Management studies and the Agri-business: Management of Agri-chains

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Introduction

The power of chains

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Ladies and gentlemen,

It is a pleasure to address you at the start of this first international congress on Agri-Chain Management. The items on the agenda for today and tomorrow are both fascinating and topical.

Chain management and quality assurance are concepts which have been in the limelight of Dutch policy for some time now. And quite successfully. Still, there are a number of questions to be answered and problems to be solved.

First I shall outline some developments that have been of major importance to the agro-industry.

New challenges

The agro-industry is facing several new challenges.

1. There is the abolition of internal frontiers within the European Union, the GATT agreement, and the developments in Eastern Europe.
   Developments which have major consequences for the production, processing and marketing of agricultural products, both within Europe and outside. Markets are becoming more open, challenges present themselves. This means more competition. It also means more opportunities.
2. A second trend is that the market is developing from a sellers' market to a buyers' market. For too long the market has been hidden behind a veil of guaranteed prices. It seemed to be a sellers' market, but now that the veil is being raised the buyers' market gradually shows its face.
   It is time for a complete change of tack in the agricultural sector. So far production has ruled the market. From now on production is to take its cue from the market. This is, in fact, a U-turn.
3. A third trend has to do with public concern about the agricultural sector. Producers are more and more up against public demands concerning the environment, nature, and animal housing and transport. They are directly tackled about their methods of production. As a result, the costs are being pushed up, initially without rate of return. Only in the longer run the rate of return will increase.

Diversification

Specialization and standardization enable agriculture in various countries, the Netherlands among them, to produce large quantities of products of a constantly high quality. Due to steady increases in productivity and an adequate marketing organization we have managed to secure a strong position on the market. A position we were able to maintain for very many years. A well-earned golden medal for the sector.

But times are changing. Consumer demand is more and more for a varied supply of foodstuffs, and increasingly for convenience products. This appears, for instance, from the appetite for the wide range of regional products from countries such as France and Germany. A development which without doubt will be strengthened by the anticipated protection of designations of origin within the European Union.

Market-oriented producers will have to find ways to add more value to a product unit. For they will have to distinguish themselves from others via their products. Product diversification is the key phrase.

Chains

Expectations are that consumer interest in the quality and origin of foodstuffs will continue to increase. The agro-industry will more and more be confronted with consumer demands. Demands for product quality. Demands for the methods used to produce food. Hence the focus on chains. Chains governing food production and marketing; controlled chains.

This approach requires and, logically, gets the producers' attention. Also since cost management necessitates a critical review of the links in the production and marketing chain. Particularly the harmonization of activities undertaken in the different links can result in major cost reductions and quality improvements.

Questions concerning chain management

If diversification and an integrated approach to quality at all stages are encouraged, there are still several questions. The idea is clear. But its implementation is difficult.

In this respect I would draw your attention to three issues. Issues in chain management and quality assurance the policy is up against. Issues I sincerely hope this congress will address.

Monitoring

First of all, there is the question of how to monitor the chain. In an integrated approach to quality assurance the question to be answered is that of who can or should monitor a chain. Many entrepreneurs are involved in producing food. They have often very dissimilar, sometimes even conflicting interests.

Traditionally, the agricultural sector of the Netherlands has been using an approach aimed at producing large quantities of products of a uniform quality. For decades this has been our strength.

It went with processing and marketing structures that also aimed at uniform and sizeable product flows. They formed the strong points of Dutch auctions and slaughterhouses, which have of old been very influential in the agri-chains. Time and again producers were able to respond quickly and adequately to the demands of generally big buyers on the traditional markets. A real success story.

Whether things will remain as they are is questionable. I am afraid that the present-day auctions and slaughterhouses will have difficulty in treating a much wider diversity of products offered. And perhaps also in adding more value to these products. Nevertheless, these organizations will have to react adequately to the tendency to diversification in agricultural products. If they do not, there is a real chance that alternative trade flows will develop, eroding their position in the chain. This is worthy of further attention.

Responsibilities

A second aspect requiring attention is concerned with the responsibilities within the chain. What link in the chain is responsible or assumes responsibility for arriving at diversification, more value added, quality improvement? Looking at the primary producers in agriculture, we cannot but conclude that market-oriented entrepreneurship is as yet not widely accepted.

Before I referred to the veiled face of the Common Agricultural Policy. Specialization and standardization, I have said so, did contribute to keep the veil up. The majority of agricultural products were and are supplied in ever increasing quantities. Others were responsible for valorizing and marketing the products.

Certificates

An example to illustrate that primary producers are indeed willing to shoulder their responsibilities is to be found in certification. At the moment the certification of products and systems of production is in the centre of attention. Certification is a valuable tool to guarantee the products and services that were supplied. Correct me if I am wrong, but I have the impression that many applicants are only concerned with obtaining the certificate. A certificate will, however, only keep its value if all parties remain watchful. If they remain watchful and focus, individually or jointly, on the objectives underlying the certificate. I doubt whether this point is sufficiently stressed.

An integrated approach to quality assurance should centre on quality improvement. This aim should be shared by all those concerned in every link of the chain. Entrepreneurship in primary agricultural production will, I think, demand special attention as it is full of challenges and problems.

Communication

Finally, there is a third aspect I would draw your attention to in view of the theme of this congress, namely: comnunication. Communication throughout the chain is far from good. As a consequence much valuable information is not used or gets lost, together with opportunities to better adjust food production to market demand.

What I have said goes for the chain of production as a whole but also for many separate links. It is doubtful whether new ideas will be recognized and taken up. The flaws in communication should be addressed. I am convinced that if someone feels responsible for a product and meets with appreciation, his creativity will boost. And creativity is what we need to answer the questions we are facing in an integrated approach to quality.

Finally

The word 'chain' evokes various reactions. In the past a chain was often used to depict confinement, restriction of freedom. This connotation is very negative. In this negative sense of the word, to burst the chains symbolizes the struggle against restraint and for independence. To become independent means that one assumes responsibilities. One of the roads to success is to voluntarily co-operate with others, from the conviction that different links may benefit each other. In other words: to forget new chains. From this moment on the word will evoke another image. Instead of the negative associations of the past, a chain will be seen as a useful instrument with a surplus value. A value which exceeds the sum of the parts. A symbol of the power of co-operation.

I trust your congress will contribute to the visualization of the power of chains. Thank you.

Sustainable chain systems

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Introduction

The title of this contribution to the first international conference on chain management refers to three interrelated concepts: "sustainable", "chain" and "systems". The first concept, "sustainable", refers to the fact that we are interested in a phenomenon of a long lasting life. Several debates can be devoted to the question of the actual duration of the phenomenon ("how long is long") and to the question whether we are really interested in a phenomenon that is extending its life for a long period ("do chains have to exist forever?"). An essential aspect of the use of sustainability as an attribute of chains is the choice of a proper criterion for measurement. Such a criterion is helpful in assisting researchers as well as practitioners with respect to the operationalisation of the concept of sustainability. Eventually, the measurement of sustainability as an attribute of chains is far from simple.

Connected to the idea of the long life of a phenomenon like a production chain is the condition that people have to restrict themselves with respect to the use of resources, esp. of nature as a resource. In several stages of the process of food production (in a broad sense) natural resources are used, or spoiled, as in the case of producing waste as a byproduct. Not only the very visible primary stage of farming is critical in this sense, the whole production process has to be studied in a critical way. Several examples of using overdose of chemicals or even water can illustrate this situation.

The second concept is the "chain", which is meant to be the production chain of food and other agri-products (like wines and industrial products based on agricultural raw material). Dealing with chains means that one needs a shared notion of the chain. Discussing the concept with people in "the business" shows that there are nearly as may notions as there are people involved. However, it seems as if everyone is understanding the meaning of the concept "chain". So the concept chain can be characterized as a sensitizing concept, because it is triggering the minds of people in such a way that they possess a common frame of reference to guide their discourses.

Some people use the concept of the chain in a very concrete way, such as the production of a specified product (like the tomato) by identifiable producers, processors and traders. Such a chain can fade away when that special product (the tomato) is not delivered any more, or when one of the entrepreneurs involved moves out of business, and cannot be replaced properly. E.g. the producer will switch to producing another product (like cut flowers), or will retire and close down his business. In this sense chains can die.

Other people will use the concept of the chain in another way. E.g. as an abstract construct of stages in an unspecified production process, just to clarify the idea of producing certain products in a series of relatively autonomous "stations" or organizations. Within the scope of this view an intriguing research question is about the discovery of general control lemma's, helpful in guiding the management of c.q. in such chains.

Besides these two options of understanding the phenomenon of the chain and chain management, several other views are in use, e.g. the notion of the physical production process, existing of flows of material along a composition of machinery, checking points, storage facilities, etc. Again another option is e.g. the view that a chain is a combination of production facilities, connected by markets. Several interesting issues can be raised, like coordination of the chain by prices, contracts, mutual agreements, etc. Economic as well as juridical problems can be formulated, that are essential in understanding the behavior of the chain. Naturally the focus on added value is a well known (strategic) perspective on the treatment of chains too.

In conclusion we may stress that the concept of the (production)chain is a complex one. The complexity is even stronger if one combines the concepts "sustainability" and "chain". It depends largely on the stance one choses whether chains can be interpreted as essentially sustainable or durable or essentially finite in existence. A critical point, as mentioned earlier is the measurement of durability or continuity.

Introducing the third concept ("systems") in the title causes an even increasing complexity. As long as chains can be interpreted as relatively straightforward patterns of stages or organizations producing certain endproducts to satisfy the demand of consumers of agri-products, the concept is relatively simple seen from a "systems" viewpoint. But, "systems" is introducing the complexity of interacting chains that together deliver "total" products to the market. With total products is referred to the specified composition of processed raw material (from agricultural origin), connected with a form of packaging, pricing, labelling, etc., as perceived by the comsumer in the retail shop or by industries when busisness-to-business deliveries are under discussion. A simple example may be a bar of chocolate, in a special form, just for a special occasion (e.g. a sports event), with a special price, packed with special material, delivered with a booklet containing recipes for using the chocolate in unorthodox ways, and connected to an action of collecting package waste in a special way. One can imagine that several (production)chains have to be coordinated to attain at a proper time the result that is sketched.

So, systems of chains, sustainable or not, are composed of several chains that are essentially independent, but have to be combined in such a -unique- way that they are adding value to a special product to be delivered to the market. Such a view on chains is very essential with respect to issues of strategy, logistics, quality, pollution, etc. Also with respect to policy making in government the chain approach is important as an analysis as well as a design philosophy.

Chains in history

Chains are nearly as old as is mankind. Since there is production of food, man had to organize this production in several consecutive stages performed by different businesses.

Sometimes one man's businesses, sometimes organizations of a larger scale. Nowadays even of a very large scale. On of the simplest examples may be the production of bread, starting with growing wheat by the farmers, milling the wheat by the miller and baking and selling the bread by several bakers. At that early times nobody had to care about packaging, freezing, etc. The production process was very dependent on the regular delivery of flour by the miller, who on his turn was dependent upon the delivery of wheat by the farmer. In terms of contemporary developments we would discuss the special power position of one the links in the chain, being the chain leader. With respect to food safety we would also be interested in the type of storage of the flour, and with respect to the quality of the bread, the stable application of the recipe would be one of our concerns.

A very remarkable historical example of a food and trade chain of a large scale is the United Dutch East India Company well known in the Netherlands as the VOC. In 1602 it was founded as a merger of several smaller businesses. A multi national "avant la lettre" in the 17th and 18th century. The company was a large enterprise both in revenues and capital as in manpower. Essentially it was composed of several chains, varying from shipbuilding, shipping, naval transport, dutch-asiatic ("world") trade, asiatic ("regional") trade, refinery of fine spices, and silk trade. It had a sound, and sometimes unconventional, experience in contracting primary sector farmers in former Dutch East India. The company is a splendid example of all the economic and managerial ups and downs a big company can face during its lifetime. There were periods of marvellous successes, exellent management, perfect logistic control, but at other times there was also failing management, loss of tradeware, corruption, disasters produced by several wars, and problems in administration too. All the problems and all the successes we experience nowadays, with bigger and smaller, national and international, firms, were already experienced in those days. In an era of doing no-nonsense business there were debates about the practice of bookkeeping as an instrument of managerial decision making, there was a debate about failing management and there was also the problem of failing information systems, with all the risks of e.g. loosing the books in a storm. The company was facing several awkward situations during the two eras of its existence. The directors of the company, known as the "Heren XVII", ordered more than once during this very long period of existence a measure of redress, meaning the reorganization of the management of the company esp. in the field of administration and bookkkeeping. Perhaps it's the activity we nowadays give the label "re-engineering". But also strategic decision making on issues like buy outs and the political game on representation of several chambers (of commerce) was practiced in the board of the "Heren XVII", which assembled two or three times a year for a few weeks. One of the severe problems was the aspect of "distance", with its consequences like very late delivery of the books and the financial statements of the Asian business. Another crucial problem was the mismatch between the bookkkeeping system in Asia and the one in the Netherlands. E.g. on the basis of the Dutch bookkeeping system directors were not capable of making inferences about added value of the products imported.

One central conclusion can be derived from the developments of the VOC: any competitive advantage, whether originated from the environment or from the organization itself, is only valid temporarily. So, for the sake of continuity, managers have to be very attentive to environmental developments and to the matching between (top level) strategy and workfloor processes.

From history several observations can be drawn that are illustrative for modern developments as well One of the interesting findings is the combination of transportation and production. Nowadays we call this value added logistics (VAL). Historical examples are the gutting of herrings when fishing at sea, as invented at the end of the 13th century by an elderman of Biervliet and the processing of whales while hunting for them in the northern seas. When the whale hunting fleet returned home, all the processing had been finished aboard.

Nowadays we are eagerly looking for opportunities to combine production and logistics in food industries. E.g. by executing production activities in destribution centers. It makes transportation more economical.

Basic chain configurations

Studying food production chains asks for structuring and modelling production chains, that emerge in practice. The aim of these activities is mainly to find out how and when it is possible and profitable to steere and control the behavior of a chain. Ideally the clue to problems in the management of production chains should be some kind of management or control paradigm. However, before dealing with management and control of chains, there should be clarity about the structure of chains as such. Some remarks in the introduction about different definitions-in-use apply to this issue.

In practice there is a large variety of structural configurations of concrete production chains. A variety in reality as well as a variety in mapping (see *fig 1*).

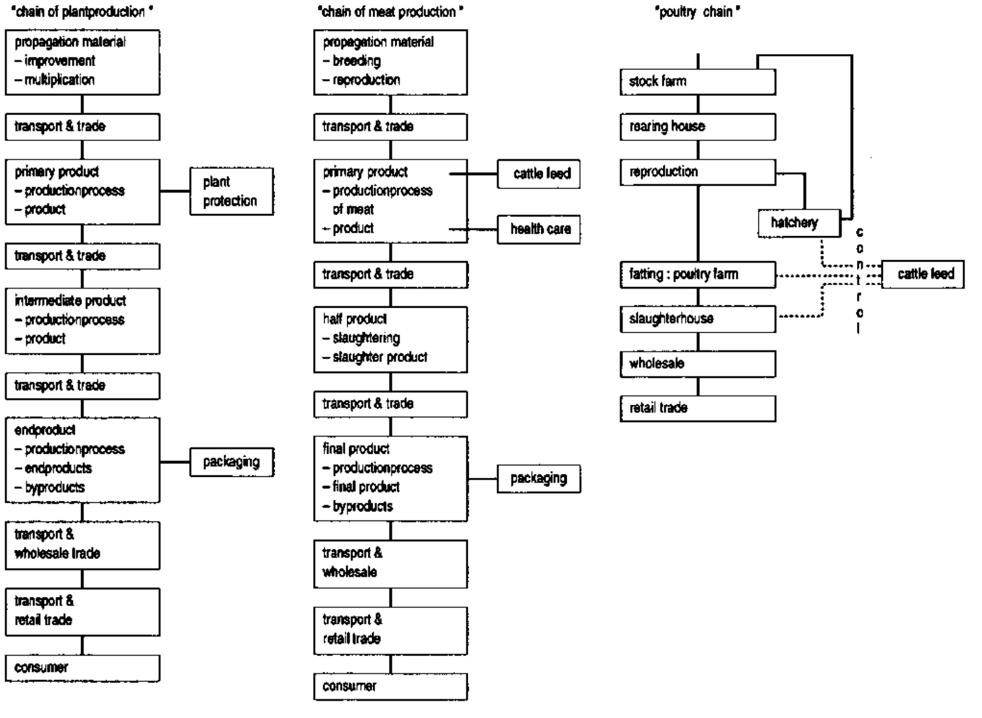

Figure 1. Configurations of production chains

Even these examples, relatively simple and presented as an abstraction, show a variety of configurations as mentioned before. Esp. the building of a network of chains by matching (or crossing) several chains makes a difference in each situation (e.g. health care, packaging, feeding chains, etc., crossing the meat production chain). In the examples of the various chains these crossing chains are not worked out extensively. Only a short hand label of such a chain is included. Like "plantprotection", which is referring to a complicated production and application process. Furthermore, the examples had to be simplified, thereby omitting a number of aspects. One of these aspects is the single or multiple character of every stage (or link) in the chain. This means e.g. that instead of one retail shop (as suggested in the examples) there may be some hundreds of these shops. "Single or multiple" makes a big difference with respect to the market mechanisms (pricing, contracting, agreements, etc.). The chain maps are also simplified with respect to e.g. the nomination of concrete firms. Also the character of the interaction between links is omitted.

To grasp the essential characteristics of chain configurations it is necessary to build models of chains of a relative high level of abstraction. Within these "generic" models certain basic configurations (if existing), as modules, will be helpful to construct a model of a chain. The generic models of chains are in a way "translations" or "maps" of real chains. Such maps are omitting a lot of practical aspects of a real chain, generating in this way simplified, sometimes caricatured, abstract chains. Sometimes it may be thought of that a translation from a practical chain to a generic chain is made stepwise (see *fig 2*).

At least two things may be clear from this representation of the translation process. One is the bilateral direction of the translation. From reality to abstraction and from abstraction to reality. Second the translation levels, varying in level of abstraction. The first level may result in an abstraction of reality, that is recognized as a relatively simple conversion of the real situation, while the second level is far more abstract and more difficult to be recognized as a map of reality. One may e.g. think of it as a systems control model. The first level translation (comparable with the examples in the former section) may be helpful in finding more direct and practical solutions to chain management problems. The second level translation, leading to a generic model, produces more general management approaches to real world problems.

To distinguish between real world production chains and the abstract maps, we call the former type of chain "chain realizations".

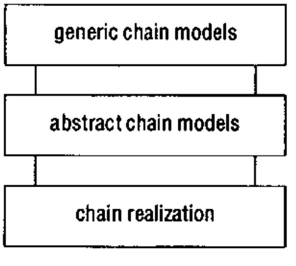

Figure 2. Steps in translation

The modules to be used, as chain components, in building generic type chains, can be depicted as follows:

a. the linear type module, in which every link is unambiguously connected to the following and the former link in the production process (like in certain flower production "lines") (see *fig 3*).

b. the convergent type module, whereby some link is connected to several parallel preceding links (like in assembling processes, e.g. ready to process meals) (see *fig 4*).

c. the divergent type module, whereby a link is connected to several parallel following links (like in disassembling processes, e.g. production of several types of pig meat out of one pig) (see *fig 5*).

d. the network type module, referring to a composition of several chains, all together supporting the production of certain produces (like processed, canned and packaged food) (see *fig 6*).

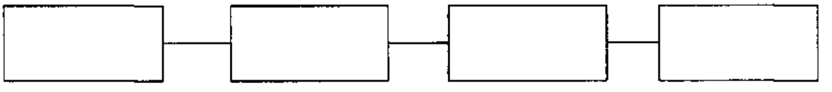

Figure 3. Lineair type of chain

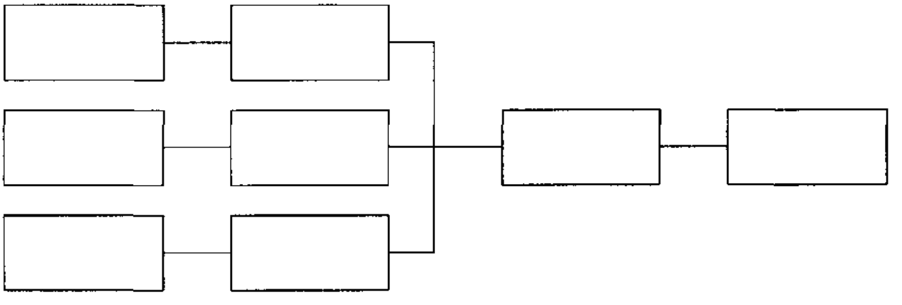

Figure 4. Convergent type of chain

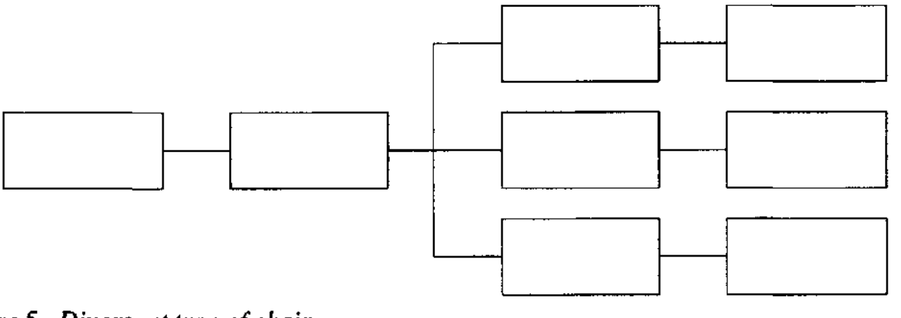

Figure 5. Divergent type of chain

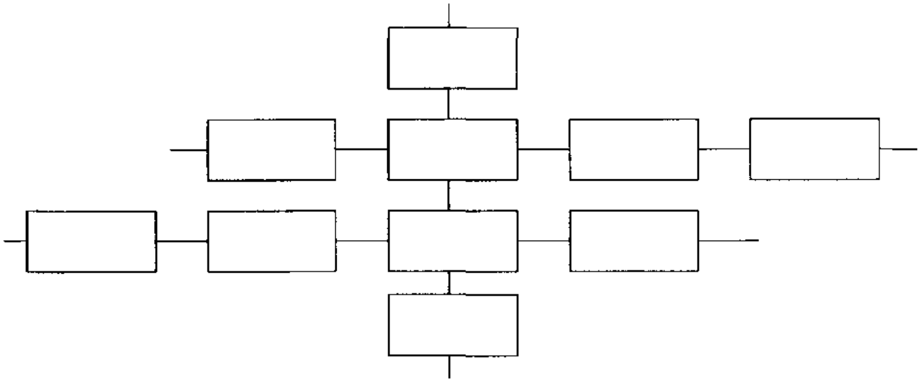

Figure 6. Network type of chain

These basic types of chain configurations will be helpful in constructing adequate chain maps. Furthermore, they will be helpfull in attempts to understand the behavior of chains and to understand the ways in which chain behavior can be changed, by managerial action.

Management en processes

Management is the act, art or manner of managing, as the Webster's dictionary is telling the interested reader. More operational we can describe management as the coordination of activities and processes in organizational settings. Management fulfills a function complementary to the central movements in every organizational setting: differentiation and integration. One step further, the management cycle can be identified, existing of four phases:

- planning, being the phase of making projections of future activities, thereby coordinating in advance the activities and processes to be performed. Categories of planning activities are strategy, budgetting, scheduling, goal setting, etc.
- execution, being the phase of real activities and processes, executed in accordance with the planning or not. Instruments supporting this management activity are procedures, hierarchy, mutual agreement, cultural traits, etc.
- control, being the phase of evaluating the things that have been done. This management phase contains activities like quality control, financial auditing, review of planning outcomes, etc.
- learning, or adaptation, being the phase of improving the organization, the processes, the activities in order to improve effectiveness of the organization. Activities belonging to this phase are problem solving, issue management, agendasetting, etc.

A theoretical as well as an empirical analysis of the construction of the four consecutive phases will lead to the conclusion that two dimensions can be thought of as the constituting bases of the management cycle: time and frame of reference. Time can be distinguished in two ways: a perspective from the input side of processes, or a perspective from the output side. In the situation mentioned first we are engaged in feed forward, in the other

		frame of reference	
		model	reality
time frame	feed forward	planning	execution
	feed back	learning	control

Figure 7. Management cycle

situation feed back is the issue. With regard to the frame of reference the following distinction can be made. On the one hand the day-to-day reality can be the frame of reference, on the other hand it is the model made as a description of that reality. Planning e.g. is based on models, while control is based upon reality.

Combining the one and the other we can depict the phases of the management cycle and their mutual relationships (see *fig 7*).

The general idea is that in practice, to secure a proper way of management, one has to pay attention to the successive phases one after another, in a clockwise direction.

