decisions which may influence the trajectories of research activities are related to: (i) the creation of research units, (ii) the hiring of new researchers and other employees and (iii) the promotion of researchers. These decisions are based on a mix of peer review and strategic considerations.

⁸ This may have important implications for the classification of biotechnology programmes. Actually, a part of the research activities in plant biotechnology are now integrated into the Direction Environment. Therefore they could have been included in “ Environmental Biotech ”, which would have changed the overall picture.

⁹ The situation is the same for CNRS and INSERM, which share with INRA the same status (EPST : Etablissement Public à Caractère Scientifique et Technique). However, for CNRS, the link with university laboratories provides, *de facto*, greater flexibility since the Centre may choose to disassociate some research units. To a lesser extent, INSERM has the same possibility with its association with medical universities. At INSERM, a research unit is formed for a maximum of 12 years and it is evaluated every four years.

Indeed, dedicated funds are quantitatively marginal. They currently represent 40 millions Francs [6 m Euro] a year (1.3% of the overall budget). These programmes (Actions Incitatives Programmées, AIP) are generally transversal : they usually involve several research departments and different scientific directorates. They mainly play a role of “seed money” or funds for concerted actions, but hardly finance research activities.

Nevertheless, the management system introduced in 1998 has proved to have a real influence and has improved the capacity of INRA to respond to the signals and demands expressed by the relevant Ministries. The new system is based on contracts that are first of all negotiated between the Direction College and the Head of Research Departments: the contract involves the construction (and agreement of) a four year strategic plan. There is also a second level system of contracts between the Heads of Departments and the Directors of Research Units. This management system allows a counterbalancing of the weight of the scientific community and peer evaluation in the definition of research orientation and improved alignment with strategic objectives.

2.5 Denmark¹⁰

A large number of research institutions are engaged in research activities relevant to the PITA project. Table 8 presents an overview of the main higher education and research funding institutions in Denmark.

The *Research Forum* is a co-ordinating body consisting of 13 members, appointed by the Ministry of Research. Its primary role is to co-ordinate the activities of the six research councils.

Table 9 lists some of the research programmes most relevant to the PITA project. These programmes are all financed by the research councils.

Apart from these projects, a considerable amount of research has been conducted within the framework of the Strategic Environmental Research Initiative. Moreover, as mentioned in the PITA National Report for Denmark (Section 2 on Science, Technology and Innovation) public initiatives have been taken to stimulate innovation and technical change in the food sector. In the following subsections some of the most PITA-relevant activities within the strategic environmental research programmes, as well as the activities related to science, technology and innovation are presented.

In recent years, the most important framework for research relevant to the PITA project has been the Strategic Environmental Research Programme. This programme was established as a result of a government initiative, following an international evaluation of Danish environmental research in 1989. The evaluation highlighted the problem that “Danish environmental research was spread across a large number of smaller research environments which only occasionally co-ordinated their activities, and that the environmental research varied strongly in both quality and depth” (Final report 1992-1996 on the Strategic Environmental Research Programme).

Seven ministries finance the research under this programme. The total funding amounts to some DKK 60 m [≈ Euro 8 m] per year, the major contributors being the Ministry of the Environment and the Ministry of Education. The aim of the Research Programme is to support *strategic* research, i.e. “research [that] would contribute to an operational application of new and existing knowledge within the political, administrative, economic and social decision-making processes in the area of the environment” (*ibid.* p. 3). Overall, it has been estimated that the Research Programme has involved some 600 researchers throughout the country.

¹⁰ This sub-section is an excerpt from Annex E2.

Table 8 Overall structure of research and research funding in Denmark

	Research Council Forum		
	Ministry of Education	Ministry of Research	Ministries of Agriculture, Environment, Trade and Industry
Objectives	Education, basic research	Research and research co-operation	Strategic research for Ministries
Supported Institutions	Universities: Copenhagen, Roskilde Århus Aalborg Univ. of Southern Denmark. Specialised Institutes: The Technical University The Agricultural and Vet. Univ. The School of Pharmacy	Universities Research Councils: Medical science Natural science Social science Agricultural sciences Technical sciences Humanities Research programmes (e.g. Biotek, Fotek)	Sector laboratories Research councils Biotechnology institute

Source: Adapted from Assouline, 1999.

