

Environmental innovations in the product chain

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Abstract:

Innovation is a distributed process involving several stakeholders, especially in Denmark with a lot of small and medium-sized companies. The enterprises are very much dependent on collaboration and knowledge sharing within the product chain as well as close relations to the knowledge and regulatory network. For environmental innovations the development in the environmental discourse has made this characteristic more conspicuous considering the product oriented environmental policy. Theoretically, the paper gives a brief overview of different positions within innovation and network theory, and on that basis a framework is developed and discussed in relation to environmental innovations. Empirically, the paper highlights how enterprises within two different trades in the Danish food industry have made environmental innovations related to their processes and products. An investigation has been made with in-depth case studies of seven dairies producing organic milk and of ten fish processing industries. The internal characteristics of the enterprises have been analysed related to environmental understanding, management style and the most important environmental innovations in a five-year period. Besides, the inter-organisational relations of the firms are analysed in a network context. Furthermore, the cases will be discussed in relation to the institutional set-up, the inter-organisational relations, actors in the product chain, the flows of materials and services, values and money, communication and collaboration in the two product chains.

The importance of creating long-term inter-organisational learning has received increasingly attention in innovation and network theory to cope with dynamic and more global business conditions. An investigation of organisations in Europe and North America showed that supply chain networks are becoming increasingly complex and global and their management is becoming an increasingly important business issue (Kielkiewicz-Young & Young, 2001).

In a Danish context, technology competencies and customised products play an important role in the competitiveness of Danish industry. Furthermore, there is a high degree of small and medium sized companies, and as Håkansson (1987) points out co-operation is one way for these companies to mobilise external resources lacking within the specific company. In many ways Danish companies are thereby forced to cope with innovation as a distributed process between several actors in the product chain, as well as in the knowledge and regulatory network of enterprises.

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In the specific case of environmental innovations, the co-operation in the product chain is important to secure innovations of cleaner products, as an improvement in one part of the product chain can cause environmental problems in another part of the product's life cycle. In this line, Kerndrup et al (2003) view environmental management and planning as a polycentric activity, taking place in settings of knowledge and capabilities dispersed on many actors. Furthermore, experiences from environmental innovations in product chains show that innovative solutions are developed by communicative acts between similar and complementary fields of practice (Kerndrup, 2002).

In this paper, co-operation in the product chain will be exemplified through empirical case studies of environmental innovations in the dairy and fish processing industries respectively. The empirical material presented in the paper is based on the POET-project (Product innovation, Organic food, Environment and Technology). The aims of the project were to make an investigation of Danish food industries regarding:

- understanding and concepts of *sustainable food production*,
- the factors influencing the innovation of new *food products*, and the possibilities for expanding the quality concept to include concerns for the environment, etc.
- development of *methods* to integrate environmental concerns in the whole life cycle of food products, including life cycle assessment, screening and design criteria,
- *collaboration and communication in the product chain and in the knowledge network* in the sector about environmental issues and development of food products.

This paper will especially focus on environmental innovations and product chain collaboration. The theoretical framework for considering collaboration in the product chain within the food industry is drawing on innovation and network theory taking a learning perspective as the point of departure.

Collaboration in the product chain – a conceptual framework

In general, innovation theory has moved towards a higher emphasis on innovation as an interactive process (see Lundwall, 1998). The term systems of innovations established in the collective work on “Technology and Economic Theory” (Dosi et al, 1988) highlight relationships and interactions between agents from inside and outside the product chain. These relationships were presented as organised markets with elements of power, trust and loyalty (Lundwall, 1985). The system of innovation approach can be further described in the following way (Edquist, 1997):

“The innovation process is characterised by complicated feedback-mechanisms and interactive relations involving science, technology, learning, policy and demand. Innovation processes occur over time and are influenced by many factors. Because of this complexity, firms almost never innovate isolated. In the pursuit of innovation they interact with other organisations to gain, develop and exchange various kinds of knowledge, information and resources.”

Recently, innovation theory has put more focus on processes of learning and the importance of the companies' capabilities to collaborate. Lundwall (1998) argues that there is an increasing need for social capital to follow the trajectory of globalisation. Among others he refers to Woolcock's definition of two basic elements of social capital in considering the micro level: Firstly, the need to combine strong internal cohesion (integration) and, secondly,

the openness to the outer world (linkages). Woolcock (1998) also points out that there is a need to see these two elements as combined.

Furthermore, it is important to analyse *the type of innovations*. According to Freeman (1992) a theory of innovation must embrace both the innumerable incremental innovations and the radical discontinuities. In the case of incremental innovations the changes can be expressed as change in the input and output of *existing* products and processes. Radical innovations cause structural change in the economy and ultimately lead to entirely new industries. Radical innovations set new demands to skills, the organisation and different types of production equipment.

Besides distinguishing between incremental and radical innovations, it can be pointed out whether the innovation activity emphasises changes in the production processes or in the product – commonly referred to as process or product innovations. This view must, as Freeman (1992) also note, be seen in relation to other kinds of technological changes referring to changes in the knowledge base and the organisation. The framework of collaboration in the product chain covers these issues.

Network theory has also moved towards a learning perspective, as described in more details by Hagedoorn and Duysters (2002). In the efficiency perspective on networks it has been argued that there is a diminishing utility of added linkages in general because of the increase of redundant information. Instead focus is on the utility for adding the “right” kind of linkages to well-established stakeholders. In contrast, a learning perspective on networks takes a different point of departure. Here the scope of the interactions is not to collect existing knowledge, but to learn different ways of doing things, and the high status player may not be the most relevant connection in that concern. Actually, a variety of sources may be an advantage in seeking new potential partners and alternative solutions.

Kerndrup et al (2003) talk about networks of practice as loose coupling of people working with the same type of practice but in different settings – their day-to-day practice is not connected. There is so to speak a cognitive distance between the actors in the network. Therefore, it is rather complicated to bring communicative acts across fields of practice, because there is a need for a common frame to translate complex and ambiguous information and knowledge in a way that makes sense in different fields of practice (Kerndrup et al, 2003).

In this perspective the focus is not only on the actors involved in the network, and the flow of materials and values in the product chain. The focus is more process-oriented emphasising the chain of activities connecting the actors and the transfer of situated experiences between different organisational settings.

This understanding of communication and collaboration in the product chain can be illustrated in the following way, defining the main actors involved as well as the activities (see figure 1).

