Economic assessment of Dutch agricultural research

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To cope with globalisation and other changes in the industry, in the last 20 years the Dutch Ministry of Agriculture has reorganised its system for education, extension and research considerably. It moved away from the concept of a linear process of innovation to that of an agro-innovation system. This paper describes the main changes. The paper argues that an evaluation of the changes is problematic. In an open economy where a large part of the public investments are targeted to reduce negative externalities of production (especially on environmental impact), a part of productivity is due to persons leaving the sector and income in farming is dependent on value added processes in its multinational cooperatives, causes and effects are hard to disentangle. The changes in the education, extension and research system cannot easily be evaluated by productivity analyses. Most research on this topic tries to develop methods for monitoring and evaluation from social learning or public administration.

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Preface

In recent years several European member states have reorganised their system for education, extension and research. Others are considering changes. Challenges as a result of globalisation and changes in the agricultural industry are often cited as an incentive for reorganisation. The introduction of ideas from the so called New Public Management school - such as benchmarking, output financed, more independance from policy - are often part of such reorganisations.

The Netherlands is no exception to this trend, it was even one of the first major agricultural countries to start such reorganisings. Section 5 of this paper provides an overview of these changes.

Researchers are not only part of such reorganisations, but sometimes also see a task to try to evaluate such policy changes. As this paper argues, this is quite a challenge for an economist. Improved education, extension and research should, with a time lag, show up in improved productivity in the industry. In an open economy like the Netherlands, where a large part of the public investments is targeted to reduce negative externalities of production (especially on environmental impact), where a part of productivity is due to persons leaving the sector and where income in farming depends on value added processes in its multinational cooperatives, causes and effects are hard to disentangle.

The first version of the paper was written for the workshop 'Trends & Forces in International Productivity Growth', held on 15 March 2007 at USDA-ERS in Washington, convened by David Schimmelpfennig. That workshop looked into the (declining) trends in agricultural productivity and its causes - a topic that since then has become an important element of the discussions in the current food crisis. A shortened version of the paper, titled 'Dynamics in Dutch agricultural research' by Krijn J. Poppe and Ruud B.M. Huirne, was presented on 4 March 2008 at a seminar at the Helsinki University of Technology in Finland, related to its centennial year.

The paper benefited from discussions at the workshop and comments from Gerrit Meester, Peter Besseling, Peter Keet, all at the Ministry of Agriculture, Nature and Food Quality, Hans Rutten from Innovatienetwerk; Wim Tacken who in 2007 was the agricultural attaché of the Ministry in Washington, who was also very supportive in having the author join the ERS workshop; and Frank Bakema from Wageningen UR. We thank ERS and especially David Schimmelpfennig for organing the workshop.

Since under the upcoming French presidency of the EU the discussion on the agricultural research system in Europe and its role in helping to solve the current global food crisis will intensify, we thought it would be a useful contribution to make this paper more widely available.

Prof. Dr R.B.M. Huirne
Director General LEI

Summary

The Netherlands has an export oriented, capital intensive agriculture and food industry. The system for education, extension and research is often quoted as one of the fundaments of the peformance of the Dutch industry, and policy makers in the Dutch Ministry of Agriculture see it as one of their main policy instruments. Over the last twenty-five years the Dutch system for education, extension and research has been considerably reorganised. Challenges as a result of globalisation and changes in the agricultural industry are often cited as an incentive. Ideas from the so called New Public Management school (like benchmarking, output financed, more independance from policy) have been part of such reorganisations.

This paper describes the developments in the Dutch agricultural knowledgde system and looks into possibilities to evaluate the changes.

The food industry is competitive although labour productivity at farm level went through a crisis in the last ten years but recently improved again. The industry is characterised by a relatively high level of public and private investments in research and a high level of education.

In chapter 4, this paper argues that an econometric estimation of a relationship between investments in R&D and productivity changes, to evaluate the changes in the agricultural knowledge system, is problematic. In an open economy where a large part of the public investments are targeted to reduce negative externalities of production (especially on environmental impact), a part of productivity is due to persons leaving the sector and income in farming is dependent on value added processes in its multinational cooperatives, causes and effects are hard to disentangle.

To cope with globalisation and other changes in the industry, in the last 20 years the Dutch Ministry of Agriculture has reorganised its system for education, extension and research considerably. It moved away from the concept of a linear process of innovation to that of an agro-innovation system. Chapter 5 describes the main changes:

- privatisation of the Extension Service;
- merging of institutes for applied research and introducing a system of output finance;
- decreasing influence of collective commodity boards;
- introduction of public-private co-innovation programme;

- merging institutes for applied research with Wageningen University in Wageningen University and Research Center;
- adopting the view of a 'Transition to sustainable agriculture', looking for new business models for agriculture by new institutions like Innovatienetwerk and Transforum;
- attention for the industrial district approach in a 'Food Valley' approach;
- improving the links between research and education.

Also these changes cannot be easily evaluated by productivity analyses. Most research on this topic tries to develop methods for monitoring and evaluation from social learning or public administration (chapter 6). A good understanding of the value creating business model could help too. Economits might evaluate institutional changes by (social) cost benefit analyses and institutional economics. The transition of the knowledge system seems still to be an unfinished agenda (Roseboom and Rutten, 1998), which implies that more research on evaluation of the system might be useful.

1 Introduction

Rural economies need to be competitive in the global market place to have a future. Sustainable competitiveness is built on gains in productivity. It is for this reason that improving productivity is a central issue in agricultural and in research policy. Productivity gains also mean cheaper food and fibre. Although that is not a major concern anymore in mature markets in the West, it is still an issue in many developing countries, especially in Africa.

Public investments in agricultural research try to support the improvement of productivity. In the past this has been a very successful strategy, with the Green Revolution in Asia as a well-known example. It not only lifted many out of hunger and poverty, but, like the Marshall Aid in Europe after the Second World War which also contributed to a modernised agriculture - has kick-started economies.

For an economist such an investment in research also raises questions of effectiveness and efficiency. Is (all) the money invested leading to the desired results and is the money allocated in the most optimal way? Should we invest more, or less?

Historically economists have studied these issues by looking at the relation between the performance or output of the agricultural sector - the productivity realised - and the inputs in terms of research money, corrected for changes in other inputs (like capital). (Huffman and Evenson, 2006) In the next sections such data is given for the Netherlands, after a short description of the relevant facts on Dutch agriculture.

However, we then argue (section 5) that there are a lot of methodological problems in linking input and output in an open economy like the Netherlands. And that such an analysis is not useful for a policy maker who has to decide on public investments in agricultural research; at best it would provide a rear-view mirror to a car driver in the fast lane of globalisation. In the Netherlands we have introduced several institutional changes to improve performance of the agricultural research system. And we try to develop additional monitoring tools to guide the policy makers in the driver's seat. This is the topic of section 6, were such initiatives are described. The paper ends with a discussion and conclusions.