Table 2.9 Research programmes supported by the Research Forum in 1997 and 1998

Programme	Participants	Period	Total grant (m Euro)
BIOTEK	SNF, SSVF, SJVF, STVF	1997	9.6
FØTEK2	SSVF, SJVF, STVF, SSF	1997	2.3
Bioethics	SNF, SSVF, SJVF, SHF, STVF	1993-1997	2.3
Man, landscape, and biodiversity	SNF, SHF, SJVF, SSF	1995-1999	5.4
Biological materials and products	SNF, SSVF, SJVF, STVF	1995-1999	5.9
The Pesticide Programme	Ministry of the Environment, Ministry of Food	1994-1998	2.0

Source: Annual Reports 1997 and 1998 from the Research Forum and the six national research councils.

The Strategic Environmental Research Programme is an umbrella programme covering a broad range of sub-programmes. Under these, research is carried out within so-called Centres Without Walls, i.e. 'centres' co-ordinating the activities of a number of geographically dispersed institutions. The Strategic Research Initiative comprises sub-programmes on:

- Atmosphere and air pollution
- Groundwater
- Soil
- Marine and fresh water
- Environmentally harmful material in terrestrial and aquatic eco-systems

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- Sustainable use of nature in developing countries
- Pesticides and groundwater
- Hormonal substances and their effect on reproduction
- Social science research on nature, the environment and energy
- Sustainable land use
- Environmentally harmful substances.

The PITA relevant sub-programmes are those on:

1. Pesticides and groundwater
2. Hormonal substances and their effect on reproduction
3. Ecological farming methods
4. Social science research on nature, the environment and energy
5. Sustainable land use.

As mentioned above, research activities are co-ordinated in centres without walls. From a PITA perspective, the most important of these are the following:

1. The Danish Centre for Environmental Oestrogen Research (DCEOR)
2. Centre for Effects and Risks of Biotechnology in Agriculture
3. Centre for Organic Farming
4. Pesticides and Groundwater

The two centres for Root Zone Processes and Agricultural Diversity should also be mentioned.

2.6 Germany¹¹

The German system of PSREs includes universities and research institutes such as the Fraunhofer and Max-Planck Gesellschaft institutes. The latter differ from university research organisations in that they are part of the public sector, although they conduct independent research that is not under the direct control of government. The research institutes were created to generate knowledge, technical services and, to a lesser extent, develop new technologies for government, business, and society at large (Dankbar, Demand and Kemp 1996). Over the last few years, the government has privatised some research institutes, reduced direct research funding, and shifted support to research contracts. The stated goal of these changes was to increase efficiency.

2.6.1 *Trends in government-sponsored R&D*

Trends in government-sponsored R&D have been influenced by several major developments in Germany's regulatory framework and political economy. The annual cost to the former West Germany of integrating the Eastern states into the larger German economy is approximately DM 200 billion [\approx 100 b Euro] and major federal expenditures for German reintegration will be necessary for several years to come. The size of these investments in the East has forced the Government to reduce substantially its spending on other priorities. Federally sponsored R&D programmes have also felt the effects of the Government's diversion of resources to the East as well as the impact of Germany's slow economic growth, high unemployment, and generally tighter government revenues during the 1990s.

¹¹ The excerpts presented in this Section are drawn from Annex E4.

Environmental and ag-biotechnology research has grown modestly in recent years, driven in part by growing efforts to improve scientific understanding of global environmental change. Similarly, investments have grown in several applied environmental technology areas, including the handling and recycling of municipal waste, water and wastewater treatment.

The Federal Ministry of Food, Agriculture and Forestry (BML) encompasses a broad research sector with ten federal research centres, a Centre for Documentation and Information in Agriculture and seven other research institutions largely financed by the Federal Government. With a total of DM 500 m [≈ Euro 256 m] in research expenditure, BML ranks among the Federal Ministries most intensively engaged in research activities with some relevance to ag-biotechnology and agriculture. The most relevant research centres under BML are the Federal Centre for Research on Cultivated Plants (BAZ) in Quedlinburg, and the Federal Agricultural Research Centre (FAL) in Braunschweig-Völkenrode. In addition, several other research institutes conduct ag-biotechnology research, including the Max Planck Gesellschaft, Fraunhofer Gesellschaft, Herman von Helmholtz-Gesellschaft and the German Research Society.

The BML [the Federal Ministry of Food, Agriculture and Forestry] has two main research goals:

- To provide the scientific basis required by agricultural policy to develop, shape and supervise agricultural policy.
- To conserve and strengthen the international competitiveness of German agriculture, forestry and fisheries.

2.6.2 *Germany's public R&D infrastructure*

Germany's public research infrastructure is large, broadly based, and decentralised; research sponsorship and policy-making involve government agencies and independent advisory bodies at both federal and state levels. Major research performers include the German university system and a large network of independent research institutes. Two of the most important PSREs for ag-biotechnology are the BAZ and the FAL.