So far the activities conected to management in organizational settings, chains included. However, an extension of this modeling of management is necessary. The objects of management are processes and activities within the organizational setting. Activities can be identified as contributions to processes. So, the extension of the model of management can be defined by elaborating the processes involved. Seven of these organizational processes can be identified:

- production and logistics, describing the ways of producing the products and services of the organisational setting. The products can be quite physical, like tomatoes, potatoes and pig meat, the products can be more abstract too, like advices, plans and training options. Essentially the material to be transformed into the desired products can be physical as well as abstract (like knowledge).
- client acquisition, concerning the identification of clients, as well as the treatment of clients, the combination of clients aggregated to (partial) markets and products, the satisfaction of clients, etc. Client acquisition encompasses more than just marketing.
- research and development, dealing with new products and processes, and the ways to cope with improvement of products and processes. Strategic and applied research is included, as well as scanning the environment (for new options), product testing, etc.
- human resource process, including the acquisition of human resources, the distribution of human resources throughout the organizational setting, the maintenance and the leave. Quality and quantity of human resources is essential to the existence of the organization.
- material resource process, dealing with the acquisition, distribution, maintenance and repulsion of production means. Business to business marketing is one of the modern issues connected to this process.

- financial resources process, which is devoted to the attraction of money means, the distribution throughout the organizational setting, and the spending.
- information resources process, refers to the acquisition of information/knowledge, the refining/reconditioning of information, storing information and distributing useful information.

Processes and management cycle together constitute a model of management that can be used as an analytical device as well as a constructional device, in the sense that the ingredients of managerial strategies and operations are given by the model. All the processes have the same form (see *fig 8*).

Interesting within the context of the production chain as an organizational setting, is the possibility to manipulate input, throuhgput, and output throughout the whole chain. It may e.g. be a succesful option to shift a certain process (like the production and logistic process) in such a way that manipulations with input or output is transferred to another link in the chain, or even (parts of) the throughput. One of the modern issues in logistics dealing with creative solutions to such profitable shifts is Value Added Logistics (VAL). The effects are always externally to the chain or to links in the chain.

Chains, Quality and Competence

The management and control (of the behavior) of chains is characterized by several aspects. One of the very important aspects is decision making. Every act of management essentially means decision making. In its turn decision making is dependent on knowledge. Situational knowledge, knowledge of conditions for the functioning of chains, knowledge of external rules by government bodies or other types of rules, knowledge of technology, knowledge of management in theory and practice, etc. With respect to decision making it is important to discover that decisions are made on different levels, with different perspectives. It is helpful to distinguish between:

- individual level of decision making, focused on just individual decisions, as they emerge every minute so to say,
- individual task level, being the aggregation of individual decisions to clusters connected to tasks to be done,
- group level, connected to the conglomerate of activities, processes and decision making behavior of groups within an organizational setting,
- organizational level, dealing e.g. with organizational issues as goal setting and strategy formation,
- chain level, encompassing the mutually linked decisions of the relatively independent organisations belonging to the chain,
- inter chain level, e.g. of importance when several chains are needed in the process of producing a certain product (e.g. physical production, packaging, informing).

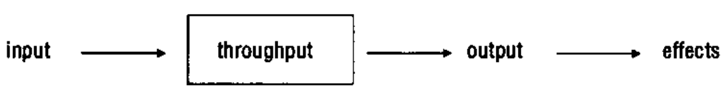

Figure 8. Process model of management

Being aware of the different levels that are emerging in decision making situations is important, just because decision making at different levels has different meanings and different effects. The -sometimes very close- relationships between decisions at different levels is important too.

One of the striking issues nowadays in production chains, esp. in agri-business is quality of product and process. High quality is brought forward by management that is recognizing the importance of chains as a "vehicle" of production, as well as an adequate "vehicle" of thinking about production. However, high quality is a concept that is operationalized by the users of products. Quality is a perception. Strikingly, the perception by management (c.q. other organizational/chain members) can differ greatly from the perception in the market. That is why it is stipulated in agri-business that agri chains have to be market oriented, just because agri-business is demand pulled. Developments in history however show an other focus: production orientation. Market conditions, partly dominated by subsidies and government interventions, causing an artificial market equilibrium, obviously were in favour of this orientation.

Moreover, it is stressed that integral chain control is the answer to most problems of ineffectiveness, meaning that management and managers of the production processes of agri-products should be guided by the concept of the production chain, and (partial) integration, or at least coordination of the successive links in the chain. The coordination can be studied and executed within the scope of the management model just presented. Ideally coordination should be extended to all the seven processes. Nevertheless a partial coordination, e.g. restricted to logistics, can cause an improvement of the effectiveness of the chain.

To practice integral chain control, chain strategies are necessary means to be able to coordinate. Chain strategies are dealing esp. with cooperation modes within the chain. These cooperation modes are of a wide variety. Market mechanisms are one type of cooperation modes, agreements, contracts, information exchange and cooperative membership are other types. Chain strategies are esp. applicable to the interfaces between links in the chain. Together with activities connected to the phases of the management cycle, chain strategies can be used in the optimization process of interface management in the chain. Esp. when market mechanisms are frustrated, and fail to coordinate the successive links in the chain, the task to design other proper cooperation modes is emergent.

Thinking about chain management, the triad "chain", "chain infrastructure" and "chain knowledge infrastructure" urges itself. Chain infrastructure can be interpreted as the structure of the chain as presented before, as well as the collection of conditions and resources, making the chain function. With this description in mind we can make inferences about the behavior of a chain in the context of its infrastructure. We even can conclude to some qualification of the infrastructure, insofar it advances the effectiveness of the chain as such. The importance of knowledge infrastructure is emerging at the very moment one recognizes that the improvement of the effectiveness of chains is enhanced by knowing more and better about the chain infrastructure and its use in practice. It is said that, on the level of individual organizations as well as on the level of chains of organizations, knowledge is a key factor for success. Keeping the idea in mind that the contribution of human resources to the functioning of a chain is dominantly dependent on the competences of the members of the human resource, individually as well as collectively, the inference about the importance of knowledge is obvious. However, knowledge is not only the invisible trait of humans in the organization. Knowledge can be retrieved from data bases, from consultants, from outside research institutes, universities, or from factual behavior too, while knowledge is also contained in structure, procedures, culture, etc. The nature of knowledge is determining largely its representation mode.

At macro level one can identify a knowledge infrastructure in society with respect to agri-production chains. Schematically one can identify markets of demand and supply of knowledge. Demand mainly represented by industry, supply by industry and knowledge institutions, like research institutes, universities, educational institutes, extension services.

Government is playing an intriguing role, being interested in knowledge e.g. in the context of its policies, offering knowledge to industry as well as to knowledge institutions, and mediating between parties (see *fig 9*).

In The Netherlands a remarkable policy-experiment is going on: the constitution of a so called Foundation for Agri-Chain Competence. The aim of this experiment is to achieve a substantial improvement of the chain knowledge infrastructure. Not for the sake of the infrastructure in itself, but for the sake of the effectiveness/competitiveness of agro-industry. Schematically the small institute of the foundation is located in the middle of the scheme just presented (filling the gap between the three participants; viz. the question mark). One of the underlying propositions of constructing such an organizational device is the idea that infrastructure, at a macro level embedded in several types of organizations, has to be improved by learning. Practical evidence shows that learning organizations are very difficult to realize. Some kind of institutionalization seems to be necessary as well as close monitoring. In this sense the institute of the Foundation is facilitating the learning competence of the agri-business knowledge infrastructure.

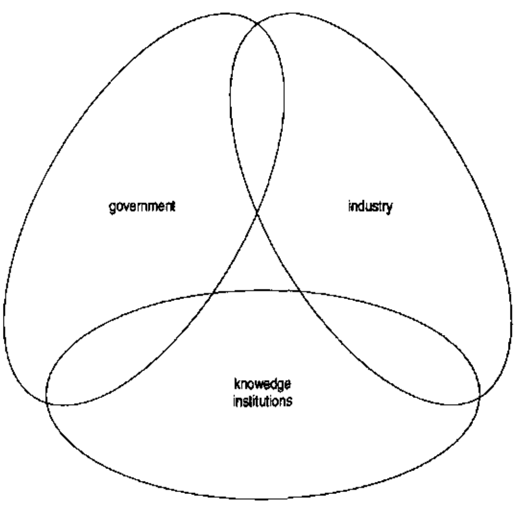

Figure 9. Knowledge relations

I. Strategy, methods and modelling in agricultural chains

International competitiveness and agri-chain management: the case of irish dairying

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Introduction

A firm's product/market strategy involves choice based on prior assessment of market trends and opportunities, strengths of competitors and the firm's own resources and capabilities. Agri-chains are typically complex, hence a food manufacturing firm's competitive pressures arise not just from other rival manufacturers, but also from powerful buyers (retail, wholesale, catering), substitute product possibilities, organised raw material suppliers and potential new entrants as conceptually outlined in Porter's seminal work on competitive strategy (Porter, 1979).

In assessing international dairy industry opportunities, manufacturing firms observe many relevant trends in the marketplace, of which a typical list is shown in *Fig 1.*

It is then necessary to assess one's own strengths and capabilities relative to competitors in devising product strategy, involving human skills, technological strengths, cost structures and scale. Given the complexity of agri-chains, this assessment must range over the whole chain, not just manufacturing, and therefore for dairying ranges from

1. Market

(a) Consumer
- More Convenience Foods
- Preference for Fresh/Chilled
- Aging Populations in West
- Smaller Family Size
- Snacking v's Full Meals

(b) Distribution
- Powerful Transnational Retail Groups
- Growth in Hard Discounters
- Greater Retailer Market Knowledge due to I.T.

Figure 1. Relevant Market Factors in Opportunity Assessment

dairy farming to milk transport, product manufacture, distribution, combined with market factors, as in Fig 1. Sometimes a manufacturer's product choice may be constrained by powerful cost or other factors elsewhere in the chain, of which the Irish dairy industry may be a good example.

Irish Dairy Industry – Introduction

Dairying is a very important component of the Irish economy, accounting for about one-third of the value of all farm input, with dairy product sales equivalent to about 8% of gross national product and exports equalling about 11% of total national exports. In employment terms there are about 50,000 dairy farmers, which account for about one-third of all farmers, and employment in dairy product manufacture is about 4% of that in total manufacturing industry. These values, in terms of employment and output, are generally far higher than other EU countries (*Table 1*).

With a large dairy industry relative to domestic population, Ireland exports a much greater proportion of its dairy output than any other EU country. As seen in *Fig 2*, Ireland is over 300% self-sufficient in milkfat and over 200% self-sufficient in solids-non-fat, with both ratios far higher than that of the next ranked country in the EU and the EU as a whole.

Ireland has a product portfolio which is considerably more concentrated on storable products (including intervention products) than most other EU countries. Ireland is the highest ranked EU country in terms of percentage of milk allocated to butter and amongst the lowest ranked in terms of milk allocation to cheese (*Fig 3*). Taking the utilisation of skim milk, Ireland is also the highest ranked in terms of allocation to milk powder, but is also highest ranked in terms of allocation to casein and derivatives (*Fig 4*).

A unique feature of Irish dairying in EU terms is the highly seasonal pattern of milk deliveries by farmers. This is reflected in the peak:trough (lowest) month milk deliveries pattern among EU countries. This shows that Ireland, with a ratio of 5.5, is far higher than any other country, all of which have ratios below 2:1, with most below 1.5:1 (*Fig 5*).

Despite 20 years of EU membership with common market access, the distinguishing features of Irish dairying have not greatly changed i.e. highly seasonal milk deliveries and a product portfolio weighted heavily towards a comparatively limited range of storable products. Given changing trends in consumer preferences, one may ask why this pattern persists. I hope to demonstrate that an answer can be found by analysing the complexity of the whole agri-chain as applied to Irish and European dairying, and in particular by focusing on three factors, EU policy, peripherality, and cost structures in the agri-chain.

Table 1. Dairying in the Economy

	Ireland	Netherlands	EU
(a) Employment			
Dairy Farmers as % of			
(i) Total Agricultural Employment	37	15	15
(ii) Total Working Population	5.5	0.7	0.9
(b) Output			
Milk as % of			
(i) Agricultural Production	32	21	16
(ii) G.D.P.	2.8	0.8	0.5

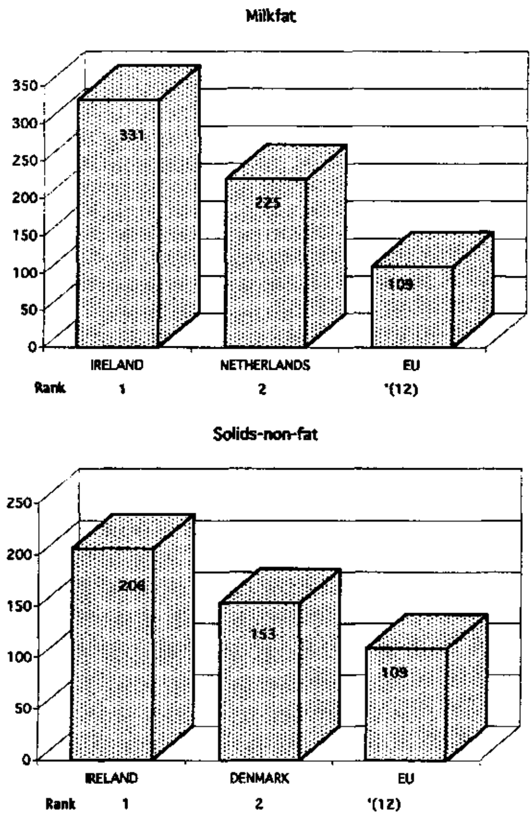


Figure 2. Self-Sufficiency Ratios 1992

EU Dairy Policy

EU dairy policy involves a price support system (target and intervention prices) maintained mainly by trade policy (import levies, export restitutions). When this led to structural surpluses, a producer quota regime was introduced. Despite the quota regime, including quota reductions, the EU itself is still in substantial surplus to around the level of 10% of overall output as shown earlier. Given that Ireland accounts for about 5% of EU milk output, with close to 70% of this being exported, EU net exports to third countries are equal to over twice total Irish net exports.

Peripherality

Islands on the periphery, such as Ireland in an EU context, are particularly likely to view trade in a spatial context, as transport costs are comparatively more important. In dairying, which involves a range of products from highly perishable liquids to dry storable goods, one might expect that peripheral islands which are large net exporters would be relatively more competitive in the dry, storable product range. In the EU, the Azores in

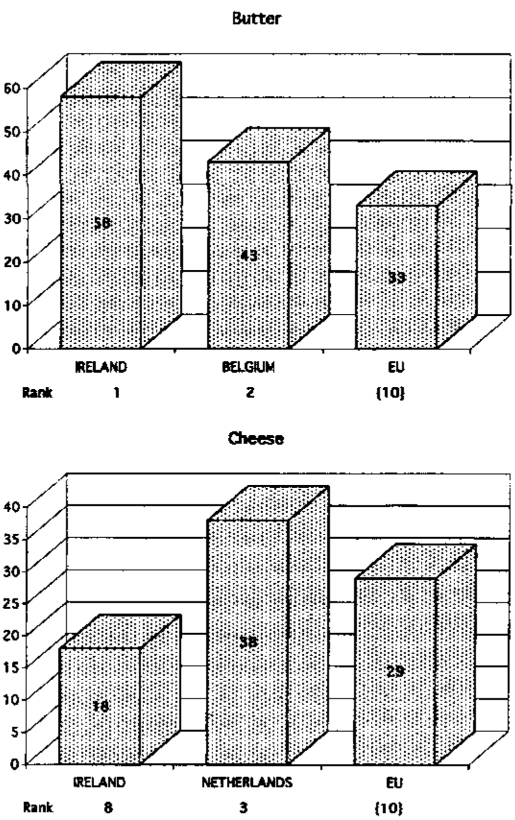


Figure 3. Utilisation of Whole Milk by Dairies, 1992, %

this respect may be another example as well as Ireland. Furthermore, with the EU as a whole obliged to export about 10% of output to third countries, and most internal EU countries more than 100% self-sufficient in most dairy products, transportation economies dictate that in this situation the net exporters on the periphery are the most likely sources of EU third country trade. The world market has a rather different product profile to that of the internal EU market, with a much greater concentration on dried products (milk powder, butter, hard cheeses) and inevitably much lower sales of perishable short shelf-life products. Thus, countries which supply proportionally more to the world market rather than the internal EU market, such as Ireland, have a product portfolio more concentrated on dried storable products.

To formally demonstrate this, spatial transportation models have been developed (Keane and Lucey, 1991, Anderson and Davis, 1993). Taking one example, the changes in dairy product portfolio and market location which would arise in EU countries due to transportation costs under alternative policy scenarios, other things being equal, were estimated (Keane and Lucey, 1991). The methodology involved a standard application of

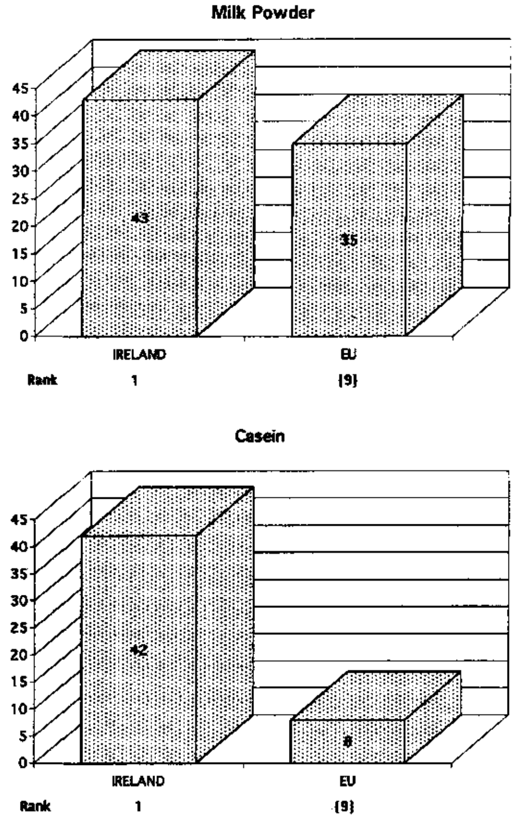


Figure 4. Utilisation of Skim Milk, 1992, %

transportation modelling, taking account of joint product relationships such as that between butter and skim powder. It was demonstrated that when policy allows considerable surpluses over internal consumption to occur in EU dairying, it may be expected on the basis of the transportation cost model that Ireland's dairy exports would have a relatively high concentration of dried products for export mainly outside the EU. However, when quotas are altered to reduce surpluses over internal consumption, the model indicates that Ireland's product mix for export would become more diverse and that markets would be found to a greater extent within the EU. This suggests that product mix and market location are not just a matter of individual firm's technological base and marketing strategy but are also related to external factors such as policy and location. For Irish dairy firms the model suggests that if the ultimate outcome of CAP reform and the GATT Uruguay Round is to move the EU closer to self-sufficiency in milk products, then it would be desirable to reorientate product mix and market location more towards internal EU demand. However if EU milk production continues to exceed internal consumption by a considerable amount, the Irish dairy industry may be expected to continue as a major supplier of

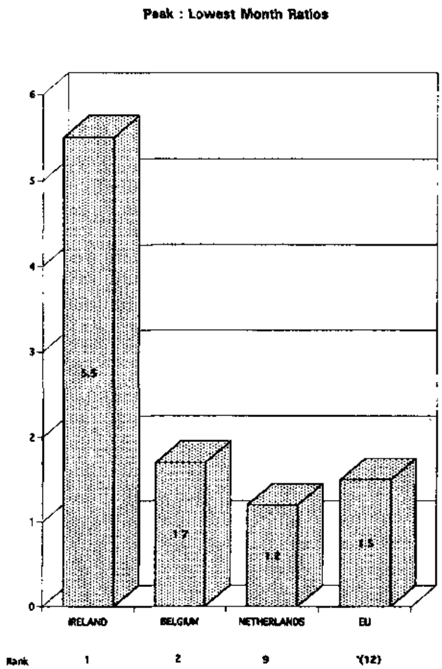


Figure 5. Seasonal milk supply pattern

dried products to third country markets. The model also indicated that one might expect dairy product prices in Ireland to be up to 2% lower than in some other EU member states, due to spatial transportation cost reasons.

Seasonality

While the overall Irish dairy industry has a unique seasonal supply pattern as demonstrated earlier, the industry can be further sub-divided into the liquid (fluid) milk sector and the manufacturing sector. The liquid milk sector, which comprises about 10% of the total, has a comparatively even supply pattern quite similar to that of the EU average (*Fig 6*). The manufacturing sector, comprising 90% of the total, has about an 8:1 peak to trough month ratio. These are managed as separate sectors, with the liquid suppliers operating under individual contract involving winter milk quotas and substantial price premia.

The unique supply pattern of the manufacturing sector in EU terms is linked to Ireland's comparatively milk climate, even in Winter, which allows for a very lengthy grass growing season of 9 months approximately. Thus cows which calve in early Spring can graze outdoors from March to November. This means that most of the typical 10 month lactation is produced cheaply from grazed grass with only limited purchase of supplementary feed. This is rather different to most EU countries where winters are more severe and cows are fed indoors for perhaps 6 months. In cost terms Irish dairying thus has a potential benefit, as reflected in a recent cost comparison which showed that Irish milk produc-

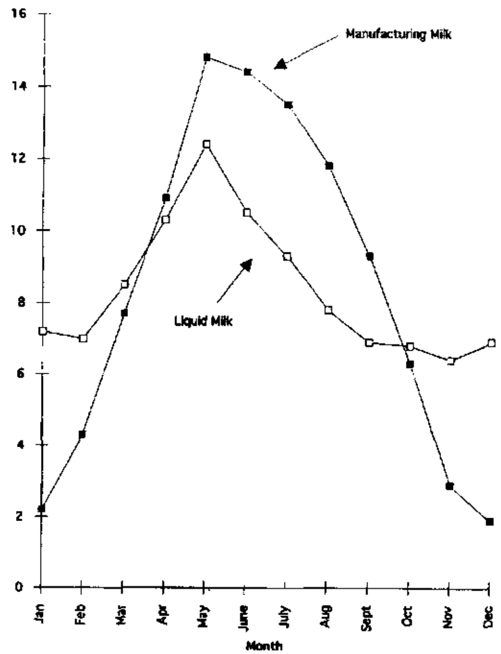


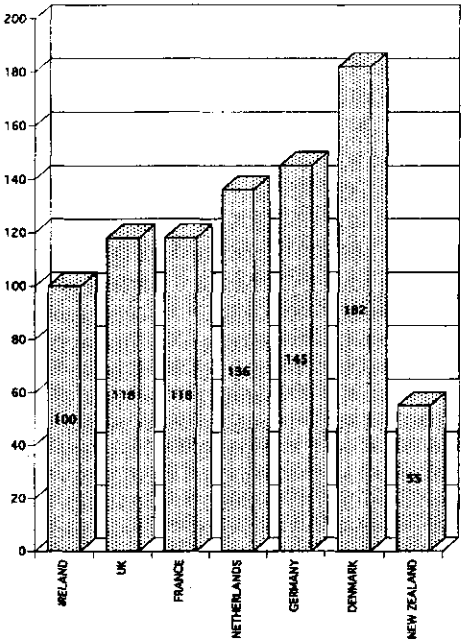
Figure 6. Liquid & manufacturing milk, seasonality supply patterns

tion costs per 100 kgs milk were substantially lower than most other major dairying countries (*Fig 7*).

While the seasonal supply pattern of milk confers cost advantages at farm level, it creates major disadvantages at assembly, processing, storage and distribution and marketing levels. At processing level, for example, plant capacity utilisation is much lower, with very limited utilisation in the winter months, giving an annual capacity utilisation level of only about 55%. Inevitably major additional costs also arise in terms of product storage and financing, as dairy companies must match the comparatively even consumption pattern of products with the highly seasonal production pattern. At the marketing level, a highly seasonal supply pattern of milk largely restricts the product portfolio to long-term storable products as shown earlier.

Decisionmaking with regard to seasonality involves an economic cost-benefit type analysis. One must ask will the extra costs in milk production, if production is changed to a comparatively even supply pattern, be outweighed by the benefits at processing and marketing levels? This issue has been examined on an occasional basis in Ireland (Pitts, 1983, Keane, 1986), and can be analysed in summary form using some simplified cost and price relationships.

Taking an initial model based on current seasonal supply patterns of milk and the manufacturing margin for storable products (butter, milk powder, cheddar cheese), it is seen that the raw material milk cost is about 80% of bulk product sales (*Fig 8*). (Manufacturing



Source: Boyle, Kearney, McCarthy, Keane, 1992

Figure 7. Farm cash costs per 100 kgs milk

margin equals bulk product sales minus ex-farm milk prices, and includes milk transport, product manufacture, product storage and finance.) To obtain an even supply pattern of milk in Ireland, it has been estimated that it would be necessary to provide an extra price incentive to suppliers of 7 to 10% on an average annual basis. This arises due to the very high additional cost in producing an even supply pattern in Ireland. This additional price incentive is consistent with the price differential that currently exists between manufacturing milk and liquid milk in Ireland (Teagasc, 1993).

