

John Warmerdam

Innovation and training in the agribusiness complex

*The case of meat production
in the Netherlands*

its



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Report to CEDEFOP
Nijmegen, may/june 1998

De particuliere prijs van deze uitgave is f 15,00.
Deze uitgave is te bestellen bij het ITS, 024 - 365 35 00.

This study has been accomplished with a financial contribution from the
European Centre for the Development of Vocational Education and Training,
CEDEFOP, in Thessaloniki

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Preface

This study is part of a CEDEFOP project which tries to assess the opportunities and limitations of a sectoral approach to training. The focus in the project is upon the agribusiness complex. In five European countries an explorative study has been conducted in which a subsegment of agribusiness has been studied with regard to the relationships between innovation and qualification. The starting points for these studies are specific product chains in agriculture: beer production in Belgium, cheese production in Greece, meat production in the Netherlands, meal and grain production in Spain and vegetables production in the United Kingdom. Taken together, these studies provide insight into how innovation and qualification are organized within various parts of agribusiness in various countries.

This report contains the results of the Dutch study, focussed upon meat production. The study was commissioned by CEDEFOP and has been conducted by ITS Nijmegen (mr. John Warmerdam), within the framework of the research programme of the Circle for Research on Trends in Occupations and Qualifications (CIRETOQ-network). Partners in the project are HIVA Leuven, Belgium; the Department of agricultural economics of the Aristotle University in Thessaloniki, Greece; CIREM Barcelona, Spain; and the Department of food science and technology of the University of Reading, United Kingdom. The project as a whole is coordinated by mrs. Tina Bertzeletou of CEDEFOP, Greece. A synthesis report of the five national studies will be published by CEDEFOP at a later stage.

Nijmegen, may/june 1998

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1 Introduction: objectives of the study

This study is part of a CEDEFOP project which tries to assess the opportunities and limitations of a sectoral approach to training. The focus in the study is on the agribusiness complex. In earlier studies, conducted in other sectors, it has been demonstrated that a sectoral approach can provide good opportunities for training policy development, but that it can also limit the development of adequate training provisions, particularly in situations of rapid economic and technological developments. Such developments often cross through sectoral domains and may imply a fading away of traditional sectoral borders. This may require a restructuring of the sectoral institutions, including those for innovation and training (Warmerdam & Van den Tillaart, 1997; Warmerdam, 1998).

In this agribusiness study, we want to 'test' the sectoral approach to training a new by looking at its opportunities and limitations in situations where, in the first instance, it seems less applicable, e.g. in relation to cross-sectoral technological innovation. The agribusiness complex has been chosen, because many innovations occur here and because it is an important segment of the economy in the countries which participate in the study: Belgium, Greece, the Netherlands, Spain and the United Kingdom.

The study is not limited to one 'sector' (in the traditional sense), but involves three 'sectors', which in some way or another belong to the agribusiness complex: the production (agriculture), processing (food en beverage) and distribution (retail trade) of agricultural products. Point of departure in this project is not so much the 'sector' as well as the 'chain' of agricultural products. In each of the participating countries a specific product chain has been chosen, within which the relationships between innovation and training have been studied:

- in Belgium: the beer production chain
- in Greece: the cheese production chain
- in the Netherlands: the meat production chain
- in Spain: the meal and bread production chain
- in the United Kingdom: the vegetables production chain

The Dutch study focusses upon the meat production sector. Its major objectives are to demonstrate how innovations take place in this sector, how they become transferred to the companies and how education and training agencies working in the field

respond to these innovations. This is analysed against the background of recent developments in the 'knowledge infrastructure' of the agribusiness complex as a whole. For practical reasons, the study has been limited in several ways. It does not pretend to give an exhaustive picture, but tries to illustrate some important aspects of the relationship between innovation and training, with the 'case' of meat production at hand.

The study is based upon an analyses of existing literature, research and documentation, and a number of interviews with experts in the field. Highly relevant in this regard is the research work done by the NRLO (Nationale Raad voor Landbouwkundig onderzoek), a governmentally supported R&D-agency, and by the labour market research unit of STOAS, an education and training institute working for the Dutch agribusiness industry. We thank both institutes for the information they have provided.

The report is structured in the following way. First we discuss some key characteristics of the agribusiness complex in the Netherlands. Secondly, we will focus upon the meat production chain, describe some major recent innovations and discuss their implications for occupations and qualifications. Third, we analyse the knowledge infrastructure in the agribusiness complex and describe some recent developments in its structure and functioning. The transfer of innovations is an important point of attention in this part of the report. Fourth, we assess the response of education and training agencies to innovation and analyse these against the background of recent discussions concerning the reform of the agribusiness knowledge infrastructure as a whole. To handle the complexity of the matter, we occasionally zoom in on concrete innovations (particularly those concerning chain management, quality assurance and animal health care) in a specific subchain of meat production (in particular pig production).

2 Some key characteristics of the agribusiness complex

2.1 Sectors involved

The structure of the agribusiness cluster is a very complicated one. As its name already indicates, it crosses the borders of traditional sectoral classifications. It encompasses several sectors and subsectors in both the primary, secondary and tertiary segments of the economy. The central process in the agribusiness cluster, as it is studied in this project, is the production, processing and distribution of agricultural products, in particular food products. Major sectors involved in this process are: agriculture, the food and beverage industry and the food wholesale and retail trade. The figures 2.1 to 2.3 give an overview and a specification of these major sectors.

2.2 Agricultural production

Figure 2.1 - Sectors involved in agricultural production (data 1995)

	number of companies
- agriculture/horticulture	38.786
- intensive cattle farms, a.o.:	11.584
- of which calf farms	1.170
- of which pig farms	7.738
- of which poultry farms	2.009
- other cattle farms:	58.004
- of which milk cattle farms	33.023
- mixed companies	4.828
total number of companies	113.204

Source: Dutch Bureau of Census, 1998.

As figure 2.1 demonstrates there are a bit more than 113.000 agricultural companies in 1995. The majority of them (57%) is involved in meat production. The total number of companies has sharply decreased since the fifties. In 1959 there were still 308.000 farms. From then on the number fell down from 185.000 in 1970, 145.000 in

1980, 125.000 in 1990 to the 113.000 in 1995. In the same period the average cultivated area per farm rose from 7,5 hectares in 1959 to 17,9 hectares in 1995. Most farms are still family owned businesses. The farmer runs the business, together with members of his family. Only a minor proportion of farmers hires extra personnel. There is a growing number of farmers, who become farmer on a part-time basis. Besides farming, they deploy other activities, usually affiliated ones like recreative activities on their farms or activities in nature conservation, but sometimes totally different ones, like jobs in (food) factories or activities in sales stores. A deteriorating financial position of their farm and the need to generate extra income are usually the main reasons for them to do this.

2.3 Agricultural industry

Figure 2.2 - Sectors involved in the agricultural industry (data 1992)

	nr. of companies	nr. of jobs
- fish processing companies	230	4.000
- slaughterhouses/meat processing companies	750	21.000
- dairy and milk processing companies	200	17.500
- butter, oil, fat industry	30	4.000
- mixed cattle feed industry	400	11.000
- meal and rice processing industry	110	1.500
- sugar industry	4	2.500
- starch processing industry	8	3.500
- fruit & vegetables processing companies	10	6.500
- bread, biscuit and bakery companies	4.400	41.000
- cacao and chocolate companies	160	8.000
- other food processing companies	440	15.500
- alcohol distilleries	50	1.300
- beer breweries	30	8.000
- drinks industry	20	2.500
- tobacco industry	35	6.000
total numbers	6.950	153.000

Source: Van der Velden & Willems, 1995.