BAZ – the Federal Centre for Breeding Research on Cultivated Plants¹²

The BAZ investigates the scientific principles governing the development of high-quality nutritional and industrial plants. It has an academic staff of 91 (non-academic staff of 362) and an annual budget of DM 45,411,800 [≈Euro 23,218,700]. The institute supports the BML programme on quality and environmentally compatible agricultural production and conducts research to aid policy decisions.

The research results contribute towards extending the general level of scientific knowledge and to the development of crop plants with improved resistance to pathogens and quality characteristics. BAZ offers these improved varieties to medium-sized private enterprises, which can develop them further.

BAZ performs applied research, seeing itself as the link between basic research and practical applications. It is 100% financed by the Government, but it is also motivated and encouraged to obtain third party research projects, for example from the European Commission. Its research foci include plant breeding research, research into the genetic, physiological and biochemical principles in forming value-providing compounds, development of test systems for the qualitative and quantitative recording of resistance and quality parameters and research on the use of genetic resources and the identification of resistance and tolerance genes.

¹² Based on an interview [by Matthias Hocke] with Dr Peter (BAZ).

Public opinion is important to BAZ. It discusses all research projects openly outside its various institutes. BAZ does not expect 100% support and agreement, but it always looks for consensus with its critics.

One of the core tasks of the BAZ is to recommend policy actions to the Government on agricultural research, including biotechnology and genetic engineering. According to Dr. Peter, the BAZ is not completely independent of Government. But, it is able to deliver neutral and independent advice on questions of general relevance. Policy relevant recommendations are made in the final reports of research projects and in a yearly report that summarises past research. In addition, politicians frequently demand specific consultative advice from the BAZ. So far, the BAZ has been able to make critical recommendations without negatively affecting its research projects.

Federal Agricultural Research Centre (FAL) in Braunschweig-Völkenrode¹³

The Federal Agricultural Research Centre conducts research on farming and related sciences with an academic staff of 252 (non-academic staff of 844) and an annual budget of approximately DM 98 million [\approx Euro 50 m] and third party project support of DM 5 million in 1996 [Euro 2.6 m]. It publishes the results of its research and co-operates at an international level with scientists and scientific organisations. Its tasks include working out scientific principles as aids to decision-making of relevance to food, agricultural, forestry and consumer policy and the extension of scientific knowledge in these areas for the benefit of the common good. The FAL consists of 16 institutes currently working in different areas.

The FAL also conducts comprehensive studies of the effects of biotechnology, mainly through field trials of GMOs. The increased intensity of land exploitation has led to the creation of agricultural surpluses that burden both the EU budget and also international trade relations to a considerable extent. It is therefore anticipated that the future economic, agricultural and environmental framework conditions will force a reduction in the use of inputs per hectare. The FAL addresses this problem by conducting research to improve the efficiency of agriculture by reducing inputs from fertilizers, pesticides, labour, and capital investment in machines and buildings.

Recommending policy actions is one of the primary tasks of the FAL.

FAL's internal statute guarantees its independence, even from the Ministry. Nevertheless, there is a frequent exchange of information between the FAL and the Ministry of Agriculture, but the FAL bases all its recommendations on the results of its research. In this respect, Dr Otto sees a clear advantage for the FAL compared to institutes that are strongly dependent on contract research. Furthermore, the FAL statute requires that all of its research results be published. The FAL is not permitted to accept research contracts that limit the ability to publish results.

According to Dr. Otto, the FAL is able to make highly critical recommendations, as long as they are backed by adequate research. But it can happen that the Ministry gives a hint, signalling the FAL that its recommendations do not fit into the political landscape at the moment, because it could start a new discussion, which could delay the passage of a law by some additional months. FAL thinks this is a legitimate procedure and it complies with it. It would become a problem if the Ministry rejected the scientific results, which would certainly lead to strong protests from the FAL.

2.6.3 University links with the ag-biotechnology sector

According to Dr Klockner (Head of the German Association of the Biotechnology Industry), there is a high level of collaboration between universities and SMEs, partly because many of the SMEs are university spin-offs that have been established by faculties. Most of the collaboration is via joint research projects. At this time, there is no data on the number of collaborations between firms and German universities. Two firms that have intensive

¹³ Based on an interview [by Matthias Hocke] with Dr Otto (FAL).