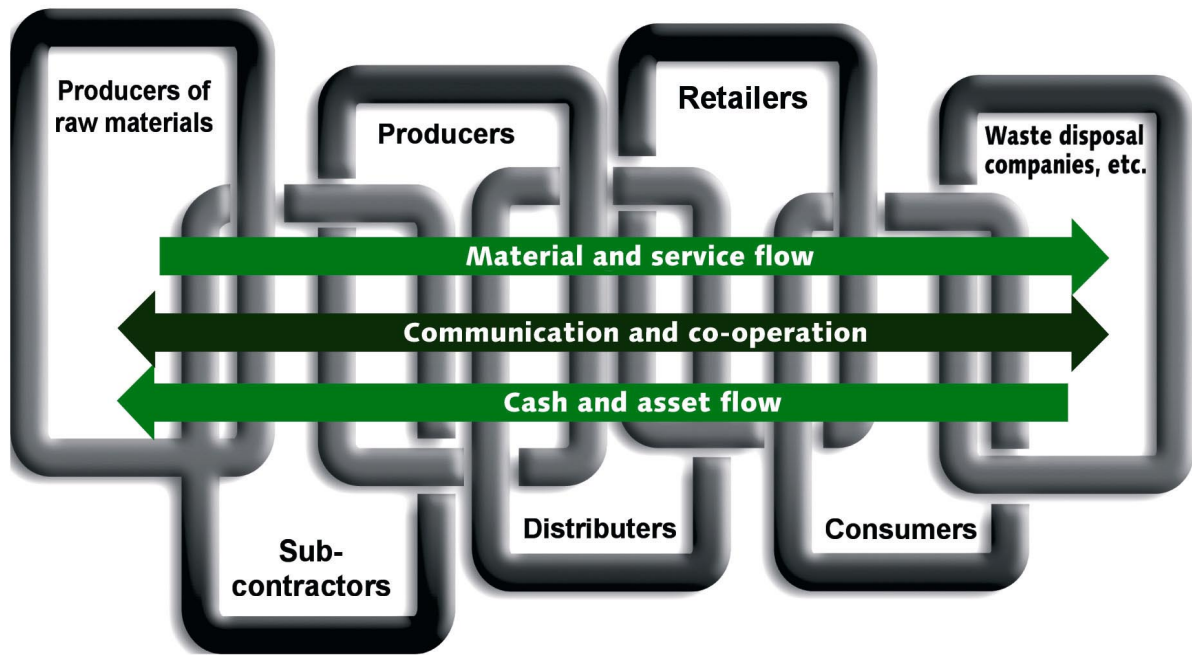


Figure 1: Communication and collaboration in the product chain (Remmen & Münster, 2003)

The framework is inspired by Christoffer (1998) who defines supply chain management as a network of collected and independent organisations mutually and co-operatively working together to control, manage and improve *the flow of materials and information* from suppliers to end users (Christoffer, 1998). Besides, the framework is similar to the definition of Integrated Supply Chain Management (ISCM) used at Massachusetts Institute of Technology where ISCM is seen as a process oriented, integrated approach to procuring, producing and delivering products and services to consumers covering the management of *material, information and funds* (Metz, 1998). In these perceptions, the flow of information is viewed in a traditionally way focusing on data exchange and delivering of orders. The notion of communication and collaboration in the product chain in figure 1 expresses a more learning based understanding involving the ongoing process of experience exchange and co-ordination of the activities in the product chain. Informative means like environmental product declarations, eco-labelling, etc. are documentation of the material flow and a necessary but not sufficient condition for collaboration on environmental issues. As pointed out above, collaboration requires dialogue and communication in order to create a common meaning, a mutual understanding and trust.

Another source of inspiration has been Håkansson (1982 & 1987) who defines three different but closely interrelated networks: the network of resources, activities and actors (Håkansson, 1987). The activity- and actor-network highlights the understanding of flows between actors as an exchange of practices and experiences beyond information exchange. The actors in the product chain can in this perspective be seen as a network of interested parties that at one point in the product chain has an ownership or a responsibility for the product, whether it is connected to semi-manufactured articles, materials, the end-product, or services.

The network of activities is closely related to the flows of materials and values. But as Håkansson points out the human resources of knowledge and relations are also a part of this network, which makes it necessary to focus on the dimension of communication and collaboration as in figure 1. Another interesting point is the concept of exchanging episodes

used in describing short term relations, where long-term relations are defined as institutional adaptations, which can be seen in parallel to the notions of communication and collaboration.

Håkansson (1982) points to the importance of viewing the interaction between organisations in their context, and in describing this context he distinguishes between the inter-organisational *atmosphere* and the surrounding environment. The atmosphere is defined within the inter-organisational sphere considering the power/dependence, co-operation, closeness and expectations. In defining the *environment* Håkansson uses market structure, dynamism, internationalisation, position in manufacturing channel and the social system as constituting factors.

Finally, Søndergaard et al (1997) have highlighted that a product chain or the business network as they call it has to be seen in relation to the knowledge and the regulatory network, see figure 2. This approach has inspired a redefinition of what Håkansson calls “environment” to the institutional context as constituted by the institutions of regulation and knowledge. However, the business network has an institutional set-up of its own, as Håkansson points out by referring to the market structure. In this context we will use the more comprehensive notion of market institutions.