As one can see in figure 2.2, the food and beverage industry is a very heterogeneous sector. The major part of the companies is in the bread and biscuit branch. Qua

number of companies and employees the meat processing branch is the second branch in size. In most branches more than 90 percent of total employment is concentrated within a few large companies. In the meat branch this is 84 percent, 16 percent of the jobs can be found in companies with less than 20 employees. The number of companies as well as employment is relatively stable during the past decade. Decrease or increase of employment since 1988 is in most branches within 5 percent (Van der Velden & Willems, 1995).

2.4 Agricultural trade

Figure 2.3 - Sectors involved in agricultural trade (data 1992)

	nr. of companies	nr. of jobs
Wholesale trade meat/meat products		
- living animals	1.150	3.200
- meat and meat products	750	9.100
- poultry	225	1.500
Wholesale trade other agr.products	9.020	77.800
Retail trade meat/meat products		
- meat and meat products	4.900	24.900
- poultry	500	2.100
Retail trade other agr. products	25.600	233.300

Source: Van der Velden & Willems, 1995.

Agricultural trade can be divided into wholesale and retail trade. Wholesale trade can be further divided into wholesale in agricultural products and living animals and wholesale in food and beverage products. Retail trade can be subdivided into food and beverage retail trade and retail trade in flowers, plants and (household) animals (Van der Velden & Willems, 1995). Figure 2.3 gives an overview of the number of companies and jobs in these sectors, with a further specification of the meat-related segment. As the figure demonstrates, meat-related trade takes account of app. 15% of employment in total wholesale and app. 10% of employment in total retail trade. With the trade in flowers and in fruit and vegetables it is one of the largest branches of agricultural trade.

As one can see from the figure, most wholesale trade in living animals is executed in small firms, with only a few staff numbers; on average less than 3 persons. The sector is relatively stable, both in number of companies as in numbers of jobs. Retail trade in meat and meat products is the largest branch of specialized agricultural retail trade. It is concentrated in butchery shops. These may be established on a separate location, they may also be established within the location of a larger supermarket. The supermarkets have increasingly become dominant in food retail trade during the past decades. They take account of app. 70 percent of total employment in the branch, two thirds of which is realized within some 40 companies, with each more than 100 employees. After some large recent mergers, actually just a few big supermarket-chains dominate the market (Van den Tillaart, 1994; Van der Velden & Willems, 1995).

2.5 Other sectors

Apart from these main sectors, a number of minor sectors or branches are involved in agribusiness. For instance: producers and deliverers of seeds and cattle feed, producers and deliverers of agricultural equipment, machinery and installations, auction halls and transport companies, specialized in livestock or other agricultural products. In this study, the emphasis will be on the 'primary process' of the agricultural production chain. Developments in these 'supportive' sectors will be only dealt with as far as they are relevant for the primary process. One can imagine, for instance, that new activities of producers of agricultural machinery and installations are important with regard to innovation in the primary agricultural process. As far as this is the case, these activities will be taken into account in the study of concrete innovations.

2.6 General tendencies

A general tendency which is visible in all three segments of agribusiness is the sharp increase in the scale of activities. This is paralleled with a rise of productivity and, in many companies, a decrease of employment.

Scale increase is clearly the case in the *retail sector*, where the number of companies dropped down from ca. 200.000 in 1950 to 137.000 in 1990. With the rise of the self-service and supermarket concepts, small businesses came under heavy pressure in the past decades and the number of self-employed entrepreneurs strongly decreased. Many of them closed their shop, merged with other shops or entered a into some kind

of larger franchise combination. As we have said, actually, a few number of large supermarkets and warehouses dominate the general food retail trade, selling a large variety of food products, leaving only market niches of special products to the small entrepreneurs and exercising a massive amount of power both towards their suppliers as well as towards their consumer markets. With the European integration, these supermarkets become more and more active across national borders (Van den Tillaart, 1994).

An equal process of concentration has occurred in the *food and beverage industry*. Since the sixties many food companies in f.i. the milk, meat and vegetable production have merged into larger combinations in order to be able to stand competition on the national and international markets. The European integration and the globalization of consumption and, later on, production have further stimulated this process and at the moment many branches of the Dutch food and beverage industry are dominated by a few large companies, which produce an increasing variety of food products on increasingly globalizing markets. With the rise of new competitors in the Asian and Eastern-European countries it is expected that concentration processes will go on further in the years to come (Feijen, 1994).

With the rapid industrialization of the Netherlands in the course of the past century and the shift towards the service economy since the second World War, *agriculture* has lost much terrain in the Dutch economy. As we have seen, the number of agricultural firms and the number of persons working in agriculture also strongly decreased in the past 30 years. The scale of the companies which survived increased as well as their productivity. With the intensification of production, farms increasingly became organized in an 'industrial' way. However, many farms, also the larger ones, are still family owned businesses, run by self-employed entrepreneurs together with their family and, sometimes, a small staff of employees, often hired on a temporarily basis. Under the parapet of European policy, for many years agricultural production in important branches, like f.i. dairy products, has been strongly regulated and supported by the government. It is expected that governmental support will be decrease in the years to come, with the liberalization of the agricultural market, and that Dutch agriculture has to confront increasing competition from Southern and Eastern European countries. Besides, the agricultural sector increasingly will have to face ecological and societal pressures, which will be translated into new legislation, new infrastructural programmes and new governmental programmes in the field of environmental protection and nature conservation. Many experts expect that these developments will lead to a fundamental transformation of Dutch agriculture in the 21th century. They have, however,

different opinions regarding the direction of this transformation (see f.i. NRLO, 1998).

2.8 Rise of the 'agro-chain' concept

An important tendency which connects the sectors involved in agribusiness is the shift from a sellers to a buyers market. With the increased competition on the product markets, thinking in terms of 'product quality', 'added value' and 'product chains' has become more important in agribusiness since the eighties. In many branches power thereby has shifted from the companies at the beginning of the chains (e.g. the producers) towards the companies at the end of the chains, e.g. the supermarkets which are directly in touch with the consumer. Consumer demands, as translated by the supermarkets and -backwards in the chain- the food producers increasingly dictate production and product quality requirements. (Willems, 1994; NRLO, 1998). This is a process which not only occurs in the Netherlands, but in many other European countries as well (King e.a., 1995). In the future, it may have important consequences for the knowledge infrastructure and for the organization of innovation and training in the agribusiness complex.