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research collaborations with universities are PlantTec in Berlin and Greentec in Cologne. At PlantTec communication with international scientists and links with basic research is normally ensured through proximity to scientific institutions such as the Max Planck Institute for Molecular Plant Physiology in Golm, the University of Potsdam, three Berlin Universities, institutes and companies. PlantTec was set up in 1996 by members of the staff of the former Berlin "Institut für Genbiologische Forschung GmbH", with the Max Planck Gesellschaft and AgrEvo as shareholders. At present the company employs 32 people, half of them scientists.

Table 10 gives the annual university expenditure on agricultural R&D and the number of personnel. Expenditure reached a peak in 1995 and then declined by 9% in 1996. Although more recent data is not available, Dr Peter of BAZ stated that funding and personnel continued to decline after 1996.

Table 10 University expenditure on R&D for agricultural sciences (in million Euro) and personnel engaged in R&D

Year	Agricultural sciences (m Euro)	Personnel	Researchers
1981	140.5	2,824	1,396
1992	309.4		
1993	327.8		
1994	333.3		
1995	374.9	5,009	2,970
1996	341.1	4,982	2,957

2.6.4 Conclusions

Germany has a well-developed system of PSREs, including both research institutes that focus on applied research and the transformation of basic research into practical applications and a university system that is more focused on basic research. The PSRE system conducts research of relevance to sustainable agriculture and to ag-biotechnology. Furthermore, several research institutes, in particular BAZ and FAL, are responsible for providing government policy makers with neutral advice on agriculture, the environment, and agricultural biotechnology. This advice is not always accepted. However, the responsible PSREs can make some research decisions independently of policy considerations, although they are also required to conduct research of relevance to Government policy objectives. The small number of ag-biotechnology SMEs in Germany have close links with PSREs, particularly universities, often via joint research projects.

3. Comparison between countries

As mentioned in the Introduction, four questions have guided this research.

- In the first place, what are the roles of PSREs in the national systems of (agricultural) innovation in the countries studied?
- Secondly, how are these institutes funded and what changes are taking place (or have taken place) in the funding?
- Thirdly, how do they manage their double role of supplying industry with useful techniques and knowledge on the one hand, and providing government agencies with independent expertise on the other hand?
- And fourthly, how do these research institutes take sustainable agriculture and environmental issues into account in their research agenda?

The first three questions (on the changing roles and role conflicts of PSREs) will be discussed in Section 3.1, and the last one (on sustainable agriculture) will be addressed in Section 3.2 below.

3.1 The changing roles and role conflicts of PSREs in national systems of innovation

As mentioned above, efficiency problems have generally been behind attempts to reconstitute PSREs in the countries studied. The countries represent markedly different approaches to solving these problems, however. In the preceding sections an overall impression of these differences has been given. At the risk of oversimplifying it seems instructive to categorise these approaches very roughly and expose their limitations. As will be argued below, some countries seem to have adopted a strategy of *commodifying* research to improve its sensitivity to user need and social relevancy. From a traditional *public goods perspective*¹⁴ on research and innovation this approach is liable to underestimate the appropriability problems pertaining to research activities. Also, not least in the light of the food scares experienced in Europe over the past decade, the commodification strategy may be criticised for underestimating the need for independent research, especially on issues of environmental protection and consumer safety.

While none of the countries appear to have followed a pure commodification strategy, the evidence suggests that elements of this strategy have been important in the UK, the Netherlands, and Denmark. Although some of these elements can be found in the French development as well, Spain and France have apparently sought to improve the efficiency of their PSR sectors without resorting to this strategy to the same extent. Germany may be somewhere in between: PSREs have been privatised in Germany, but for some PSREs the independence discourse is still quite important (cf. e.g. subsection 2.6.2 on the Federal Agricultural Research Centre, FAL).

In terms of input and employment, the role of PSREs in national systems of innovation appears to be rather important. For example, in Spain the public system of research “comprises 49 universities which share about 32% of national expenditure on R&D and about 42% of personnel, the research institutes which represent 12% of R&D expenditure and 9% of personnel, and other government laboratories which represent about 10% of R&D and about 15% of personnel.” Similarly, the Dutch national report explains: “in the Netherlands, the government accounts for about 40% of all R&D expenditure.” Although the data are not

¹⁴ In economic theory the ‘consumption’ of a public good is non-rival, i.e. the fact that one person or company uses a research result does not prevent others from doing so. Although public goods can be provided by private producers, it is generally recognised that market provision of public goods is socially inefficient.

directly comparable from country to country, data for France and Denmark confirm that publicly financed research activities are significant in terms of money and employment in these countries as well relative to total R&D expenditure. In other words, public sector research activities use up substantial amounts of scarce resources.