2 A brief description of Dutch agriculture and its history in agricultural research[1]

The Netherlands is located in one of the big river deltas in the world. For centuries this meant an open economy based on trade and agriculture on fertile land with a relatively small manufacturing industry. Essentially the Netherlands is a city state, densely populated, and an agricultural power house in production and trade. Primary agriculture (agriculture and horticulture) counts only for about 3% of the economy. The total food industry and related activities, including agriculture and for a part based on import of raw material, accounts for about 10%. Nearly 50% of the production is nowadays in horticulture. The Netherlands is a major exporter of food and flowers. The value added of the total agribusiness is 40 billion (10^1) euro, of which 7.5 billion is realised at farm level. Table 2.1 provides some data on the relevance and characteristics of the sub-sectors. For the main sectors we list the most important products and some elements of the Common Agricultural Policy (CAP). Compared to other EU countries, the Netherlands is not heavily dependent on the CAP. Milk, sugar and starch potatoes are the most heavily regulated products. Seed and ware potatoes -important products on most arable farms - are unregulated. Flowers and vegetables, produced both outdoors as well as in glasshouses, and intensive livestock are also unregulated or only lightly covered by the CAP. All sectors are dominated by traditional family farms, but especially those in glasshouse horticulture are large and dynamic. Arable farms, as well as mixed farms and grassland farms, are rather small. Many of them are managed by elderly persons, and are often the remnants of dairy farms that sold their quota, such as grazing farms with some sheep, or arable farms with only silage maize.

[1] The first part of this section is taken from Poppe and Van Meijl (2006). The description of the EER Tryptich is partly based on Leeuwis et al. (2006).

Table 2.1 Characteristics of Dutch agriculture and its sub-sectors

Sub sector	Main products	Coverage by CAP	Share (%) in production	Number of farms	% of farms > 100 nge [a])
Arable farming	Seed-, ware and starch potatoes, sugar beet	Partly: quota for sugar and starch, historical single farm payments	14	12,600	15
Horticulture	Vegetables, flowers	Some vegetables very light	40	16,000	48
Dairy farming	Milk	Milk quota	22	22,800	39
Pigs and poultry	Meat and eggs	Some import restrictions	16	7,000	31
Total [b])			100	85,00	27

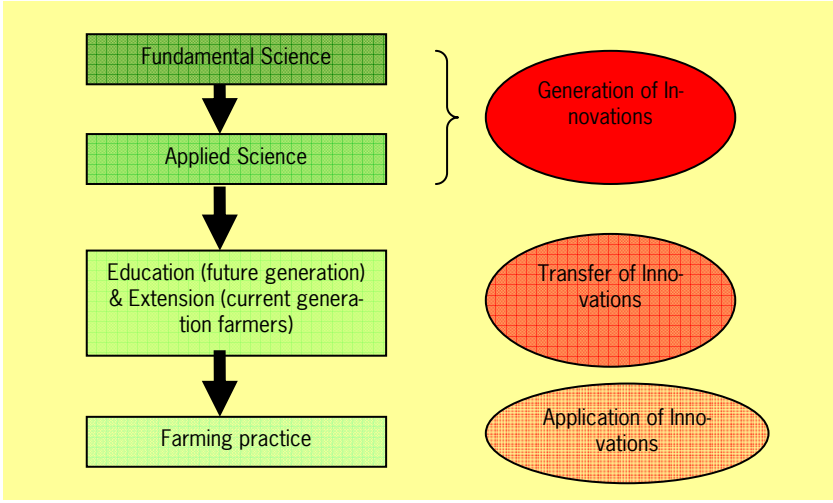
[a]) nge (Dutch size units) is a measure for the size of the holding, based on the estimated gross margin of the farm. 100 nge implies a gross margin (output minus variable costs) of 137,500 euro (price level of 2000)
[b]) including other farm activities, 7,700 mixed and 19,000 grassland farms (number of farms).

Public investment in the agricultural research system goes back in Dutch history for more than a century. In the agricultural crisis of the 1880s some European countries such as industrialising France and Germany started to protect their agriculture from cheap American cereals. The Netherlands, like Denmark, chose to keep international markets open and started to invest in quality management, education, public extension and research for agriculture. Fiscal accounting became compulsory in the early 20th Century, and supported extension. All these activities were coordinated by or even under the control of the Ministry of Agriculture. The Netherlands is one of the few countries where the Agricultural University in Wageningen and all (specialized) agricultural schools are not part of the Ministry of Education but of the Ministry of Agriculture. This means that all legislation on education is signed by two ministers.

After the Second World War public investments in Education, Extension and Research - the EER triptych, OVO in Dutch - were intensified as it was realised that investments in the agricultural knowledge system were economically profitable, and small farms and local cooperatives had no capacity nor interest to invest in research or extension (which were public goods due to their non-rivalry/ excludability character). The hunger during war times should 'never happen

again' and dollars for import had to be earned. With the kick-off support of the Marshall Aid that arrived in 1948, this became the big modernisation project that contributed to specialisation, economies of scale and intensification of land use. Farm workers, many farmers' sons and some small farmers voted with their feet for higher pay in other sectors of the economy and relocated themselves to the cities. Part of the productivity gain came from mechanisation and laying off this unproductive labour input. The other part came from higher yields - driven by embedded innovation in better inputs and unlocked by extension to realise this at farm level. The philosophy behind the EER triptych was the classical linear model of innovation (figure 2.1). It consisted of a large agricultural university, many specialised institutes for applied research, numerous experimental stations and regional operating demonstration farms (Leeuwis et al., 2006). This provided the knowledge for the agricultural schools and the extension service. The extension service was publicly financed too, although a part of it, mainly dealing with socio-economic and household issues including gender, was governed by the farmers unions that were organised along religious lines.

Figure 2.1 **The linear model of innovation**



Based on Leeuwis et al. (2006).

Even today, officials in the Ministry of Agriculture see investments in education, extension and research as one of their main policy instruments, even more important than e.g. trade policy, which is decided upon at EU level in Brussels and has to compromise with other interests. It also fits well with the co-decision making (governance) model in Dutch politics, the so-called Polder model. In this political model, much effort is put in creating consensus with stakeholders. In situations where the government would like to see changes in business behaviour, e.g. on environmental externalities of production, support in research and extension is offered in return for changing behaviour.

The results of this policy are reflected in the large international reputation of 'Wageningen' and the fact that the level of formal education of Dutch farmers is much higher than in other European countries.