The benefit of an even supply pattern would arise at all levels beyond the farm. For example, manufacturing plant utilisation would increase and operating costs would substantially reduce and product storage/financing costs and milk transport costs would also fall. True variable costs such as packaging would however remain unchanged. Taking storable products the combined benefits have been estimated at about 4% of bulk product sales. While this represents a reduction of about one-third in the non-variable costs segment of the manufacturing margin, it is substantially less than the benefit required to fund the incentive necessary to alter farm supply patterns. Hence supply patterns remain unchanged.

It is interesting to note that studies on this issue have also been completed in New Zealand which has pasture based milk production and a seasonal supply pattern very similar to Ireland. These studies have also concluded that 'if the European pattern of milk production (excluding Ireland) were adopted, the improvement in efficiency has a potential

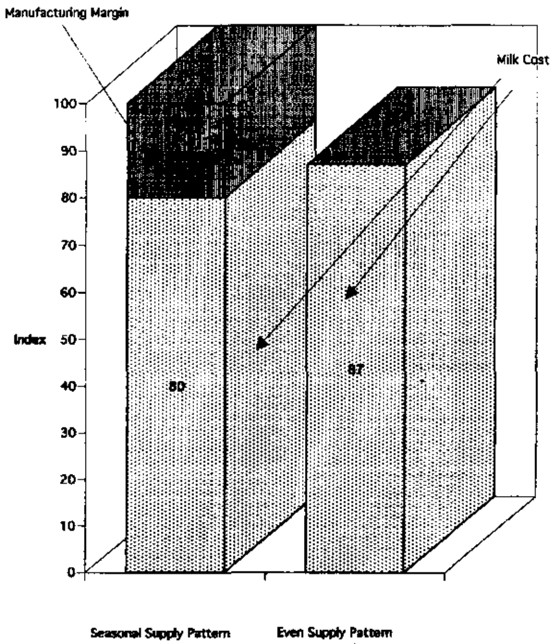


Figure 8. Cost-price realtionships – storable products

of providing savings equal to only 1.6% of the value of manufactured output, but would require the discarding of the principal advantage of the New Zealand dairy industry – the ability to graze stock on pasture throughout the year' (McCombs, 1985). When the Irish situation is compared with other EU countries, the fundamental difference is that the milk production costs differential between a seasonal and an even supply pattern is much more limited. Hence the benefits beyond the farm gate, even for storable products, outweigh the additional costs of an even supply pattern and the incentive to provide a more even supply pattern is therefore present.

Value-Added Products

The above analysis may be criticised for not taking account of the scope for value-added dairy products which are often of short shelf-life. The merits of adopting such products in the portfolio can be analysed by taking the Irish estimates earlier. The position is that if market opportunities are identified which require an even milk supply pattern, then where these opportunities have the potential to provide a return sufficient to pay milk suppliers the required incentive, the projects should be proceeded with. Based on the earlier estimates, it would be necessary to pay the suppliers at least to the level of 87 on the scale shown in Fig 8.

Some dairy companies in Ireland have identified particular products requiring an all-year-round milk supply which they claim will provide sufficient premium over current products such that the extra payments required by farmers to produce milk on an even all-year-round basis can be made. This requires the identification of a pool of committed farmers to whom substantial winter milk price premia are offered. The author has analysed these 'winter milk' schemes and has used linear programming to evaluate their benefits to both farmers and processors (Keane, 1987).

Conclusions

In complex agri-chains, a manufacturer's product choice may sometimes be constrained by powerful factors elsewhere in the chain. The Irish dairy industry is a good example of this. It has been demonstrated that a combination of EU dairy policy, a peripheral location and unique farm cost structures has resulted in a dairy product portfolio which differs substantially from other EU countries.

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Strategic options and modern financial theory

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Introduction

According to the mainstream of strategic management literature allocating resources is one of the major strategic activities to provide conditions for successful business performance. The final output of the business strategy is translated into a budget. The budget includes all the strategic and operational funds demanded for implementing the business strategy.

These strategic funds contain investments, increases in net working capital and developmental expenses. Whether these strategic funds follow strategy, as stressed by the prescriptive scholars on strategy, or whether strategy follows the process of formation of strategic funds, as enhanced by writers on financial theory, is still a matter of debate.

A somewhat broader perspective on financial strategy takes into consideration the main activities, being providing the firm with the appropriate financial structure and funds to achieve the overall objectives, the measuring of outcomes of strategic options and the selection of the best financial course of action. A particular interesting function of financial strategy is, according to Clarke (1988) to give competitive advantage trough a lower cost of funds and a flexible ability to raise capital.

Taking into account this broader set of functions of financial strategy, it is still open how financial theory can contribute to the core decision in the process of strategy formation: the selection of strategic options.

From the traditional point of view, financial theorists claim the use of pay-back period, internal rate of return, sensitivity analysis or capital project controls as key features for capital budgeting (Mills; 1988). In modern financial theory, however, the concept of net present value is the central theme. While writers on strategy formation and selection advocate completely different aspects to be included, as craft, creativity, experience and dedication (Mintzberg and Quinn; 1992).

So, the question is, how to select strategic options? In this article we advocate the use of a stronger financial dimension into strategy-making. More specifically, we consider the issues involved in the selection of strategic options using option theory, as one of the contributions to systematize decision-making processes on selection of strategic options.

First we describe the characteristics of strategic options and the problems enhanced to the selection of options. Second we look into the modern financial theory on market value. Third, the contribution to decision-making on selecting strategic options is clarified. Fourth, some evaluative conclusions are drawn on contributions of financial theory to strategic management theory.

Strategic Options

Strategic options cover the alternatives the firm can exploit to maximize the market value of the firm. It is assumed that firms can exercise real options open to the organization. What options are meant? Strategic options can be classified according to the directions and methods of firm development. Porter introduced three generic strategic options based on two dimensions: scope and competitive advantage (Porter, 1985).

The three generic strategies are as follows:

- a cost leadership strategy assumes getting competitive advantage trough cost based advantage from all sources
- a differentiation strategy assumes getting competitive advantage trough unique dimensions widely valued by buyers
- a focus strategy assumes the choice of a narrow competitive scope within a industry by selecting a segment or group of segments in the industry; in cost focus a firm seeks a cost advantage in its segments, while in differentiation focus a firm seeks differentiation in its segments.

Although these generic strategies are debatable as far as their nature concern (Johnson and Scholes; 1992), they illustrate the importance of core competence of the firm in the industry and the value chain. The directions in which the organization may choose to develop within its generic strategy are developed by Ansoff (1965) and others. Using the two dimensions market development and product development, four strategic options are defined:

Assuming an expected lower return on investment, firms may decide to withdraw from a market. Remaining the product-market combination, consolidation provides opportunities to reduce costs and keep up market share or step up product quality, offering means for competitive advantage. Market penetration chances mostly depend on the nature of the market and the position of competitors.

Table 1. Generic Strategies

	competitive advantage	
Competitive scope	lower cost	differentiation
broad target	cost leadership	differentiation
narrow target	cost focus	differentiation focus

Table 2. Strategic Options

	Product	
Market	present	new
present	withdrawal market penetration	product development
new	market development	diversification

In growing markets market penetration for new entrants is relatively easy, while in declining markets market penetration is possible depending on the firms that exit from the market.

The product development strategy may give competitive advantage in markets with short product life cycles. Market development assumes the firm maintains the range of products, while venturing into new market segments.

Diversification may be related, assuming new product-market combinations that follow the competence of the firm, or non-related when these competence do not relate to the new product-market combinations.

As far as the way the firm can achieve the overall objectives and generic strategies, different methods of sustaining competitive advantage are open to the firm. Within the value chain or across value chains the firm can drive down costs, create bases of differentiation and add value. Apart from vertical integration of the firm with another firm backwards or forwards in the value chain, numerous alternatives are open to the firm, enabling the strengthening of the relation between the firm and another firm as shown in *Figure 1*.

Horizontal strategies exploit interrelationships across distinct but related business units or firms. If the firm can not cope with environmental demands from internal resources alone, arrangements for joint activities and alliances might occur. A wide variety of options exist, like joint-ventures, consortia, licensing, sub-contracting and functional cooperations (see *Figure 2*).

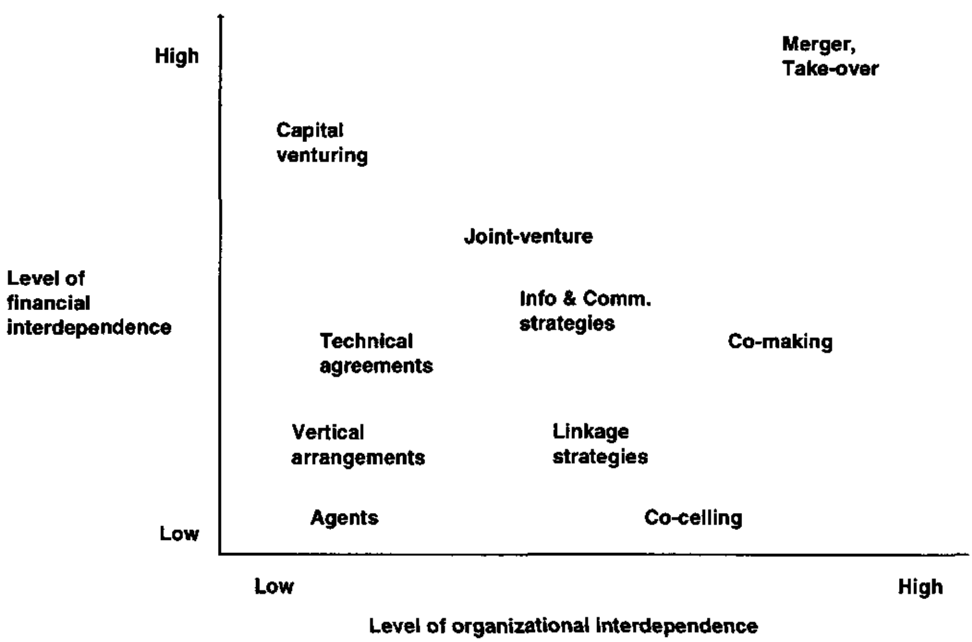

Figure 1. Vertical linkages between firms or business units

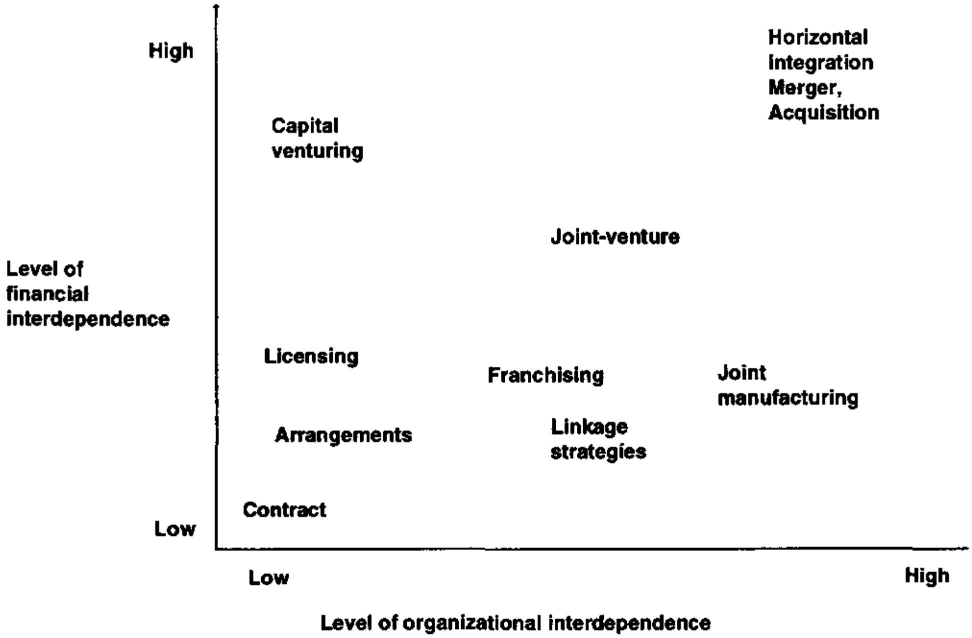

Figure 2. Horizontal linkages between firms or business units

Considering the financial and organizational dimensions of relatedness between firms or business units, some of the horizontal strategies are shown.

In short, the firm seeking for a future course of action, may choose out of a wide range of potential strategic options. Identifying options is a prerequisite for the assessment of its potentiality and suitability.

So, how to evaluate the value of options ? Therefore, we look into the selection criteria.

Screening and selecting strategic options

From strategic management theory many criteria have been introduced to screen and select strategic options. Johnson and Scholes (1992) distinguish suitability, based on the fit between the results of the strategic analysis and the option favored, feasibility, based on the notion of chances for successful implementation and acceptability, related to stakeholders expectations. Within the limited space of this article we elaborate on the acceptability criterium. Acceptability is the likely return from a particular strategic option and refers to the goal of the firm.

Modern financial theory assumes value maximization as the overall goal of the firm. An empirical study by Lanzillotti (1958) concludes that the two primary concerns of management are long-run profitability and stability. These goals appear to be inconsistent, but the dilemma can be solved by assuming maximization of the market value of the shareholders' wealth as corporate goal. This goal is equivalent to maximization of the market value of the existing stock as shown by for instance Levy and Sarnat (1986).

The maximization of market value as corporate goal is supported by the participation theory (see Simon et al; 1950, and Rhenman and Stymne; 1965). In this both sociological as economic approach the organization is viewed as a coalition of participants who all contribute to the organization with rewards as incentives, although this view is criticized by Agency theorists. They claim that internal stakeholders incline to optimize their own agents rewards instead of the firms value. Survival of the organization is guaranteed as long as all participants are prepared to contribute. This is, of course, depending on the rewards. It is the task of the management to distribute the rewards in a way that is acceptable to the participants and it is also its task to maximize the total rewards in order to achieve the maximal probability of survival, the goal with the highest priority of all goals, with an absolute priority (see Ijiri; 1965) above all other goals. An illustration of the participant theory is given below. So, screening and selecting strategic options may be evaluated by the acceptability criterium, measured by the maximization of the market value: the higher the option contribution to market value, the more acceptable the option is.

Market value: the Firm in Real and Financial Markets

Maximization of market value is not the only standard against which strategic options may be assessed. Another factor is risk the organization faces. The firm invests in real as-

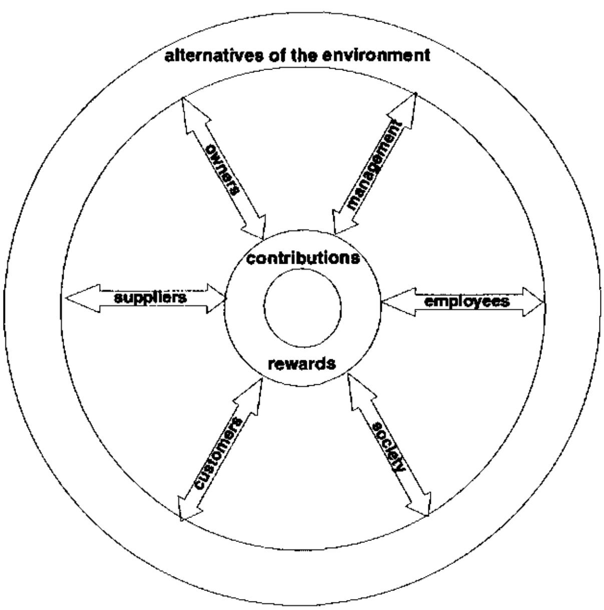

Figure 3. Contributions and rewards

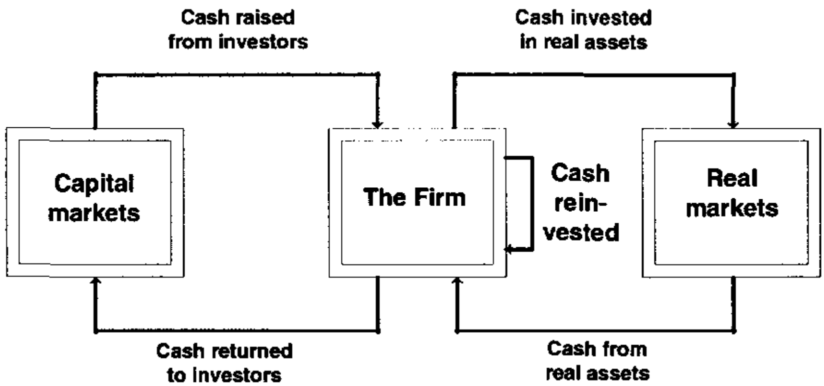

Figure 4. Cash flows in real and financial markets

sets with money from the capital market and is dependent on both real and capital markets.

The firm is an intermediary between the capital markets and the real markets on which the firm is operating. On real markets the firm has to make investment decisions and on capital markets it has to make financing decisions. The basic similarity between those decisions is evident in the light of the value maximalization goal.

"The decision to purchase a machine tool or to sell a bond each involve valuation of a risky asset. The fact that one asset is real and the other financial doesn't matter. In both cases we end up computing net present value." (Brealey and Myers, 1988).

The financial markets are highly competitive, in fact they are efficient. The first study on this subject was made by Kendall (1953) and the classic study was made by Jensen (1964). There are three levels of market efficiency defined:

1. Weak: Prices reflect all information contained in the record of past prices.
2. Semistrong: Prices reflect not only all information contained in the record of past prices but also all published information.
3. Hard: Prices reflect not only all information contained in the record of past prices and all published information but all the information that can be acquired by fundamental analysis of the company and the economy.

It is evident that the capital markets are efficient in at least the semistrong way and that the hard form of efficiency can be applied to at least the relative prices of stocks (Brealey and Myers, 1988). This implies that the expected value of capital market decisions is zero because all securities are fairly priced as they contain all relevant information. In other words, it is difficult to find financing schemes with net present values significantly different from zero. In fact, this is the fundamental concept of efficient capital markets; if capital markets are efficient, then purchase or sale of any security at the prevailing price is never a transaction with a positive net present value.

When a firm looks at capital investment decisions on real markets it does not assume that it is facing efficient markets. It may have just a few competitors or own some unique tangible or intangible asset. That is where positive net present values come from.

There has been a tremendous lot of research done about capital markets. Some thirty years ago the Capital Asset Pricing Model (CAPM) was developed to explain market values of stocks. It was a development of the pioneering work by Markowitz (1958), who presented a model of portfolio selection based on covariances between all existing securities. Assuming equal borrowing and lending rates it can be shown that all investors should choose the market portfolio in combination with borrowing or lending. This is known as the separation theorem and the original development of this theorem is due to Tobin (1958).

In the following figure AB is the efficient frontier of all combinations of securities, P* is the market portfolio, r_B the borrowing rate, and r_L the lending rate. The line from the rates to P* is known as the capital market line, and shows the required rate of return at different levels of risk.

The first article in which the CAPM was presented was written by Sharp (1964). Other founders of this approach are Lintner (1965), Mossin (1966) and Fama (1968). This theory states that the required rate of return is equal to the risk free rate plus a risk premium based on non-diversible or systematic risk. Diversible or unsystematic risk can totally be reduced by diversification as shown in *Figure 6.*

The non-diversible risk is measured by beta defined as

$$\beta_i = \frac{covariance(m,i)}{variance(m)}$$

where m is the market portfolio and i the individual stock i.
The required return of any risky asset (r_i) follows the security market line:

$$r_i = r_f + \beta(r_m - r_f)$$

where r_f the risk-free rate is and r_m the required rate of market as a whole measured by a market index. In *Figure 7* the security market line is pictured.

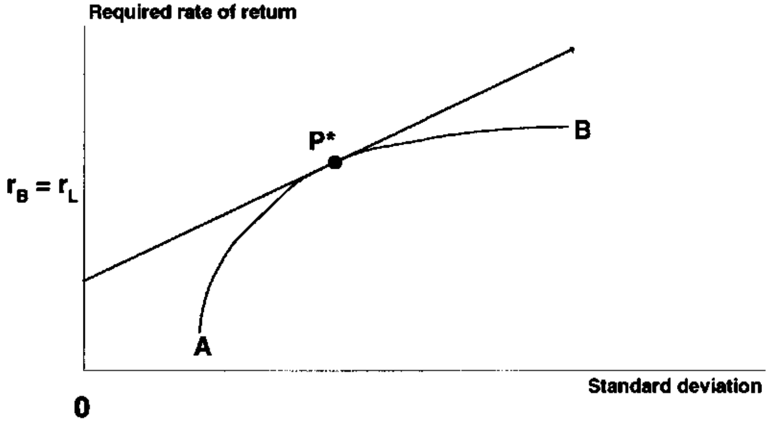

Figure 5. The capital market line

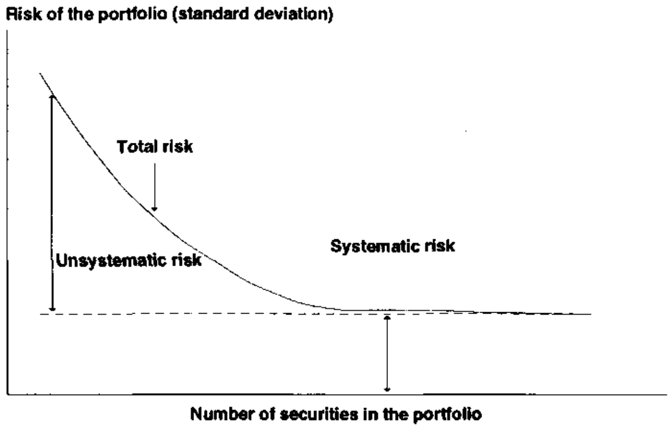

Figure 6. Systematic and unsystematic risk

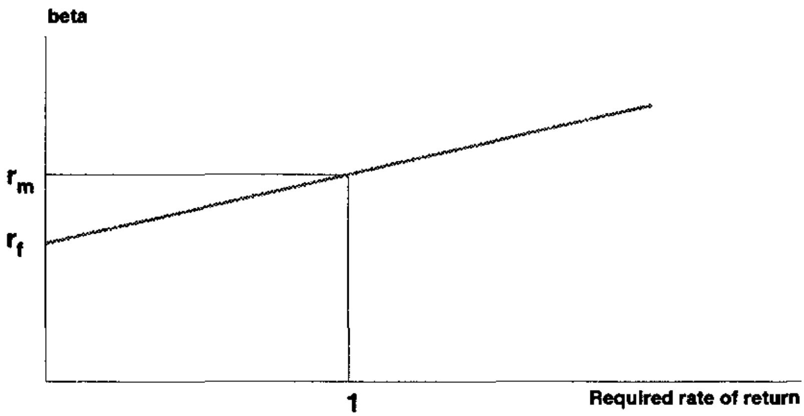

Figure 7. The security market line

However, the risk of a stock is a combination of business risk and risk due to financial leverage. For our purpose the risk of debt financing should be excluded. Assuming risk free debt the equation:

$$\beta_{Business} = \beta_{Equity} * \frac{Equity}{Equity + Debt} + \beta_{Debt} * \frac{Debt}{Debt + Equity}$$

reduces to:

$$\beta_{Business} = \beta_{Equity} * \frac{Equity}{Equity + Debt}$$

In this way a benchmark can be found for valuation of a strategic option. All cash flows associated with an alternative can be reduced to a present value by using a beta of a firm with a risk equivalent to the alternative. As pointed out before, there hardly is an efficient market in real investment projects we need this link with the capital market.

Assume that a firm has the opportunity to cooperate with another firm in a joint venture for production in the agribusiness sector. Other firms operating solely in this sector have a beta of about 1.5 and are financed with debt and equity in equal proportions. The capital market risk-free rate is 7 percent. Using the equation for calculating business beta:

$$\beta_{Business} = 1.5 * \frac{.5}{.5 + .5} = .75$$

The appropriate risk-adjusted discount rate will be:

$$r = .07 + .75 * (.11 - .07) = .10$$

The project involves an investment of \$ 1 million and will return an annual stream of equivalent cash flows the coming two years. The expected value is \$ 570,000 a year. The present value of this project is:

$$NPV = -\$\ 1{,}000{,}000 + \sum_{t+1}^{2} \frac{\$\ 570{,}000}{(1 + .10)^t} = -\$\ 10.744$$

As the net present value is negative, the project should be rejected.

This approach involves evaluating the total cash flows of the business units individually and the total cash flow of the firm in order to valuate the strategic option to its current owners.

Valuing Strategic Options

The concept of real options was introduced by Myers (1977). The assets of a firm are twofold:

1. Real assets with a market value independent of the firms' investment strategy
2. Real options or possibilities real assets to acquire on favorable terms

This is consistent with the Modigliani and Miller theory (1958) in which the market value of the firm consists of the present value of the current assets and the present value of growth opportunities.

Both Myers (1984) and Kester (1984) emphasize the existence of a gap between finance theory and strategic planning and suggest that besides correct use of finance theory an extension is needed by the use of the concept of real options. In Kemna (1988) the theoretical development of real options is treated.