The changes in public sector research over the past decades reflect growing concerns about the output from these investments – not only in commercial terms, but also in terms of their social use value. According to the Spanish national report “PSRs seem to function independently from other systems, in particular the economic and productive systems”. Similarly, recent data for Denmark suggests that PSREs account for only about 8% of the external R&D purchased by industry (Research Statistics 1997). It is noteworthy that during the 1990s the roles of PSREs appear to have changed significantly in all of the countries studied. The primary motivation for these changes has been to improve the efficiency of public sector research *in order to increase their contributions to national systems of innovation*.

Although the concept of efficiency may be somewhat ambiguous in this context, two aspects seem common to the ‘efficiency discourse’ of most countries.

First, the quest for efficiency entails *improved research coordination* to avoid wasteful duplication research and the building up of research environments sufficiently large to obtain what has sometimes been termed ‘a critical mass’. Also, a more clearly defined division of labour between PSREs and private sector research may be included under this heading. The second aspect of efficiency improvement is a *stronger output orientation*, i.e. a more highly developed sensitivity to user needs. Let us consider these two aspects of efficiency in turn.

In Spain, the Law of University Reform of 1983 and the Law of Promotion and General Coordination of Scientific Research of 1986 were passed to improve the coordination of the activities of R&D centres within the different ministries, which was also the purpose of establishing the Office for Science and Technology (OCYT) in January 1998. Similarly, in the Netherlands, “the Ministry of LNV, pressed by the Ministry of Finance, is looking more critically at the spending of research funds, urging recipients to increase their efficiency”. In the Netherlands, research institutions have been – or are being – amalgamated as part of this strategy. The focus in Great Britain seems to have been on obtaining a more clearly defined division of labour between public and private research. Thus, government funding for agricultural R&D has been withdrawn from ‘pre-competitive research’, on grounds that this was the proper role of industry. In order to obtain government funding, research had to be justified as ‘basic’, i.e. potentially benefiting a wide range of companies, or as ‘public interest’. The latter criterion features research aimed at health and environmental improvements, often responding to various food scares; the food retail and manufacturing sectors have been involved in setting R&D priorities. In France, incentives to improve efficiency (in terms of improved coordination) seem to have been somewhat weaker, as the bulk of public sector research for agriculture has traditionally been concentrated within three main organisations, INRA (Institut National de la Recherche Agronomique), CEMAGREF (The Centre d’Etudes du Machinisme et du Génie Rural des Eaux et Forêts), and CIRAD (Centre de Coopération Internationale en Recherche Agronomique pour le Développement). A new management strategy within INRA has clearly been motivated by the wish to improve efficiency, however. In Germany, “the government has privatised some research institutes [over the last five years], reduced direct research funding, and shifted support to research contracts. The stated goal of these changes was to increase efficiency.” In Denmark it became clear in the late 1980s that Danish food research was “modest, dispersed, uncoordinated, and process oriented” (The Danish Ministry of Agriculture, 1987: 7), and similarly an international evaluation of Danish environmental research in 1989 pointed out that “Danish environmental research was spread across a large number of smaller research environments which only occasionally co-ordinated their activities, and that the environmental research varied strongly in both quality and depth” (Final report 1992-1996 on the Strategic Environmental Research Programme). As a result, efforts have been made to improve the efficiency of research in much the same way as in Spain and the Netherlands.

As mentioned above, the second objective of reorganising public sector research has been to make it more output oriented and hence more responsive to purchasers' needs. In particular, the changes seem to reflect a growing recognition that the close functional linkages between innovation, production and marketing make the company the obvious locus of applied research. A recurrent argument related to this has been to avoid the element of public subsidisation inherent in the combination of publicly financed research benefitting private companies.

In some of the countries studied (the UK, the Netherlands, Denmark, and – perhaps to a lesser degree – Germany) it makes sense to speak of a *commodification discourse* in relation to public sector research. Privatised public research establishments are intended to produce and sell research results in the open market much as other companies produce and sell marketable products in other business areas.

This development raises a number of fundamental questions. Public research has traditionally been seen as a public good, i.e. as a type of good which should be publicly provided and made available at low cost. Perhaps the most obvious question raised by this development, therefore, is if 'the public interest' is sacrificed by privatising PSREs.