3 Investments in R&D and performance of the sector

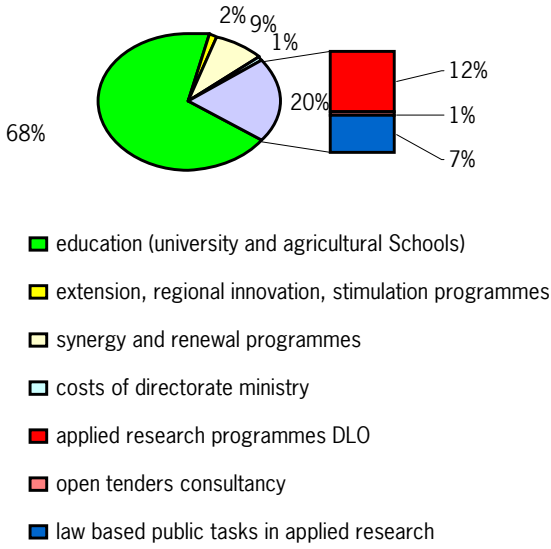
Table 3.1 provides data from the Budget 2007 of the Ministry of Agriculture, Nature management and Food quality on its cash flow related to policies in 'Knowledge and Innovation'. This excludes investments by other Ministries (such as the Ministry for the Environment or Economic Affairs, by regional authorities - negligible - and the European Union. Total investments in the knowledge system are nearly 900 million euro, of which 635 million (70%) is used to finance the agricultural university (including part of its research) and other educational institutes. This is not pure input finance as payments are related to the number of students and graduations. Less than 20% is used for research programmes, including public tasks like surveillance of animal diseases and the production of vaccines. Figure 3.1 provides a graphical summary of table 3.1

The 900 million euros mentioned above is nearly 40% of the total budget of the Ministry of Agriculture, which illustrates the importance of this policy instrument for the ministry. It is equivalent to 4% of the production value of primary agriculture, 22.000 mln euro. From the numbers it is probably fair to say that the budgets for research are about 1% of the production value, and budgets for education about 3%.

Table 3.1	Budget per year (budgeted cash flows in mln euro) on Knowledge and innovation (article 26) of the Ministry of Agriculture, Nature management and Food quality a)						
	2005	2006	2007	2008	2009	2010	2011
Total cash outflow	865	885	900	893	896	896	891
26.11 Guarantee the system	606	620	635	636	637	638	642
Agricultural University	141	141	140	141	142	142	142
Applied research (DLO)	33	38	42	42	42	42	46
Other education	432	441	451	452	452	453	453
26.12 Synergy programmes	34	33	33	33	33	33	33
26.13 Renewal projects	33	52	61	55	56	54	45
26.14 Policy support with knowledge	186	166	158	156	156	156	156
Research programmes for applied research (DLO)	106	84	72	69	70	70	70
Open tenders	2	5	9	9	9	9	9
Stimulation programmes	6	11	9	9	8	8	8
Public tasks Applied research	63	54	54	54	54	54	54
Regional innovation projects	3	5	4	4	4	4	4
Extension projects	5	6	9	10	10	10	10
26.2 Cost Directorate Minitery	5	14	14	13	13	13	13
Total cash inflow	13	35	28	21	21	19	14

a) Amounts do not necessarily add up as some minor items are not shown.
Source: Ministry of Finance - Budget 2007.

Figure 3.1 **Budget 2007 for Education, Extension and Research of the Ministry of Agriculture, summary**



The R&D expenditures in the food industry differ between countries. A relatively high percentage is achieved in Denmark and the Netherlands, even higher than the US (Table 3.2). A relatively low percentage is seen in the Czech Republic, Germany and Italy, but also in Canada. Italy focuses in its exports on traditional products, Canada has nearly no agri-businesses in the world's top-50. The Dutch food industry has increased its (relative) R&D expenditure over the period 1992-2002 by 50%. This increase is not as strong as in Denmark, but much stronger than in the USA. There the increase at a lower level was only 30%, but in the US companies are larger and therefore more economies of scale are realised.

Table 3.2	R&D expenditure as percentage of value of production in food products, beverages and tobacco, different years, and total value of R&D in 2002, per country				
	1987	**1992**	**1997**	**2002**	**R&D expenditure mln USD PPP current prices 2002**
Belgium	0.16	0.26	0.26	0.38	115
Czech rep.	..	0.07	0.02	0.02	5
Denmark	0.32	0.32	0.40	0.80	125
Finland	0.40	0.72	0.51	0.51	46
France	0.20	0.26	0.28	0.40	548
Germany	..	0.17	0.14	0.20	302
Ireland	0.21	0.30	0.29	..	51
Italy	..	0.08	0.07	0.11	130
Netherlands	0.42	0.37	0.47	0.61	307
Poland	..	..	0.04	..	9
Spain	0.08	0.11	0.10	0.16	155
Sweden	0.45	0.41	0.45	0.29	39
United Kingdom	0.31	0.43	0.29	0.48	490
Australia	0.28	0.36	0.38	..	175
Canada	0.17	0.15	0.16	0.11	69
Japan	0.57	0.64	0.78	0.78	1,742
Korea	..	..	0.24	0.35	218
Norway	0.20	0.26	0.45	0.54	70
US	0.35	0.31	0.37	0.39	2,205

Source: RDIP indicator: OECD, STAT 2005; Values from OECD, R&D expenditure in industry 2004; Taken from Wijnands et al. (2006).

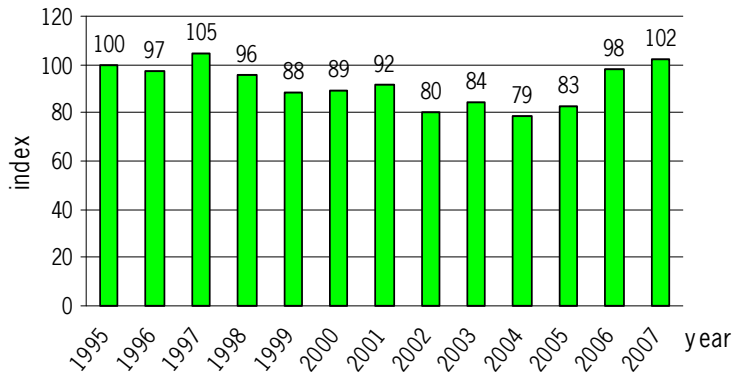
A quick calculation combining the tables 3.1 and 3.2 indicates a total research budget of about 400 to 500 million euro in the Netherlands, excluding education and research at the university, more or less evenly financed by public sources and the food industry. This raises the questions: Is this amount optimal? To what extent does it improve the performance of the sector?

To measure the performance of the agricultural sector, we used two indicators here: productivity and competitiveness. The development in labour produc-

tivity[1] at farm level (figure 3.2) has not developed very favourably. Around the turn of the millennium farmers - and to a lesser extent horticulture - had severe problems, mainly related to a number of severe animal disease crises, such as classical swine fever, food and mouth disease, and avian influenza. That reduced output and value added. It also led to a restructuring in the sector, with a strong decline in the number of farms and increased farm size. This contributed to a recovery in the last three years.