3 Focus of the study: the meat production chain

3.1 Structure of the chain

In this study, we will highlight some of the implications of this process by focussing on the meat production chain. In a recent study Van der Velden en Willems (1995) have assembled some basic data concerning production, employment and education within the different subsegments of agribusiness. They define the agrisector as the whole of companies which is involved in production, processing and distribution of agricultural products and use the concept of 'company chains' to give more specific data. One of such chains is the 'meat chain'. Within every company chain different groups and subgroups of companies can be distinguished. The meat chain f.i. consists of respectively:

- cattle breeders
- cattle dealers
- cattle farmers
- slaughterhouses
- meat processing companies
- meat dealers
- butchery shops

To these major groups of companies one sometimes adds two another ones, one in the beginning of the chain, namely the cattle feed producers, the other one at the end of the chain, namely companies specialized in the processing or recycling of slaughtered animals waste. Besides these major groups in the 'primary process' there are also some supportive services involved, like the inspection services, the veterinary surgeons and transport service companies. There is a sharp division at the one side between companies active in farming, processing and selling of meat. Within these subprocesses, however, specialization has been less developed and may differ from chain to chain. There are for instance special farms for pig breeding and for pig raising but breeding and raising may also be combined within one farm. There are specialized slaughter houses, but slaughtering and processing may also be part of one and the same company. Especially in poultry production this is the case.

The meat chain can be further divided into 'subchains' according to type of animal. In the Netherlands, the major subchains are cattle, pig and poultry production.

Production of sheep meat and horse meat occur only on a minor scale. The different subchains grossly have the same structure, but the relationships between the different parts of the subchains may be structured in a different way, varying from chain to chain. Up until now there is only limited information available about how chains are structured exactly, how relationships between the different companies within the chain develop and how these relationships are regulated and managed. Thinking in terms of 'product chains', 'chain relationships' and 'chain management' is a rather recent phenomenon and more systematic research in this field has been carried out only for a couple of years. Information is mainly available on the level of parts of the chain, e.g. groups of companies, as illustrated in the previous chapter.

3.2 Main agencies

Like other segments of agricultural production in the Netherlands, meat production is strongly regulated by governmental legislation and governmental agricultural policies. The government intervenes for a number of reasons. Firstly, agricultural production is an important factor influencing the quality of food products and thus the level of public health. An important objective of governmental policy is to safeguard the quality of food products. Secondly, agricultural production is also an important factor influencing the quality of the natural environment. Safeguarding ecological values is also an important objective of governmental intervention. A third interest of the government is in environmental planning. Agricultural production often occupies extensive space, which by nature is very scarce in the Netherlands. By legislation and planning procedures strict limitations have been set to the expansion of agricultural production. Fourth, there is a social-economic interest for the government in intervening in agricultural production. Agricultural production in the Netherlands is under heavy economic and social pressures and the government tries to define new ways for connecting ecological, economic and social values and for supporting the agricultural sector in the necessary process of transformation. So, the *national government*, in particular the Department of Agriculture, Nature Conservation and Fishery, is a major actor in the field. It organizes a.o. the Agricultural Policy Departments, the Inspection Services for Product Quality and what is called the major agencies of the 'Knowledge Infrastructure', e.g. the institutes for research, consultancy and education in agriculture. In the following paragraphs we will describe this knowledge infrastructure in a more extensive way.

A second type of agencies are the *sectoral policy agencies*. These are organized in a different way in the major subsegments of agribusiness.

- a. In agricultural production sectoral agencies are predominantly associations of farmers. There are the national organizations of farmers, but specifically relevant here are the so called Commodity Boards, e.g. associations of farmers grouped together according to the type of commodity they produce. In meat production the Commodity Board for Cattle and Meat is the most important association. Another one is the Commodity Board for Poultry and Eggs. These boards have several functions. At the one side they operate as a representative interest group of the associated farmers towards the government. At the other side they fulfill several supportive functions towards their members. The Commodity Board for Cattle and Meat for instance conducts activities in the sphere of market research, quality improvement and management consultancy.
- b. In the food and beverage industry sectoral policy agencies are predominantly organized according to the employer/employment-relationship. Here, employers and employee organizations are major policy agencies in the field. The employers are mainly organized according to branch. The employees are organized in two large trade unions, the Voedingsbond CNV (christian) and the Voedingsbond FNV (general), which cover the whole food and beverage industry. Employers' and employee organizations have arranged terms and employment, including some agreements on education and training, in a number of Collective Labour Agreements (CAO's). Partly these CAO's are concluded on branch level. Some of the big food processing companies, however, have separate CAO's for their own staff. As far as labour relations is concerned, the food industry generally is considered to be a pretty 'wild' sector. Labour conditions are often bad, labour turnover is high, labour regulations are often not observed, the degree of workers' organization is rather low, relations between the social partners are marked by conflicts in the past. This affects also the initiatives in the field of education and training.
- c. Generally, in the food retail trade sectoral policy organizations have also been less developed. Here, the big supermarket dominate the picture. In labour relations they negotiate directly with their counterparts, the trade unions in the service sector, who organize also a small percentage of workers in the retail trade. The butchery shop sector, however, is somewhat an exemption to this general situation. The sector consists of many smaller companies, who have established a relatively strong branch organization (employers). This branch organization acts as a binding force. It has developed together with educational institutes working in the field a relatively well functioning sectoral infrastructure for education and training in butchery shops.

So, we see that in the three distinguished segments of agribusiness - production, processing, trade - different sectoral policy agencies are active, which come from different traditions and have established different kinds of institutions and relationships. Agricultural production, i.c. meat production, is most 'sectoralized' as far as policy making is concerned. The employers i.c. the farmers, however, dominate the picture here and they are organized along the lines of product groups; workers are hardly represented on the sectoral level. In the food i.c. meat processing industry and the food i.c. meat retail trade, there is less activity on the sectoral level, although the butchery shops have a strong branch organization. On the whole, however, the large private companies dominate the picture here (Feijen, 1994; Van den Tillaart, 1994). We have to take these different situations into account when we discuss the role of sectoral training agencies in the transfer of innovations through the meat production chain in the following paragraphs.

4 Innovation in the meat production chain

4.1 Contextual developments

Like other branches in the Dutch agribusiness, the meat sector faces a number of general developments which will have major consequences for the organization of production and the structure of the sector in the future. Grooters (1994), citing an analysis of an advisory Committee on agricultural vocational education, summarizes these developments in the following way:

- a parallel tendency of an increase of scale and specialization
- a shift from primary production towards processing, i.e. growth of the agro-industry
- a stronger orientation towards 'durable agriculture' in order to protect environment and health
- a stronger orientation towards market-oriented production, with more care for safety and quality within the framework of 'integrated chain management'
- more attention for 'nature conservation' from an ecological point of view, in a balanced relationship to agriculture
- a larger interconnectedness with international developments.

According to Grooters, these developments will imply a growing complexity of agricultural production, a growing adjustment of agricultural products and production processes to next steps in the product chain, growing attention for quality issues and an extension of quality control from products to production processes and whole production chains and a growing involvement of values concerning ecological protection, nature conservation and animal health care, besides sheer economic values, in considerations and decisions concerning agricultural production. This will require a reorientation, even a transformation of the agribusiness sector and the agencies involved (Grooters, 1994).