However, although the concept of a private PSRE may sound like a contradiction in terms, it is important to bear in mind that 'the public' (i.e. national or international authorities such as the EU) often continue to be the most important client(s) of the privatised research establishments. Thus, privatisation need not imply that public concerns cease to have any bearing on the activities of these research institutions. Rather, as with other forms of privatisation, 'the public interest' comes to be articulated *in a different way*: 'The public' becomes a demanding (and in many cases: a major) client rather than the formally independent owner of the PSRE.

The case studies underlying the present analysis do not enable us to draw any firm conclusions concerning the net impact of these changes in terms of strengthening or weakening the impact of public concerns (most notably environmental and health concerns) on the activities of these organisations. While it is conceivable that privatisation *per se* has weakened this influence, other factors may have offset this. Thus, it deserves notice that the Ministries of Agriculture of at least three countries (The Netherlands, The UK, and Denmark) have been reconstituted in a way which appears to have challenged the elements of 'agricultural corporatism' which have historically been very strong, both in the Netherlands and Denmark (see e.g. Frouws and Tatenhove (1993), Just & Omholt (1984)). In the Dutch national report it is mentioned that the Ministry of Agriculture (LNV) "in funding research is shifting from input financing to output financing. As a result, research projects will have to be more tuned towards the (policy) demands from the LNV." Furthermore "LNV wants Wageningen University to be more aware of its societal responsibility. This means that societal questions and public or consumer concerns should be more pronounced in the list of research topics."

In other words, the commodification of research need not imply that 'the common purpose' be sacrificed. It is important to keep in mind, however, that even for some types of applied research appropriability conditions may be very unfavourable. Appropriability denotes the capacity to appropriate the returns from innovation. In highly competitive industries (such as the farming sector) conditions of appropriability have generally been poor. In contrast, agricultural input sectors (such as those studied under the PITA project) have been much better positioned to reap the benefits of innovation. As a result, agriculture has been categorised by innovation researchers as a 'supplier dominated' industry (see e.g. Pavitt (1987)), receiving its technology from suppliers – or from public sector research conducted by agricultural universities and other institutions.

This begs further questions, e.g.:

to what extent the benefits from innovation for agriculture will be appropriated by the input sectors (cf. e.g. Moschini and Lapan, 1997).

How it is possible to support the production and dissemination of socially relevant applied research for which conditions of appropriability are poor.

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If there are other ways of making PSREs more sensitive to the social need for their output.

Similarly, public concerns are strongly reflected in the research activities of major French PSREs, such as INRA for example. As mentioned in the French national report, INRA and the Ministry for Research have decided to reinforce the research on risk assessment, setting up a research programme with some 50 researchers from INRA, CNRS, CIRAD, IRD and various university laboratories.

In terms of funding structure the impact of these policy changes varies a great deal from country to country. In Spain, agricultural research conducted by PSREs is “financed basically by the National R&D Plan and by the Agricultural R&D Sectoral Programme of the Ministry of Agriculture, Fisheries and Food.” In the Netherlands, research at Wageningen University seems to depend heavily on external funds. Thus, the PITA Dutch national report on PSREs states that last year Wageningen University received about 51 million Euro from the Ministry of Agriculture and earned 45 million Euro in contract research. In the UK a decline in government funding appears to have been replaced to some extent by funding from “a small group of highly concentrated, science-intensive agro-chemical/seeds companies who have the capability for fruitful interaction with PSR” (Senker and Faulkner, forthcoming). The general impression from the French national report is that public funding is still absolutely predominant, at least for INRA.

1. Providing the basic research for the applied research activities of industrial enterprises;
2. Transmitting technical knowledge to (local) companies by participating in technology programmes;
3. Developing the competencies of researchers, to enable them to
set up companies of their own
provide a local pool of skilled labour for industry
4. Supporting the controls performed by regulatory bodies by conducting laboratory analyses etc.
5. Being the critical watchdog of the public.

From an industry perspective, roles 1-3 are probably the most important ones and could have implications for location decisions or decisions to sponsor technology programmes.

Knowledge generated for one of these purposes may be used for some of the others as well. In order to economise on the knowledge and competencies developed by PSREs it is tempting, therefore, to let them draw on the same resource base in performing a variety of different roles.

This could easily lead to role conflicts, however. To some extent 1, 2 and 3 may conflict with the more independent roles assumed for 4 and 5. Nonetheless, some research institutions are involved in all of these activities, as discussed in Section 2 above. There are reasons for taking the potential role conflict very seriously. Thus, the food scandals of the last decade have given issues of food safety a prominent position on the agro-political agenda. Serious consumer concerns also pertain to the public acceptance of GMOs and biotechnology in general.