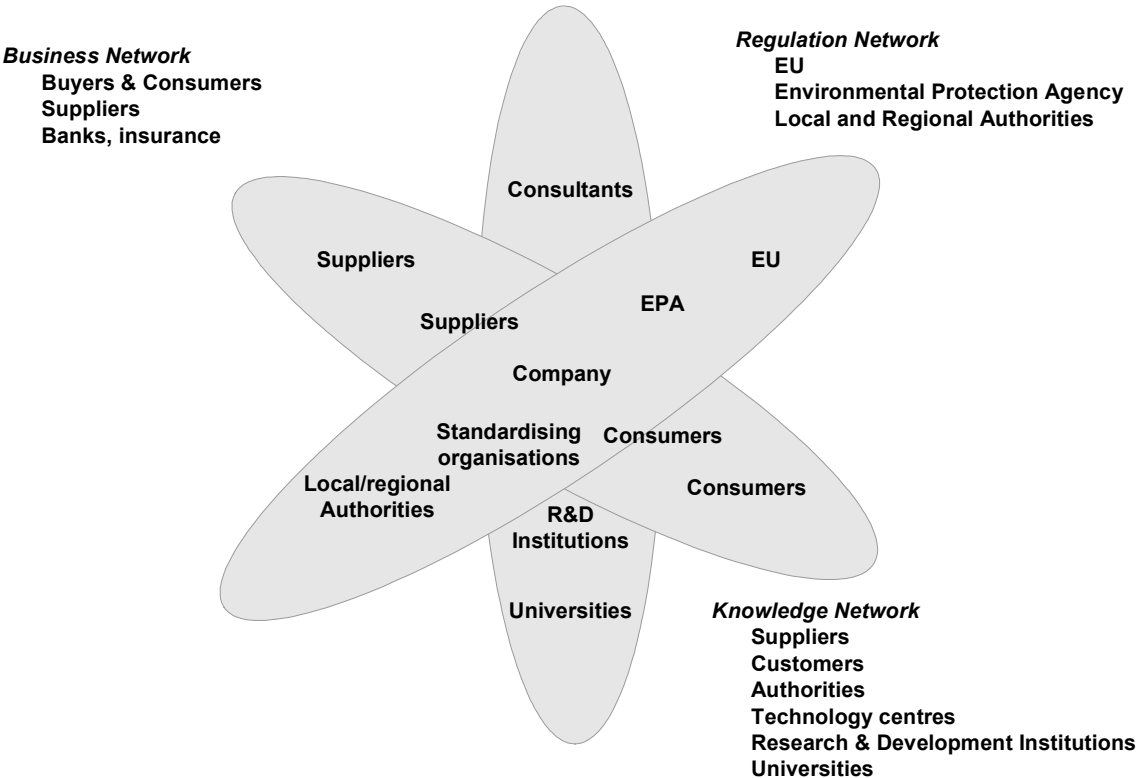


Figure 2: The business, regulation and knowledge network (Søndergaard et al, 1997).

This rather short introduction has highlighted the following concepts in order to investigate collaboration in a product chain:

- *The institutional set-up* of the product chain is constituted by the regulatory, knowledge and market institutions.
- *The actors in the product chain* are seen as a business network of interested parties, who at one point are transforming or adding value to the product, and who have different kinds of knowledge and capabilities.
- *The flows of resources* are including the flow of materials and services downstream and a value and money flow upstream the product chain.
- *Communication and collaboration* are interactive processes in order to exchange, document and co-ordinate the activities in the product chain, and which involve learning.
- *The inter-organisational conditions* are constituted of power relations/dependency, co-operation, closeness and expectations as well as trust, loyalty and credibility.

Environmental innovations as network activities

From the mid 1990's it was recognised that the environmental efforts within the companies were not sufficient, as the main environmental problems were regarded to be the general resource consumption in society and the impacts from the use of products (Wenzel, et al, 1996). Beside production, other phases in the lifecycle of products were highlighted, such as extraction of materials, transportation, use and recycling of products.

As for the types of innovations focus has changed from mainly process innovations towards product innovations, and to some extent there is an increasing awareness that some environmental problems e.g. related to transportation can only be reduced through radical and systemic innovations.

The environmental discourse has changed from a focus on the environmental impacts from production to lifecycle management (LCM) focusing on impacts in the whole life cycle of the products. Cleaner production, environmental management and life cycle assessment are together with product chain and network co-operation the cornerstones in LCM (Remmen, 2001). The life cycle perspective confronts the companies with new challenges, as the environmental initiatives have to be co-ordinated throughout the product chain.

Life cycle management can be seen as an umbrella for different concepts trying to capture the product chain dynamics related to environmental innovations. Responsible chain management is one notion, defined as managing issues of responsibility across the life cycle where responsibility is based on sincere expectation to act in a desired way (de Bakker & Nijhof, 2002). The focus is the capability to meet the interests of the stakeholders, but social, environmental and ethical dimensions are also connected to this concept. Another notion is sustainable supply chain management (see Charter, 2001) emphasising that the environmental and social aspects have to be seen together with the economic aspects of purchase. Hall (2000) uses the term environmental supply chain dynamics to show how environmental innovations diffuse from firms putting demand to their suppliers.

In the following we will line up some characteristics of changes in the environmental discourse in relation to the framework developed in the previous part.

The institutional set-up

Awareness of environmental problems and solutions is constantly undergoing changes as a result of inadequacy of the previous approaches and in recognition of new problems and possibilities. Until recently, the awareness of environmental problems mainly focused on resource use and emissions from the production process like smoke, waste and noise. However, the environmental awareness has increasingly been extended to cover the entire production system and the product life cycle, including the choice of materials and design, transport, as well as the use and disposal of products.

In a Danish context, regulatory institutions like the Danish Environmental Protection Agency (DEPA) have focused on different means in order to improve the environmental performance of industry, and have furthermore supported the capacity building of a knowledge network consisting of consultants, universities, etc. The institutional set-up has – until recently – improved the conditions for environmental innovations of cleaner processes and products in the firms (Remmen, 2000).

However, the focus in the product oriented environmental policy in Denmark in the mid 1990's has had a point of departure in a rather instrumental platform, emphasising the development of tools for life cycle assessment, and informative means like ECO-labelling, guidelines for including environmental criteria in public procurements, etc.. The main assumption has been: If the enterprises have the right tools, they will develop cleaner products. If the consumers – including public purchasers – have the right information they will buy and increase the demand for cleaner products.

However, practical experiences have showed this has not been the case. The firms are only to a limited extent using LCA as a tool (Broberg et. al, 1998). The demand for eco-labelled products is rather limited – with some organic food products as the exception that proves the rule. Furthermore, an investigation of 500 Danish companies indicated that the market driven pull in industry today is far from sufficient to respond to the environmental problems (Madsen & Ulhøi, 2001).

Since the late 1990's and up till now the product oriented policy has had a comprehensive perspective with more attention to actors and the market, e.g. by introducing product panels involving key stakeholders in a trade with the aim to kick-start the development and marketing of cleaner products. This policy has among other themes resulted in projects with focus on collaboration in the product chain.

The actors in the product chain

More actors have become involved in environmental management, as the focus has been extended from preventing environmental impacts of the production to innovation of cleaner products in a life cycle perspective. Besides management and employees in the production, also designers, product developers, purchasers, logistic, and marketing people become necessary in a product-oriented environmental effort (Remmen, 2000). The designers and product developers play an important role, as many environmental problems can be prevented already in the design and construction of the product. The role of the purchasers is to evaluate the environmental standard of the companies' suppliers and to be up-dated regarding more environmentally friendly materials and technologies. Development of cleaner products that never makes it to the market is a waste. Therefore, participation of the marketing and sales department is a precondition for diffusion of cleaner products (Remmen & Münster, 2003).