Also in the sector of animal production, these developments have given rise to a discussion concerning the future orientation. The Knowledge Centre for Animal Farming has recently published a scenario study of the possible development of animal farming in the next century (Kolkman e.a., 1994; Van Woerkom & Le Rütte, 1996). Three different scenarios are distinguished. The first is a basic scenario in which actual trends will continue without major changes. Animal farming will

continue in family owned businesses as it is actually the case. Farmers will respond to new requirements with modernization, automation systems, increase of scale and specialization. Customer-orientedness, quality and ecological values will be integrated in business management. The number of companies and animals will gradually be diminished. The second scenario is called the 'industrialization scenario'. In this scenario the market becomes fully liberated, the sector will experience fierce competition and will respond to this by rapid increase of scale, specialization, industrialization of production processes and company management, rapid introduction of new technologies (biotechnology). Besides family businesses large holdings of companies will appear. Some sectors will not be able to stand competition on the world market, in other sectors only a number of larger top businesses will survive. The third scenario is called the 'austerity scenario'. In this scenario bulk production nearly disappears, agricultural production becomes regionally specialized, ecological cycles become important in organizing production, agricultural functions become interwoven with other functions like nature conservation and recreation, many farms will develop into farms of a mixed kind. Actually, it is not clear how things will work out in the future. It is clear, however, that the way things will develop will have major implications for both the innovation and the qualification processes in agribusiness.

4.2 Innovations in animal production

Traditionally, innovation in Dutch agriculture is strongly science-driven. Scientific priorities, i.e. priorities of fundamental and applied research and development, are set by the scientific communities and elaborated into R&D-programmes which are usually for a large part financed by public means. We will come back to this organization of innovation in the next paragraph. Here, we first want to discuss what innovations actually take place within animal production and in how far the considerations mentioned above are reflected in innovation programmes and priorities.

Recently two major Dutch R&D-institutes, the Nationale Raad voor Landbouwkundig Onderzoek (NRLO) en de Dienst Landbouwkundig Onderzoek (DLO), have elaborated a systematic overview of the new knowledge fields which are relevant for what they call 'durable animal production' (Visser e.a., 1997). They explicitly assess new developments in science and technology with regard to a number of 'desired goals': growth of world food production, adjustment of animal production to consumer demands and societal conditions; horizontal and vertical integration of production systems; improvement of the quality of the 'green space'; and

implications for primary production in terms of safety, quality and animal health care. They mention the following fields, which will provide major angles for innovation:

- biotechnology: transgenesis of animals, genoom analysis, improvement of reproduction technologies like artificial insemination and embryo transplantation;
- physiology: research into the stress-system and the immune systems of animals; animal food physiology; improvement of animal food products and animal food production and processing;
- measurement technology and instrumentation: application of micro-system and nano-system technology; development of biosensors and chipdiagnostics; applications of new vision, scanning and imaging technology in equipment;
- application of information technology, modelling and simulation techniques, f.i. in animal breeding;
- environmental protection technology: development of new energy sources, new techniques for handling of waste material;
- process, packaging and conservation technology: automation of slaughter lines; improvement of conservation, extrusion, sterilisation techniques; recycling of packaging material;
- medical-veterinary technology: application of microbiological knowledge and new vaccination techniques to raise disease resistancy;
- communication technology and social scientific applications: multimedia; new techniques for measuring and translating consumer demands.

According to the researchers, further innovation in these fields will provide the animal production sector with new chances for combining economic demands and ecological values in the sphere of environmental protection, health care, animal well-being and quality production. They explicitly plea for a reorientation of animal production in integrated product chains organized and managed on the basis of durable production (Visscher e.a., 1997).

4.3 Focus: quality improvement and animal health care

Quality issues already play an important role in animal production for a long time. Programmes for quality improvement have already been introduced in the eighties (Feijen, 1994). In later years, they have been connected with discussions concerning the improvement of production process control and product chain management. Recently, quality improvement got new impulses by placing it within the framework of 'animal health care'. Improvement of animal health care became a major issue in governmental and sectoral policies in the past two years, when both the cattle branch

and the pig branch were hit by severe outbreaks of animal diseases (respectively: crazy cow disease and swine fever). These caused great economic damage to the whole industry and lead to a lot of negative publicity and heavy criticism in the public opinion concerning the circumstances of agricultural production. The NRLO has declared animal health care to be the 'hamstring' of Dutch animal production. Development of adequate animal health care strategies, it argues, have to be one of the spearpoints of the research and innovation agenda for the next years (NRLO, 1997).

In a recent study, the NRLO has elaborated some of the basis implications of this reorientation towards 'sane animal production' (NRLO, 1998). Animal health care, it argues, has to be embedded in systems of quality management and these, in their turn, have to be organized on a cross-company level, i.e. on the level of the product chain. On this level requirements concerning animal health have to be defined and monitored. New technologies and information systems may support improvement of quality aspects in the diverse stages of production (early diagnostics, on-line measurement) and - the other way round - considerations concerning animal health may play a more important role in the design of new equipment and production systems in the future. Quality management on chain level and improvement of animal health care also require adaptations in the knowledge infrastructure, according to the NRLO. One pleas for the development of better strategies for animal disease prevention and management, the establishment of an expertise network for the epidemiology of animal diseases, the design of more integrated cattle breeding systems and the development of new educational programmes for epidemiologists and veterinary quality managers. Also, a fundamental restructuring of the organization innovation and qualification processes in agribusiness would be necessary (NRLO, 1998). We will come back to this point in the next paragraphs.

In a certain sense, all the new technologies mentioned in the previous paragraph may contribute to the improvement of animal health care and product quality. However, with the introduction of ISO and HACCP regulations, quality management and quality improvement became an innovation in itself in many agribusiness branches. The meat production sector was one of the first branches in which quality improvement programmes became connected with programmes aimed at integrated chain management. If adequate quality (and safety) on the market has to be assured, so the argument was, quality control can not be limited to control of (final) products, but has to be extended to control of production processes as well, and this not only within the companies at the end of the production process but throughout the whole product chain. In this sens adequate quality control requires adequate care for the animal from the beginning to the end, adequate monitoring and management of

processes in the diverse stages of production, an adequate organization of the product chain and an adequate exchange of information between the companies which are part of the chain. In this sense, quality improvement and integrated chain management became key concepts towards which innovations in product, process and system technology became oriented.

For practical reasons we can not discuss here the impact on occupations and qualifications of all technologies mentioned above in the meat production chain. We will concentrate on the impact of quality improvement and integrated chain management as the focal points for many innovations. We will further zoom in on the pig production sector, because this is the sector with the most experience in this field. Some of this experience has been documented (Willems, 1994).

4.4 Impact of innovations, as illustrated in the pig production chain

The pig production sector was one of the first sectors to put the above mentioned arguments into practice. In the mid eighties the pig production department of the Commodity Board for Cattle and Meat developed a system of quality control through integrated product chain management. Companies working within the chain could participate in the system on a voluntary basis. Under the assignment of the Board, Willems (1994) investigated the impact of the programmes for occupations and qualifications in the pig production chain. He also assessed the impact for secondary vocational education and training. We present some of his major conclusions here (for more details see Willems, 1994):

- An important conclusion is that there is a discrepancy between the discussion on integrated chain management on policy levels and actual practice on the level of companies. On policy levels chain management is seen as a new organization concept for the sector, within companies, as far as it is recognized, it is mainly seen as an element of the problem of quality management.
- Within companies participation in chains especially has consequences for management and for jobs in the sales departments (inputs, outputs). Participation in chains thus far is primarily exchange of information about products and production methods between companies.
- On company level no new types of jobs have been established related to chain management. Activities in this field are primarily organized within the framework of quality management. Modern systems of quality management (process monitoring and control across companies) may lead to the same results as which are intended by chain management.