It seems reasonable to assume that the lay person's concerns about these issues are affected by his or her confidence – or lack of confidence – in the credibility and impartiality of public regulation at national and European level, which in turn hinges on the credibility and impartiality of the research institutions that inform the regulatory process.

This line of argument raises some controversial but relevant questions: Will the European public expect privatised PSREs to act in the public interest if this conflicts with the commercial interests of a major client? Suppose research findings suggest that a chemical compound or a genetically modified crop may have seriously adverse long-term effects on health or environment. If the company behind this product is a major client of the PSRE

making the discovery, can the PSRE be trusted to disclose its concerns at the risk of losing a major client?

The national reports reflect different views on these issues. For example, according to the Dutch report DLO institutes “combine work for governmental agencies, particularly the Ministry of Agriculture, with work for private clients. According to our interviewees, this does not pose any problems of confidentiality or conflicting interests. Strategic knowledge developed with public funds can often be transformed into commercial products with funds from private companies.” It is added, however, that some research institutes continue to present themselves as public research organisations “in order to keep distance from private interests.” According to the national report for the UK, PSREs have been criticized for their dependence on industry. “These links are often cited by NGOs to cast doubt upon the political neutrality of risk research on gm crops. ‘Current Government policy to privatise many MAFF research laboratories and extension services, as well as encouraging public sector researchers to seek contracts from industry, makes it unclear where independent knowledge about the governance of technology now resides’ (Senker and Faulkner, forthcoming).”¹⁵

What this limited evidence suggests is that although there may not be unmanageable role conflicts *from the point of view of the PSREs in question*, such problems may nevertheless arise *vis-à-vis the general public*. When it comes to food safety and the credibility of the research informing public regulation, it is hardly sufficient for PSREs to think of themselves as impartial. The general public must trust their impartiality. For analogous reasons legal systems normally prevent lawyers from conducting a case against any of their own clients, not because these lawyers would be unable to manage the conflicts of interest, but because the general public might not trust their ability to do so.

This line of reasoning need not imply that privatisation and joint ventures between public research establishments and private companies should be avoided. In fact there are strong reasons to believe that such measures may add significantly to the contributions made by PSREs to national systems of innovation. What it does suggest, however, is that some PSREs should not be permitted to serve several masters with potentially conflicting interests. The inevitable loss of efficiency inherent in not harnessing the expertise of such PSREs for purposes other than those of the Ministry, or the public regulatory system, is an inevitable price of safeguarding their independence. This conflict between the objectives of impartiality and efficiency would be reinforced by having competing PSREs, of course.

3.2 Sustainable agriculture and PSREs

As shown in the national reports, the role and perception of environmental issues differs significantly from country to country. In the Netherlands “environmental issues are high on the policy agenda of the Dutch government – particularly the Ministries of Environment and Agriculture – [and] agricultural research institutes spend substantial amounts of resources on research for sustainable agriculture. After the Multi-Year Crop Protection Plan (MJP-G) was approved by Parliament in 1991, reduction of chemical plant protection products became a major target of government funded research programmes at DLO, Wageningen University and other PSREs. Examples of such research at the three institutes ... are the development of biological crop protection devices, the development of minimum herbicide use methods, the development of breeding techniques to enhance pest resistance in plants, and the development of integrated pest management systems and biological farming methods.” (PITA Dutch national PSRE report, Section 5.2).

In Spain “environmental issues have an increasing importance in research priorities, mainly because policy pressures on the reduction of environmental impacts of agriculture, but also

¹⁵ Recently, researchers at the Dental College in Aarhus published the results of research, funded by a local chewing gum company, which showed that a product of this company could *not* be shown to protect against caries as promised in the company’s advertisements. Not surprisingly, this aroused a great deal of consternation, and the company went a long way to denounce the methodology and results of the research in newspaper advertisements.


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because the need to preserve the natural resources for agriculture and for rural development, There is an area of Sustainable Use of the Natural Environment within the SECE [the Central Office of R&D units] of SGIT [the Vice-Directorate General of Research and Technology] that is focused on these issues, but other groups in other areas (plant protection, biotechnology, etc.) work on some environmental problems too.” (PITA Spanish national PSRE report, Section 2.2.4)

In France, it is one of INRA’s goals to contribute to integrated land development and sustainable management of natural resources.

In Denmark environmental issues play a prominent part in practically all of the activities under the Strategic Environmental Research Programme. Of particular interest, perhaps, is the Research Centre for Organic Farming, which was established as part of a Government initiative to promote organic farming more generally.

To sum up, environmental issues generally play an increasing role in the countries studied.