The importance of creating organisational conditions for synergy between the environmental function and other functions involved in the formulation of the business strategy has been stressed by Cramer & Schot (1993). With focus on innovation of cleaner products it can be questioned whether collaboration and synergy are enough. Such a comprehensive environmental perspective makes it necessary with an integration of the business and environmental strategy of the firm, where environmental issues are transformed to be an integrated way of doing business and involving all departments as well as product chain and network relations. However, as Cramer & Scot (1993) also point out innovation processes most seldom occur within the single company but between companies in an interplay. In the case of cleaner products, suppliers, customers and consumers have to be integrated in the traditional environmental network consisting of environmental authorities, business associations, auditors and management consultants (Remmen, 2000).

The flow of resources

The manufacturing, distribution, use, recycling and/or disposal of products are mainly seen as a flow of materials and services – a supply chain. One challenge is to change the open material flows to a close cycle with a high degree of reuse and recovery of old materials as resources in new products as well as reducing the amount and speed of exchange of materials between nature and society.

In the environmental debate attention has been given to the development of tools like LCA and to informative means like eco-labelling. The focus has been on the documentation of the environmental impacts of a product. However, in a life cycle perspective it is just as important to focus on the value flow related to the demands of consumers and how they consider the product (Remmen & Münster, 2003). So far the value chain had rather little attention in the environmental debate and, consequently, there is also a lack of tools and investigations.

For a specific company the challenge is to tight the product chain together in a way that creates synergy between the environmental optimisations of the material flow, and the expectations of the customers in regard to the money and value flow. One of the means to combine these flows in a comprehensive way is environmental communication and co-operation in the product chain (Remmen & Münster, 2003).

Communication and collaboration

The exchange, documentation and co-ordination of activities in the product chain constitute communication and collaboration and these processes can be viewed in a learning perspective. The differences between information, communication and collaboration can be seen as cumulative levels of learning. As Håkansson (1986) puts it, the dynamics of interaction are shown by the fact that it can be perceived as a learning process.

In the context of cleaner production Vickers & Cordey-Hayes (1999) see organisational learning as the process of organisational awareness recognising the potential benefits of information inputs by associating it with organisational needs and capabilities. The relevant information is afterwards communicated and assimilated within the organisation and applied for competitive advantage. Four types of learning can be distinguished (Vickers & Cordey-Hayes, 1999):

- *Learning by doing* in manufacturing as a result of optimisation of the production process.

- *Learning by interaction* as a result of contacts between supplier and contractor, or other external sources of knowledge and expertise.
- *Learning by using* as a result of feedback from users.
- *Learning by learning* where organisations develop the ability to be reflexive, such that institutionalised monitoring becomes an embedded characteristic.

The understanding that “doing” is only taking place in production, and “interaction” only in the relations to external stakeholder, etc. is quite simple. Doing, using, interaction and reflections on learning are taking place in all phases of the product chain as well as in the relations and linkages among the different stakeholders. This understanding of learning corresponds to the framework for organisational learning set up by Nancy Dixon (1999). The organisational learning process is similarly defined by four steps: collection and distribution of information, integration of this in a specific organisational context, collective interpretation of the information by the organisational members and actions taken on this basis. Experiences from the actions taken by the organisational members are compared to new information inputs and the process of organisational learning begins once again.

This understanding of organisational learning especially focuses on integration of information, but as pointed out this is a too narrow understanding of the dynamics in the product chain. Information is one-way e.g. transmitting environmental data from one company to another. Communication is learning by interaction, e.g. collaborating with the end-users in a product-development process. Using the notion of communities of practice Wenger (1998) emphasises inter-organisational communication. A community of practice has a common interest and engagement in solving a specific problem that brings members together - and this might also imply a relationship across organisational limits. Thereby, communication becomes a matter in both organisational and inter-organisational relations.

The inter-organisational relations

Cramer & Schot (1993) talk about environmental co-maker-ship consisting of two steps, where the first step is exchange of environmental information between firms, and the second is placing environmental demands on suppliers by firms. In many cases, more environmental pressure is exercised by customers on their suppliers (that is, upstream) than by suppliers on their customers (that is, downstream), as customers often hold the balance of power in a customer – supplier relationship (Hill, 1996). One important impetus for customers to exert environmental pressure on their suppliers is legislative pressure (Hill, 1996). In the matter of the inter-organisational relations of *power/dependence* it is clear that the customers demand for cleaner products plays an important role, and in that relation trust and a common “language” in the product chain are important for the exchange of sometimes sensible information and experience.

However, Cramer (1996) uses the concept of Integrated Chain Management, which opens up for a higher agency at the supply side. Producers can have a significant role in changing the perceptions on the market, e.g. through intensive marketing of cleaner products. This can be initiated by unfulfilled expectations from downstream in the product chain, giving the producer a potential competitive advantage. Also differences in the environmental knowledge throughout the product chain can influence the power/dependence relations when it comes to co-ordinating environmental innovations.

For some companies informal relations will be adequate to exchange information on an ad hoc basis. For other companies a formalised co-operation or partnership will be necessary to

secure co-ordination and commitment in the product-oriented environmental activities. Such a formalisation can be practised by creating an inter-organisational working group taking responsibility for co-ordination of the environmental activities, knowledge sharing, and exchange of experiences and information (Remmen & Münster, 2003). If the companies create such *closeness* /proximity in the inter-organisational relations, they facilitate a community of practice, where existing values and norms can be questioned and a common ground for environmental practice can be created.

One of the pre-conditions for creating such a relation is building up mutual trust by meeting other *expectations* through commitment. Such an engagement involves a mutual problem solving under considerations of the specific organisational interests. As Håkansson (1986) points out, all inter-organisational relations have elements of both mutual and conflicting interest and their relative importance depends on how the companies view each other. Two different kinds of expectations can be distinguished depending on whether these are directed towards the content or the form of collaboration (Holgaard, 2003). Expectations to the content are increased if the members perceive the former exchanged environmental knowledge as relevant and competent. Whereas expectations towards the form of the collaboration are strengthened, if the members act in accordance with the culture and structure of the community e.g. the created norms and values, the used methods and the formal decisions made in the community of practice. But also due to different perceptions of future outcomes, actors will act in certain ways (Gadde & Håkansson, 1992).

Innovation and network activities in the organic dairies

One of the cases in the investigation of cleaner products in the POET-project was the product chain of organic milk, with an empirical, in-depth investigation of seven organic dairies, of which three of them also have a considerable conventional production. One company has around 14.000 employees; but otherwise the dairies are small companies with 10-50 employees. In the following section, the case studies will be described in line with the conceptual framework outlined in the previous sections. Where nothing else is noted the description is based on Ingemann et al (2000) and Thrane et al (2000).