- Within companies quality management affects the jobs of all workers, from upper management to the production workers on the shop floor. Tasks in this field must be integrated into their regular jobs.
- In a number of larger companies specific jobs in the sphere of quality control and management have come into being. Often, these jobs cover a broader range of tasks, like f.i. also tasks in the field of environmental care and care for better and safer work conditions.

Given these results, according to Willems, it is not necessary to develop whole new educational programmes. He suggest a stronger inclusion of quality and chain management issues in the programmes of initial vocational education, together with the development of an adequate supply of (short) continuing training courses for workers and some specific training trajectories for specialized quality supervisors and coaches (Willems, 1994).

Recently, Gielen (1995) has done a survey in which she looked especially to the impact of technological and commercial developments in commercial functions in the food retail trade. She particularly addressed the question of whether more food-technological knowledge (commodity knowledge, hygiene, commodity handling, conservation techniques etc.) was needed in jobs in food retail firms, in relation to the trend of selling more fresh foods in the shops and supermarkets. Her main conclusion is that this trend only has a limited impact on the activities of the staff in the shops. Especially, shop managers, distribution staff and regional managers are affected. Depending on the kind of trade formula, in some shops some specialization occurs within functions like fresh-food specialist and sales-specialist. On the whole, Gielen concludes, jobs are changing because more elements of quality care, communication and information exchange become incorporated, but the changes are not so severe that new types of educational programmes would be necessary.

4.5 Impact on higher level occupations

So, the impact of new technologies on the shop floor in the producing, processing and trading companies seems to be indirect and of a limited kind. More direct effects are visible in the higher levels of the job hierarchy, in particularly in the commercial and technical staff departments of the larger food companies and in supportive services like inspection services, research laboratories and consultancy firms. Here, new developments in food science and technology indeed do affect the jobs of many of the higher and often academically qualified workers. Recently, the sector of Higher Agricultural Vocational Education has restructured its educational supply and

concentrated its formerly fragmented programmes in six major occupational fields: product developer, process technologist, commercial manager, manager integrated quality care, production manager and laboratory researcher. Especially, the programmes for product developers, process technologist and quality managers contain new elements in the field of quality control. In the programme for commercial managers knowledge of product-chains and information exchange across chains are new points of attention (Van Woerkom & Le Rütte, 1996).

As we have seen earlier, the NRLO, pleads for the development of two new academic programmes to stimulate quality management and animal health care in meat production: specialised epidemiologist in animal diseases and veterinary quality managers. These programmes have to be developed in an interdisciplinary way. Not only technical knowledge should be included, but also knowledge concerning ecological, political, business management, ethical and social-organizational aspects of the problems should be given attention. Traditional borders between academic disciplines therefore should be partly broken up (NRLO, 1998).

5 The knowledge infrastructure

5.1 Main domains

Now, how did sectoral training agencies respond to these developments?

Before addressing this question we first have to give some information concerning the structure of the training systems and arrangements in agribusiness. In doing this we will use the term 'sectoral training agencies' in a broad sense. It will not only refer to training institutes in the traditional sense, but - broader - to all sectoral agencies who contribute in one way or another to the flow of knowledge in the sector, as regards the introduction of new technology, and who play some role or another in the development of qualifications in relation to innovation. In short, we will cover all agencies which are part of the 'knowledge infrastructure'.

In the Dutch agribusiness sector, the terms 'knowledge infrastructure' or 'knowledge system' are normally used to depict a configuration of agencies working in three major fields (Grooters, 1994):

- research and development (Onderzoek)
- consultancy and advice (Voorlichting)
- education and training (Onderwijs)

Traditionally, each of these fields is subjected to strong governmental regulation. There are special directorates for each field in the Agricultural Department. Activities in each field are usually programmed and planned by extensive policy procedures. Agencies are autonomous in the execution of programmes, but have only limited autonomy in strategical decision making. Programmes and activities are largely directly financed by public means, under the authority of the Department of Agriculture. Decision making in the whole infrastructure is rather centralized, with an important role of the central government and the central agricultural organizations. The infrastructure is typically based on a science-driven linear innovation model, which supposes direct lines from knowledge generation in research and development to knowledge application and dissemination in consultancy and education (Berkhout e.a., 1997).

This model is has become under severe pressure in recent years and has undergone important transformations, a.o. as a consequences of deregulation and

decentralization of governmental policies, privatization of functions and institutions, rapid (international) developments in technology and on the 'knowledge market' and the introduction of new concepts for organizing innovation and dissemination of new knowledge towards the companies (see f.i. a recent advice to the Minister of Agriculture - Commissie Peper, 1996). We will discuss this later on. First, we will give a picture of the different domains and the agencies active in these fields, following a recent study of Grooters into the perspectives of agricultural education and the agricultural knowledge network (Grooters, 1994; 1996, also Commission Peper, 1996).

5.2 Education and training

In the Netherlands, unlike education in other sectors, vocational education in agriculture is not organized and financed by Department of Education but by the Department of Agriculture. The central agencies for initial vocational education are the post-secondary agricultural schools (daytime education and dual education) and the schools for higher agricultural vocational education. We will focus here upon developments regarding the post-secondary vocational schools, because they deliver many of the employees working on lower and medium qualified jobs in agricultural production and the food processing industry.

During the nineties, in secondary agricultural vocational education a number of important developments took place, which changed initial education both regarding organization as well as content (cfr. Grooters, 1994).

- First, a process of concentration and integration took place. Formerly dispersed and often small agricultural schools merged into a number of larger Agricultural Education Centres (AOC's). These AOC's operate on a regional scale and integrate many different disciplines and types of education, a.o. daytime education and agricultural education in the framework of the apprenticeship system. In total, there are 21 AOC's in the Netherlands. With this construction, agriculture is one of the few sectors in the Netherlands (the printing industry is another one) which has not integrated its initial vocational schools in the multisectoral Regional Colleges for Vocational Education, which are promoted by the Dutch government.
- Secondly, new legislation was introduced which brought also agricultural vocational education under the regime of a national vocational qualifications system. In this system the qualification to be met with education are set by national standards. The route along which these qualifications are met is left to the schools and the trainees. In this way, the schools have got more opportunities to modularize

their training programmes and develop more tailor made training programmes for specific target groups.

- In the third place, the schools got more autonomy in the field of financing and policy making. They are now financed by a kind of lumpsum-system, which gives them more opportunities to develop their own policies, a.o. in the field of training programming, pupil tutoring, establishment of relationships with the business community etc.
- Fourth, by a new law the government opened up the opportunity for the agricultural colleges to work directly for the market, i.e. to offer (parts of) their training supply on a contract basis to interested parties. They now can offer also specific activities on a contract basis, like f.i. continuing training course for employees, consultancy services and applied research. In this regard, there is a certain overlap now with the activities of the traditional agricultural consultancy agencies.