A recent benchmark of competitiveness (Wijnands et al., 2006) shows that the competitiveness of the Dutch food sector has improved in the period 1996 - 2004. The share in the world market declined. This was mainly due to the output reduction due to animal disease crises (see above), production quotas and environmental legislation that made expansion of farming in the Netherlands difficult and hampered the growth of the food industry and food exports to a growing world market. But on all other indicators like labour productivity, growth in value added and export specialisation (Balassa index) performed above aver

Figuur 3.2 **Labour productivity (index real net value per labour unit, 1994-1996=100)**



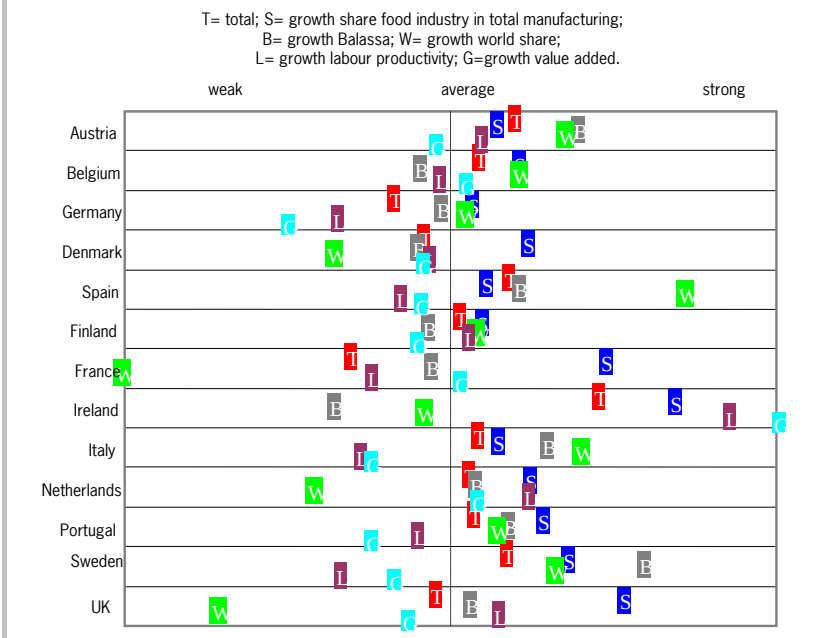
Source: Sector index, quoted in De Bont et al., several years.

[1] Data on total factor productivity are not available.

age. The Netherlands is only surpassed by some small countries and new member states such as Ireland, Austria and even Spain that still pick the fruits of integration into the common market.

The same study compared Europe with the USA, Canada and Brazil. Compared to the USA and Canada, the competitiveness of the food industry in Europe is weak, and at about the same level as Australia and Brazil. Even if - a big if - productivity growth would increase considerably, this would probably still be the case (Wijnands et al., 2006).

Figuur 3.3 **The competitiveness of the Dutch food sector (processing industries), benchmarked with other EU Countries, 1996 - 2004**



Source: Wijnands et al. (2006).

4 Methodological problems in linking investments to performance

Dutch agriculture seems to do fine in terms of competitive position. Labour productivity in primary agriculture has been disappointing over the last 10 years, but seems to be on the rebound. Public and private investment in R&D are relatively high, compared to other countries. These two facts are most likely related and structural econometric models could be used to try to measure this relation (Huffman and Evenson, 2006). However, there are a number of issues that question the causality between the two when measured for the Netherlands, and the usefulness of estimating such a relationship for policy makers. And over the last 20 years these issues have gained in importance.

First of all there is the openness of the Dutch economy. Although trade is not necessary to benefit from spillins of technology from other countries, it certainly supports it: innovations are embedded in goods, trade brings an international network, confronts inland developments with ideas elsewhere and puts a competitive pressure on adoption. The openness has also generated some spillouts. This has always been the case (see section 2 above). Not only was there always a knowledge drain to e.g. the USA but also when Indonesia was a Dutch colony, the Netherlands invested in research for tropical agriculture, and nowadays contributes to development cooperation. Although some of the research results are eventually sometimes also seen as useful in the Western world - in the social sciences for instance farm systems research, institutional learning - such investments are not linked to the performance of Dutch agriculture. In recent years two new aspects of openness have become important. The first is that the share of funding by the European Union has increased. The EU's Framework and other research programmes have become an important source of funding that also guide directions in research. Many of the research priorities are linked to national ones, also as co-finance from national sources is needed. But linkages become weaker, also as the main incentive for scientists is their benchmark score in international publications. The second aspect is that several leading Dutch food companies have become international players. They have their headquarters and often their laboratories in the Netherlands, but the results of their research are used directly, and sometimes exclusively, abroad. Even farmers, especially in horticulture, set up business abroad, for instance Africa, and start to supply knowledge (Poppe et al., 2007). In the world of national

statistics and tax-driven transfer pricing it is not clear if the monetary gains of such research shows up in productivity figures of the Dutch food sector.

A second issue that questions the causality in the measurement for the Netherlands is that many innovations originate in fundamental research in other sectors. Such investments are not taken into account in when estimating relations between investments and performance. That has been the case in the past too (fertilizers based on chemistry; tractors on mechanical engineering). It is now experienced in information and communication technology and even in biotechnology, where the fundamental research is done in biology, not in agricultural science. But what matters more is that, with improved education of farmers, industrialising of agricultural processes and perhaps more flexibility engineered in products, less research is needed to adapt the products to local soil and climate circumstances. In the 1970s an applied research institute in the Netherlands still did research on innovations in tractors. That has gone, improvements are now shipped worldwide by John Deere or Microsoft and seem to need less adaptation to local circumstances than in the past. The result is that probably a larger part of the productivity gain in Dutch arable farming depends on inventions in the US, where for glasshouse horticulture probably the reverse is true.

A third issue that questions the causality is that in the 1980s public agricultural research in the Netherlands moved from the model of focussing on the modernisation process to trying to solve the negative externalities of intensive agricultural production systems, especially in environmental issues. The modernisation process started in the 1950s ran into environmental problems - in particular concerning manure and pesticide issues - and the Ministry of Agriculture had to move from a ministry for agricultural interests to a ministry for the public interest.

The research on environmental issues supports to competitiveness and productivity compared to a situation of more severe environmental legislation. But it not necessarily improves productivity in agriculture. An example is the technical research to reduce the emissions of ammonia from animal housing facilities, for instance by changes in feed regimes or cheap amendments of buildings. Results of such research can lead to keeping productivity levels at former levels, compared to a situation where the production in certain locations would be forbidden, or more expensive buildings would be ordered. In some exceptional cases research has led to restrictions on certain practices, which would mean a drop in productivity. In such cases the link between investments in research and agricultural productivity breaks down. However, one hopes that the benefits of such research show up in improved health statistics and cheaper natural stew-

ardship. Essentially the problem for measurement is here that such research is hard to classify as agricultural or environmental research.