The institutional set-up

In 1987 the Danish Parliament passed an act on organic farming, and among other things introduced a label for organic food products in 1990. The red Ø label guarantees that the production is organic and is monitored by state inspectors. This label has created the foundation for the increase in the production and sale of organic food products. The criteria for the ECO-label are focused on the impact from the primary production, which is the organic farming, whereas the regulation only vaguely addresses other phases in the product's lifecycle. For example the ECO-label does not cover environmental impacts from the production at the dairies or the amount of transportation used in delivering the product down-stream the chain.

The regulatory network has been important in promoting organic farming through the organic label and the inspection. However, this initiative was strongly influenced by the pioneers in organic farming and their association (LØJ – Landsforeningen for økologisk Jordbrug) setting criteria to organic production that was nearly the same in the final Act on Organic Farming in 1987. An important explanation for the market boom from 1993 was that the main supermarket chain – FDB/COOP – changed their pricing policy so the difference between traditional and organic milk narrowed down.

The market is characterised by a low export/import rate and a market structure with one large company and a handful of small organic dairies trying to stay in business by competing on organic products. The large company is dominating the market by having its own distribution system, a high degree of power in the business association, the resources to make an intensive marketing of its products and the size to make different types of products. The co-operation and exchange of knowledge between the dairies is limited, and some of the small firms are not connected to any organisation in the trade. Also the relation to research institutions is quite limited for the small dairies, however, some of them are occasionally using consultants.

The actors in the product chain

Up-stream the chain, the organic farmers are closely related to the dairies, as most of the dairies are cooperatives and have some of their suppliers in the board of directors.

Downstream the chain, the retailers have played an important role in increasing the market share of organic food. In 1993 the market for organic food products changed drastically in a relatively short period of time, due to an intensive marketing campaign and a different pricing policy among the retailers. In the beginning, these initiatives mainly came from the Danish retailer chain FDB (Forenede Danske Brugsforeninger – the COOP), which invested 1 million Danish Kr. in an information campaign stimulating sales of organic food, but later the same pricing policy spread to other retailers due to the interest from the consumers.

The consumers' understanding of quality is the key to a higher market share for organic milk. The consumers are gradually moving towards a broader perception of food quality. Some consumers go beyond focusing on traditional product parameters as taste, convenience and food safety, and are also considering the production methods to some extent including ethical, social and environmental concerns (Nielsen & Kristensen, 1996). In this way quality is changing to an immaterial sphere and product quality can no longer only be sensed by smelling, tasting or looking. The "hidden" quality has to be communicated to the consumers.

The investigation of the organic dairies resulted in a distinction of three different profiles among these seven dairies:

- The first type was primarily driven by an economic rationality, where the organic dimension tended to be a mean more than a goal in itself. The product and process innovations related to organic milk were limited.
- The second type was motivated by an economic rationality but an ecological understanding was also present. The product and process innovations were prioritised as a way of differentiating on the market for organic products.
- The third type was driven by a strong ecological attitude closely related to their private "way of living". The product and process innovations were prioritised, but also social concerns had a high priority in their way of "doing business", e.g. making initiatives to engage people in urban areas.

In general, the ecological understanding was related to the primary production and informally integrated in the organisational culture in the small dairies (only one had an environmental policy). The large firm was more focussed on organising and documenting a systematic environmental effort.

The traditional flows

The flow down-stream the chain is beginning at the organic farm, continuing to manufacturing at the dairies. The dairies also take care of the marketing and distribution to the retailers. The retailers sell the product to consumers, who use it in the households and afterwards put the packaging material in the waste. This flow is shown in figure 3.

At the organic farm two primary types of production take place: cultivation of plants and animal production. The output from cultivation of plants is vegetables, fruit and corn for sale or feed for animals, e.g. beets, clover and green fodder. In the animal production a part is for meat-production and the other part is for producing secondary products as milk and eggs. For organic milk with the Danish State controlled ECO-label, the production of fodder has to be organic. Furthermore, the milk must not be homogenised, that is the particles of fat are to keep their normal structure (Økologisk landscenter, 1998). After manufacturing the organic milk is distributed to the retailers. A small amount of organic milk is sold directly from the farms or the dairies. The consumption of the milk is then taking place in private households, industries and public institutions.

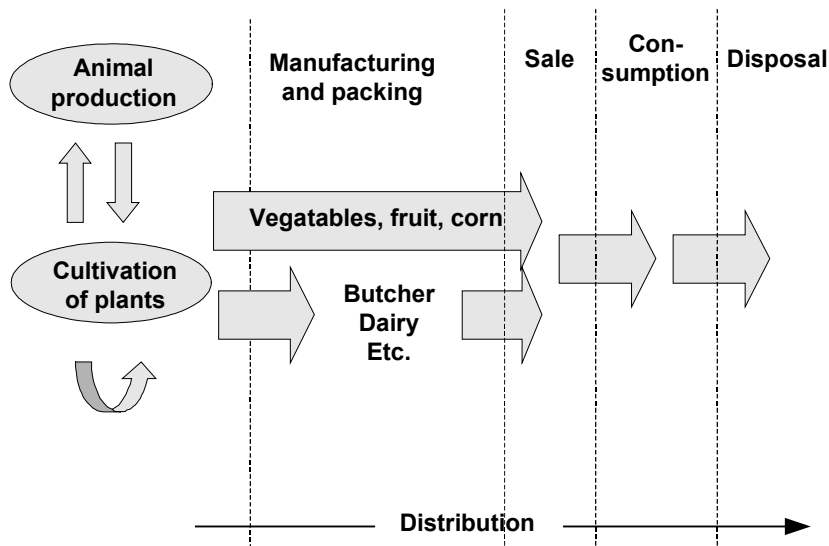


Figure 3: The traditional flow downstream in relation to agriculture products.

From the mid 1990's there was a considerable increase in the market for organic products indicating a change in the preferences of the consumers. For example, the number of organic farms in Denmark increased by a factor eight, the square metres of organically cultivated land increased by a factor 150 and the organic milk production increased by a factor 20. This was due to initiatives of the state, the organic farmers and the retailers. Furthermore, conventional farmers and food industries have integrated organic methods into part of their production, and this tendency has been most prominent in the dairy sector (Ministeriet for Fødevarer, Landbrug og Fiskeri, 1999). At a certain point in the mid 90's, which was said to be the first time in the history of Danish agriculture, the organic farmers and dairies could not meet the market demand from the consumers. To some extent this has increased the focus on product innovation and the need "to have an ear on the market" in the food industries. Today the picture is to some extent the opposite: The production of organic food is higher than the demand, and for that reason the organic farmers are paid a lower price from the dairies.