In the context of strategic cooperation, a framework for an option pricing approach can be found in Stemne and Zuurbier (1992).

The valuation of European options (to be exercised on a particular day) is mostly based on the valuation formula of Black and Scholes (1973). The value of a European call option is:

$$C(0) = SN(a) - Ee^{-rT}N(a - \sigma\sqrt{T})$$

where: S = market value of the stock
E = exercise price
T = number of periods to exercise date
r = interest rate
σ = volatility

a is defined as:

$$a = \frac{\ln(\frac{S}{E}) + (r + 0.5\sigma^2)T}{\sigma\sqrt{T}}$$

N(a) is the cumulative normal distribution:

$$N(a) = \int_{-inf}^{a} \frac{1}{\sqrt{2\pi}} e^{-0.5x^2} dx$$

Using the put-call parity the value of a European put option is:

$$P(0) = Ee - rTN(-a + \sigma\sqrt{T}) - SN(-a)$$

American options can be exercised during the whole period until expiration date. As an American call option never will be exercised before maturity the Black and Scholes formula will hold, but an American put option could be exercised sometimes with profit before maturity. For this kind of options a binomial model (see Cox, Ross, and Rubinstein, 1979) can be used.

To illustrate the application of an option theory approach we use the following example. The management of a firm has to decide if they should maintain capacity for hardly profitable products. The capacity can be sold on the second-hand market and, of course, the current capacity can be expended if the market goes up.

Using S(t) for the present value of future cash flows at time and ß for the cash flow that per year becomes realized, we get the following relationship:

$$S(t) = S(t-1) * (1 - \beta)$$

It is possible to sell the capacity involved at a fixed price (E). This is an American put-option with E as the exercise price.

The possibility of expansion (with the fraction f) is an American call-option with the investment outlay (I) as exercise price.

In this case the current capacity has a value of $ 10 million and this value will decrease by 10 percent per year. The value on the second-hands market is $ 6 million and the capacity can be expanded by 40 percent at a cost of \$ 3 million. The value of the capacity can per year rise or go down by 50 percent. The risk-free interest rate (r) is 8 percent. The variables can be summarized as follows where the upward and downward swing are denoted by u and d, respectively:

$S(0) = \$\,10$	$f = .4$
$ß = .12$	$u = 1.5$
$E = \$\,6$	$d = .5$
$I = \$\,3$	$r = .08$

The data seems hard to find in real life, but let us examine them more in detail. The value of the current capacity (\$ 10 million) is the current market value which is easy to find for a firm on the stock exchange, in other cases this value has to be estimated. The annual decrease in market value (10 percent) should be estimated by management as the value on the second-hand market (\$6 million) and the cost of expansion (\$3 million).

The variability of the value of the capacity (up- or downswing by 50 percent) is based on subjective probability assessment of management. The risk-free interest rate can hardly be difficult to find.

Assume that the options can be exercised at once or at the end of each of the next two years. Using the binomial method, the value of the production capacity in millions of dollars one year ahead [S(1)] has two possibilities:

$$S(1) = S(0) * u * (1 - ß) \quad = \$\,10 * 1.5 * .88 \quad = \$\,13.2$$
$$S(1) = S(0) * d * (1 - ß) \quad = \$\,10 * 0.5 * .88 \quad = \$\,4.4$$

The value of the production capacity after two years from now can take the following values:

$$S(2) = S(0)*u^2*(1-ß)^2 \quad = \$\,10 * 2.25 * .77 \quad = \$\,17.4$$
$$S(2) = S(0)*u*d*(1-ß)^2 \quad = \$\,10 * 1.5 * .5 * .77 \quad = \$\,5.8$$
$$S(2) = S(0)*d^2*(1-ß)^2 \quad = \$\,10 * .25 * .77 \quad = \$\,1.9$$

The binomial tree for the coming two years becomes:

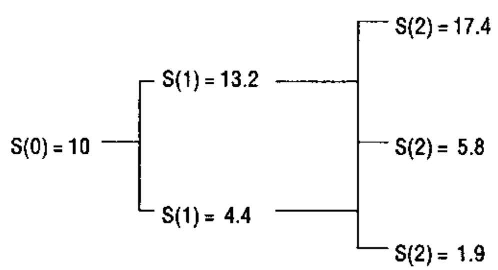

Figure 8. Value of Production Capacity

The option to stop (P) is valuable only if S(t) is below the exercise price of \$ 50 million and the option for expansion has a value of:

$$C(2) = S(2) * f - 1 = S(2) * .5 - \$ 3$$

If this value is positive. The tree can be completed by the option values where T(t) is the value of the combination of the call- and the put-option at time t:

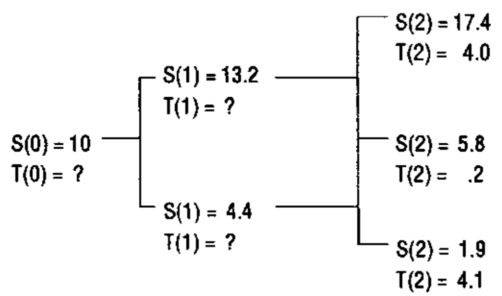

Figure 9. Option Values after Two Years

From the following relationship the probability of an upward change be determined:

$$p = \frac{\frac{r}{h} - (1 - d)}{(u - 1) - (1 - d)}$$

$$p = \frac{.08 - (-.5)}{.5 - (-.5)} = .6$$

The possible values of the options one year from now [T(1)] are:

T(1) = {(.6 * \$ 17.4 + (1 - .6) * \$ 5.8}/1.08 = \$ 2.2
T(1) = {(.6 * \$ 5.8 + (1 - .6) * \$ 4.1}/1.08 = \$ 1.7

But at time 1, when the option value is \$ 2.2 exercising the call option is worth more: 13.2 * .4 - 3 = 2.3
and at time 0 the value [T(0)] is:
T(0) = {(.6 * \$ 2.3 + (1 - .6) * \$ 1.7}/1.08 = \$ 1.9

The complete binomial tree becomes:

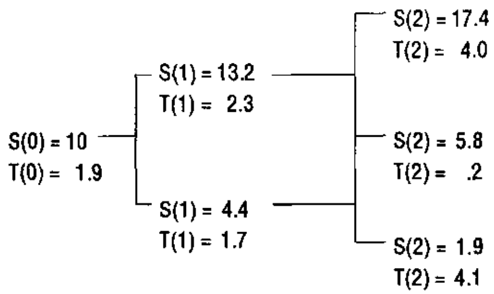

Figure 10. The Complete Binomial Tree

The total value of the project becomes:

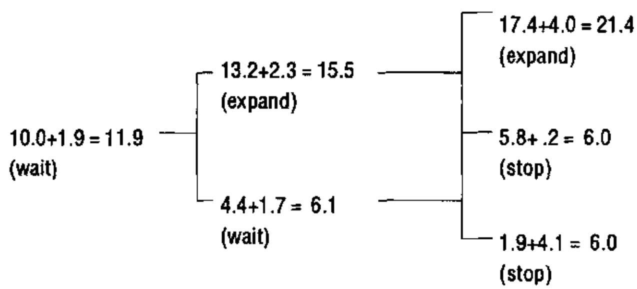

Figure 11. Total Value of the Project

By the two options (to stop and to expand) the project is worth $ 1.9 million more than without these options. The best strategy is to wait, and thus keeping both options. This example shows the usefulness of option theory for screening and selecting options.

Option theory: some critical notions

Based on our arguments, selecting the preferred option is, among other criteria, based on acceptability by internal and external stakeholders.

Real options are measured by market value, considering risk and the worth of real options. More specifically, one can hypothesize that option A is more preferred than option B, if and when

1. A contributes more to the overall objectives of the firm, expressed by maximization of market value, than B;
2. B contributes less to risk than B and
3. A shows a higher value than B.

If these conditions prevail, internal and external stakeholders will perceive option A more acceptable than B.

So far, these elaborations have shown their potential contribution to improving the quality of strategic decision making in general and selection of strategic option more specifically. However, some critical notions have to be considered.

First, the option pricing theory developed for financial markets should be treated very carefully when used for valuing real options. Compared to financial markets, real markets are obviously less efficient. The option valuation is based on put-call parity. Investors can create two alternative strategies which yield the same income, regardless of the future stock price at expiration. The alternative to buy a call option is then equivalent to the alternative to buy a stock and put option in combination with borrowing. As pointed out by Levy and Sarnat (1986) this is true only in perfect markets. However in real, non-perfect and even far from efficient markets the put-call parity should be used with great caution.

Second, option theory is focussed on the maximization of market value as perceived by internal and external stakeholders. However, internal and external stakeholders do not necessarily share the same ideas on the how and what of the maximization of market value. In fact, under opportunism conditions shirking behavior is likely to occur among agents, such as the board of directors allocating an increase in income to themselves, vis-a-vis the interests of external stakeholders such as investors and stockholders. More in general, organizations, as defined by Fama and Jensen (1983), as nexus of contracts between principals and agents, are assumed to show differences of interests between them. Consequently, maximization of market value is a perceptual phenomenon, a social construct, expressed by internal and external stakeholders, poses a theoretical problem. The nexus of contracts view of the firm reduces to conceiving the firm as an efficient bundle of skills, competencies and shared ideas on maximization of market value.

Third, option theory poses a methodological problem. Considering market value, potential cash flows and risks as the major concepts in the paradigm, the question of measuring these concepts has to be clarified. If firms are registered on the stock market, the market value of the firm over time can be approximated. However, what, if the firm is not operating on the stock market. How can the market value be measured, then? Moreover, how to estimate the potential cash flow and risks, if information in that respect is scarce or even unreliable?

Fourth, option theory offers a set of criteria to evaluate the potentiality of a real option. However, as we discussed earlier, what about the other criteria that are deployed, such as suitability of the option, consonance with the firms' policy or consistency over time ? The process of selection of options may well be regarded as a multi-criteria evaluation. If that is the case, how shall the relative weight of the option theory contribution be compared with other criteria?

In short, option theory promises to improving the quality of strategic decision making, but between promises and real contributing some barriers have to be taken first.

Conclusion

In this article we discussed option theory within the context of the process of selecting strategic options. We referred to Brealey and Myers (1990) who challenged strategy theorists and scholars in modern financial theory to bridge the gap between them. We ela-

borated on the potential use of option theory, considering the major concepts: market value, potential cash flow and risk.

Based on our argument, we conclude that option theory may contribute to the understanding of strategy making processes in general and the process of selecting strategic option specifically.

However, some problems have to be solved. Problems that deal with the basic assumptions of option theory, as the maximization of market value in view of internal and external stakeholders, the intransparency of real markets, the measurement of the basic concepts and their relative weight compared with other selection criteria.

The importance of the option theory with respect to strategy making is that is gives a source of information that may raise the quality of decision- making. In that respect, the contribution is comparable with other technical-financial instruments, such as funds-flow analysis, break-even analysis, sensitivity analysis and cost-benefit analysis. These instruments may clarify the attractiveness of strategic options and, by that, create a consensus between internal and external stakeholders.

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Economic optimization of pork production-marketing chains: taking in account animal welfare and environmental constraints

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Introduction

Consumers show increasing interest in the quality of the product and the production process, including animal welfare, environmental pollution and food safety issues (Burbee and Kramer, 1985). This creates opportunities for selecting market segments to which more value can be offered through product differentiation. Demands of this type almost entirely concern the upstream farm stages of the so-called Production-Marketing Chain, requiring the transmission of those – changed – consumer preferences to primary stages. Vertical cooperation is considered a promising strategy in this respect. Whereas forward cooperation gives better access to market information, allowing a specific adjustment of product or process characteristics to consumer needs, backward cooperation increases the possibility of obtaining specialized inputs through which final products may be improved or at least distinguished (Porter, 1980). In the Dutch swine industry, the pork chain producing 'Outdoors' pork meat, is an example of a chain that includes consumers demands on animal welfare.

In the Netherlands, the surplus of animal manure causes environmental problems in terms of soil acidification and soil saturation. Major causal factors are considered to be Phosphate, Ammonia and Nitrate. In May 1993, representatives of agribusiness and government reached an agreement on environmental pollution. Targets were set to reduce pollution by agriculture. At the same time, national legislation was prepared that prescribes conditions under which pigs must be kept with respect to their welfare. Both types of agreements will require high future investments of farmers.

Various on-farm measures are available in order to reduce environmental pollution and improve animal welfare. Environmental measures include adaptations of feed types and regimes, housing facilities, and storage and processing of manure. Housing facilities are also considered to affect animal welfare, e.g. the amount of floor space per animal and whether or not animals have access to outdoors facilities outside the barn.

Market demands and government regulations are not static but change over time. A relevant differential advantage of a chain system today, therefore, may be irrelevant in the future. Anticipating future developments, it is interesting to explore how these changes will influence the structure and profitability of chain concepts, especially in case of potentially conflicting issues (e.g. demands involving lower costs, higher animal welfare standards and more environmental friendly systems). Therefore it is important to gain insight into ways to optimize chain concepts at minimal costs under (current and future) constraints of animal welfare and environmental issues.

The objective of this paper is to present and describe the economic effects of factors considered to improve animal welfare throughout the stages of the pork production marketing chain. Potential impact of these factors on environmental pollution, is also taken into consideration. At first, outline and definitions of the production-marketing chain, will be described. Subsequently, an economic chain simulation model is presented, which is used to calculate the costs and benefits of the factors related to animal welfare within the pork production-marketing chain. In the chain model a farrowing stage producing feeder pigs, a fattening stage producing hogs, and a slaughtering stage, are included. Transportation of feeder pigs and hogs between the stages, is also considered. Following the description of the chain simulation model, it is described how animal welfare is taken into account. Factors assumed to affect animal welfare throughout the pork chain, as well as the questionnaire, used to estimate their impact on animal welfare, are described. The questionnaire was created and analyzed using conjoint analysis of multi-attribute parameters (Steenkamp, 1985), enabling an estimation of animal welfare coefficients in terms of both main effects and interactions of the factors considered. The questionnaire was sent to pig welfare experts and representatives of consumer organisations, retailers, and animal welfare advocacy groups. Potential environmental effects of the factors considered, are measured in terms of ammonia emission. Finally, a linear programming model is presented which is used to minimize costs of producing pork products, under various constraints on both animal welfare and environmental pollution criteria.

Chain definitions

Theoretically the successive steps or activities involved in converting raw materials into final products and distributing them to the final user can be subdivided indefinitely (Ikerd and Higgins, 1973; Porter, 1985). However, in defining the boundaries between stages, most authors emphasize technological, functional, geographical and/or economic separability. For instance in Porter's (1985) 'value chain' concept, the relevant 'value-activities' in which a firm is disaggregated, are separated on technological, economic and strategic relevant distinctions. In its turn, the value chain of a firm is embedded in a larger stream of value activities, called the 'value system' (Porter, 1985). The value system also includes the value chains of supplying and buying firms. According to Porter (1985), the appropriate degree of (dis)aggregation of activities depends on their economics and the purpose of analysis. Since this paper is especially concerned with the activities performed within separate farms and agribusiness firms of the pork chain, a stage is described in economic terms. An 'economic' stage can be defined as the combination of activities performed between two adjacent marketing levels, i.e. a saleable product or service exists at the separation between stages (Ikerd and Higgins, 1973). This means that a 'stage' is defined within the boundaries of a firm in a way comparable to Porter's value-chain. The term 'production-marketing chain' is used here to describe the combination of vertically related firms or stages through which a product flows from raw material to final consumption. This is comparable to Porter's value system. As the above definition indicates, an important characteristic of production-marketing chains is that their stages are interlinked vertically. Vertical linkages are relationships between the way supplier or buyer activities are performed and the cost or performance of a firm's activities; and vice versa (Porter, 1985).

Vertical integration can be defined as the combination of two or more stages of a production-marketing chain, under single ownership (Porter, 1980). Compared to regular market exchange, in which stages are coordinated through the functioning of the price system only, vertical integration alludes to internal coordination by one firm having complete control over the integrated neighbouring stages. Incomplete vertical integration or vertical cooperation refers to vertical relationships between two or more adjacent stages without full ownership or control (Porter, 1980) in which the partners fundamentally maintain their independence but for example share information or coordinate pricing. Control is transferred of some, but not all, aspects of production, distribution or marketing. This incomplete shift of control accompanied by maintenance of autonomy distinguishes vertical cooperation from vertical integration. Vertical cooperation is a way of 'broadening scope without broadening the firm' (Porter, 1985).

Material and methods

Economic chain simulation model

Basically the purpose of the chain simulation model is to simulate technical and economic performance of an average - representative - sow farm, fattening farm or slaughterhouse. The farrowing stage in the model produces feeder pigs which are transported to the fattening stage at a live weight of approximately 23 kilogram. At the fattening stage the feeder pigs are grown and finished (hogs). At a live weight of approximately 108 kilogram the finished hogs are transported to the slaughterhouse where they are slaughtered and either sold as a carcass or processed further.

Costs are calculated as opportunity costs, representing the potential benefit that is given up because one application of an asset is chosen over another. The cost calculations are presented at an animal basis, i.e. per feeder pig sold (farrowing stage), per hog sold (fattening stage) and per hog slaughtered and sold (slaughtering stage). With respect to the farrowing and the fattening stage, the efficient scale of operation is based on the number of animals (sows and hogs respectively) that one skilled worker or full time equivalent, can handle within a regular number of working hours per year. Regarding the slaughtering stage it is assumed that the efficient scale of operation equals a slaughter capacity of 300 to 400 pigs slaughtered per hour (Product Board for Livestock and Meat, 1991).

In general four types of variables are distinguished in the model: input variables, variables representing interstage relations, technical output variables, and economic output variables. A variable controlling interstage relations, can be an input variable, requiring an input value of the user, or a technical output variable, calculated by the chain model. A schematic description of the relations between major groups of variables, is presented in *Figure 1*. The model runs with - Dutch - default input values but allows the user to enter data for all input variables considered, and therefore, can be adjusted to individual price and production conditions worldwide. Default values of important input variables are presented in appendix I.

Input variables concern input both on farm lay-out and on technical performance, such as culling and reproduction information in the farrowing stage. The farm lay-out, i.e housing and feeding facility, is related to the labour required for handling the animals in the farm stages. Based on the input values, technical output is calculated. An important technical output variable in the farm stages is the farm scale. Combined with other technical output, the farm scale determines how many pigs can be sold per year. In this way, it effects both the interstage relation between the farrowing stage and the fattening stage, represented by the number of feeder pig suppliers (*Figure 1*), and economic results of the farm. Although no specific interstage relation is defined concerning pig transportation, transportation costs per animal strongly depend on the output of the farm stages, such as the number of pigs that has to be transported per time and the average weight of the animals. As the slaughtering stage performs an important step in matching the supplied hogs to the demand of carcasses and primary parts, demand is an important input variable in this stage, as is the revenue of the various carcasses and parts.

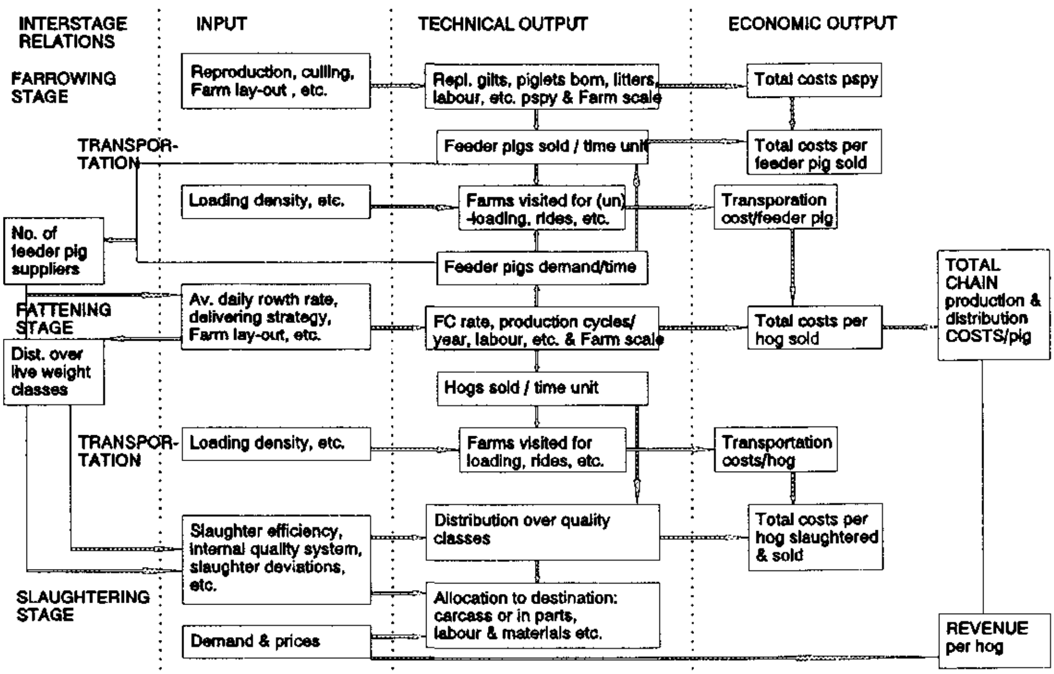

Figure 1. Schematic representation of the economic pork chain simulation model (pspy = per sow per year, FC = Feed Conversion)

Transportation of feeder pigs to the fattening farm and transportation of hogs to the slaughterhouse, are assumed to take place on cost of the fattening stage and the slaughtering stage respectively. Feeder pigs can be delivered to the fattening farm, approximately once per week, as is common in practice. The exact length of this period, however, depends on the delivery schedule of hogs to the slaughterhouse. Based on the loading density during transportation of pigs, the average live weight, and the net transportation surface, the loading capacity of the truck is calculated. Truck loading capacity, occupation rate of the truck and the number of feeder pigs available for transportation, yield the number of farrowing farms that have to be visited to load the truck. The number of feeder pigs needed per time unit at the fattening stage, determines how many farms a transportation truck has to visit for complete unloading. The number of farms visited are related to the time needed for loading and unloading. Moreover, comparison of the number of feeder pigs available for sale per time unit, with the number of feeder pigs needed per time unit in the fattening stage, reveals how many feeder pig suppliers are required. Elbers (1991) found that the number of feeder pigs suppliers of a fattening farm, influenced its productive performance. Both effects on daily growth rate, mortality rate and drug use in the fattening stage, and effects on the prevalence of pathological lesions observed in the slaughtering stage, were quantified.

With respect to the fattening stage, average daily growth rate can be considered a major input variable of the model. The average growth rate is related to the feed conversion ratio, implying a smaller use of feed per kg live weight gain as the growth rate increases. The daily growth rate is assumed to be normally distributed. The delivering strategy is defined by the number of deliveries per production cycle from one compartment, and the relative distribution of hogs over those deliveries. Growth rate, the standard deviation in growth rate and the delivering strategy, are the primary variables used to calculate the distribution of hogs sold over live weight classes, the number of production cycles per year and the occupation rate of hog places. The distribution of saleable hogs over live weight classes is related to the distribution of carcasses over quality classes within the slaughterhouse, as such representing an important interstage relation. Combined with the choice of housing facility and feeding system, the number of production cycles per year is used to calculate the hog farm scale (*Figure 1*).

Transportation of hogs resembles transportation of feeder pigs. The only difference refers to unloading at one place (slaughterhouse) instead of at several fattening farms.

In the slaughtering stage the following processes can be distinguished: supply of hogs, slaughtering, cutting of carcasses into primary parts, and sale and expedition of end-products. The distribution over live weight classes of hogs and the slaughter efficiency, are the primary variables used to determine the relative distribution over quality classes. Carcasses are distributed over the various quality classes by means of the internal quality system, which is based on various combinations of slaughter weight, lean meat percentage and overall body composition. The quality classes determine the processing options of the carcass and therefore, the processing costs and the potential value of a carcass (Figure 1).

To evaluate the consequences of changes in the production or distribution system on costs and benefits along the chain, both costs that vary proportionally with the scale of operation, and costs that remain constant over a specified range of activity, are considered. Since total cost in the last case remain constant, cost per animal varies inversely with changes in scale of operation. Examples of cost components of this type include labour costs (excluding hired labour), costs of buildings and transportation facilities, and overhead costs. Activities that require labour time in direct proportion to the scale of farrowing or fattening, involve common activities such as feeding, cleaning and health care. In the default situation the animals within the farrowing stage are fed automatically. Investments in buildings and equipment per sow place and per hog place are related to the number of places per farm. By increasing the number of places, the investments per place decrease less than proportionally.

Animal Welfare

Public concern about animal welfare and animal rights appears to be increasing in the north-western European countries as well as in the United States of America. While the mood of the general public is difficult to gauge, one indication is a proliferation of advocacy groups dedicated to improving animal welfare. As some of these advocacy groups in the Netherlands are known to carry on successful campaigns, they are assumed to both represent and influence the opinion of various consumer groups.