A fourth issue is the change from farm level to chain and network management. In the 1950s it was clear: food production had to be raised and productivity increases at farm level were central. From an industry perspective the objective was to lower cost prices and to gain markets. From a public perspective: the goal was to supply enough food and to earn dollars in export markets. That made productivity analysis relatively easy. But the bottlenecks are not in food production anymore, since the EU is now a food exporter and the subsidised exports from the CAP products are still criticised, despite recent high food prices.) From an industry perspective bottlenecks are in marketing and catering for the heterogeneous consumers. From a public perspective bottlenecks are negative effects of subsidised production on world markets as well as effects on the environment, and the health aspects of food. Dedicating more research to issues in other levels of the food chain makes productivity analysis more difficult. Technically, the separation between price and volume, needed in a productivity analysis, becomes much more difficult. Measuring the tons of wheat per ha is one thing. Measuring the increase in productivity if you are able to sell your pineapples sliced and fresh in a petrol station due to improved logistics and packaging techniques is a bit more difficult. Or what if your roses are of a higher value because they smell better and are nicely packed for Valentine's Day in Rome. Measuring productivity here can be as problematic as in ICT. The shift from farm level to the food chain in total also brought more attention to the role of small and medium sized enterprises (SME) in innovation and productivity improvement. Productivity improvements at farm level are often a result of people leaving the sector and of using better inputs in which potential productivity gains are packed (and unlocked by extension). It is not so clear if this is also the case in SME that have their bottlenecks in learning to survive in saturated markets.

A fifth issue is that there are many other factors that a change in research might have caused a lower productivity in recent years. Schimmelpfennig and Thirtle (2007) provided a list of 12 potential factors, including climate change. It has also been pointed out[1] that for instance an increase in cereal yields of 100 kg per year resulted in a bigger relative productivity in the 1950s, with average yields of 4,500 kg, than at current levels of 9,000 kg.

[1] Prof. Gerrit Meester (University of Amsterdam) pointed out to me that a famous Wageningen professor in plant breeding, C.T. de Wit, often raised this point some decades ago.

In addition to these issues that question the causality between the investments in agricultural research and productivity when measured for the Netherlands, the usefulness of estimating such a relationship for policy makers has to be questioned. The method is too crude and the results come too late. Policy makers have become less oriented on doing the right investments in research - 'picking the winners' - and more on possibilities to create an innovative environment. They would like to monitor and evaluate recent progress. Providing them only with the measured link between investments in research and productivity, where a number of years is needed before investments in a certain area materialize in productivity, amounts to driving forward in the fast lane of globalisation with the rear-view mirror as the main instrument. The argument that investments have a return higher than the market interest rate (Roseboom, 2003) does not seem very convincing anymore to finance additional agricultural research programmes.

5 Institutional changes to improve performance

Over the last 20 years the Dutch agricultural education, extension and research system - the EER Triptych - has been adapted to improve its performance (Roseboom and Rutten, 1998). These adaptions resulted in moving away from the linear model of innovation (figure 2.1) to a more complex agro-innovation system. Several driving forces contributed to this transition. Some of them, like the rising prominence of negative externalities, the food chain and the forming of multinational food companies have already been touched upon in the previous section. Figure 5.1 summarizes those trends (see also Project group, 2007; Poppe, 2006; Boehlje, 1999).

Figuur 5.1 **Driving forces in Dutch agriculture that lead to institutional changes in the organisation of extension and research**

Driving force	From…	To…
Consumer demand	Production of (basic) food	Value added by food chain
Public interest	Modernisation of farming	Cope with externalities, supply management and 'consumer concerns' (like landscape and animal welfare)
Labour market	Hidden unemployment in farming, low education and local labour market	Regional, metorpolitan labour markets with shortages and well educated farmers
Farm households	Weak integration in markets	Heavily integrated, often non-farm income of spouse
Farm business	Lack of (access to) capital	Capital intensive, high land prices (collateral), well integrated in credit market
Organisation of food chain	Small local cooperatives	Large (cooperative) multinationals

These trends have led to a number of institutional changes in agricultural research in Dutch agriculture in the 1990s:

- the adaptation of the EER Triptych started with the privatisation of the extension service. The incentive to do so was a general government decision in

1986 to reduce the number of civil servants and put executing operational departments at arm's length (Wielinga, 2001). The Ministry choose the Extension Service as a target for privatisation for several reasons[1]:

- an increasing risk of liability issues in cases where the public Extension Service advised farmers to enlarge farms, where a week later the council of Ministers in Brussels could introduce supply management (quota) that made such investments unprofitable;
- an increasing political risk in those cases where the Extension Service advised farmers not to implement directly e.g. the EU Nitrate Directive as it expected more delays in implementation than Dutch politicians or in cases where it thought it to be against the interest of its client farmers to help the Ministry to implement certain proposals.
- a problem to attract and retain good staff at government pay levels as the best persons left for private industry or started their own consultancy (farmers were prepared to pay for excellent advise);
- and hence a clear possibility for cost recovery.

In the second half of the eighties this government service was turned into an agency (called DLV), later a limited company; farmers had to pay for the services they ordered and in the end the company was sold to the management. Predictably it went through a series or reorganisations and it slimmed down. It faced competition from new private business consultancies, especially in horticulture. DLV started activities abroad (which were initially sometimes criticized by its Dutch clients as they would not like to see foreign competitors improve their performance) and had in some domains a troubled image as it was involved in state sponsored extension programmes to improve environmental performance of farmers, linked to unpopular (at least with farmers) government policies;

- around 1990 the research institutes for applied research were merged into one organisation (DLO, at a later stage including the experimental stations) and the governance structure of this agency was moved from input to output finance. This goverance structure was strengthened by taking away the civil servant status, and creating a client-principal rela-

[1] Partly based on a public statement by mr. Wim Tacken in a Farm Foundation conference 'Funding research and extension to assure the future of US Agricultural Competitiveness', March 14, 2007, Washington DC. Mr. Tacken was in that conference as Dutch Agricultural Counselor in Washington; he was charged with the privatisation of DLV in the 1980s

tionship: research became a product or a service. Multi-year research programmes were created, governed by research officers of relevant directorates of the Ministry of Agriculture, Nature management and Food Quality (as it is now called). Programmes consist of projects that are commissioned on the basis of a proposal and project plan, following the identification of a research question by the research officers. This governance structure was strengthened in 1995 after an investigation of the Dutch Court of Auditors that was very critical on accountability of the spending in a large research programme to improve energy efficiency in glasshouse horticulture (cf. Wielinga, 2001). The new structure created extra flexibility for the Ministry in moving funds between topics, research domains and hence institutes. Social sciences and environmental sciences (that work mainly for the public sector, delivering reports that can be used in the policy process) did relatively well, production topics (especially those not linked to environmental problems and where the government mainly sponsors activities that benefit farmers) had much more problems. It also contributed to the need for multidisciplinary and interdisciplinary research to try to solve persistent problems, although such research is not so easy to execute (Boer, 2006; Bruce et al., 2004). Researchers had to learn new competences (in acquisition and management of projects) and some institutes faced severe reorganisations. The institute for mechanical engineering for instance disappeared. Recently the Ministry started to experiment on a small scale with tendering and handing out research contracts to consultancies, institutes and universities that are not historically a part of the EER Triptych;