In their activities, the AOC's can get help from a number of supportive services, like a number of 'Innovation and Practice Centres (IPC's) - there are three such IPC's now, one of them for cattle farming - and some educational consultancy services, f.i. for curriculum development, testing and training of teachers. Together with this support structure, the AOC's have the potential to become important agencies in the agribusiness knowledge infrastructure. In fact, one of the governments' objectives of the development of AOC's was to get more coherence between the three domains of research, consultancy and education. According to Grooters, however, this process is still in the beginning. One of the few fields where coordination between education and consultancy takes place, is in the field of continuing training courses. The AOC's have the primary responsibility for these courses (Grooters, 1994).

5.3 Consultancy and advice

The second segment of the knowledge infrastructure consists of the agencies for agricultural consultancy and advice. Grooters divides them into four types:

- agencies, related to the government: the Agricultural Consultancy Service (DLV), 3 Information and Knowledge Centres (IKC's) and the agricultural consultancy agencies of the Dutch provinces;
- consultancy services, related to the agricultural sector organizations, like f.i. consultancy services for social and economic affairs and for specific commodities,
- private consultancy firms, who operate on a commercial basis; these are mainly active in horticultural branches;
- consultants of private companies, mainly suppliers and food processing companies; they mainly give advices concerning specific products.

The Agricultural Consultancy Service (DLV) is an important actor in the field. It is often considered as the 'speaker' of the Department of Agriculture and many farmers have to do with it. Like education, also agricultural consultancy has been restructured in the past years. In the new structure the DLV primarily gives technical and economic consultancy to farmers. It is 'sectoralized' to a certain degree. There are 12 sectors now, governed by a sector council, consisting of representatives of both the business community and the trade unions. In every sector, teams of business consultants have been formed who do the actual consultancy work. The teams are spread over the country. Besides, there are a number of regional Consultancy Units, which provide consultancy on the provincial level, in particular concerning policy matters. These frontline consultancy services are backed up by 3 second-line Information and Knowledge Centres, for resp. agriculture and horticulture, cattle farming and nature, wood and landscape (Grooters, 1994). Like in education, we may conclude, also in agricultural consultancy a tendency of decentralization of activities towards the regional level is visible.

5.4 Research and development

The third segment is agricultural research and development. This is partly financed by the government, partly it takes place within the (larger) private companies. We focus here upon the public research agencies. Grooters (1994) distinguishes the following categories:

- agencies for fundamental agricultural research, i.e. the Agricultural University in Wageningen and some faculties of other universities;
- agencies for strategic applied research, these are mainly the different disciplinary units of the Dienst Landbouwkundig Onderzoek DLO (Agricultural Research Service);
- 10 experimental stations for applied, integrating research; these are organized per branch (f.i. the station for pig farming); the stations combine fundamental and disciplinary knowledge to develop new technologies which can be applied in the companies;
- adaptive research, i.e. adaption of new technologies to local circumstances, done on a number of regional research centres; these are also organized per branch and often coordinated by the experimental station in their branch; usually they also deploy demonstration activities.

An important development which takes place in this sector is the partial privatization of research. In particular the DLO has been placed in a more distant position vis-a-vis the government by changing it from a policy directorate into an executive service, by

giving it more autonomy in this way and by stimulating it to broaden the financial basis through the establishment of partnerships with the business community. Contract research on a commercial basis, both at the Universities and the DLO, is expected to increase. The research of the experimental stations and the regional research centres is already partly financed by contributions of the business community (Grooters, 1994).

5.5 Infrastructure under pressure

According to many experts this coherent knowledge infrastructure, outlined above, has contributed a lot to the success of Dutch agriculture in the past (cfr. Grooters, 1994; Commissie Peper, 1996; NRLO, 1998). It has made it possible that Dutch farmers could keep up with changes in products and production systems and that several agricultural branches could develop a strong position on the world market. This success, however, so it is argued, has also its shadow side. The agricultural sector as a whole, and within it the agricultural knowledge infrastructure, has developed too much into what sometimes is called a 'closed system', too much inward looking, too less able to tackle fundamental 'non-routine' changes in an adequate way. The term 'the green front' depicts this situation. Some experts argue that what once was an advantage may become a disadvantage in future years, if the system is not able to open itself for new developments and chances, covered by expressions like 'global competition', 'quality production', 'durable production', 'economic-ecological balance' and 'integration of agriculture, nature and culture'. In a recent study of long-term perspectives for Dutch agriculture the NRLO envisages a fundamental transformation, including a transformation of the knowledge infrastructure (NRLO, 1998). We will discuss the opinions concerning this long-term response and its implications for education and training in the next paragraph.

6 Response of education and training agencies

6.1 Limited level of sectoralization

A typical characteristic of both the agriculture as well as the food and beverage industry and the food retail trade, is that they are 'sectoralized' only to a limited degree. Each of these three segments of the economy not so much constitutes a 'sector', as for instance in the case of the installation sector or the car repair sector, as well as a conglomerate of branches, with often very different economic activities. Agriculture for instance covers such diverse activities like cattle breeding and glasshouse horticulture. The food and beverage industry covers meat, vegetables, drinks etc. production and processing. The food retail trade even covers a much larger diversity of products and product groups. Besides, agriculture consists of many, only loosely organized small businesses, whereas both the food production and food retail trade are dominated by a few number of (very) large companies.

This heterogeneity of economic activities is one of the reasons why sectoral institutions have been developed in a less extensive way than in many other segments of the economy. That also holds through in the field of continuing vocational training. Continuing vocational training is less organized on the sectoral level as well as on the level of initial education at the one side and the level of companies or groups of companies at the other side. This means that also the adoption of innovations and qualification of employees with regard to innovations is primarily a matter of initial educational agencies at the one side and the companies themselves at the other side. An exemption on this point, however, has to be made for agricultural production. Here, as we have seen, a whole intermediate infrastructure for the transfer of innovations from the field of research toward the companies has been developed.

We will go on to discuss now the response to innovation in respectively agriculture and the food industry and retail trade. We will discuss them separately because in these different segments different response strategies can be distinguished. We will focus upon direct responses to innovation, especially in the field of quality improvement. More fundamental, systemic, responses as they occur actually in agribusiness under the influence of chain and network thinking will be discussed in the next paragraph.

6.2 Agriculture

In agriculture, for a long time, a linear model of innovation has been dominant. In this model transfer of innovations, developed in the research domain, was assured in two ways. Firstly, through the specialized transfer agencies, like experimental farms and farming consultancy services; these directed themselves towards farmers, active in the field. Secondly, through the initial educational institutes, which take care for the qualification of both new farmers and agricultural staff. With regard to quality management both of these agencies have adapted their services. The transfer agencies developed special consultancy services in the sphere of quality management for farmers and organized special quality improvement projects. We have discussed already the projects of the Commodity Board for Cattle and Meat concerning integrated chain management and quality care. The vocational schools incorporated quality issues into their regular training programmes for young forthcoming farmers, particularly into the programmes on primary and secondary level. The qualification structure of LOBAS, the national organization of apprenticeship training in agriculture and food processing, now has special basic education routes for 'quality care cattle and meat' (level 3), 'quality care meat and meat-processing' and 'quality management meat chain' (level 4). The schools for higher vocational education also have developed special programmes for quality specialist and quality managers, to be deployed either in the companies themselves or in external inspection services and laboratories.