The purpose of this study is to evaluate the impacts that potentially could occur in the various stages of the pork production-marketing chain, if production systems and tools which address selected animal welfare concerns, are adopted. In order to explore how these concerns may influence production and transportation systems and their costs, one would anticipate on which concerns are important regarding pig welfare, and their degree of importance. Based on literature (e.g. Putten and Elshof, 1978; Ruiterkamp, 1985; Gloor, 1988; Wolbert et al, 1993) and consultation of experts, various factors, described in *Table 1*, are assumed to be related to pig welfare along the pork production-marketing chain. The factors are presented per stage of the chain to which they refer. For each factor the possible values considered, are presented as well.

Mixing a socially stable group of animals may increase fighting behaviour to re-establish a new social order (Scheepens, 1992). However, mixing animals, e.g. during transportation, that have no experience of being placed in socially new groups, is regarded to have a bigger negative impact on their welfare compared to when they have experienced this at an earlier age. Moreover, by grouping pigs according to their live weight and age, variation in market weight can be reduced, increasing profitability of the fattening stage by increasing the number of production cycles per year and reducing the price discounts received due to slaughter weights outside the highest paid range of 75 to 95 kg in the Netherlands (Hoste and Baltussen, 1992).

Moving piglets at weaning from the known environment of the nursery room to an unknown rearing pen, may cause substantial stress (Scheepens, 1992). In general, providing more (concrete) space to pigs, straw for distraction, day-night rhythm of light available and outdoors space, is considered beneficial with respect to the welfare of the pig. Housing non-lactating sows in groups instead of individually, enables them to have social contacts and more freedom of movement. With respect to welfare of the sow, housing in cubicles in often preferred above tethered housing.

Regarding the fattening stage, feeding roughage to hogs is considered to improve their welfare as it supplies stomage contents and distraction. Climatic conditions should provide the hog with a thermo-neutral zone and prevent draft. Using a computer to control climate, may improve climatical conditions.

Table 1. Factors, considered in this study, which are assumed to be related to pig welfare in the various stages of the pork production-marketing chain

Farrowing		*Fattening*	
socially mixing at weaning	Y/N	socially mixing start fattening period	Y/N
weaning age (weeks)	4-6	ventilation automated	Y/N
move at weaning	Y/N	roughage fed	Y/N
concrete:total floor nursery pen (m^2)	0:3.8/4:6.5	concrete:total floor (m^2)	0:0.6/0.4:0.9
group housing non lactating	Y/N[1]	straw available	Y/N
total floor space (m^2) non lactating	1/2.2-1.4/3[2]	light available (lux)	0/20
straw available	Y/N	outdoors space (m^2)	0-1.1
light available (lux)	0/20		
outdoors space (m^2)	0-5		
Transportation		*Slaughtering*	
socially mixed at loading	Y/N	socially mixing	Y/N
handling	rough/quiet	slope loading bridge	>20°/≤20°
loading at more farms	Y/N	resting period (hours)	2/4
loading density (kg/m^2)	300/235	showering	Y/N
ventilation automated	Y/N	stocking density (kg/m^2)	300/235
		handling	rough/quiet
		lay overnight	Y/N

1 In case of individual housing, non-lactating sows can be tethered or be housed in cubicles.
2 The first figure (1 m^2 to 1.4 m^2) relates to individual housing, while the second figure (2.2 m^2 - 3 m^2) relates to group-housing of non-lactating sows.

Removing pigs from a known environment, causes stress and scares the pigs which may not be moved easily then. Rough handling, using electric prodders to force the pigs, may save labour time but cannot be regarded beneficial to the welfare of the animal. Each time, the truck stops to load pigs at another farm, the pigs may start to explore their new environment and start fighting for social order. Moreover, the screaming noises of the new loaded and unknown pigs, may cause additional stress.

High stocking densities as a result of high loading factors, are less preferred with respect to pig welfare. However, too low stocking densities must be avoided also in order to prevent the pigs from falling during transportation. Pigs dislike climbing and descending steep loading bridges. Reducing the angle makes loading much easier for the inexperienced animals, as does a lifting-platform as a loading device attached to the lorry, even more (Putten and Elshof, 1978). Showering the animals during the resting period in the slaughterhouse, has a beneficial effect on hogs by cooling them and reducing fighting behaviour.

Much literature is available on how to measure animal welfare in general, and on the differences in pig welfare in different production systems. Parameters described to measure animal welfare involve physiological, veterinarian and ethological variables. Body temperature, heart beat rate and blood composition, are examples of physiological parameters, while mortality, morbidity and external injuries of the animal, are examples of veterinarian parameters. Ethological parameters relate to the behaviour of the animal, concerning both changed behaviour, inability to express certain behaviours and so on (e.g. see Ruiterkamp (1985) and Gloor (1988)). The problem with this kind of parameters is that different ones are used to measure the various animal welfare related factors. Therefore, the impact of several animal welfare related factors along the stages of the pork chain, may not be measured in a unique parameter, making it impossible to compare and use these factors simultaneously. Moreover, it may be expected that members of animal welfare advocacy groups, consumer groups, and retailers, being the closest to (buying) public opinion, are not acquainted with - the interpretation of - these parameters. Therefore, a questionnaire based on conjoint analysis, is used here to estimate the impact of the various factors, or attributes, on animal welfare, on an interval scale of numbers, ranging from 0 to 100. A comprehensive description of the usage of conjoint analysis to measure consumer preferences to product attributes, can be found in Steenkamp (1985). Production system characteristics are considered external attributes of the pork meat product. Each possible combination of the values of these attributes, a so-called product 'profile', yields a potential new product. Understanding how each of the attributes contributes to the preference of the respondent of the product as a whole, it often is not possible to let the respondents judge all possible profiles (full factorial design), because of the great number of possible profiles. For example, combination of three attributes at three possible values with two attributes at two possible values, would yield $3^3 * 2^2 = 108$ profiles to be judged. Using fractional factorial designs in conjoint analysis (Steenkamp, 1985), enables the researcher to strongly reduce the number of profiles that have to be judged. Moreover, by employing compromise designs it is also possible to take potential interactions into account. Per stage, one questionnaire (case) was developed. To link stage results to results that can be used for the chain as a whole, each respondent was asked to quantify the relative importance of each stage to overall pig welfare throughout the stage. Besides the 8 to 16 profiles needed per stage to estimate the contribution of each welfare related attribute, 3 hold-out profiles were added to each case to test the predictive validity of the estimated coefficients per respondent. The predictive validity can be described as the way in which the scores of new profiles can be predicted correctly, by means of the estimated model coefficients.

The questionnaires were sent to 11 respondents, of which half could be regarded as experts on pig welfare, while the other half represented animal welfare advocacy groups and retailers (denoted as the consumer-related group). As the interests of the animal welfare groups appear to 'evolve' over time, it is expected that their opinions show a greater variance and may differ from the opinions of the experts.

The questionnaires were analyzed using the ANOVA procedure for linear regression of SPSS (Norusis, 1992). The hypothesis that the group of experts would yield significantly different welfare coefficients compared to the consumer-related group, is tested by means of the F-test of ANOVA. The R^2 or correlation coefficients were used as a measure of internal validity of the models estimated. The predictive validity of the models was tested using Chi^2-test.

Linear Programming

In order to explore how increasing levels of animal welfare will interact with costs incurred to achieve those levels in the pork production marketing chain, a linear programming model was developed. The objective of the linear programming model is to minimize costs under various constraints on animal welfare (and environmental issues). The relations between the various models used in the study, is presented in *Figure 2*.

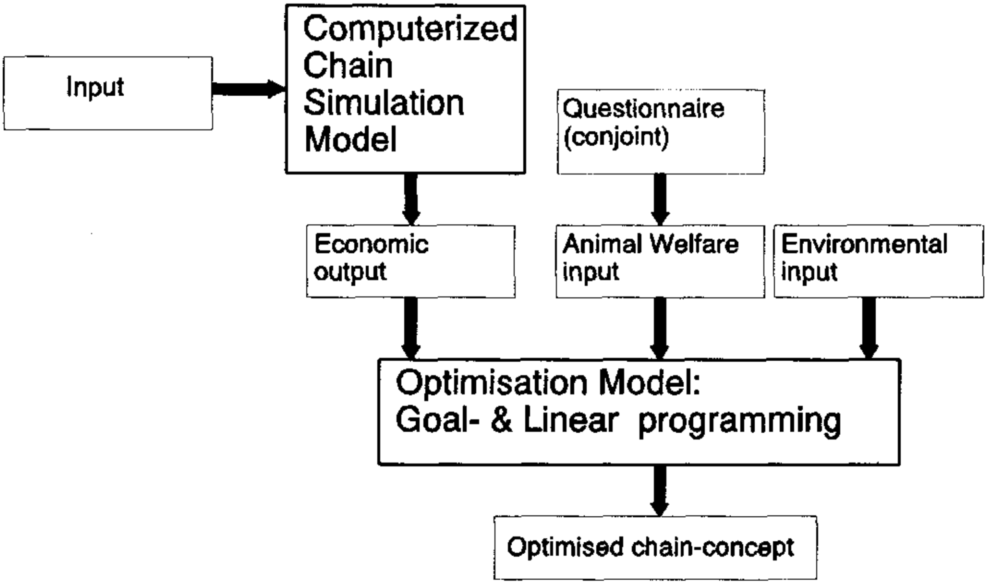

Figure 2. Schematic representation of the overall model structure, linking the chain simulation model to the optimisation model

As is shown in Figure 2, the economic input of the optimisation model is generated as economic output by the pork chain simulation model. In this way, additional costs, incurred by adding an animal welfare related attribute to the chain concept, are calculated taking into account the interstage relations between the various stages. The animal welfare coefficients, representing the relative importance of an attribute to the overall welfare of the pig in the chain, are calculated from the questionnaires, using the conjoint analysis. Environmental input, in terms of ammonia emission, is required from literature. By means of the optimisation model, additional chain production costs per pig, can be minimized taking into account both animal welfare and environmental constraints.

Results

Chain simulation model

With the – Dutch – default values of input variables used in the chain model, sows produce 2.26 litters per year resulting in 20.8 feeder pigs sold per sow per year. Within the fattening stage 2.94 production cycles are realized per year. The integral cost price analysis resulted in production costs per feeder pig sold of Dfl. 118, while the cost price per hog sold equals Dfl. 189. The total production costs per hog sold to the slaughterhouse, therefore, equal Dfl. 307 from farrow-to-finish. Total costs of slaughtering hogs and selling them as either carcasses or in parts ('first cut'), equal Dfl. 49 and Dfl. 63 respectively. The higher costs of processing and selling first cuts instead of carcasses, mainly result from the additional labour time required.

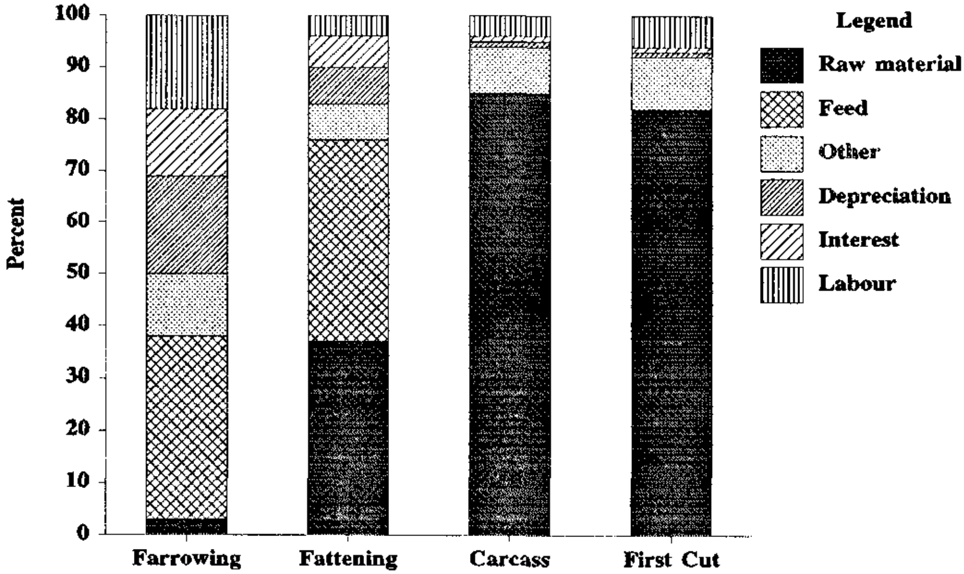

Figure 3. Cost composition of feeder pigs (farrowing stage), hogs (fattening stage), carcasses and first cuts (slaughtering stage)

In *Figure 3*, the distribution of the overall cost price over the various cost components is presented per feeder pig sold, per hog sold and per carcass or first cut sold. Raw material costs included, are based on the average 1992 market prices. As shown in Figure 3, feed costs are the major cost components in both the farrowing and the fattening stage, representing 35% and 39% of the total cost per feeder pig and hog sold, respectively. Excluding the costs of feeder pigs bought in the fattening stage, the feed costs per hog sold, even represent 61% of total production costs. However, the farrowing stage is relatively labour-intensive compared to the more capital-intensive fattening stage. The overall costs of slaughtering and selling hogs, mainly consist of raw material costs. Comparable figures of the composition of slaughtering costs were described by Lorenz (1991), who also mentioned the raw material costs as the major cost component in the slaughtering stage.

In Table 2, the costs coefficients calculated by the chain simulation model, are presented. Cost coefficients are presented on animal basis and represent the extra or marginal costs of changing a variable from the lowest to the highest value considered in the questionnaire (Table 1). For example, when, in the farrowing stage, the weaning age is changed from 4 to 6 weeks, the production costs per pig produced in the chain, increase by Dfl. 12.2. The effect of not socially mixing of piglets at weaning, is assumed to increase the standard deviation in daily growth rate in the fattening stage with 10%. As a result, total production costs per pig, are increased by Dfl. 0.50. Of these costs, 18% was incurred at the fattening stage, 6% at hog transportation, and 76% at slaughtering the hogs and selling them at a lower value. This clearly demonstrates the effect of an interstage relation. Moreover, with respect to cost effects, some attributes are related to each other.

Table 2. Chain costs coefficients (Dfl. per pig) calculated by the chain simulation model for use in the linear programming model

Farrowing		*Fattening*	
no socially mixing at weaning	0.5	no socially mixing start fattening period	0.5
weaning age	12.2	ventilation automated	1.6
move at weaning	1.4	roughage fed	8.5
concrete:total floor nursery	3.3	concrete:total floor	5.5
housing non-lactating[1]	2.2/3.7	straw available	9.5
total floor space non-actating[1]	0.3/0.7	light available	0.2
straw available	6.0	outdoors space	7.3
light available	0.4		
outdoors space	1.9		
Transportation		*Slaughtering*	
no socially mixing at loading	3.49	no socially mixing	0.02
handling	0.09	slope loading bridge	0.04
loading at more farms	2.2	resting period	0.02
loading density	0.7	showering	0.04
ventilation automated	0.05	stocking density	0.01
interaction[2]		handling	1.4
		lay overnight	0.14

1 The first figure relates to individual housing, while the second figure relates to group-housing of non-lactating sows.
2 Interaction between loading density and ventilation.

For example, due to the fact that the available light depends on the area of the pen, adding extra space will also require additional light to meet the desired light (lux) standards. If outdoors space is provided to hogs, the departments have to be build along the central passage of the barn instead of transversely to the passage, implying an increase of total housing costs and higher costs of additional concrete space. As a result, the additional chain production costs per pig, incurred in case all animal welfare related attributes are added, will be higher than the sum of the costs presented in *Table 2*.

Animal welfare

All respondents were asked by phone for their cooperation, before the questionnaire was sent to them. Questionnaires were sent back by 7 of the 11 respondents, resulting in a response rate of 64%. The non-respondents involved one 'expert' and three representatives of animal welfare advocacy groups.

On average, good fits of the estimated models per respondent were obtained. Per attribute, the estimated coefficients varied greatly between respondents. Although the estimated coefficients revealed little consensus between the respondents in general, respondents showed greater concordance with respect to the attributes they regarded most important in each case. When the estimated coefficients per respondent were ranked hierarchically according to their absolute value, it was found that the respondents, on average, rated the factors 'socially mixing', 'housing of non-lactating sows', and 'availability of straw', as the three most important welfare related factors of the farrowing stage. Regarding the fattening stage, in general, the attributes 'straw available', 'light available' and the ratio of 'concrete to total floor space', were judged most relevant to the welfare of hogs, as were 'handling' and 'socially mixing' during transportation and slaughtering.

Table 3. The estimated pig welfare coefficients of a consumer representative and an expert, which were used in the linear programming model.

	consumer repr.	expert		consumer repr.	expert
Farrowing			*Fattening*		
no socially mixing at weaning	1.3	8.6	no socially mixing start	3.2	1.6
weaning age	1	4.7	fattening period		
move at weaning	2.2	0	straw available	10.1	11.4
concrete:total floor nursery	3.3	0	(0.1 kg/pig/day)		
housing non-lactating	3.8	9.2	concrete:total floor	12.9	1.5
total floor space non-lactating	2.3	−2.2	light available (20 lux)	6.5	8.2
straw available	3.0	2.7	ventilation automated	1	0.6
(0.2 kg/pig/day)			roughage fed[1]	5.1	3.8
light available (20 lux)	2.5	1.8	outdoors space (1.1 m^2)	16.1	7.0
outdoors space (5 m^2/sow)	5.6	2.1			
Max. welfare points	24.9	29.1		54.9	34.1
Transportation			*Slaughtering*		
no socially mixed at loading	0.8	5.1	no socially mixing	1.6	3.1
handling	6.0	6.2	slope loading bridge	0.9	2.5
loading at more farms	0.8	2.4	resting period	−1.2	1.5
loading density	1.0	2.2	showering	0.9	1.5
ventilation automated	0.3	0.5	stocking density	1.2	2.3
interaction[2]	1.0	2.7	handling	5.2	3.1
			lay overnight	0.1	0.1
Max. welfare points	9.9	19.1		9.9	14.1
3-way interaction socially mixing	0.4	3.6			

1 The amount of roughage that had to be fed to hogs was quantified at one tenth of the daily amount of concentrated feed and at 1 kg per hog per day respectively.
2 Interaction between loading density and ventilation.

Analysis per group of respondents, that is the experts versus the consumer-related group, did not yield a significant difference, implying that the expected contrast between the two groups could not be proved with the data of this study.

When the predictive validity of the estimated models per respondent was tested (Chi^2) by means of the hold-out profiles, it was found that the predicted values and real values of the hold-out profiles of each case, did not differ significantly for one respondent (= 0.10). With respect to the data of the other respondents, predictive validity in total, was lower. For purpose of illustration, the estimated welfare coefficients based on the data of a respondent out of the consumer-related group and of an expert, are used in the linear programming (LP) model (*Table 3*).

As is shown in Table 3, the welfare coefficients based on the data of the expert and the consumer representative, add up to different maximum welfare points per stage. For example, using the welfare coefficients of the expert would result in a maximum of 34.1 points, in case all the welfare related attributes of the fattening stage were added to the chain concept. In contrary, the coefficients of the consumer representatives, add up to a maximum of 54.9 points. Combined with the - interstage - interaction coefficient, a maximum of 100 points can be realised in case all attributes are included. This holds for the welfare coefficients based on both the expert and the consumer representative.

Optimization: costs and animal welfare
In *Figure 4*, the additional chain production costs per pig sold, are presented, at increasing levels of animal welfare. Both the results based on the welfare coefficients of the expert and the consumer representative (Table 3), are shown.

In case of relatively low levels of animal welfare, the usage of the coefficients of the expert in the LP-model, yields the same desired animal welfare level at lower costs per pig as compared to using the welfare coefficients of the consumer representative. Apparently, the expert has valued the attributes, which require relatively low costs to implement, with more animal welfare points. Examples involve diminishing the slope of the loading bridge at unloading the truck at the slaughterhouse and adding additional light to hogs at the fattening stage. Recall the fact that in the questionnaire, the costs of implementing the attributes were not described. However, as the desired level of animal welfare increases, the difference between expert and consumer representative, in marginal costs per pig necessary to achieve this level, becomes smaller. In fact, at a level of 90 animal welfare points, the costs of the chain concept, incurred by using the coefficients of the expert, are even higher than those incurred in case the coefficients of the consumer representative, are used. Moreover, it is shown in Figure 4, that the additional per pig increase progressively at higher desired levels of animal welfare. The highest additional costs per pig in the

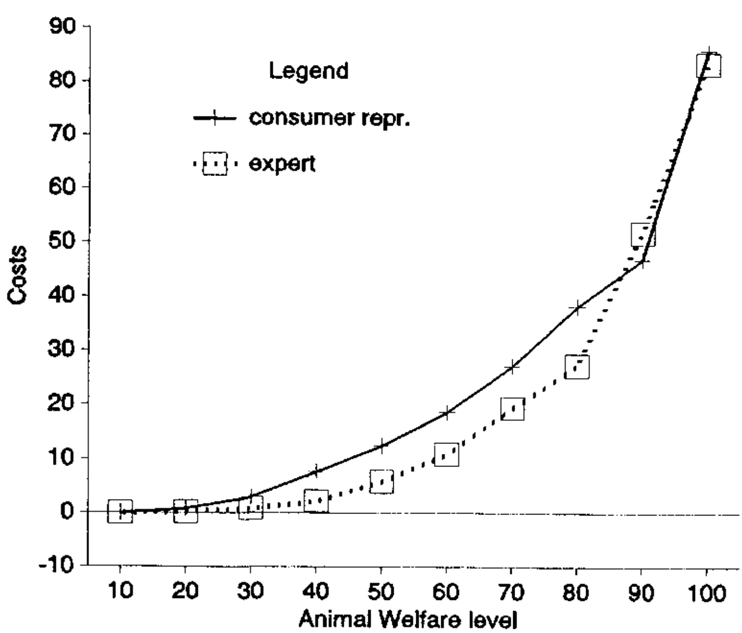

Figure 4. Additional chain production costs per pig sold at increasing levels of animal welfare, using both the animal welfare coefficients of an expert and a consumer representative

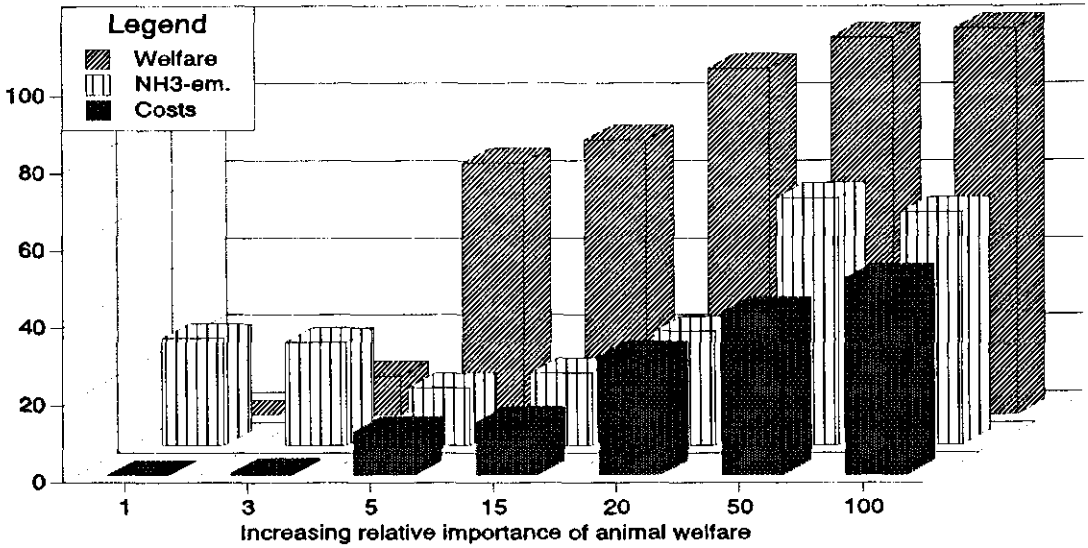

Figure 5. Effects of increasing the importance of an improved animal welfare on additional costs per hog, and the reduction of ammonia emission

chain, incurred in case a maximum level of 100 animal welfare point is desired, account for approximately 22% of the total chain production costs from farrow to slaughtering, in the default situation.

The same trend of progressively increasing costs at increasing constraints, becomes apparent in case higher levels of reduction of ammonia emission were desired. Some attributes, such as the percentage of concrete floor space and the outdoors space, are both related to pig welfare and environmental pollution (ammonia emission). While the first is believed to influence both criteria positively, that is to benefit the welfare of the pig and to reduce the ammonia emission, the second one is believed to have a reverse effect. Allowing pigs to outdoors space is considered beneficial with respect to the welfare of the animal, but harmful to the environment as it increases ammonia emission (Verdoes, 1990). In case an increase in animal welfare is desired simultaneously with a decrease in ammonia emission, this attribute will cause conflicts. As an example, goal programming (Romero and Rehman, 1989) is used to evaluate the effects of increasing the importance of animal welfare in relation to environmental pollution, on both criteria and costs incurred per hog at the fattening stage.