- in the 1990s the formal organisation of farmers and food industry underwent important institutional changes with effects on research. In the Dutch co-governance Polder model collective Commodity Boards and the Farmers Board (Landbouwschap) have (or had, in case of the Farmers Board) important co-legislation tasks and are able to create funds by levies for e.g. research, extension and product promotion. With the merger of cooperatives into large multinationals the role of the Commodity Boards became smaller. Large firms can organise and lobby themselves and less and less topics became non- or pre-competitive. Collective trade promotion for e.g. milk or cheese (Frau Antje) more or less disappearded. Also the farming community became more heterogeneous with farmers pursuing different strategies (see Poppe and van Meijl, 2006) and different views on agricultural policy. This made (co-)funding of research more difficult. The Farmers Board (Landbouwschap), that had

pledged to co-finance the extension service after its privatisation, was even abolished, handing over some of its tasks to the farmers unions (that not represent all farmers and are not able to impose taxes);

- to improve the linkage between research and the food-business, in the nineties some private-public research schemes with co-innovation programmes were funded. Such schemes are run by private-public foundations like AKK (Agro Chain Knowledge) and focus on food chain issues. The board of such a foundation agrees on a research programme, and publishes calls for tender in which food companies can submit a project proposal. In such a proposal the activities should be carried out by the staff of the company and researchers of the applied research institute. On acceptance of the project, the researchers are paid by the programme funds of the Ministry of Agriculture, the companies have to finance their own staff;
- a major institutional change happened in 1996. The Minister of Agriculture and Parliament were unsatisfied with the relationship between Ministry and the 'knowledge institutions'. Based on an external advice of a consulting politician (Mr. Bram Peper) it was decided to merge the applied research institutes (DLO) and Wageningen University into one organisation: Wageningen University and Research Centre.

  One of the schools for higher agricultural education (BA level) also merged into this structure.[1] Wageningen UR has experimented with sev-

[1] A comparison between the two often quite comparable countries The Netherlands and Denmark might be useful on this point. More recently Denmark also reorganised its knowledge system and brought applied research in the institutes and more fundamental research in universities under one roof. But it also moved agricultural faculties (now including applied research) into three general universities in stead of adopting "the Wageningen" model of one specialised university, although the last option was preferred by the agri-business. In a seminar March 2008 in Wageningen (at the occassion of the retirement of prof. Fons Werry) the Danish expert Søren A. Mikkelsen explained that the reorganisation was very much driven by the Ministry of Education and Innovation, following up a high level advisory group's report to government on how to react to the globalisation trend. At the same time the small Danish Ministry for Agriculture was said to be politically rather weak; the agricultural faculties themselves were also not in favour for the 'Wageningen model' of one specialised university as they hoped to gain from contacts with other disciplines and feared they would otherwise be confronted with overcapacity.

Somebody at that time close to the negotiations on this issue in the Netherlands (and now in academia) explained me that in the Netherlands the situation was quite opposite. Besides the strong negotiation skills of the Secretary General of the Ministry of Agriculture, an important element was that the Ministry of Education was in favour for, or at least not against, this solution. Itself often under fire for changing the education system too often and not caring enough for the needs of business, it had an interest to share responsibility on the education policy and have an 'experimental set up' of a specialised technical university that includes applied research for agri-business. These differences

eral organisational forms to create synergy between applied research and the university. There are examples of nearly full integration where domain-related groups take care for education, PhD research and applied research or even consultancy (e.g. environmental sciences) and examples of a very light facilitating structure that respects differences in culture and output (e.g. social sciences);

- a similar trend towards involvement of business in research planning can be seen in research on a number of important societal issues. Organic farming was a prime example. In the end of the nineties Dutch Parliament decided that 10% of research money should be earmarked as dedicated to 'research for organic farming'. The (private) interest group Biologica (as a representative of the sector) was given an important say in the allocation of those programme funds. A special Task Force is involved in commissioning consumer research to support its efforts in chain management and marketing; Such a governance approach has also been choosen for Multifuncitonal Agriculture and - in the framework of so-called FES claims that reinvest windfall profits from the government's natural gas exploitation into the knowledge economy- on Watertechnologie, Food & Nutrition, Avian Influenza and others;
- in addition experiments were organised with voucher systems (e.g. in the framework of the mineral policy) and in so called 'network programmes', where funds and expertise from applied research and experimental stations are made available to support farmers and fishermen with a common interest and problem. This also led to the creation of innovation intermediaries that act as broker organisations, with names like Know House or the Dairy Academy. A recent PhD study (Klerkx, 2008) finds a number of problems with these developments. Seen from a principal-agent relationship there are problems due to information asymmetry. R&D funding institutions have to improve the articulation of their needs by capacity building, and in some cases (like the mineral policy) the policy risk that farmers experience in legislation is more a bottleneck for changing behaviour than the lack of knowledge;
- the changes in agriculture in the 1990s, characterised with terms like globalisation, industrialisation, reform of agricultural policy, animal diseases and food safety crises, ongoing environmental issues, discussions on animal welfare and restructuring of farming and high off- farm em-

suggest that comparing the two countries with an institutional and political economy approach might reveal interesting insights.

ployment and a booming economy, resulted in the official policy view that a 'Transition to a sustainable agriculture' is necessary. The idea of a transition (structural adjustment) is that we are experiencing a fundamental change in the way a problem is viewed, with drastic changes in reflection on the roles of stakeholders and the entrance of new stakeholders (Rotmans, 2001). For agriculture this could include the idea that agriculture is not so different from other small and medium sized businesses (Poppe, 2006), which questions the need for a protective agricultural policy, and that new outputs can be found in recreational, health and energy products. In line with this thinking of structural adjustment and the need for break through innovations, the Ministry of Agriculture created some foundations with research programmes to act as a change agent. One of them is InnovatieNetwerk (Innovation Network) that tries to come up with mind challenging new concepts for agriculture. It describes itself as follows:

> 'InnovatieNetwerk develops radical new concepts in agriculture, agribusiness, nutrition and green space and ensures that these are put into practice by interested parties. This involves innovations aimed at sustainable development with a longer-term focus. InnovatieNetwerk makes efforts to set the radical new concepts in motion by developing radical concepts which, once put into practice, ensures radical changes. (www.innovatienetwerk.org).'

The concept of the 25 storey pig-apartment tower with optimal animal welfare conditions in a port environment near big cities is world (in) famous. Another example of such an organisation is Transforum (www.transforum.nl). It wants to be a change-agent in the transition from the agri-knowledge structure (the EER Triptych) to an open 'Agro Innovation System'. It chooses not to be just a broker between business, government and research institutes to organise research, but a co-creating change-agent with an active role in the creation and management of (large) research projects. Transforum likes to contribute to the creation of a new innovation environment, and therefore also teams up with Dutch universities outside Wageningen.