Besides, the educational agencies have developed a number of short courses on quality, for continuing training. The level of continuing training in agriculture is rather low, however. There is a special fund for the financing of continuing training, but this is not used in an optimal way. Many farmers are self-employed and many farms are one-person businesses. Farmers often deploy family members as workers, but seldom have a personal staff. In general, especially in meat production, farmers and farm workers are not very training-minded, according to experts. They do engage themselves in learning processes, however, but mostly this is learning in a more informal way. They get their new knowledge not so much from training courses, as well as from collegial and professional sources in their direct environment, through the farmers' associations and through the farmers consultancy services.

6.3 Food industry and retail trade

In the food industry and retail trade, large companies dominate the picture. Here, training in relation to new processes and new production techniques is often tackled

through in-company training programmes, designed by in-company training staff (cfr. Feijen, 1994; Van den Tillaart, 1994). The same holds through for training in quality issues. As it has been said earlier, quality is an issue in the companies for a already a long time, in particular in the meat industry. Government regulations, legal consumer protection measures and the introduction of ISO have given major impulses to tackle this issue. Several companies have introduced procedures for total quality management, accompanied by intensive training efforts. Feijen (1994) describes f.i. the introduction of quality training programmes in a large Dutch meat processing company. Here, the whole production staff got a training programme, specifically adjusted to the needs of the company and the learning capabilities of the workers. The programme was a mix of elements of vocational education programmes and specific in-company modules, developed by the companies training staff itself. One of the major aims was to raise workers quality conciseness by giving them more insight into the basic elements of the products and the processes and by learning them to overview the whole of the production process, not only their own part of it, so that they could oversee the consequences of their own mistakes for steps further on in the process. Besides, workers were trained to execute several quality controls, formerly done by specialists, themselves. In such types of in-company training, in particular in longer trajectories, sometimes elements of external courses, f.i. module of apprenticeship courses or tailored courses offered by the agricultural schools and apprenticeship institutes, are incorporated.

In general, continuous training in the food industry and retail trade are on a relatively low level. Compared to other sectors, they belong to the sectors with the lowest degree of workers to be trained annually - in-company ways of training included (CBS, 1996). Partly, this has to do with the low degree of qualification in the sectors. Many employees have left school on an early age and are only qualified on a basic or lower vocational level. An important factor may also be the high rate of labour turnover in the sector, in particular the meat processing industry. This industry has a bad image, not in the last place because of its relatively bad labour conditions. There are companies in the industry with annual turn-over rates of more than 100 percent. Such high rates do not stimulate investments in training.

Innovations in the food industry and retail trade are mainly absorbed in the higher levels of the job hierarchy, i.e. by the in-company staff departments for research, product development and process control, and by higher management. These persons get their basic qualifications primarily through initial higher vocational education. These schools for higher education increasingly offer application courses in new technology on a contract bases. In an number of cases, the schools or certain disciplines within them (food technology, process technology) have established

relationships with companies or with other knowledge institutes in their discipline (University Wageningen).

6.4 Résumé

So, in sum, we can say that the focal points in the training in response to innovation in agribusiness are not laying on the level of the sector but rather on the level of the initial vocational schools, the intermediate consultancy services and the farms and (bigger) companies themselves. Training fulfills primarily a reactive role in relation to innovation and is of minor importance for the majority of farmers and workers. In general, we may say, agribusiness is primarily involved with innovation, qualification comes in the second place.

7 Towards a transformation of the system?

7.1 Need for change

As we have said earlier, according to many experts, the way agribusiness deals with innovation and qualification was successful in the past but will no longer be a guarantee for success in the future. Growing internationalization and competition on world scale, increased technological innovation, new policy regulations in the sphere of product safety and quality, new demands concerning ecologically responsible production and environmental protection and higher demands from customers in the diverse segments of the markets, require a reorientation and perhaps even a transformation of Dutch agriculture into the direction of 'durable production' (Commissie Peper, 1996). This will also have major implications for the knowledge infrastructure. Recently, the NRLO has organized a debate among experts and interest groups in order to assess these implications and to develop a view upon the new arrangements for innovation and education which are needed to cope with the threats and challenges facing agriculture in the next years. We will discuss some basic proposals of the NRLO here, because they provide a good illustration of the way sectoral agencies may reposition themselves with regard to new developments in their environment (NRLO, 1998).

Point of departure of the NRLO is a choice for pluriformity in agribusiness. This will give the Dutch agribusiness the best chances in the future. Pluriformity will probably become more visible on policy level, with a more pronounced balancing in policy making of economic and technical against ecological, country planning, socio-cultural and ethical values. Pluriformity will also become more visible on company level, in a greater diversity of company types. For instance, in meat production, very different types of companies are foreseen to coexist in the future. Dijkhuizen & Horst (1997), for instance, distinguish the following types:

- companies aiming at cost leadership, i.e. large scale companies or holdings of companies, who control earlier parts in the product chain and form a direct counterweight against the large supermarkets; in particular in pig production such companies may come into existence;
- special product companies, i.e. companies concentrating on niches of the markets, like f.i. eco- and bio-production or production of regional specialties; this is a real option for cattle farmers;

- firma cattle raising, i.e. companies which raise cattle for a whole new objective, namely the production of organs and human medicines, these farms will be closely related to the pharmaceutical industry;
- agriculture in nature conservation areas, i.e. companies who not primarily have an economical function, but are part of the broader natural-cultural environment.

It is clear that these companies are very different with regard to products, production system, company management and economic-ecological function. We may presume that they also will require different approaches with regard to innovation and qualification.

We want to stress that the vision of the NRLO is only one vision. However, it is the result of a number of in-depth studies of specific problems and an extensive consultation of a great number of experts in the field. We will give extra attention to the implications of this vision for the position of the education and training institutes in agribusiness and for their relationships with other agencies in the knowledge infrastructure.

7.2 From chains to networks

Thinking in terms of agrochains has contributed a lot to the reorientation of Dutch agriculture towards more market-oriented production in the past years. This is f.i. illustrated by the establishment of a new agency in this field: the Stichting Agro Keten Kennis AKK (Agro Chain Knowledge). This agency was established a few years ago, supported by the Dutch government, and has as the major objective to strengthen the 'chain knowledge infrastructure'. It is a research and development agency which has the task to generate more knowledge concerning specific agrochains through projects, carried out in public-private partnerships. Involvement of companies in the projects will stimulate cooperation between researchers and entrepreneurs and will strengthen the bonds between knowledge institutes and the business community. The AKK deploys activities in four connected fields: information and promotion of chain knowledge, education and training, development of chain information systems, and management consultancy. Its major research areas are: chain strategy and organization, chain management, chain marketing and agrologistics. A substantial part of its budget goes to projects in the meat production chain. Actually, for instance, a project is conducted which tries to detect the image-determining factors of porc meat. Besides the Commodity Board for Cattle and Meat, several companies from the total meat chain participate, as does the Agricultural

University. The AKK collaborates with many other companies and institutes, a.o. the Centre for Agro Chain Knowledge of the University of Wageningen (AKK, 1998).