At first the ammonia emission is reduced simultaneously with an increase in animal welfare (*Figure 5*). However, when a conflicting attribute is added to the concept to improve animal welfare, the ammonia emission increases again, as shown by a lower percentage of reduction of ammonia emission in Figure 5.

Concluding remarks

By means of the chain simulation model, it was shown that cost and benefits of differentiated pork chain products, can be quantified per stage as well as for the chain as a whole. Using a chain model instead of separate stage simulation models, offers the advantage of taking into account interstage relations, which were quantified for both economic effects and animal welfare aspects. Various criteria, such as economic, animal welfare and environmental criteria, concerning the pork production-marketing chain, were taken into account. Animal welfare coefficients, were quantified using the conjoint analysis in a questionnaire sent both to pig welfare experts and consumer related groups, such as advocacy groups and retailers. In using this method both main effects of the welfare attributes considered, and interaction effects, could be quantified. Moreover, the number of profiles, i.e. combinations of attributes, a respondent had to evaluate, could be reduced considerably, by using this method. At analyzing the questionnaires, major differences were found with respect to the valuation of animal welfare attributes by the various respondents. Moreover, is was found that, although the coefficients of one respondent proved to be significantly predictively valid for all cases, most other respondents yielded less consistent result. In the data, no statistical significant difference could be found between the group of experts versus the group of consumer-related respondents. By means of an optimisation model, based on linear programming, the effects of increasing levels of desired pig welfare on the production costs of a pig in the chain, could be quantified. The pig welfare coefficients of both an expert and a consumer representative, used in the optimisation model, resulted in relatively small differences. However, as a high variation was found in opinions regarding how to improve pig welfare along the chain, this does not have to hold for the coefficients of other respondents. The optimisation model was also used to take environmental effects into account, besides animal welfare and costs. Both increasing demands on animal welfare and environmental pollution, proved to result in progressively increasing costs along the pork production-marketing chain to meet these demands. Besides additional costs incurred by fulfilling demands on animal welfare and environmental issues, it may be possible that - a certain segment of - consumers are willing to pay a surplus value for these products. Using the pork chain simulation and optimisation models, it can be calculated how big the extra price should be to make a differentiated chain system profitable, or at least to break-even. However, additionally to marketing research to estimate how many consumers are willing to pay which amount of money, research is needed on ways to redistribute this surplus value back along the stages of the chain. Moreover, several production and market risks are involved in producing this kind of differentiated products. For example, it may happen that due to health circumstances, hogs may no longer meet the specific standards of a differentiated chain concept, and devalued to a lower concept. Although additional costs already have been incurred, the surplus value is missed then. Within the total research project, of which the study described in this paper is a part, these subjects are taken into consideration as well.

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Appendix I. Major technical and economic default values of the pork simulation model

Variable	Default
Farrowing	
Duration of production cycle of a sow (days)	153
Max. no. of breedings per production cycle	3
Age at which feeder pigs are sold (days)	70
Litter size (piglets born alive)	10.8
Piglet mortality rate (%)	14.5
Culling rate of young and mature gilts resp. (%)	25/10
Price replacement gilts	
young (age 10 weeks) (Dfl./head)	220
mature (age 6.5 months) (Dfl./head)	520
Price feed (Dfl./100 kg)	
piglets	66.40
non-lactating sows	42.10
gilts, lactating sows and boars	46.35
Feeder pig price (Dfl./head)	107.58
Fattening	
Average growth rate of hogs (grams/day)	719
Standard deviation growth rate (grams/day)	72
Mortality rate (%)	2.1
Number of hog deliveries per production cycle	2
Distribution of hogs over 1st and 2nd delivery (%)	20/80
Number of pens per compartment of the barn	8
Price of feed first part fattening period (Dfl./100 kg)	52.3
Price of finishing feed (Dfl./100 kg)	43.6
Price of finishing feed (Dfl./100 kg)	45.5
Meat price (Dfl./kg slaughter weight)	3.41
Hog transportation	
Loading density transportation (kg live weight/m^2)	300
Occupation rate transportation truck (%)	90
Distance covered per drive (km)	175
Slaughtering	
Hogs condemned at life visual inspection (%)	1.6
Boars supplied (%)	4.8
Slaughter efficiency (%)	77
Hogs without slaughter deviations (%)	79
Relative distrubution slaughter deviations (%)	
Pleurisy	48
Abcesses in Lungs & Pneumonia	32
Lungs impossible to mark	9
partially Affected Liver	1
Condemned Liver	6
Inflammation of the Leg	3
Skin Lesions	1
Ratio Sold as carcass : Sold in parts	30:70
Slaughtering labour (Dfl./hour)	35

Recycling of slaughter by-products: logistical, environmental and safety aspects

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Introduction

Any type of industrial processing creates waste (by-products and pollution). Meat production and processing is no exception to this general rule. The main objective of meat production is to produce food for the consumer and anything else leaving the abattoir or meat-packaging plant may be qualified as by-products or waste. If these are not handled and disposed of properly they may create pollution problems.

In this paper a prototype-mathematical-model is reported to trace the optimal processing configuration of these slaughter by-products for animal nutrition. The model is focused on optimization of economical and technological factors within environmental restrictions and veterinary assumptions and legislation. The current processing strategies are compared with alternative innovative ways of processing. The model includes both process integrated as end of pipe measures to meet environmental objectives. Investments, operational costs, quality development, product values and environmental loads are integrated into a so-called mixed integer linear programming model, a common way of modelling, in operations research.

Key words: (recycling of) slaughter by-products, environmental load in meat processing industry, integral logistical chain management, costs/profit analysis in meat processing industry, animal feed, mixed integer linear programming, decision support in agrichains

Current chain of recycling slaughter by-products

In areas which have an intensive animal production also large amounts of slaughter by-products are produced. About 20-30 percent of live weight of slaughtered animals are disposed to animal feed (Logtenstijn, 1993:14). From pigs at least 7 kg is processed as animal feed (Van Dijk, 1993:28). In the Netherlands at least 800.000 ton of these by-products are produced annually. Mainly as a result of the concentration of the animal slaughter during the past decade, the production volume per slaughterhouse has increased. This development implied in a concentration of the release of by-products to only a few places. In 1992 about 40% of the slaughterhouses produced more than 70% of the slaughter by-products (Urlings, 1993:20).

In the Netherlands also the process of rendering is centralised in two large plants. It is obvious that these larger volumes of slaughter by-products create considerable logistical and environmental problems during collection and disposal. Quality, safety and economical profitability of the slaughter by-products can be influenced negatively by applying wrong logistics and processing strategies:

(i) insufficiently differentiated collection of the products at slaughter;

(ii) storage at too high temperatures;

(iii) too long time lag between slaughtering and processing.

Intensive safety treatment of the by-products such as sterilization, can have a negative influence on the quality of the endproduct and environmental drawbacks. Sterilization and additional drying changes the most valuable amino acids to indigestible components, is energy intensive, produces high sludge quantities and can cause odour hinder. One ton raw material now consumes 65 kWh electricity and 3 m^3 water when sterilization is applied (NTF, 1993).

Besides the central processing at rendering plants slaughter by-products can be delivered to petfood- and fur animal feed industries. Nevertheless what type of disposal is chosen, quality and safety is degraded by spoilage during transportation and storage. As a consequence sustainability and economical feasibility are not guaranteed fully in future.

Veterinary aspects

There is a need for strict rules for the disposal and processing of slaughter by-products to prevent the dispersion of pathogens so that animal and public health and the environment are protected.

Until now hardly any attention, in practice or in research, has been paid to the collection and disposal of these by-products. However there are several reasons why this situation should be improved:

(i) Storage of by-products at slaughterhouses - in general not chilled for relatively long periods (6-30 h) can result in high levels of metabolites, because of degradation processes in the product which make it less suitable as a raw material for animal feed. Furthermore, the production of volatile degradation products at the slaughterhouse and/or the rendering plant can result in pollution of the environment. Some kind of preservation at the slaughterhouse is therefore necessary;

(ii) Transportation of these often malodorous and highly contaminated by-products is mainly carried out by road. This represents a certain risk in terms of environmental pollution and spread of microorganisms. Also the time between release and processing of these by-products is often prolonged by too long storage and transportation distances.

Because of their high protein and fat content and favourable amino acid composition slaughter by-products can serve as highly valuable raw materials for animal feed production. The main threat to human health from the use of slaughter by-products is the spread of pathogenic bacteria, such as salmonella and *Campylobacter jejuni*. Risks for livestock implied by slaughter by-products are pathogenic viruses, bacteria, toxins and undefined pathogenic agents, such as that of BSE (bovine spongiform encephalopathy). For this reason the upgrading of slaughter by-products must also include processing for safety in order to prevent any dispersion of pathogens.

Logistical, economical and environmental aspects

Logistical aspects, disposal and process technology of slaughter by-products need to be evaluated on their environmental, safety, quality and economical merits, based on an integrated approach. Slaughter by-products are nowadays mainly upgraded at rendering plants and disposed for petfood and fur animal feed production.

The future economical feasibility of the current logistical structure will be weakened, because of the following reasons:

(i) Sinking prices for feed constituents, because of their competition with other agricultural products, such as soy.

(ii) Increasing energy costs

(iii) Increasing environmental costs.

Also the requirements for animal feed production will be more stringent in future. A higher nutritional value of feed constituents resulting in less manure production is necessary to obtain a sustainable animal husbandry.

In future the dutch meat processing industry will be confronted with more stringent environmental restrictions and higher costs. The purification of processwater will be more expensive; costs increase 37% in 1996 with the same regime (Willemse, 1993:2). The government prepares more stringent legislation for air pollution. The deposit of processwater sludge will occur at higher rates and most sludge may not be deposited on agricultural land any more from 1995 (B.O.O.M., 1991). Hinder due to the frequent and long distance transportation of slaughter by-products and spread of odour and/or micro-organisms can be considered as not desirable (ca. 10 million km per year in the Netherlands, i.e. more than 10 km per ton fresh product) (Cebeson, 1993). An other result of environmental policy will be an increase of energy costs and a reduction of the energy consumption for the meatprocessing industry (20% less energy consumption in 2005 due to international agreement) (WRR, 1992). In *Table 1* is estimated how costs can develop depending on processing strategies.

An other important issue in relation to environmental protection is the public opinion towards the meat industry. The meat industry has to prevent itself to obtain an image of environmental polluters, because of the attention that is paid to environmental issues in other (agricultural) chains. In future the production methods will also be evaluated towards their implications on the product image. Also in this point of view environmental efficacy will obtain a high priority.

Table 1. Cost/benefit impression concerning the use of slaughter by-product as animal feed constituents for the whole chain.

	current cost/benefit situation	expected cost/benefit development in future with no change
yields (for whole chain)	low	decreasing
logistical costs	high	increasing
environmental costs	high	increasing
processing costs	high	increasing

Environmental problems can be solved by introducing:

(i) End of pipe measures. The environmental pollution can be reduced by additional investments, such as energy regain, air rarefying (with high chimneys), biofiltration, burning of sludge, burning of polluted air, chemical cleaning, etc. When these measures are applied to slaughterhouses for solving their own environmental problems they are creating other environmental loads elsewhere. This implies suboptimization. In current logistical processes has to be invested in these so-called end-of-pipe measures, because of the long time lag between slaughtering and processing.

(ii) Process integrated measures. This means an integrated approach towards all links of the production chain. These links are controlled integrally as much as possible. Goals are drawn up in order to minimize the environmental losses throughout the whole production chain.

In the Netherlands two centralised (modern equiped) rendering plants are left. These are the largest in the world. Because of their legal protection over the past decades they have an almost full monopolistic position, with regards to supply of their raw materials, they are pricesetters on the local slaughter by-product market. These rendering plants are protected in a way that slaughterhouses have a kind of delivery duty. They upgrade the slaughter by-products from approximately US$ 0.015 to about US$ 0.07 per kg raw materials (Cebeson, 1993). The price the rendering plants will pay for their raw materials will be lower in future because of higher processing costs. In their monopolistic position they can shift their costs increase (e.g. environmental costs) towards their suppliers.

Mathematical modelling

Introduction

With vertical integration it is possible to improve the efficiency and effectivity in the chain. The total efficiency and effectivity can be improved by determined efforts that will give a higher product quality and reduced environmental costs.

A mathematical model (a so-called mixed integer linear programming model) has been built (Hendriks, 1991). In this model the disposal and upgrading of slaughter by-products can be optimised. Costs of energy, environmental costs and restrictions, durable investments, and labour are incorporated in the model. Also the product quality and value have been taken into account.

Objective of the model is to be a tool that represents the slaughter by-product business, and that finds and evaluates optimal processing strategies for these products. Main purpose is to compare the current central large scale rendering with decentral source processing (of a relatively small scale) at the slaughterhouse, at different ways of sorting the by-products, and different storage methods.

If the by-products are treated immediately after slaughter then the highest nutritional value can be preserved, with a lower disintegration of the best amino- and fatty-acids. This means some logistical flexibility, less environmental costs, a more valuable product, a different energy consumption, changes in processing costs, and shifts of the processing costs within the chain. The modelling of these cost- and benefit identifiers can result in valuable management support for future strategic decisions concerning chain structure.

It is expected that in future a full chain analysis to optimize all aspects of disposal and upgrading of slaughter by-products is necessary to undertake strategic decisions regarding this subject.

Modeloptions

The mixed integer linear programming model to be discussed later (see *figure 1*) is based on a decision tree containing three decision moments (indicated by d=1,2,3):

d=1: way of sorting the by-products (raw materials) after slaughtering

d=2: way of storage

d=3: way of processing (both central and decentral processing)

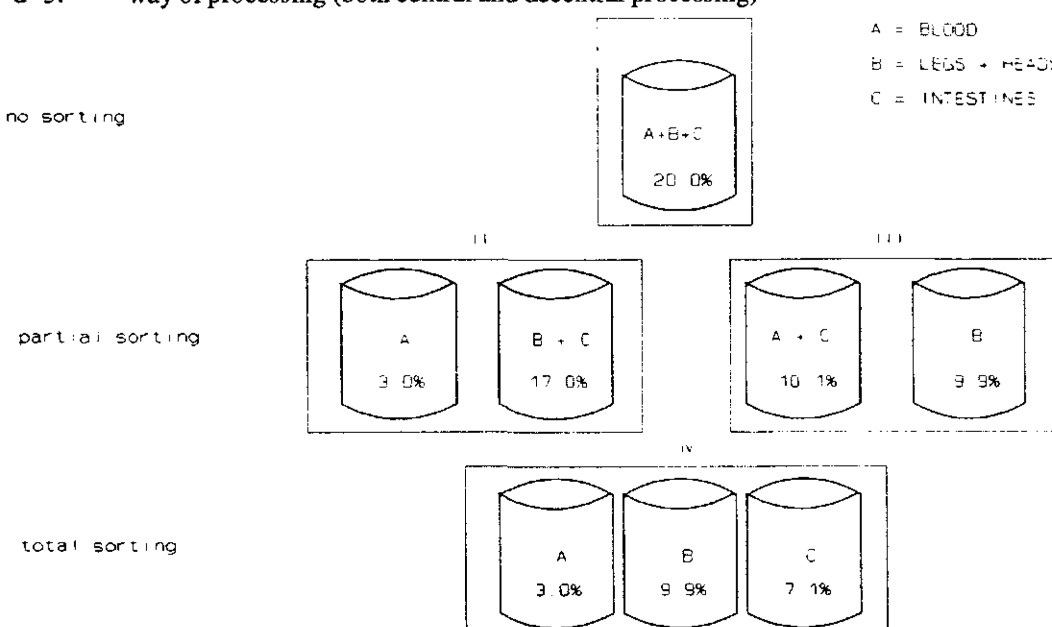

Figure 1. The four sorting groups (I,..,IV) in the model for poultry slaughter by-products. Different combinations of A, B, and C are collected in containers. Also the mass percentage in relation to live weight has been displayed.

d=1: *Sorting raw materials*

At decision moment 1 can be chosen in which way three kinds of poultry and pork slaughter by-products A, B and C will be sorted. Possibilities are given in *figure 1*. So it is suggested to sort the slaughter by-products in four ways so-called sorting groups. These sorting groups result in six different raw-material combinations. Because of economical feasibility the combination A+B is not considered.

d=2: *Storage*

After the release of slaughter by-product some way of buffering is necessary. The following options are considered:

(i) Unconditioned storage: this storage is interesting for the sorting groups with a relatively low spoilage rate and a short time lag between release and processing.

(ii) Cooled storage: this storage is interesting for the sorting groups with a relative high spoilage rate and/or a long time lag between release and processing.

(iii) Frozen storage: this storage is interesting for the sorting groups with a relative high spoilage rate and/or a very long time lag between release and processing. Because of common demand fluctuations in the season and a constant supply, storage of the products during a few months can be profitable. To cope with these demand/supply discrepancies it could be interesting to freeze the products. Of course this option is only feasible for high market prices.

d=3: *Processing*

In the third stage has to be decided which way of processing has to be applied. There are four (sub)decisions considered:

(i) Central processing versus processing at source, i.e. at the slaughterhouse.

(ii) When central processing at the rendering plant is applied, it can be chosen between: conditioned and unconditioned transportation. In case of processing at the source the way of production can be: on-line, full-batch, and semi-batch.

(iii) Processing for safety:
  - (a) sterilization (high temperature, long time, high pressure)
  - (b) pasteurization (relative low temperature, short time)
  - (c) no treatment (immediately fresh to fur animal and petfood processor)

(iv) preservation treatment:
  - (a) drying
  - (b) fermentation

On-line processing: This means that the product almost immediately after the slaughter process is treated for safety and additionally preserved. There is a storage of raw materials needed for situations of irregularity to decouple the slaughter process from safety-treatment. If the by-products are separated after the slaughtering and it is intended to produce several types of products then more processing units are required.

Full batch processing: This way of production implies that the slaughter by-products will be collected (several tons or for several houres). In case of partial or no sorting only one processing unit is used for the different slaughter by-product. If one storage batch is full, the batch will be processed, followed by the next full batch.

Semi-batch processing: This alternative is a combination of on-line processing and batch processing with one processing unit. In this way of processing the products that are the most vulnerable to spoilage are processed on-line during slaughtering. The other products are processed in batch after the slaughtering.

Processing for safety: Central sterilization followed by drying is in the Netherlands the conventional rendering process. Although processing efficiency has been improved during the last decade considerably, the process is not yet optimal. Sterilization is considered as necessary because of the microbiological contamination. Due to the increasing quantities the environmental impact is high. Odour emission, sludge production, energy consumption and relative low product quality are not considered as optimal. For sterilization investment costs are high because of the installation has to resist high temperatures and pressures. It is an effective way to reduce microbiological contamination, but at very high costlevels.

Pasteurization is a relative low cost process. If this process is used immediately after slaughtering energy consumption is low. The heating traject, from ca. 30°C to 90°C and the heating time are considerable shorter than in case of severe heating during sterilization. Quality reduction of the product is less too.

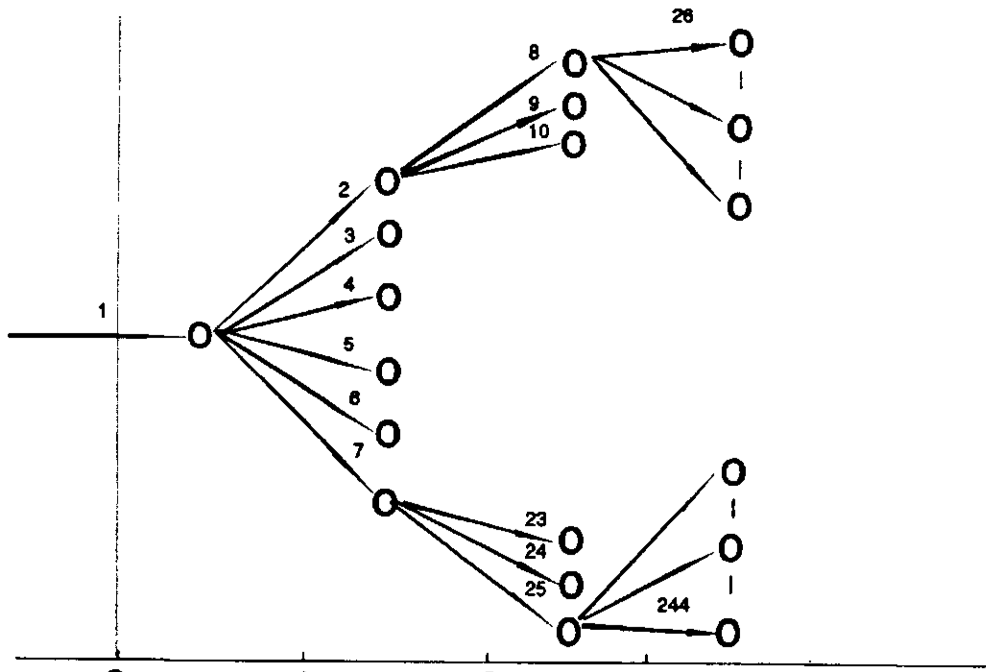

Figure 2. Decision tree

Preservation: The use of heating and drying, such as in conventional rendering processes had been criticized for its detrimental effects on protein quality. An effective preservation of slaughter by-products after pasteurization is fermentation (Urlings, 1992:123). Fermentation holds some promises towards a reduction of the environmental pollution.

Mixed integer linear programming problem
In the sequel the following notation is used:

i :	index of a logistical treatment, a branch number in the decision tree; i= 1,2,..,I (in this study I=244)
d :	decision moment for d = 0,1,2,..,D (in this study D=3)
j :	counter 1
k :	index for environmental measure for k = 0,1,..,K. If k = 0, no environmental measure is realized; k=1 environmental measure 1 is realized; k=2 then measure 2, and so on
l:	counter 2
imin(d):	lowest branch number in decision moment d
imax(d):	highest branch number in decision moment d
itela(i):	first branch number from i for i = 1,..,imax(D-1)
itelb(i):	last branch number from i for i = 1,..,imax(D-1)

Optimization variables

X(i):	fraction of total flow slaughter by-products that is subjected to branch i; X(i) is a variable with range [0,1].
Y(i):	binary variable to charge for fixed costs; 0, if branch i is not used in optimization or 1, if branch i is used in optimization (charge for fixed costs)
Z(i,k):	binary variable to charge for environmental costs; 0, if the environmental measure k in branch i is not used in optimization or 1, if that environmental measure k in branch i is used in optimization (charge for environmental costs)

Coefficients and parameters

S :	average supply of slaughter by-products per year (metric ton per year)
FC(i):	fixed costs for branch i at a certain capacity on a yearly basis (US$ per year)
VC(i):	variable costs for branch i per metric ton raw material (US$ per metric ton)
VAL(i):	value per metric ton raw material in branch i (US$ per metric ton)
N(i):	number of possible branches (logistical treatments) after branch i; for i= 0,..,imax(D-1)
CAPMIN(i):	minimal capacity for flow S*X(i) in branch i (metric ton per year)

CAPMAX(i):	maximal capacity for flow S*X(i) in branch i (metric ton per year)
QUAL(i) :	quality change that occurs after passing through branch i (%)
TQUAL(i):	quality state at end of branch i (%)
PRICE :	(market)price index (US$ per metric ton) for i = imin(D),..,imax(D)
OE(i,k) :	odour emission per ton slaughter by-product in branch i per hour applying environmental measure k (odour units per metric ton per hour)
OS(i) :	maximum odour emission at branch i is realized (odour units per hour)
M :	very large number
EC(i,k) :	environmental costs for measure k in branch i at a certain capacity on a yearly basis (US$ per year)
E(i):	energy consumption in branch i (kJoule per metric ton slaughter by-products)
TEMAX:	maximal energy consumption on a yearly basis (GJoule per year)
PWS(i):	processwater sludge production in branch i (cm^3 per metric ton slaughter by-products)
PWSMAX :	maximal processwater sludge production on a yearly basis (cm^3 per year)
QMAX :	initial quality (fresh product at harvest assumed as 100%)
PRC(i) :	percentage slaughter by-products of live weight through branche i; for i=2,..,7 (%)
PERC :	total percentage of live weight slaughter by-products assigned to animal feed (%)

The decision tree has three decision moments (d=1,2,3). There are: 1 + 6*1 + 6*3 + 18*17 = 331 theoretical branches. Only 244 of these branches turned out to be feasible. These feasible branches are numbered top-down-left-right. The number of possible branches N(i) after logistical branchs i is variable. This makes the decision tree flexible and compact (see figure 3).