Executive Summary

1. The role of Public Sector Research Establishments in six European countries (France, Germany, the Netherlands, Spain, the UK, and Denmark) is studied. In all six countries, the role of PSREs seems to be changing rapidly. A number of efforts have been made to improve the efficiency of these organisations in terms of their contribution to national systems of innovation. In general terms, these efforts are aimed at improving coordination among research establishments, at targeting and focusing their activities, at clarifying the division of labour between public and private research units, and at enhancing the sensitivity of PSREs to user needs.
2. In some of the countries the commodification of public sector research seems to be a dominant element of the restructuring strategy. The privatisation of PSREs is one way of making them more customer oriented. At the same time, various forms of research co-operation are being stimulated, e.g. by amalgamating research units or by the formation of so-called Centres without Walls, i.e. 'virtual' research centres drawing on the resources of the participating institutions. Also, various kinds of joint venture between PSREs and private enterprises have emerged to cultivate the linkages between the two sectors.
3. With the State as a major client, this changes the way in which 'the public interest' is articulated vis-à-vis these organisations.
4. The commodification strategy *per se* tends to favour those forms of research for which appropriability conditions are most favourable. National competitiveness may suffer if applied research in areas with less favourable appropriability conditions is to survive under pure market conditions.
5. Moreover, the commodification strategy may compromise the independence of PSREs in the eyes of the public. In some countries this issue has been raised against the background of the European 'food scandals' of the 1990s.
6. In general, the PSRE sector appears to be paying increasing attention to environmental issues, with both private and public clients showing an interest in sustainable agriculture.

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List of Abbreviations

AB	The Research Institute for Agrobiology and Soil Fertility (an institute under the DLO, the Netherlands).
ADAS	The Agricultural Development and Advisory Service.
ANEP	National Prospective Agency (Spain).
BAZ	Federal Centre for Breeding Research on Cultivated Plants (Germany).
BBSRC	The Biotechnology and Biological Sciences Research Council (UK).
BML	Federal Ministry of Food, Agriculture and Forestry (Germany).
BMU	Federal Ministry of the Environment, Nature Protection and Reactor Safety (Germany).
BSC	British Sugar Corporation (UK).
CICYT	Inter-ministry Commission of Science and Technology (Spain).
CIRAD	International Centre for International Co-operation on Agronomic Research for Development (France).
CIS	Sociological Research Centre (Spain).
CISA	Animal Health and Research Centre (Spain).
CPRO	The Centre for Plant Breeding and Reproduction Research (an institute under the DLO, the Netherlands).
CSIC	Higher Council for Scientific Research (Spain).
DANI	The Department of Agriculture for Northern Ireland (UK).
DETR	The Department of the Environment, Transport and the Regions (UK).
DfID	Department for International Development (UK).
DLO	The Agricultural Research Department (Netherlands).
DTI	The Department of Trade and Industry (UK).
EPSRC	The Engineering and Physical Sciences Research Council (UK).
EPST	Public Scientific and Technical Establishment (France).
EZ	The Ministry of Economic Affairs (Netherlands).
FAL	Federal Agricultural Research Centre (Germany).
HEI	Higher Education Institution.
HGCA	Home Grown Cereals Authority (UK).
IESA	Advanced Social Studies Institute (Spain).
INIA	National Institute for Agriculture and Food Research and Technology (Spain).
INRA	The National Agronomic Research Institute (France).
IPO	The Research Institute for Plant Protection (an institute under the DLO, the Netherlands).
IRNAS	Sustainable Resources Institute (Spain).
LNv	The Ministry of Agriculture (Netherlands).
MAFF	Ministry of Agriculture, Fisheries and Food (UK).

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MAPA	Ministry of Agriculture, Fisheries and Food (Spain)
MEC	Ministry of Education and Culture (Spain).
MP	Ministry of the Presidency (Spain).
MSYC	Ministry of Health and Consumers (Spain).
NERC	The Natural Environment Research Council (UK).
OCYT	Science and Technology Office (Spain).
OC&W	The Ministry of Education, Culture and Science (Netherlands).
PSRE	Public sector research establishment.
SE.CE	Head Office of R&D Units (Spain).
SERC	The Social and Economic Research Council (UK).
SEUID	Secretariat of State of Universities and Research and Development (Spain).
SOAEFD	The Scottish Office Agriculture, Environment and Fisheries Department (UK).
SJVF	The National Research Council for Agricultural Sciences (Denmark).
SNF	The National Research Council for Natural Sciences (Denmark).
SSF	The National Social Science Research Council (Denmark).
UR	University research.