Communication and collaboration

The small dairies are nearly all cooperatives, and this means a strong tradition for partnership and very close communication and collaboration between the organic farmers and the dairies. The managers of the minor dairies described the relation to the farmers as positive regarding knowledge exchange and periodic meetings in the board. A manager of one dairy also had private relations to some suppliers, which strengthened the trust and mutual collaboration. Besides, the close collaboration between primary and secondary producers is followed up by monitoring and control systems to secure the quality of the milk, e.g. by reflecting quality in the price paid for the milk.

With regard to the suppliers of machinery and cleaning, the managers of the dairies had a positive collaboration and exchange of knowledge with them, but environmental issues were seldom on the agenda. This also seemed to be the case in the collaboration with the retailers, which was oriented towards the traditional flows in the business network. The knowledge exchange was mainly in connection to unexpected problems, and often the concern was traditional quality features and the position to deliver. The retailers do not have a tradition to serve as a link of information and knowledge exchange from the consumers to the producers.

Close contact to the consumers was stressed as an important source of information, e.g. through market investigations, feedback from the consumers by email or by demonstrations of the product in the stores. Here, the organic farmers took part in presenting their own product, and at the same time in giving the history of the products to create a proximity between the primary producers and consumers. Only the large dairy had an intensive marketing of organic products, trying to affect the attitudes of the consumers via commercials in television and newspapers.

An overall evaluation of the communication and collaboration in the chain of organic products showed that the weak links in environmental communication were related to the retailers. Only one chain of retailers showed interest in an environmental dialogue within the product chain and in preparing information to the customers, which went beyond ECO-labels. Learning by interaction in inter-organisational communities of practice was only present in the co-operation between the primary and secondary producers, besides initiatives to demonstrate the ecological products to consumers.

The inter-organisational relations

The knowledge of organic milk is most often concentrated in the primary production. In cases where organic farmers have a role in the board of the dairies their knowledge was also reflected in the secondary production. However, the focus on primary production seem to have an important role in defining quality, as working conditions and environmental impact from the production and distribution are not a main concern. One of the reasons is perhaps that small dairies do not need an environmental approval from the authorities.

Many consumers are lacking information to value the criteria for organic products, and therefore demand for specific features of quality is not common. The choice of buying an organic product is related to sporadic information given in the media and a matter of life-style – and in both cases it is a question of trust to the actors in the product chain. The prices of organic products are higher than of traditional products and therefore the arguments for buying organic products have to be much more rooted in the consumers' perception of quality and health. A trend is that the organic producers try to compensate for the "missing link" of information from the retailers by putting a fair amount of information on the products. Today,

it is quite common that an organic farmer tells the story about his/her farm and motivation to produce organic products. In some cases a picture from the farm is shown in order to create a feeling of proximity to the primary producers.

Closeness and trust seem to be an important part of the inter-organisational relation among the minor dairies, and for some it is a decisive condition for their presence on the market. For example one dairy has only one customer, and a good relation to that customer is therefore essential. However, even though many minor dairies complain about the conditions on a market dominated by one large company, there have not been initiatives towards stronger collaboration between the minor dairies. One reason is that they are afraid of being caught in the middle – being too big to have proximity to their suppliers and consumers, but too small to compete with the large company dominating the market.

The types of innovation activities

A new institutional set-up has been created to regulate organic food products, and therefore Ø-labelled products can be seen as a radical innovation. At least it has resulted in different types of marketing and financing, different types of input and a different pattern of productivity gain. The value-flow from the customers has changed to consider the hidden quality of the products including the willingness and the information to choose an organic product even if the price is higher. However, this green consumerism did stagnate in the end of the 1990's, and still most consumers are buying traditional products at low prices.

Even though there has been a considerable change in the market institutions of dairy products, the changes in the production processes at the dairies are quite limited. Because of the small scale of production it is likely that the environmental impacts are higher from the production process in organic dairies compared to conventional. This is partly due to the emphasis on the primary production in the regulation and labelling of organic dairy products. Furthermore, the lack of resources to invest in environmental innovations and the small administrations in the minor dairies make barriers to a systematic environmental effort with continuous environmental improvements.

However, some of the minor organic dairies are trying to differentiate themselves on the market by making incremental process or product innovations. To reduce the environmental impact from the production, the emphasis has been on improving the working environment and reducing the use of resources. But only few of the minor dairies are working with this in a systematic way, except from one dairy having an ISO 14000 certification like the large dairy. The innovation of organic dairy products has been at the incremental level, transforming traditional products to organic and at the same time improving the quality of the products. In that way traditional products have been supplemented by organic alternatives in other types of dairy products, e.g. cheese and butter. Especially, Thise Dairy has used the knowledge that milk from different kinds of cows has different qualities and therefore has to be used to different purposes like cheese, butter, etc. Only, one example of a more radical product innovation was found in one of the minor dairies using goat milk for the production of ecologically sound products.

Innovation and network activities within the fish processing industry

The empirical investigation of the product chain of fish products in the POET-project consisted of in-depth case studies of ten fish processing industries. Three companies have less than 50 employees, four less than 200, and three have more than 200 employees. In the

following we will describe these studies in line with the conceptual framework applied in the last section. The description is based on Thrane (2000a & 2000b), if nothing else is noted.

The institutional set-up

The regulation of the Danish fish sector can only be understood in relation to EU-policy on resource conservation, modernisation of technology and market conditions. The means to regulate the fish stock have mainly been normative by setting quotas for the catch of different kinds of fish and economic support to renewal of the vessels. The regulation is highly focused on primary production. The EU regulation has been criticised for its complexity, its limitation in reducing the number and capacity of the vessels and a lack of consideration regarding sustainability issues.

In a Danish context it has been considered to label fish products in order to give the consumers a possibility to choose an ECO-friendly fish product. However, this process has stranded in discussions on criteria. The business associations in the sector have been reluctant, as they consider the environmental impacts from fishing as insignificant compared to other environmental impacts on the ocean. Furthermore, they fear that “non-labelled” products will be met with suspicion by the consumers.

In general the fish sector in Denmark is characterised by relatively few and old organisations. The focus on environmental issues is limited and emphasis is on having influence on future regulations. However, in the 1990's a couple of organisations were founded with a specific focus on promoting more sustainable fishery and a cleaner ocean. Landsforeningen Levende Hav (The Danish Society for A Living Sea) and Fiskernes Økologiske Netværk (The Fishermen's Ecological Network – www.ecofishery.com) are two significant non-governmental organisations. Only few knowledge institutions related to the sector are dealing with the environmental impacts and development of cleaner products. The notion of sustainability is not new in the fish sector, apart from aspects of resource exploitation.