According to the NRLO, thinking in terms of agrochains did contribute to a reorientation of agribusiness in the past years, but 'rigid agrochain thinking' will not be sufficient anymore in the future. There are two reasons for this. First, consumer markets will become still more differentiated and unpredictable (mass-individualization, momentary consumerism) and, so argues the NRLO, 'this will require from agribusiness the development of new forms of organization, responsive, flexible innovative networks, in stead of rigidly organized product chains'. Secondly, the agricultural sector has to strengthen its relationships with other sectors, in particular the industrial sector, some service sectors, and the transport and distribution sector. This also can be done by the establishment of new, innovative network forms of organization. So, the NRLO concludes, 'In this context, the future is not for (vertical) chains but for a conglomerate of responsive, flexible organizations, which continuously will establish new (vertical, horizontal and diagonal) alliances' (NRLO, 1998).

7.3 From linear to interactive innovation

In this context, the traditional model of linear innovation will be replaced by a model of interactive innovation (cfr. also Berkhout, e.a., 1997; Gielen & Nieuwenhuis, 1997). In this conception there is more attention for all kinds of feedback mechanisms in the innovation process. Innovation not only takes place at the beginning of the 'technology chain', i.e. in the research institutes, but it may also spread of from the market or from initiatives in the 'community of practitioners', which is active on the market. Particularly innovations of a less fundamental kind may have their origins in companies or groups of companies, which work with or develop certain processes and products. Also, engineering and consultancy firms, sometimes collaborating with companies, may contribute to the further development of new technologies. Exchange of information through joint bodies may provide feedback from the sector or the market towards agencies responsible for research. Demands from practitioners (companies, engineering firms, consultancy institutes) becomes to give more impulses towards fundamental research and product development. Interactions between producers and consumers of knowledge become more important.

Examples of such interactive processes in innovation are already visible in some branches of Dutch agriculture, in particular in horticulture. Famous is f.i. the organization of innovation and learning in glass house horticulture (cfr. Grooters &

Nieuwenhuis, 1996; Nieuwenhuis & Grooters, 1997). Here, groups of farmers have developed forms of self-organization in the field of innovation and learning, by establishing 'study circles' in which they discuss new methods and techniques and exchange experiences concerning the results in their companies. Gradually, these product-oriented networks have extended and have included also experts from consultancy firms and educational institutes. The farmers' networks generate a lot of practical information, which in its turn can be used by research institutes working for the field. Actually, these forms of networks are particularly relevant in agriculture and horticulture. In cattle raising and meat production more centralized and linear chain thinking appears to be still dominant.

7.4 From product- and process-innovation to system-innovation

In the past, Dutch agriculture has strongly rested upon product- and process-innovation in order to improve the efficiency and quality of its products and production systems. Typical for product- and process-innovation, however, is that they go on in a rather incremental way. Usually, small innovations are introduced which focus on specific aspects of a product or a production system (f.i. new additives, receipts, measurement equipment, monitoring devices etc.), Their objective is usually an improvement of the existing systems.

According to the NRLO, such incremental innovation will be no longer adequate in the future, regarding the problems Dutch agribusiness faces at the moment. These problems require more fundamental, systemic, innovations, which exceed the level of companies and the short time interests of the business community. System innovations put existing technical systems into question, take fundamental problems as their point of departure and develop strategies to tackle these problems from a variety of values and perspectives, in close cooperation with the variety of actors in the field. As examples of system innovation the NRLO refers f.i. to the need to design new company systems from a multi-value perspective and the need to develop integrated animal health care strategies (NRLO, 1998).

Because of its radical consequences, system innovation is a complex matter, which requires new concepts and new forms of organization of the innovation process. The NRLO pleads for the establishment of '*innovation creating networks*', in which a multitude of actors/agencies involved in certain branches of production work together. In such networks researchers and practitioners participate, so that scientific knowledge and practical knowledge can be combined and interaction between interaction between experts and 'problem owners' in the field can be organized.

These public-private networks can direct themselves towards creation of new knowledge, but also towards information exchange, exchange of experiences and development of new combinations of available technologies (NRLO, 1998). In the promotion of animal health care strategies, for instance, within such a context a programme could be developed, which includes a.o. assembling of data concerning animal diseases in practice, modelling of better health care strategies, execution of pilot projects on farms and systematic evaluation of the experiences by scientists (NRLO, 1997; 1998). In such an approach researchers and stakeholders closely cooperate in tackling a major problem in the meat production chain.

7.5 Positioning of education and training institutes

It is clear that such a radical reorientation of innovation and learning, as it is envisaged by the NRLO, will also have major consequences for the interrelationships between the major domains and agencies of the knowledge infrastructure (see chapter 5). Grooters (1994) perceives major problems in this regard, on the basis of his research into opinions of major actors concerning the perspectives of the agribusiness knowledge system. At the one side, he concludes, for many experts it is clear that the traditional institutional division between the three domains of research, consultancy and education ('OVO-drieluik') can not be sustained. There is too less coherence and cooperation between the three segments. Agencies in each field focus too much upon their own domain. Several governmental measures (privatization, more market regulation) have already blurred some borders between them, but, at the other hand, it is not clear what will replace the traditional institutions. The network concept is a powerful alternative, Grooters argues, but the traditional agencies - and behind them: the interest groups they represent - are still dominant in the field and the community of practitioners is still not organized well enough to counterbalance their influence in an adequate way. With the growth of public-private partnerships, the influence of the business community in the knowledge infrastructure will increase and this will bring with it the risk that - through the back door - traditional agribusiness interests will continue to dominate developments. As a consequence, Grooters pleads for a rather distant position of the agricultural educational institutes in this situation, also vis-a-vis newly developing knowledge networks. In the first place, he argues, agricultural education should try to bring order in its own domain. It should take the major problems Dutch agriculture faces at the moment as its point of departure and broaden its view towards a societal reorientation of agriculture. '*Country development*' should be the new leading concept for the definition of target groups and the programming of training trajectories. In practice, this would imply more distance toward the traditional target groups: the (potential) agricultural farmers, and broadening of training

programmes from merely 'technical' training toward programmes which can support 'durable agriculture' (Grooters, 1994).

In a recent study, Gielen & Nieuwenhuis (1998), specifically discuss the position of the agricultural vocational schools (AOC's) in relation to the newly developing structures in agricultural innovation. They explicitly take the concept of the '*regional knowledge network*' as their point of departure. The regionally oriented AOC's, with traditionally strong bonds with the companies in their environment, may occupy several positions in such networks: deliverer of qualified staff, provider of training courses for staff, external provider of knowledge on specific company demands, participant in regional knowledge networks and partner in in-company learning processes. In the newly envisaged configurations (like f.i. the NRLO foresees), in which companies themselves become important actors in knowledge development and innovation, the AOC's could potentially develop themselves into regional knowledge centres. On the basis of research in a number of AOC's, Gielen and Nieuwenhuis, conclude however that in actual practice AOC's are less committed and equipped to fulfill this role. The AOC's, thus far, mainly discuss these issues, they seldom take active measures. They mainly strive to become participants in regional networks. They mainly focus on playing a role in knowledge transfer by way of their continuous training programmes: 'The AOC's are and will not be real regional knowledge centres, but the challenge for them is to become valued co-players in regional knowledge networks' (Gielen & Nieuwenhuis, 1998).

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ISBN 90 5554 090 0
NUGI 835, 684