Also here it is a general government policy that is used as a starting point for the policies of the Ministry of Agriculture. In line with the EU's Lisbon Agenda to create a competitive economy based on knowledge the Dutch government (and it top level Innovation Platform, chaired by

the prime minister - copied from a Finnish example) has identified a number of Transitions (to Sustainable Agriculture, but also on Energy, Transport and Biodiversity) and a number of Key areas for the 'knowledge economy'. Food and Flowers is one of them. Transitions and Key areas benefit from large public investments in research based on the national income from natural gas;

- in line with the attention on industrial districts and clustering, following the work of Porter (1985) and the success of Silicon Valley in ICT, initiatives have been taken around Wageningen to create a 'Food Valley'[1] Here new organisational forms (science parks, business parks with spin-outs and spin-offs, foundations to promote exchange of knowledge between university, research institutes, multinationals and SMEs), are tested. A European research project, called FINE (Jongebloed et al., 2007) benchmarks European food regions (like Oresund in Copenhagen/Malmo, Parma in Italy, Flanders) and first outcomes suggest that Wageningens Food Valley is doing fine;
- the most recent institutional change in the EER Triptych initiated by the Ministry of Agriculture is to improve the links between the educational system and research (Kupper et al., 2006). Once the applied research system became output and profit oriented, the contacts with education came under stress. In the 1990s also several regional experimental farms were closed: it became too expensive, less adaptation of innovations to regional circumstances was needed and the declining number of farmers could travel much more easily (or use internet) to get in contact with central facilities in Wageningen or Lelystad. Many more farmers had higher educations and had studied there anyway. That meant less regional contacts between research and education too. At the same time the idea gained ground that a lot of knowledge was created and available, but that the problem was accessibility, networking and problem-driven cooperation between research and business. This is called the knowledge paradox: Europe excels in science (at least in some areas), but innovation is lacking and there are persistent societal problems. As a leading professor in communication management in Wageningen voiced: 'the Netherlands is not a country for ideas - we excel in improvement of existing ideas, organising networks. Not in inventing new ideas' (Woerkom, 2007). The Netherlands is not a nation with a large manufacturing

[1] The name comes not from a lack of imagination but reflects the fact that Wageningen is situated in a valley named Gelre's Valley, named after the province (and former duchy) of Gelre.

history and there are several examples of recent technologies (wind turbines, biogas installations) that were perfected in Germany or Denmark in stead of in the Netherlands. The core competence seems to be in the Dutch food sector that copies and adapts developments from other industries. This has resulted in the idea that cooperation between research and education should be improved. The Green Knowledge Cooperation has been set up as a platform to improve links between research and education. Higher agricultural schools (B.A. level) do some research themselves, have joint projects with research institutes and try to develop into regional innovation centres for life-long learning. Research programmes in the applied research institutes are required to spend 5% of their budgets on communication. The network aspects have also become an important issue in some of the applied research programmes, especially those that are carried out by former experimental stations and that deal with farm systems of the future. In these programmes much attention is paid to interaction and co-creation with groups of innovative farmers. Geerling-Eiff et al. (2006) discuss the critical success factors for arrangements like co-creation, transfer and circulation of knowledge.

The institutional changes in Dutch agriculture research seem to be in line with the changes in the Duch science system at large. A recent evaluation by the Rathenau insitute, a think tank on the impact of science and technology (Versleijen, 2007) concludes that the number of research programmes has increased exponentially, in line with the policy objectives linked to them. The research is more often organised outside the research institute / university in the form of programmes, centra, consortia and dedicated institutes. Even the responsibility of certain aspects of the human resource management and investments moves from the management of research institutes to intermediate governance structures. As the growth of the number of organisations, programmes and subsidy programmes is in line with the growth in budgets, the complexitiy has increased quickly. The Rathenau institutes therefor questions if the system has improved.

6 Towards assessment of effectiveness and efficiency

The changes in the research system as described in the previous sections present a challenge for analysis on performance, and especially effectiveness and efficiency. In the end the competitiveness of the sector and productivity data are the key indicators to see if investments can be justified. But -as argued in section 4- that takes time and it is difficult to link them to the different policy decisions on institutional change.

Analysis starts with interpretation. The driving forces in table 5.1 as well as the official jargon adopted by the government, suggests that Dutch agriculture is indeed experiencing a Transition process. In Transitions knowledge creation is not seen as a linear top down process (figure 2.1), but as a complex process with many iterations. Gibbons (1994) labelled this as the change from Mode 1 to Mode 2 science (figure 6.1). It is a Triple Helix approach (Leydesdorff and Etskowitz, 2003) in which three independent institutional structures (government, business and science) interact from time to time with each other, steered rather autonomously by their own development. This framework for analysis stresses the importance of the dynamics of networks and alliances between institutions instead of the 'how' and 'where' of creation of knowledge (extra-mural over intra-mural).

Monitoring and evaluation tools are not very well developed for such a post-modern framework. Based on the work by Rotmans (2001) and others, Ten Pierick at all (2005) made some suggestions. Some measure people, profit and/or planet indicators (Boone and ten Pierick, 2005; Ros, 2003). In a project setting the concept of Learning Histories, developed at MIT by Kleiner & Roth (1997) seems to work as it provides context-specific information that makes results more transferable to other contexts. Others work on 'Reflexive Process Monitoring'. Many of these monitoring tools come from a social learning environment (Wals, 2007).

Figure 6.1 Mode-1 and Mode-2 Science, according to Gibbons (1994)	
Mode 1	**Mode 2**
Academic	Oriented towards application
Discipline-oriented	Transdisciplinary
Homogeneous	Heterogeneous
Linear and stable	Non-linear and volatile
Academic quality control	Quality management on a broader set of criteria
Accountable to peers	Accountable to society

From a public administration/public management perspective Termeer (2006), applying theories by Weick (2000) and a hypothesis formulated by Beer and Nohria (2000) suggests that the programmes or instruments that managers apply do not matter that much, as long as they contribute to the basic conditions of creating meaning or relevance that is essential for learning, adapting and changing in a turbulent world. These basic conditions are:

- motivate people to keep moving and experimenting to make unknown possibilities known (vitalising);
- create a general direction to evaluate experiments;
- promote a process of adapting to local situations (updates) by precise attention to developments, context and meaningful details;
- facilitate open interactions in which trust, reliability and self respect can grow in such a way that people can appraise the situation and developments.

Until now this framework of analysis has not been applied to the research system, where institutions (in the economic sense) and governance structures can be seen, and more importantly are seen by the government, as policy instruments.