The market for fish products is characterised by a high export rate – most of the fish landed in Denmark is exported, approx. 95 %, and 80% of it to countries within the European Union. The Danish fish sector is under pressure from different kinds of competition. Firstly, the international competition has increased due to the opening of the market and due to more imported semi-manufactured products. Also products like chicken and turkey are increasingly being competitive to fish products. Secondly, a centralisation among the retailers has taken place and their possibility to put pressure on the primary and secondary producers to lower prices has increased. Thirdly, the amount of fish resources is decreasing, causing the regulatory authorities to set up fish quotas. Finally, the Danish fleet of fishing boats is relatively old, and therefore investments will be needed within a limited period of time.

The actors in the product chain

There is no tradition for cleaner technology in the primary production, e.g. developing new fishing methods. Seen from the perspective of the fish processing industry, the fishermen are emphasising the amount and quotas for the different fish stocks and neglecting the environmental dimensions. The fish processing industry have made some demands to the fishermen regarding quality, but it is difficult to motivate the fishermen to begin a dialogue, as they have no problems in selling the legal amount of fish.

Instead, the initiative to environmental activities has come from fish processing industries, and more than half of the companies visited had an environmental effort beyond compliance.

Four of the companies had a certified/registered environmental management system and three of the companies had some experience with life cycle assessment. However, the understanding of environmental problems and solutions was closely related to the companies' production process. A few companies have potential for increasing the environmental co-ordination up-stream in the product chain, as they also own the vessels.

As in the case of organic agriculture products, some of the retailers have taken initiatives towards promoting fish products of higher quality, also considering environmental concerns in the fish processing industry. Retailers as Marks and Spencers and Unilever are rating the companies' environmental performance via environmental audits. The German and Austrian purchasers have been concerned with environmental impacts related to the packaging materials. Danish retailers are also showing an interest in the quality of products. Several firms point to FDB as a frontrunner in the case of agricultural products. The manager for environment and quality in FDB thinks that the consumers will be positive towards ECO-labelled fish products, but they have to be informed about the criteria for the label.

In general, there has been increasing awareness among the consumers about environmental impacts related to the products, indicating a potential market for "ecological" fish products. In an analysis of 65 Danish and German retailers, based on interviews with purchasers of fish and pig products, it was concluded that the importance of the price was decreasing due to changes in consumer attitudes. Thereby the 4Ps (price, product, place and promotion) may not be sufficient to stay in business. Trust, liability and creation of long-term relationships are becoming more important in the future business to business relations (MAPP, 2000), even though the price-aspect is still important for many consumers.

The traditional flows

The product chain from sea to table includes activities in fishing, auctioning, manufacturing, distribution, trade and use of the products. The disposal is mainly connected with packaging materials. A simple picture of the flow of materials downstream the chain is shown in figure 4. This picture is more complex when it comes to information, e.g. there is a low possibility of following a particular fish from sea to table, and information regarding traceability is lost, besides what can be seen, felt or tasted.

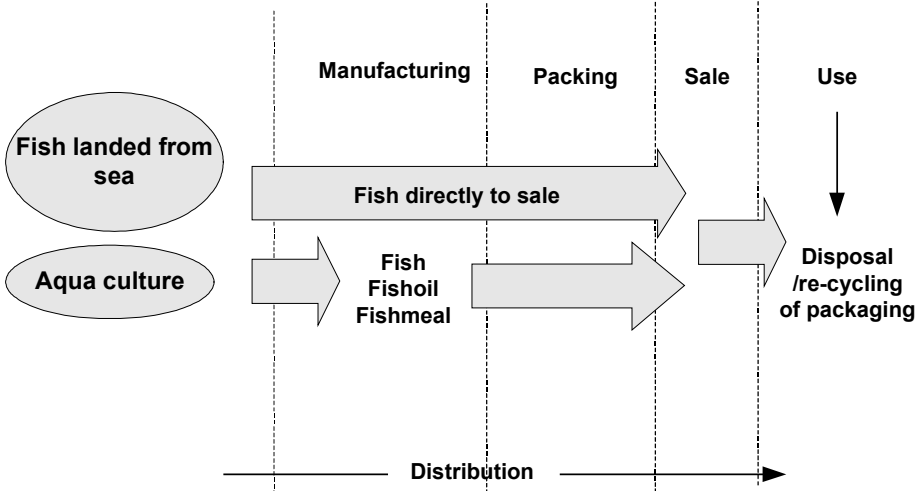


Figure 4: The traditional flow downstream related to fish provision.

Most fish are caught by the use of trawl, which is an energy consuming type of fishing. Depending on the fishing method and way of treatment there will be a certain by-catch and discharge of fish and other animals/plants. Also in aqua-culture there is a waste of resources, mainly due to the use of fodder. Fish from sea is typically landed close to or transported to the fish processing industry and a decreasing amount of fish is sold on auctions. Mackerel and herrings are sent directly to manufacturing, and the same is the case for fish used for production of fishmeal and fish oil.

The next link in the chain is the fish processing industry, where one part is semi-manufactured and exported, while another part is manufactured to finished goods. After that the fish is distributed to the retailers, eventually through a wholesale dealer. The transportation means are important in relation to the quality of the fish, but also related to the environmental impacts in a life cycle perspective. After that the fresh fish or the fish products are sold in supermarkets, specialised shops, and to professional kitchens like restaurants, hospitals, etc. During the use phase there is some environmental impact in relation to the storage and preparation of the fish, e.g. due to energy consumption, discharge of wastewater and disposal.

Several companies have noticed a higher emphasis on environmental concerns. Even though there is a market for high quality fish products, the companies stress that the price is still the most important competition factor on the Danish market and likewise for Eastern European markets. In other words, a dual trend is noticed with both a discount-market and a high quality market. In total, the money-flow has increased from 1993 to 1998, where the economic value of the fish landed in Danish harbours increased from 3.12 to 4.23 billion Danish Kr. (landings from national vessels were about 80%).

Communication and collaboration

Closer and more long-term relations between the primary and secondary producers are a pronounced tendency, and mainly with quality in the traditional understanding on the agenda. One fish processing company has an environmental management system according to EMAS (EU's Environmental Management and Audit Scheme), and has tried to set environmental demands to their suppliers. However, in general the fishermen are perceived as reluctant and hard to convince to an environmental effort.

The collaboration with other suppliers, e.g. of machinery is positive in the case of knowledge exchange, often resulting in cleaner technology and a better quality of the product. In relation to suppliers of semi-manufactured products, there has been knowledge exchange in order to prevent GMO and dioxin in the products. One of the companies was auditing some of the suppliers of salt and had prepared evaluation schemes in relation to their environmental performance. However, the companies' interest at this point is to evaluate whether the suppliers have a matching environmental attitude, more than it is an evaluation of environmental data (the amount of GMO and dioxin was an exception).