Total costs

Total costs are based on variable costs VC(I), fixed costs FC(I) and environmental costs EC(i) on a yearly basis:

$$\underbrace{\sum_{i=1}^{I} [VC(i) * X(i) * S]}_{\text{variable costs}} + \underbrace{\sum_{i=1}^{I} [FC(i) * Y(i)]}_{\text{fixed costs}} + \underbrace{\sum_{i=1}^{I} \sum_{k=1}^{K} [EC(i,k) * Z(i,k)]}_{\text{environmental costs}} \qquad (1)$$

Total yields

The total yields are generated in stage d=3 in the decision tree:

$$\sum_{i-26}^{244} [VAL(i) * X(i) * S] \qquad (2)$$

where $VAL(i) = PRICE * TQUAL(i) / 100$ (2a)
and $QMAX = TQUAL(1) = 100\%$ (2b)

Product value is dependent of the market price and the quality condition of the slaughter by-products at the end of the processing network.

Restrictions

(i) Modelling the sorting operation

The first restriction forces the sorting groups in the right live weight proportions through the network. The 4 combinations I, II, III, and IV of separated collecting of the slaughter by-products are displayed in figure 2, and result in 6 different combinations of A, B, and C. These combinations of A, B, and C get the branch numbers i = 2,..,7 (see figure 3). The binary variables Y(2), Y(3),..,Y(7) and parameters PRC(1), PRC(2),..,PRC(7) are used to force that exactly one of the groups I, II, III, or IV is chosen. The following equation (3) accomplishes this objective:

$$\sum_{i=2}^{7} PRC(i) * Y(i) = PERC \tag{3}$$

In our case this means:

$20.0*Y(2)+3.0*Y(3)+17.0*Y(4)+10.1*Y(5)+9.9*Y(6)+7.1*Y(7)=20.0$

So the possible combinations are feasible:

group I: Y(2)=1 other Y(i) values are zero.

group II: Y(3)=1 and Y(4)=1 other Y(i) values are zero.

group III: Y(5)=1 and Y(6)=1 other Y(i) values are zero.

group IV: Y(3)=1, Y(6)=1, and Y(7)=1 other Y(i) values are zero.

Now for i = 2,..,7 the fractions X(i) can calculated using the equations (4):

$$PERC * X(i) - PRC(i) * Y(i) = 0 \tag{4}$$

for i = 2,..,7

(ii) Balance equations

First the flow of slaughter by-products in the decision tree has to be initialised:

$$X(1) = 1 \tag{5a}$$

The sum of incoming flows equals to the outgoing flows at every node in the decision tree. So the incoming fraction X(i) equals to the sum of outgoing fractions X(j) for i = 1,..,25 and j = itela(i),..,itelb(i).

Thus:

$$X(i) = \sum_{j=itela(i)}^{itelb(i)} X(j) \tag{5b}$$

for i = 1,..,25
where:

$$itela(i) = 2 + \sum_{l=1}^{i-1} N(1) \tag{6}$$

and

$$itelb(i) = itela(i) + N(i)\text{-}1 \tag{7}$$

(iii) Capacity X(i)
The possible treatments in the model have to meet minimal and maximal constraints, since every investment is feasible only at a certain capacity range. The flow X(i)*S through branch i has to be greater than CAPMIN(i) and lower than CAPMAX(i). The minimum and maximum restrictions are presented in the formulas (8) and (9).

$$X(i) * S \quad Y(i) * CAPMIN(i) \qquad \text{for } i = 2,..,244 \tag{8}$$
$$X(i) * S \quad Y(i) * CAPMAX(i) \qquad \text{for } i = 2,..,244 \tag{9}$$

(iv) Energy consumption restrictions
For years saving of energy is a major priority in society and industry, and will even gain more importance. In 1992 during the UNCED conference a goal for the reduction of energy consumption has been formulated, as a measure to reduce the greenhouse-effect (Lee, 1992:823). In the Netherlands an agreement between the government and the industry has been established to save 1.1% energy yearly. The actual reduction of energy consumption in processing industry is 0.4% yearly (WRR, 1992). So energy management needs to be improved. The following restriction for energy reduction has been introduced:

$$\sum_{i=2}^{I} E(i) * X(i) * S \quad \leq TEMAX \tag{10}$$

where TEMAX = 0.989 * energy consumption preceding year

Costs of energy are part of the variable costs VC(i) in the objectfunction.

(v) Processwater sludge production restriction
Reduction of processwater sludge production will be an important issue in future. The costs of sludge deposition is considered to increase from about 7.5 US$ now to 25-100 US$ per metric ton in near future. The costs will be dependent from heavy metal consti-

tuents. To reduce the water- and soil-pollution with sludge a reasonable measure in future can be following restriction:

$$\sum_{i=2}^{I} \mathrm{PWS}(i) * X(i) * S \leq \mathrm{TPWSMAX} \qquad (11)$$

Costs of sludge disposal are part of the variable costs VC(i) in the objectfunction.

(vi) Odour emission restriction.
Odour emission is considered as a local problem. Per metric ton slaughter by-products a quantity odour (quantified by OE(i,k)) is produced during treatment i with application of environmental measure k (if k=0 then no environmental measure is considered). Odour emission is assumed to be linear dependent on X(i). Goal is to produce within a maximum quantity of odour (OS(i)) to prevent odour hinder problems. If the produced odour emission OE(i,k)*S*X(i) exceeds OS(i), the model can select an other environmental measure k with a smaller value OE(i,k). If measure k is not considered then the large number M makes equation (12) not restricting. This measure k at treatment i implies some environmental costs (EC(i,k)) in the object function. The odour emission constraints can be formulated as follows (Hendriks,1994):

$$\mathrm{OE}(i,k) * S * X(i) \quad \mathrm{OS}(i) * Z(i,k) + (1-Z(i,k)) * M \qquad (12)$$

$$\text{at condition} \sum_{k=0}^{K} Z(i,k)=1 \text{ (select one environmental measure)} \qquad (13)$$

for $i = 2,..,244$, $k = 0,..,K$, and $M >> \mathrm{OE}(i,k) * S$

Conclusions

A practicable optimization model has been built to find the optimal processing strategies of slaughter by-products for animal feed for the meat processing industry in the Netherlands. Current processing methods are compared with new methods. Different ways of sorting, storage, and processing are built into the model for integral evaluation of benefits, costs and environmental loads. The Mixed Integer Linear Programming model optimizes investments in technology, operational costs, market yields, quality, odour emission, energy consumption and sludge production at dutch circumstances. Regarding costs and product prices, values for variable X, Y and Z can be found in such a way that total yields minus costs are maximized taking into account all restrictions (i) through (vi). This optimization model can be used to find optimal processing strategies.

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Distance related factors and location choice in horticulture.

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Introduction

Due to external (eg. urbanisation) as well as internal (eg. possibilities for expansion) circumstances, relocation of horticultural holdings is a topical subject of concern for many growers in the Netherlands. Spatial distribution of horticultural holdings is changing under influence of the individual location decisions of growers.

In Neo-Classical location theories, of which the theory of Von Thünen (1826-1876) is a well known example, distance is a determining factor. Distance to the suppliers of goods and people (cities) and the distance to the market for horticultural products are, according to this theory, determinant for the location of horticultural production. According to the theory of von Thünen, horticultural production takes place nearby the cities. In the 19th century cities acted as a market of horticultural products and supplier of labour and dung. According to Bruurs (1981) the spatial pattern of the location of dutch horticultural production more or less corresponds with this theory, but he also states that von Thünens theory has no explanatory power any more. Nowadays transport costs have become relatively cheap due to technological developments regarding transport facilities. Those developments have also enlarged the action radius of a grower. In the past, horticultural products were sold within a radius of a few dozens km.. Since, dutch horticultural products are sold all over the world, distances seem to have become less important. However the vicinity of the auction, supplying industries and firms, information and knowledge still has important advantages. From a research of Voskuilen (1990) it appears that growers valued the vicinity of the auction as an important location factor, because of the lower transport costs and the possibilities for personal contacts with traders and exporters. The vicinity of supplying industries will reduce the costs of the means of production and in case of a technical failure the distance to the supplier plays an important role because of the rapidity in which the failure can be corrected. (Cardol, 1983; Groenewegen, 1975). To keep his knowledge level up to date, a grower has to gather information. Informal face to face contacts with colleagues and participation in 'study clubs' contribute for an important part to the knowledge level of a grower (Maas, 1984). A location nearby those information sources will save a grower a lot of time.

In conclusion it appears that the importance of the factor distance is liable to changes during time. Distance to the market became less important, but on the other hand distance to information and knowledge became more important.

In this paper, the relevance for growers of the different distance related location factors will be examined. Attention will be paid to the distance to the different links of the network a horticultural holding is part of. Because in the Netherlands horticultural holdings are still family businesses, we will also examine the importance of the distance to existing social contacts (family, friends etc.). Further we will examine the relation between some firm, personal, and family characteristics on one hand and the role the different distance related factors play in their location decision on the other hand.

Materials and methods

The results presented in this paper are based on a survey among growers in the Westland, dutch most important horticultural production centre with more than 3000 horticultural holdings. The Westland was chosen as the research area because most growers with spatial problems could be expected in this production centre. In a preliminary examination we sent a short questionnaire to 1000 growers in this production centre to trace growers who are considering or once have considered a relocation of their horticultural holding.

About 440 growers sent back this questionnaire and from those 440 growers 110 are considering or have considered a relocation of their horticultural holding in the past. For the main survey we visited 73 growers who answered in the preliminary examination that they consider or once have considered relocation of their firm.

In the main survey the respondents were asked to indicate which role a number of location factors have in the choice of a new location. They were asked to indicate on a five points scale the importance those factors have in their choice of a new location. The survey contained 37 location factors of which 11 distance related location factors are discussed in this paper.

Figure 1 shows the different groups of variables studied in this paper. Three groups of distance related location factors can be distinguished, namely the distance to social factors, market factors and knowledge factors. As distance to social factors we examined the distance to the present place of residence and the presence of acquaintances in the new location. In the second group, the distance to market factors, we examined the importance of the presence of supplying industries and firms, presence of a good supply of labour and the distance to the auction as well as the vicinity of a city (supplier of labour, goods?). And the third group, the distance to knowledge factors, contains the presence of horticultural education, the presence of growers with the same cropping plan, the presence of study clubs, the presence of an extension service and the presence of knowledge exchange.

To examine the influence of firm, personal and family characteristics on the role the different distance factors have in the location decision many of those characteristics were measured in the survey. In this paper only the influence of a few of those characteristics will be discussed.

As *firm characteristics* we will discuss the influence of the kind of crops the respondent grows, on how many m^2 he grows his crops and how his financial position is.

As *personal characteristics* we restricted us to the age and the value orientation of the respondents. According to Gasson (1973) values can be instrumental, social, expressive

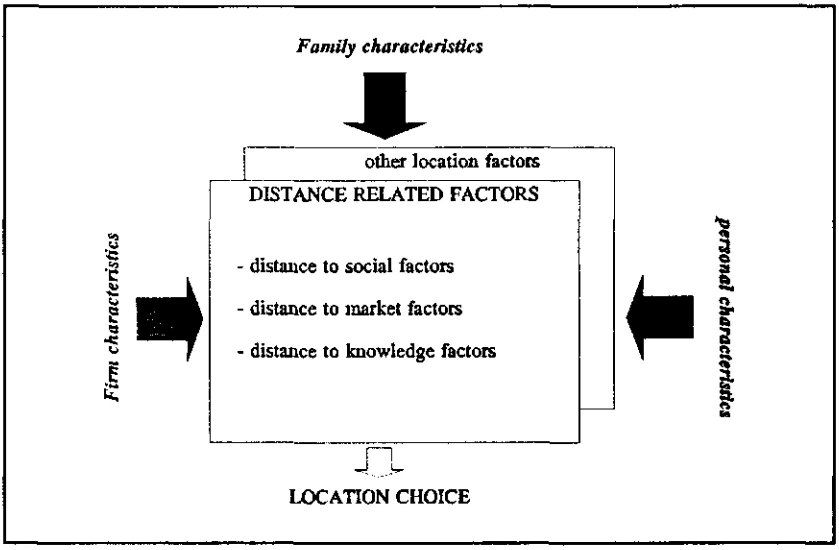

Figure 1. Examined relations in this study

and intrinsic orientated. An instrumental orientation implies that farming is viewed as a means of obtaining income and security with pleasant working conditions. Examples of instrumental goals are making maximum income, expanding the business. Farmers with a predominantly social orientation are farming for the sake of interpersonal relationships in work, e.g. gaining recognition, prestige as a farmer or belonging to the farmers community. Expressive values suggest that farming is a mean of self-expression or personal fulfilment. Examples of expressive goals are feeling pride of ownership and exercising special abilities. An intrinsic orientation means that farming is valued as an activity in its own right. Examples of intrinsic goals are independence and enjoyment of work tasks (Gasson, 1973). To measure the goals and value orientation of the growers we made use of a measurement technique developed and described by Ziggers (1993). With a few adjustments, Ziggers' situation sketches could be used for our research population.

The instrumental value orientation is not examined in this paper because of (multi) collinearity with the other value orientations.

As *family characteristics* we only discuss in this paper whether the grower has a successor for his firm or not.

The percentages of respondents indicating a particular location factor important or very important are computed, in order to get insight in the importance of the 11 distance related location factors. A principal component analysis was executed to analyze the relations between the firm, personal and family characteristics on one hand and how the different location factors are weighed by the growers on the other hand. Eight aspects are extracted using the criterion of minimum eigenvalue of 1. This principal component analysis was computed by SAS. The firm characteristic "cropping plan" is not included in the principal component analysis because of its nominal scale level. How growers with different cropping plans (vegetables, cut flowers and potplants) indicate the distance related location factors is given in percentages of growers indicating certain location factors as important or very important.

Results

Relative importance of distance related location factors
Table 1 shows the rank numbers of the 11 distance related location factors on a ranking list of all 37 in the survey examined location factors. This ranking list is based on the mean scores of the different location factors on a five-point scale.

Looking at all 37 examined location factors the distance related location factors are relatively less important. For example, the infrastructure and climate of a new location are more often indicated as important location factors. The most important distance related factor is the presence of a good supply of labour, which only ranks number eight. Most distance related factors are even found in the second half of the ranking list.

Importance of distance related factors
Figure 2 shows for the eleven distance related location factors the percentage of respondents who indicated the particular factor of being important or very important (4 or respectively 5 on the 5- points scale).

Distance to the social factors have been indicated least often as important factors. However, when the respondents were asked to which location they don not want to relocate in advance and for which reason, the location factor distance to the present place of residence, the Westland, was the most often mentioned reason. For example, 68% of the respondents who do not want to relocate to Emmen, mentioned the distance (240 km) to the Westland as the most important reason. With the distance to the Westland those respondents meant on one hand the distance to the Westland as main production centre with auctions, a lot of supplying industries and knowledge. On the other hand the respondents meant the distance to family and friends. Therefore, the role the distance to social factors

Table 1. Ranking numbers of the to distance related location factors in the top 37 and the mean scores

	rank number	mean score
supply of labour	8	3.96
knowledge exchange	17	3.64
supplying industry	18	3.60
study clubs	19	3.56
auction	21	3.45
Horticultural education	23	3.37
extension service	27	3.27
grow. with same crops	31	2.86
present residence	32	2.81
city	34	2.63
acquaintances	35	2.62

5 = very important
1 = not important

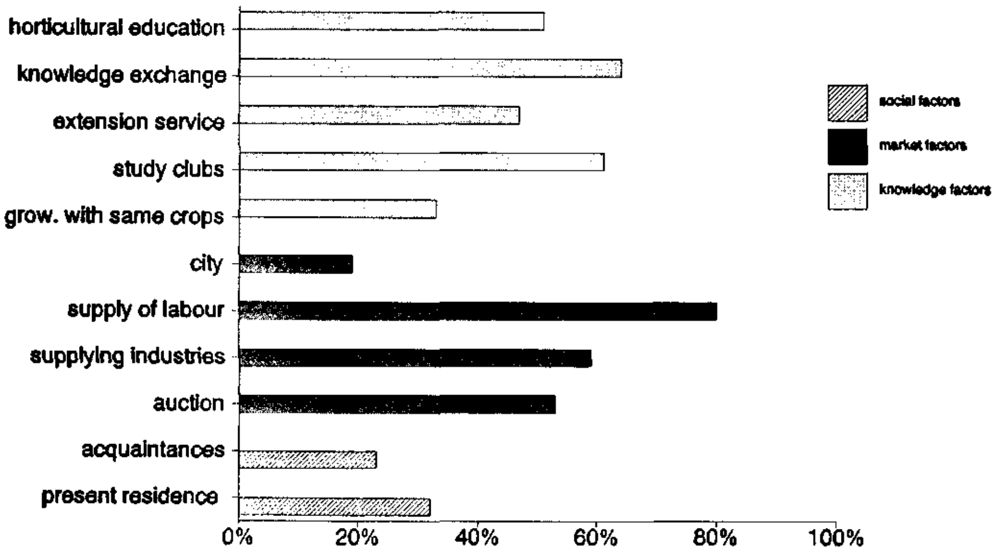

Figure 2. % of respondents indicating factor important or very important

plays in the location decision certainly should not be underestimated. Especially when relocation refers to relocation in an other part of the country.

Notable is the high score of the presence of a supply of labour. 80% of the respondents indicated this factor important or very important. The fact the supply of labour is indicated by that number of growers as an important factor reflects one of the problems dutch horticulture is confronted with.

The vicinity of a bigger city, which factor in von Thünens theory was determinant for the location of horticultural production, was only indicated important by 19% of the respondents. During the interviews it was noticed that for some growers who prefer a location nearby a bigger city, the city acts as a place for leisure activities and for others the city acts as a supplier of labour. The city has lost his function as direct market where growers sell their products. Nowadays the auction is the place where growers meet the buyers of their products. And as Figure 2 shows, the distance to this market (the auction) is indicated (very) important by 53% of the respondents.

The distance to knowledge is for many growers an important location factor. The presence of intensive knowledge exchange is indicated important by 64% of the respondents and the presence of study clubs by 61% . The presence of growers with the same crops is not for all growers a necessary condition for intensive knowledge exchange (Figure 2). The presence of study clubs and extension services seem to be a more important factor related to knowledge exchange

Relation of firm, personal and family characteristics on the importance of distance factors.
The factor pattern resulting from the principal component analysis after VARIMAX rotation is presented in Table 2. 72% of total variance is explained by the 8 extracted aspects with a eigen value > 1. A short interpretation of the eight extracted aspects is given.

Table 2. Factor pattern

Variable	H2	asp1	asp2	asp3	asp4	asp5	asp6	asp7	asp8
knowledge factors									
grow. with same crops	0.74	0.50	0.11	0.28	–0.14	0.52	0.06	0.19	–0.26
study clubs	0.76	0.77	–0.12	–0.07	0.02	–0.03	0.28	0.15	–0.21
extension service	0.77	0.83	–0.05	0.02	0.16	–0.18	0.04	–0.15	–0.02
knowledge exchange	0.80	0.84	–0.07	–0.02	–0.22	0.08	0.01	0.12	–0.14
horticult. education	0.64	0.28	–0.12	0.08	6.24	–0.02	0.68	0.12	–0.07
market factors									
auction	0.78	–0.17	–0.16	–0.28	0.75	–0.14	–0.11	0.19	–0.16
supplying industry	0.70	0.23	–0.14	0.32	0.68	0.02	0.12	–0,23	–0.01
supply of labour	0.71	0.13	0.01	0.06	0.36	–0.09	–0.21	–0.29	–0.65
city	0.57	–0.10	0.07	–0.10	–0.18	0.02	0.69	–0.19	–0.02
social factors									
present residence	0.72	0.11	0.21	0.05	0.36	0.56	0.37	0.18	0.22
acquaintances	0.59	0.66	–0.01	–0.02	0.16	0.24	–0.16	–0.13	0.17
characteristics									
growing area	0.76	–0.01	–0.08	0.13	0.01	–0.06	–0.04	0.85	–0.08
% net worth	0.50	–0.13	–0.37	0.38	0.00	–0.06	0.20	–0.37	–0.11
probl. getting labour	0.74	–0.11	–0.12	–0.06	0.05	–0.10	–0.21	–0.2S	0.77
age of grower	0.84	0.22	–0.84	0.08	0.09	0.02	0.01	0.16	0.23
intrinsic values	0.81	–0.14	0.07	0.81	0.13	–0.23	–0.24	0.01	–0.04
social values	0.69	–0.10	0.15	–0.75	0.12	–0.19	–0.11	–0.17	0.04

Aspect 1
The distance to knowledge factors shows only a little correlation with the firm, personal and family characteristics. Those factors seem to be indicated a little more often as important by older growers. This aspect also shows that growers who indicate the presence of knowledge factors important, also often indicate the presence of acquaintances in a new location as an important location factor. The acquaintances of growers are often colleague growers with whom information exchange takes place. So, the presence of acquaintances is not only seen as a social factor but presence of acquaintances might be also important for knowledge exchange.

Aspect 2
This aspect shows a correlation between age and the preference of a location in the vicinity of the present place of residence. Growers without a successor for their firm, mainly younger growers, seem to indicate the distance to present place of residence more often as an important location factor. Those growers have often a lower % net worth. During the interviews it was noticed that younger growers, who were often unmarried yet,

prefer a location within the Westland because they don't want to lose the contacts with their friends.

Aspect 3
Intrinsic orientated growers who have a good financial position and do not prefer social value orientations indicate the presence of supplying industries and the presence of growers with the same production plan more often as an important location factor. The distance to the auction seems to be often less important for those growers.

Aspect 4
This aspect has positive loadings on the distance to market factors, namely distance to the auction, presence of supplying industries and presence of a good supply of labour as well as distance to the present place of residence. An intensive knowledge exchange seems to be less important for those growers. Their is no clear correlation in this aspect with firm, personal or family characteristics, apperently the distance to market factors is indicated important by very different types of growers.

Aspect 5
Growers who appreciate the expressive value orientations seem to prefer a location in the vicinity of their present habitat and seem to appreciate the presence of growers with the same cropping plan and acquaintances.

The presence of growers with the same cropping plan is correlated partly with knowledge factors in aspect 1 and partly with more social factors in aspect 5. So, the presence of growers with the same cropping plan is not only appreciate for knowledge exchange but also for social contacts. Many growers have friends with the same cropping plan.

Aspect 6
The vicinity of a bigger city and the presence of horticultural education seem to be indicated more important by growers with a relative good financial position and growers who have problems with finding enough workers. Those growers may consider the city as an important supplier of labour and the presence of horticultural education as a source for skilled workers. Those growers have less often an intrinsic value orientation.

Aspect 7
Growers with a larger growing area and a less good financial position seem to prefer more often a location nearby the auction and indicate more often the presence of growers with the same cropping plan as an important location factor. Presence of supplying industries seem to be indicated as less important by those growers. This aspect also shows that growers with a larger growing area have more often problems with finding enough good workers, but they seem to indicate the presence of a good supply of labour less important, when choosing a new location.

Aspect 8
Growers who indicate that they have problems with finding enough workers of good quality, often prefer a location with a good supply of labour (inverse of aspect 8). The distance to the present place of residence is for those growers, often younger growers, of less

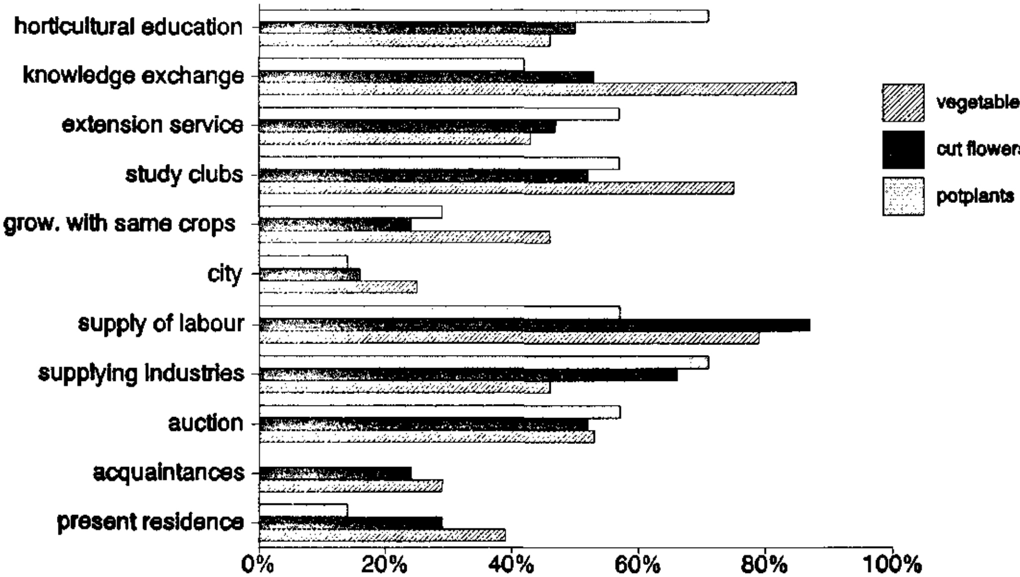

Figure 3. The importance of the distance factors in relation with the cropping plan

importance. On the other hand the presence of growers with the same cropping plan and the presence of study clubs are more often indicated as important.

In the discussion of this paper we will discuss some relevant relations found in the eight aspects interpreted in this paragraph.