Stakeholder analysis can be important in monitoring Transition processes, as this can reflect on the basic conditions cited above. This has been the tool used in two ex-post policy analyses commissioned by the Dutch Ministry of Agriculture to evaluate two major policy decisions mentioned in section 5. The first analysis concerned AKK, and was carried out by a consultancy, Berenschot (Beemer et al., 2005). It was quite critical for the performance of the public-private co-innovation programmes run by AKK. The study concluded that

'up till now the effect of co-innovation on the competitive position and sustainability of the pig meat and organic sector has been restricted to improvements for some participating companies (..). If the Ministry would like to stimulate a substantial improvement of the competitive position of the agro-food chains, other policy instruments are needed.'

Co-innovation is an instrument of learning, applying and upscaling, and less an instrument for innovation. It mainly generates experience-based know how, and only to a lesser extent explicit knowledge, portable product- and process innovations. The evaluators also concluded that if an instrument for learning, applying and upscaling was preferred, other competences (like training, consultancy and knowledge transfer) would be more effective than scientific research and reports.

Recently the same consultancy (Beemer et al., 2007), evaluated the effects of the privatisation of applied research and its merging into Wageningen UR on the usefulness and use of the agricultural research output (including environmental and social sciences). The evaluation was based on a large questionnaire for users, including agri-business. The evaluation concludes that privatisation has been a success. Although there was restructuring and a 10% decline in capacity, the quality of the research remained at a relatively good level. According to the clients, the usefulness of the knowledge improved. Clients seemed to be more satisfied than the researchers themselves: they have a more negative view of the quality of their own work. Second conclusion of the evaluation was that the separation of public and private tasks has been successful. Money flows are clearer, the programmeming of research in the Ministry of Agriculture improved strongly, but the input from other stakeholders on especially long term research has become too small. Third conclusion was that cooperation between the university and applied research improved and more multidisciplinary research is carried out. There is more focus and economies of scale. However seperate identities of fundamental research at a university and a policy or management oriented research in an applied research institute should be kept. Fourth conclusion is that output financing has worked: the orientation of the research institutes to the clients and the usefulness of the knowledge has increased.

From the point of view of economic theory such a stakeholder analysis provides an incomplete picture. It provides a first insight into effectiveness but not into efficiency. To be fair it should be noted that the analysis also tried to com-

ment on some transaction costs (especially monitoring costs) that can probably be reduced.

A standard economic tool to investigate investments in agricultural R&D would be cost-benefit analysis (Roseboom, 2003). In the Netherlands some economic analysis has been applied ex-ante to investments in large R&D programmemes that have been financed by the government from extraordinary returns on the exploitation of natural gas resources (the so-called FES programme). This included some agriculture/biotechnology proposals (CPB, 2005). Proposals were evaluated on criteria like legitimacy/subsidiarity (that is: is there an argument for public intervention by the Dutch government?), and efficacy and efficiency from a societal point of view. Schimmelpfennig and Norton (2003) provide a probalistic methodology to appraise such projects that makes it possible to take into account different scenarios.

The problem with these economic analyses is that they work for programmes and projects or for agricultural R&D in total (Roseboom, 2003), but it is not so clear if they can realistically calculate the costs and benefits (under different scenario's) for a major reorganisation of a large part of the institutional framework of agricultural research. Scenarios contribute to that, but it seems to me that also a better understanding is needed of the value-creating business model of Dutch agriculture and the role of innovation, research and education in this value-creating process. Scenario-analysis (Heijden, 1996) can contribute to that. Such a scenario-analysis could also reflect on the role of the Ministry of Agriculture itself: there are some driving forces that could influence the coordination role of the Ministry itself, and this could lead to bigger, and heavier institutional changes - this time not only in the EER triptych itself, but also in its coordination Ministry (figure 6.2).

To analyse alternative institutional arrangements, it seems to me that an institutional economics analysis would be attractive. That approach could look into transaction costs and agency costs (like monitoring costs, bonding costs, residual losses) as well as into the ownership of problems and research output (Dalrymple, 2006).

Figure 6.2	**Driving forces in the research environment that might effect the role of the Ministry of Agriculture in organising agricultural research and lead to more institutional changes**	
Driving force	**From…**	**To…**
ICT and cheap travel	Regional suppliers of advise and research	International accessibility of know how for educated farmers
Relative decline in GDP of the sector and agriculture becoming more similar to other industries	Flowers and food per definition important in general innovation policy	Money invested in flowers and food research questioned, and more and more an add on to general government programmes
International / EU coordination of research	Everything done in the NL	Joint agenda setting (SCAR) and joint planning: some tasks can be left to other member states, others can concentrate in NL (ERA-NETs) Emphasis on absorption capacity in addition to contribute to knowledge development
Decentralization of policies to regions	Demands for research from Ministry only.	Coordination of demand Ministry and regions needed
FDI and emigration farmers	Out of sight - out of mind	Farmers are in global networks, keep contact with the Netherlands, and start shopping for best advice and research, sometimes localized by local advisors.
Multidisciplinary research with health, ICT, leisure, culture	All know how in Wageningen	Cooperation with other universities and coordination between ministries.
Changing bottlenecks in agriculture	Production oriented research that benefits all producers (at least in the short run)	Niche-marketing oriented, that benefits special groups of producers More emphasis on access to results, communication, impact on innovation than on knowledge development as such.

Figure 6.2	Driving forces in the research environment that might effect the role of the Ministry of Agriculture in organising agricultural research and lead to more institutional changes (continued)	
Driving force	**From…**	**To…**
Law	Open source research for the common interest	More possibilities to use and enforce intellectual property rights

7 Discussion and conclusions

In this paper we looked at the performance of Dutch agriculture in terms of productivity and competitive performance. The restructuring in the industry, the declining number of farmers and even the decrease in the production of some commodities (like pork) leave the impression that a scenario of the Netherlands without agriculture is possible or even desirable (Luttik et al., 2006). The performance indicators presented here, do not support that conclusion. Structural adjustments seem to be one of the motors of productivity and competitiveness.

Investments in R&D are an important element in the Dutch strategy to specialise in flowers and food. Therefore the question is how this happens and if these investments contribute to the performance of the sector. There are several methodological problems in linking investments and performance in an open economy, where part of the research is aimed at solving the problems of negative externalities (like the environment).

The structural adjustments in agriculture included major changes in the education, extension and research institutions (the EER Triptych). These changes try to convert the traditional, hierarchal knowledge-oriented system with a linear model of innovation into a networked Agro-Innovation System. The transformation is still an unfinished agenda, to quote Roseboom and Rutten (1998).

There is a need for improved tools to monitor and evaluate the effects of such a transition. An overall productivity analysis is not suitable for that. In research programmes experiments with methods from social learning have been attempted. From the view of management science a good qualitative scenario analysis to see the driving forces and value creation model of the agricultural system and the role of knowledge and innovation seems to be appropriate. An institutional economics approach could consider property rights and transaction costs, that could be substantial. For individual projects a (social) cost benefit analysis might also make sense.

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