Collaboration is far from being a tradition in the fish processing industry, but the companies seated in the town of Skagen have had success with such collaboration. First of all, many companies have implemented environmental management systems and thereby they got a common reference for discussing environmental problems and solutions. According to the industry they now also see each other as colleagues and not only as competitors. Secondly, the collaboration is also on the operational level with co-ordinated strategies in several areas, e.g. introduction on new markets like China.

The relation to customers on environmental issues is rather limited, and there has not been a pressure in this area, but there is general control of the performance of the manufacturers. There are a few examples, e.g. discussions to make the packaging material more environmentally friendly. Regarding product innovations in general, collaboration was seldom among the small and medium-sized companies. However, one large company collaborated with several retailers on arranging meetings and brainstorming on potential product improvements considering the market situation. The contacts to consumers were even more limited, and the marketing effort in relation to new product development is limited.

The inter-organisational relations

Most of the companies consider trust as a parameter with increasing importance, but they focus on a selected group of customers. One of the companies separates the customers into three types: dialogue customers, basic customers and secondary customers. With dialogue customers the company has a relation based on mutual interests and trust. The same tendency is seen among the retailers in the case of FDB in their collaboration with suppliers. The result of this strategy among the retailers can be that the suppliers have to consider social capital in business to business relations.

An understanding of fish-products as beneficial to your health has been dominating. In Denmark, the fish industry has tried to increase the consumption of fish through an intensive campaign. The campaign ran from 1996-1999 with a total cost of 110 million Danish Kr. and was financed by the European Union and the Danish government. In a positive view investigations showed that the campaign did increase the consumption of fish. On the negative side this campaign has not motivated a differentiated understanding of the quality of fish products, and this can be a future barrier for introducing “ecological” fish products.

The power-dependency of the customers of the fish processing industry is also important as they compete on the international market. The European retailers have been centralised and this has strengthened their power-position on the market. The ten largest chains of retailers have about one third of the sale of food products in Western Europe (Fiskebranchen, 1999). Therefore, the strategy of the different retailers concerning organic products has a high importance.

The types of innovation activities

The overall impression of the fish industry was that the fish processing companies were innovative and creative in making process innovations. Especially, the small and medium-sized companies have made several environmental process innovations. The focus is on cleaner technology in order to reduce the use of energy, water and raw materials. As mentioned, half of the companies have a certified/registered environmental management system and three companies have some experience with life cycle assessment.

The results from this effort have been considerable. Nielsen (2000) has analysed the reduction of organic material and the reduction of water consumption from five Danish fish processing companies in the period from 1989 to 1997. These companies have reduced the kg COD per ton raw material with up to 80% and the m³ of water per ton raw material with up to 50%. Actually, in some companies the process innovations have been so radical, that the possibility of reducing resource consumption any further is considered to be limited, because this will then influence the product quality.

The tradition of making process innovation is strong, but this is not the case for product innovations – also in comparison with the dairy industry analysed in the previous section. In the small and medium-sized companies many changes in the product were caused as an effect of process innovations. However, these spin-offs are mainly incremental changes, e.g. de-skinning of herrings.

Most companies investigated are sub-suppliers to other companies, and this is a considerable barrier for product innovations, as the fish processing companies do not want to compete with their customers. This power dependency is an important explanation in order to understand why the producers hesitate to make product innovations.

Concluding remarks

In this paper we have analysed organic milk and fish products by using a comprehensive framework for collaboration in the product chain, constituted by the following elements:

- *The institutional set-up* of the product chain is constituted by the regulative, knowledge and market institutions.
- *The actors in the product chain* are seen as a network of interested parties, who at one point in the product chain has responsibility for the product.
- *The traditional flows* including the flow of resources (material and service) downstream the product chain and a value and money flow upstream the chain.
- *Communication and collaboration* is interactive – “running” upstream and downstream, exchanging, documenting and co-ordinating the activities in the product chain.
- *The inter-organisational relations* are constituted of power/dependence, co-operation, closeness and expectations.

The collaboration in the product chain has been seen in close relation to the environmental innovations in the two product chains, whereas the *type of innovation activity* in the two industries also has been a part of the investigation.

In the product chain of organic milk there has been a huge effort in order to develop and diffuse organic milk products; especially concentrated among the primary producers. The environmental focus has been product oriented, and environmental process innovations were neglected in small and medium sized dairies. However, the institutional collaboration between NGO's, retailers and state institutions has been strong, resulting in the possibility to label organic products. In the product chain, organic farmers with a deeply rooted ecological understanding have been the drivers behind these institutional changes - with important support from the retailers, especially COOP Denmark in the beginning. However, only one chain of retailers showed interest in an environmental dialogue within this product chain and in preparing information to the customers beyond the organic label.

In the fish industry the environmental effort was mainly carried by initiatives in the fish processing companies, motivated by regulation and requests from the international market. The ecological focus was process oriented, focusing on good environmental housekeeping in manufacturing of the products. The institutional set-up for environmental considerations in a product oriented perspective is vague, e.g. only few criteria are available for marketing of fish products, and so far it has not been possible to reach consensus regarding a set of criteria for eco-friendly fish products. Reluctance from the fishermen and a lack of communication

between environmental organisations, sector organisations, authorities, retailers and customers seem to be the strongest barrier for promoting a more sustainable fish industry. However, the investigation also shows that the fish industry is interested in continuing the environmental effort further in the product chain.

In order to promote a development towards more sustainable food products it is important to consider the differences in the collaboration and innovation activities in the different product chains of the food industry. Taking the product chain of dairy and fish products as an example there are some main differences concerning:

- *Who in the product chain has the environmental initiative:* For the dairy industry the initiative was taken in the primary production, whereas the secondary production has been the driving actors in the fish industry. In both sectors some retailers have supported these initiatives.
- *The type of innovation activity:* In the dairy industry focus has been on incremental product innovations, and the production of organic products is closely related to the conventional production. In the fish industry product innovations are very limited, but there is considerable process innovations using cleaner technology to reduce the consumption of resources.
- *The possibility to market more sustainable products:* In the dairy industry an important driver has been the possibility of getting a state-controlled organic label on the products, while in the fish industry a similar initiative has ended up in discussions.

In the long run the development in the sector of food products is expected to change from upstream dominance to downstream dominance. This has been the case with organic milk – at least in a period of time – with the consumers as important drivers. But even though the consumption of food products is affecting the health of the consumers, the price is still a considerable and often overshadowing parameter in the marketing of food products.

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