Effect of the cropping plan

We distuinguised three types of cropping plans, namely vegetables (28 resp. in survey) cut flowers (38 in survey) and potplants(7 in survey). *Figure 3* shows the percentage of vegetable, cut flower and potplant growers who indicated the different distance factors as important or very important. The presence of knowledge factors like presence of intensive information exchange, study clubs and growers with the same crop is more often indicated important by vegetable growers (respectively 85%, 75% and 46%) than by cut flower(respectively 53%, 52% and 24%) and potplant growers (respectively 42%, 57% and 29%).

Vegetable growers seem to appreciate knowledge exchange with colleague growers more than cut flower and potplant growers, because the factors presence of growers with the same crop, study clubs and intensive knowledge exchange are indicated important by a much higher percentage of vegetable growers than cut flower and potplant growers. Potplant growers at the contrary seem to appreciate the presence of extension services to gather information from. This difference between vegetable growers on one hand and cut flower and potplant growers on the other hand could be explained by the way growers look at their colleague growers. Especially, cut flower and potplant growers consider other growers with the same crop more as a competitor than as a colleague with whom one should exchange information. This difference is partly due to the way in which the different crops are sold on the auction.

The presence of horticultural education is often indicated as an important location factor by potplant growers. This preference for a location in the vicinity of a school for horticultural education may have two reasons. First, the seven potplant growers in the survey may have children who want to go to a school for horticultural education. Another reason could be that potplant growers contract more skilled workers and a school for horticultural education is an important supplier of skilled workers.

Another difference we can derive from Figure 3 is the relative low percentage of potplant growers who indicate the supply of employees as important: 57% against 87% of the cut flower growers and 79% of the vegetable growers. Potplant growers seem to have less problems with finding enough good workers.

Social factors seem to be less important for potplant growers. None of the potplant growers indicated the presence of acquaintances as an important factor and only 14% indicate the distance to the present location as an important location factor.

Discussion and conclusions

In the nineteenth century distance to the market was the most determining factor for the location of horticultural production. Cities acted as direct markets for horticultural products and as suppliers of dung and labour. Because horticultural products are perishable and voluminous, a location nearby the market was essential. For those reasons, horticultural production was located nearby cities. However, technological developments regarding transporting facilities made the transport of horticultural products over longer distances relatively cheap. Rodewijk (1988) stated that the vicinity of a city has lost its importance as a location factor for horticultural production. From our research it appears that the vicinity of a city is not for many growers an important location factor, but still some growers prefer a location nearby a city. However, the reason for this preference has changed. During the interviews respondents often mentioned the supply of labour and the function of the city as a place for leisure activities as reasons for their preference. Nevertheless, most growers see the expanding cities, nowadays, more often as a threat for their horticultural holdings, because of the competition for land. Urbanisation is one of the most important reasons growers have to relocate their firm.

Nowadays the auction has taken over the function of market place where supply and demand of horticultural products is brought together. In the survey the distance to the auction is indicated as a relative important distance related location factor. It seems to be an important location factor for very different types of growers (Aspect 4). However, growers with social value orientations (are not intrinsic orientated) seem to have more often a preference for a location in the vicinity of the auction (inverse of aspect 3). Those growers might be more involved in the social system surrounding the auction.

The auction has not only the function of selling horticultural products, but it is also a source of information for growers and a meeting point of producers and buyers of horticultural products. However, the auction as institution of trade is liable to changes (tele-auction), which may have its influence on the importance of the vicinity of an auction as location factor in future.

The last decades much attention was paid to the advantages of a location in or nearby a spatial concentration of horticulture together with related activities, such as supplying industries, research stations and auctions. Those advantages are called the centre function of a production centre. From research of Verhaegh (1979) it appears that the average net returns of horticultural holdings which are located outside the large production centres are low in comparison with the average net returns of horticultural holdings located in a production centre. Verhaegh (1979) stated that the regional differences in yield are not caused by regional differences in soil, climate, water, technical or economical factors, but they are mainly caused by human factors. The intensive information exchange between growers in a production centre has been often mentioned in literature as an important cause of the higher production level and better quality of the products in those production centres (Soomer, 1987; Maas, 1984; Groenewegen, 1975; Zandsteeg, 1978; Verhaegh, 1979). For large horticultural holdings those regional differences between net returns do not exist (De Haan & Stein, 1975). This difference between small and large firms may be explained by the way small and large firms are managed. Owners of small firms often have to do all management tasks and all operational tasks. For larger firms, at the contrary, management tasks and operational task are often split up over different persons. So it will give no problems when one of those persons leaves the firm for a whole day to gather information. For smaller firms with only one manager this will give some more difficulties. For those firms location in the vicinity of knowledge factors is essential (Vijverberg,1992). However in our research no relation is found between the size of the firm and the importance of the distance to knowledge factors (Aspect 1).

Gathering information to keep his knowledge level up to date is and will be in the future an important task for a grower. Our results show that the distance to knowledge factors are still important for growers, especially for vegetable growers. A noticeable difference seems to exist in the way vegetable growers on one hand and cut flower and potplant growers on the other hand gather their information. Growers with the same cropping plan are for vegetable growers colleagues with whom information is exchanged. A grower with the same crops is for a potplant grower more a competitor than a colleague. Potplant growers get their information more often from extension or advisory services. Our results also show that the presence of growers with the same crop is not always seen as a condition for intensive knowledge exchange. The presence of study clubs for vegetable growers and the presence of extension services for cut flower and potplant growers seem to be important conditions for intensive knowledge exchange.

Noticeable is the fact that the distance to knowledge factors plays for younger growers a less important role in comparison with the older growers. This indicates that this factor may become less important in the future. Different developments have enabled the growers to get their information over longer distances. And the developments regarding information technology are still going on at a quick rate. Younger growers are better capable to use modern information technology for information gathering and they are more willing to travel for information gathering. This findings agree more or less with the prognoses given by Alleblas (1992) that the geographical scale of the centre function will become larger in future.

Labour is an important production factor for horticulture. In our survey the presence of a good supply of labour scores as most important distance related location factor. A lot of respondents told they had problems with finding enough workers of good quality. So, it is not only the presence of a good quantity of workers, but possibly more important, the quality of the available workers. During the survey respondents mentioned two aspects concerning the quality of workers. For unskilled work a good motivation of the worker is important and his skills are less important and for skilled work the skills of the worker are important. For this last group of qualitative good workers horticultural education seems to be indispensable. This may explain the relative high score for the presence of horticultural education, especially for potplant growers.

In conclusion it appears that the distance related location factors are still important. Most distance related factors have an average score on the five point scale higher then three. But besides distance related location factors, growers indicate other location factors like infrastructure, water quality, climate factors etc. as important or even more important. This certainly is not surprising, because before a certain location could be attractive for horticultural holdings some basic conditions for horticultural production have to be fulfilled.

The vicinity of the different links of the network seems to have important advantages, which in the past have resulted in a concentration of horticultural production. Distance related factors still seem to be important keep factors for growers in the Westland. But other factors which represent the disadvantages of a location in the Westland will play the role of push factors, like the bad infrastructure, bad water quality or the problems of getting enough workers. Push factors will stimulate the relocation of growers from the Westland to relocate in other regions in the Netherlands or even in other countries. Some growers will weigh the keep factors more important in their decision and they may decide to relocate within the Westland. Others will weigh the push factors more important and may decide to leave the Westland and relocate in a other region.

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Agricultural commodities: Missing the link with the chain

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Summary

The aim of this paper is to contribute to the discussion about the possibilities and constrains for agricultural commodities to take part in a value added chain in reference to theoretical concepts and actual situation. Different chains; grains, sugar and industrial crops, will be described and analyzed in terms of market structure and the possibilities of improving the competitive advantage by collaborative relationship between the agricultural commodity producer and the chain as a whole.

Most literature on cooperation in agricultural chains as well as most of the actual initiatives taken to strengthen agricultural chains have been focussed on fresh and/or processed/fresh agricultural products. The mutual advantages of some sort of cooperation between different links in these chains are more or less obvious. The main issue is what kind of cooperation is optimal and how can a more optimal organization of the chains be achieved.

For agricultural commodities the government policy in all parts of the world has played an important role. In some cases this has led to strong links between agricultural production and processing combined with high entry-barriers (quota's) as in the sugar and milk chains in the EU. In other cases it has led to imperfect market conditions where the government has played a dominant role in the link between agricultural production and markets as in the cereal chain. Because of the changing role of governments and changing market condition the need for more interaction of agricultural production with next links in the chain emerged.

Introduction

The division of agricultural chains on the basis of the nature of the product seems to be a rather crucial one with regards to forming of value added chains. The type of production chains that can be distinquist are:

A. The chain for fresh and/or semi-processed agricultural products: In these production chains the intrinsic product attributes on consumer level are the same as those on production level (like vegetables and meat). The role of the chain is the balancing of production and consumers need (in both quality and quantity) and a smooth and quick distribution of the products to the consumer in order to reduce quality losses.

B. The chain for processed agricultural products in the food markets: Although the quality on primary level is the basis, the processing industries have a substantial influence on the quality on consumer level. The role of the chain is enhanced with an extra value added link in which the most substantial balancing of consumers wishes and product attributes takes place.

C. The chain for industrial commodities. In this chain the end user of the agricultural product is an other production chain. On these markets the chemo-physical properties of the agricultural product plays a dominant role. The demand for these commodities is determent by the performance of the non-agricultural chain.

In most literature the illustrations of advantages of a value added chain refer to the first type of production chains. Also almost all the initiatives taken up to now in forming some kind of value added chains have been in the first type. Even in the pork chain the compound feed industry as such is included in the initiatives to form a value added chain but does not include the agricultural crops as an important supplier of inputs.

This raises the question whether or not agricultural commodities can and/or will be able to take part in value added chains.

Some characteristics of agricultural commodity markets and market structures

For the objective of this paper a specific definition of agricultural commodities will be used in order to be able to make more general remarks without continuously referring to exceptions. In this definition an agricultural product is labeled as commodity when it needs some form of processing before it reaches the consumer and the product can be stored for a longer period without loosing (much) quality in various stages of processing. This implies that all product that can be sold fresh as well, such as preserved vegetable and fruit, meat preparations and milk products are not marked as commodities. All grains, oil crops, sugar and industrial crops are included in the definition although for instance rice does not needs processing but because it is easily storable it does not fit in the fresh chain.

A general similarity of agricultural commodities is that they know an international, world market. Most individual product or close substitutes are grown all over the world. A second important characteristic is the importance of these products for the food supply in terms of energetic needs all over the world. 65% of the human energy needs is covered by the direct consumption of these tree product categories. Additionally 40% of the world grain production and 20% of the oilcrops goes to the animal consumption and contributes indirectly to both energy, protein and fat intake of people. The strategic importance in terms of food security has led to a strong interference of governments in the markets. The sheltering of the primary production against market influences has led to a disconnection of production and trade/processing or in other cases a forced integration of production and processing, separated from end markets or further processing. Herewith a third common factor is identified: At some place in the production chain the government formes the connection between two links.

The food industry in the world has shown a strong process of horizontal integration in the past decades. In the US, the UK and in France the fifty biggest industries have a market share of 50% or more in the total turnover in the food market on retail level. These industries generally produce a wide range of product and can be characterized as global, multi branched industrial conglomerates. In spite of the horizontal concentration there are only a few market(segments) with monopolistic characteristics because of the broad assortment of product per holding and the fact that most multi-nationals are present on all important markets. Although competition is strong, these multi nationals have a substantial influence on food markets. As a whole it is a financially strong and a highly innovative industry.

On retail level the same horizontal concentration development has taken place. The unification of the European market will further stimulate this international concentration, where as most bigger US and EU retail chains also by mergers and take-overs seek access to each other markets. Also on this level competition is strong. The saturation on the food market has forced the retail chains to become more than just a serving-hatch. By building up a profile through marketing, service level, quality and most certainly also by the assortment on the shelves, the retail link has become a determining factor in the decision what products will even get a chance to prove them selves on the market.

The feed and non-food market

In the US and in Europe about tree-quarters of the grain production and 60 to 70% of the oilcrops are used as animal feedstuff. This means these product are raw materials for an other production chain. The same goes for the non-food applications. Because of the inter exchangability of food, feed and non-food applications, the markets off farm are inter-related and dominated by a few trading companies. Although some of these trading companies also have processing facilities the relation between arable production and the other production chains is almost absent.

The position of arable production in the chain.

The position of arable production is mainly determent by the nature of the product and the governmental interference.

The sugar case

For sugar in the EU there is a quotum regulation in which the quota have been assigned to the processing industries. Imports are restricted by a.o. import levies. In the US imports are restricted by quotas, adjusted to domestic processing capacities and consumption. Because of this the sugar beet/cane production and the processing unit are condemned to each other where as on the end markets the processing industries face competition of other production units working under the same limiting conditions. Although in the EU there is a close relationship between the farmer and the processing industry with regard to production quantity, quality, logistics etc., it is doubtful whether or not this can be qualified as a value added chain. One of the characteristics of a value added chain is that it is a collaborative action between independent organizations. Although according to civil law both organizations are independent (whether or not there is a cooperative processing is not relevant), the relation is heavily biased by governmental regulations. The possibilities for the farmer to influence the relationship in terms of quantity, quality or choosing an other processor are very limited.

A quota system as in the milk production leaves the farmer every possible liberty to choose a relationship with the processor. In fact there is a competition between the processing industries with respect to the supply.

Cereals

The production chain for cereal (consumer) products is very complex. It quickly divergates into an almost endless number of consumer products. Although cereals used for human consumption are in general referred to as quality grains, quality has a limited content. For bakery products some minimum quality standard have to be met. Further in the production chains all kinds of different quality measures are relevant dependent on specific end products which are sometimes also related to storage conditions and first processing. The minimum price system in the EU has led to a minor interest in quality on farm level. A high yield of "low" quality gave more income security than the dependency of a quality premium. In spite off the national/regional protection there is a world market for cereals and flour. Regional shortcuts in production, due to for instance whether conditions, have there impacts on the free market prices all over the world. On the world market for cereals only 5 big trading houses are active. Their influence on the market has diminished by the role of government as the largest stock holders, who manipulates the stocks with more political than market point of view.

On the market for bakery products there is a continues flow of product innovations. On consumer level these products, with the exception of plain bread, are sold under brand names. Quality plays an important role but is more related to the absence or presence of additives, health impacts and taste than to quality aspect of the cereals as the basic production material.

On the feed market, the largest outlet for cereals in the Western World, quality plays a minor role. The presence of a strong compound feed industry in Western Europe, that uses highly sophisticated models to optimize the composition of animal feed in relation to the prices of the components, has strongly focused attention to the price as a main market factor.

Oilcrops

Oilcrops are used both for human consumption as for animal feed. The most important crop on world scale is soya. Sometimes the by-product in the crushing process for producing vegetable oil for human consumption (oilcackes for animal feed) is more important in economic term than the oil itself. Because of the inter-exchangability of the oilcops both for human as for animal consumption the price is a dominant market factor. Because of the substitution possibilities between oilcrops and cereals in animal feed as well as on the production side, the market for both products are strongly interrelated. The main trading houses in the grain sector are also active in the oilseed markets.

The value added chain

In the literature a number of advantages of a value added chain are given. Although different authors use different arguments most of them can be fitted in the seven motives mentioned by Zuurbier (1991). These arguments will be discussed with emphasis to the arable production in relation to the next links in the chain. The starting point is the definition of a value added chain as a collaborative action of independent organizations.

Transaction and coordination costs
Because of the world markets for cereals and oilcrops, fluctuations in regional production quantity and qualities due to whether conditions and regional prices differences, the processing industries in general do not want to be dependent of regional supplies. The saturation on their end-markets and the international competition puts a high pressure on costs of inputs. The disadvantages of having to pay a higher price than competitor due to regional shortages are much bigger than the reductions in transaction costs possible by closer cooperation with regional agricultural suppliers. A multi regional (world) cooperation with agricultural producers will increase coordination costs extremely. The presence of multi-national operating trading houses, with a thorough knowledge of market developments and price differences all over the world, makes a direct contact with arable producers redundant. A "free" market is the most cost efficient way to obtain the raw material.

In the sugar chain in the EU transaction costs are minimized. Due to the quota system an almost full integration has taken place between agricultural producers and processors. All efforts are directed towarth a reduction in coordination costs. As been said before it is questionable whether this can be qualified as a value added chain and therefore also whether transaction costs as such can be distinguished. The minimum price system and the quotas do not leave space for transaction freedom.

Acquisition of required technology
Agricultural technology is in general widely and freely available. The processing industries have little interests in the arable production it self. The competitive advantages of possessing knowledge of agricultural technologies are restricted to use them to get better raw material. The technology itself will not contribute to their performance on end-markets.

Creating, enlarging entry barriers
The almost absence of entry barriers for agricultural production (except for the quoted products is one of the biggest problems for the agricultural sector. The moment there is a high price for a product because of inclining demand, an immediate shift in production takes place and prices fall to a lower level they have ever been. A value added chain with entry barriers would be very beneficial to the primary agricultural sector. As long as the processing industries however will be able to obtain their required quality and quantity of agricultural products on a free raw material market they have nothing to gain by including the agricultural link in their value added chain but only to lose. The increase in cost will not be compensated on end-market if standard quality of raw material is sufficient.

Consolidation, strengthening of competitive position
As been said before the competitive position of the processing industry will not be influenced by cooperation with the primary agricultural sector when a standard quality of raw material is sufficient. The ability of the industry to develop new products within the processing (mix of raw materials, additives, processes etc.) is far greater than the possibilities of the agricultural production to contribute to the product development. With respect to product quality recent problems with consumer products in The Netherlands (salmonella in breakfast cereals) show standard quality is not always sufficient. It is

nevertheless doubtful whether the cost of collaboration with the agricultural production in order to prevent quality disorders counterbalance the cost of such incidents. More and more these quality aspects will be imposed on the markets as a whole, as all processors face the same possible problems on their end markets.

Optimizing logistic processes
It is this argument together with product quality that has been the leading force for the attempts to form a value added chain in the chains for fresh agricultural products. The problem of los of quality during transport is almost absent in the chain for processed products. The large stocks of cereals and oilcrop (products) on world level show logistics have a different dimension for the agricultural commodities. More profits can be made by buying when the prices are low than by reducing inventory costs etc..

In the sugar industry the logistic process between agricultural production and processor has reached a high degree of perfection. The dominant position of the processor as the "owner" of the quotum, has given them the power to streamline logistics according to their wishes.

The government as stakeholder
As been stated before the government influence on agricultural production is strong. In the sugar chain this has led to an intensive relation between production and processing. In the cereal chain the US and EU governments are besides stake holders also the world largest stock holders. This means they are also operate as a market participant and not only as regulator. Especially in the EU the government has sheltered the agricultural production from almost all market influences. The reform of the agricultural policy has led to a more direct relation between farmer prices and world markets but not to a closer relation between agricultural production and processing. For cereals and oilcrops governmental policies has been a barrier for the forming of value added chains

The need for linking
The partial withdrawal of the EU government from agricultural markets has led to substantial reductions in earnings on farm level, partly compensated by direct income support. The competitive power of the EU agricultural commodities on world markets is not very strong. The high prices of inputs (labor, ground) can only be compensated by a high productivity. The restriction on the use of chemical inputs due to a higher interest of environmental problems will limit the possibility for further increases in yield per hectare. The high level of expertise on farm level and in the seed industry, the highly developed knowledge transfer system does not match the position of raw material producer. It could be better used for the production of high value products. On commodity market a small change in supply has a strong effect on prices and bass periods last longer than price peaks. The only way to escape somewhat from these waves in prices is to add value to the products in terms of quality or processing. For this the agricultural producers need the processing industries. High quality products or specific product require a close contact with the next links in the chain. The basic definition of quality lies in the end market. The agricultural commodity producers have grown away from market and lack a clear view on what is happening there. The historical structural and cultural development of the primary producers, separated from the other links in the production chain makes it difficult to

catch up with the market. As been stated before the advantages of the processing industry for a closer collaboration with agricultural commodity production in the current situation are minimal. It is the primary production that has to do something to ensure a sufficient income and continuity.

Possible option for the agricultural commodity producers

The attention of the public for al kinds of aspect related to the production of food and foodstuff is growing. Environmental friendly production systems and especially health aspect are becoming more and more important in the selection process on consumer level. Although with processed products the attention is mainly focussed on the processing itself and the additives used in the process, the interest of both processing industries as consumers in production systems on primary level is growing. This interest will not lead automaticly to collaboration but does offer opportunities for the agricultural producers.

Up till now the agricultural producers in times of troubles have always demanded support from the government. Even now the politics are blamed for the situation and are pushed to create solutions for the income decrease on farmers level. Al kinds of arguments are used: the strategic importance with respect to food supply, public responsibility towarth the agricultural sector, employment, the value of agricultural production in landscapes etc.. Although a responsibility of government for the agricultural sector can not be denied, a sustainable and competitive agricultural production is only possible when it is more market-driven. This will need a cultural change and a restructuring of the organizations on primary level. The sector has to show and to prove the processing industries they are an interesting partner to collaborate with. In some small application field initiatives have been taken such as barley for beer, regional specialties (bread) and they seem to be successful. The main question remains whether or not the linking with the chain is an option restricted to some niche-market or whether it can be a solution for the sector as a whole.

Discussion items

For agricultural commodities the free market with the price as balancing principle is the most optimal link between producers and processors. Even exchanging information as a basic form of collaboration offers to little advantages to compensate the efforts as proven for example in failure the coffee and coco agreements.

If the agricultural sector does not succeed in linking with the chains, the production of agricultural commodities will move away from Western Europe to Eastern Europe and Latin America unless the protection will be enlarged.

The changing consumers wishes and demands with respect to environmental impact of production, food safety, health aspect and diversified product will force the processing industries to get more involved with agricultural production. The creation of value added chains for commodities is therefore just a matter of time

Simulation model for the apple chain

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This paper is the result of participation of the author in a LEI-DLO project with regard to chain management in the apple sector. His eight month's research has been supervised by prof.dr. P. van Beek (Department of Operations Research) and dr.ir. W.J. Marcelis (Department of Management Studies) of the Wageningen Agricultural University and ir. J.J. de Vlieger of the Agricultural Economics Research Institute (LEI-DLO). The latter can give further information about the LEI-DLO project (tel. 070-3308332).

Abstract
Numerous (simulation) models have already been made for all kinds of companies and products. Many of these models deal with the isolated problems of a separate company c.q. a link of a chain. This paper presents a simulation model for the entire apple distribution chain. The model aims to minimize the total distribution costs, taking into account the restrictions set by the final consumers. The model, although it is not ready for implementing in practise yet, can help the strategic decision making in the chain, while it is possible to evaluate strategic alternatives for there impacts. It is the author's hope that this paper can contribute to further exploration of (agri)chain modelling.

Keywords: chain logistics, operations research, simulation model, apple, distribution chain, quality, strategic decision making.

Introduction

Traditionally the logistical production chain is seen as a line of coupled, but separately functioning enterprises. The communication, co-operation and adaptability between organisations in these chains is not always optimal. The organisations are primarily concerned with their own position, profits and interests, which leads to the well-known sub-optimizations. Although all participants in the chain have different interests, they still have the mutual goal to provide the final consumer with an excellent product. Last years, it has become clear that enterprises do not stand alone in merchandising there products, but that they are a part of a greater whole of economical activities in the successive links of the production chain. Therefore, an integral approach of the production chain is necessary (De Vlieger, 1992).

Chain logistics can play an major role in improving the performance of all the organisations in the chain separately and as a whole. Chain-logistics aims at the streamlining of the entire logistical chain and chain management, the improvement of the position of the organisation in the chain and of the position of the chain with respect to competitive chains (Van Ballegooie, 1992). The production chains are not always restricted to the national borderlines of the country, but may also reach over these borderlines. This is especially so for an exporting country as the Netherlands are.

This paper deals with the apple chain. The Netherlands are exporting a great deal of its produced apples. Our main export market is Germany, where we have to compete with apples from all over the world. At the moment, the fruit-market in West-Europe is coping with satiation symptoms, where the Dutch supply is ever more increasing. The supply of high quality apples is probably the only way to market these products (De kleijn, 1992).

This paper presents a method which can help to solve the above mentioned chain problems: a simulation model of the apple distribution chain. The aim was to develop a model which is able to evaluate different distribution chain arrangements with respect to costs and quality-decay. First of all, such a model can give more insight in the functioning of international agricultural chains in order to reach an optimal market supply for the consumer. Furthermore, the model may be helpful to localise logistical handling of which the costs can be reduced, taking into account the quality and environmental demands asked for by the market. Finally, use of this model can improve the insight in the coherence of the elements of the apple chain, the logistical processes that take place during the distribution, the costs of these processes and the quality-decay that occurs during these processes.

In section 2, a description of the apple chain is given. Section 3 presents the simulation model, whereas section 4 discusses the quality(decay) and decision making in the apple chain. The status of the present simulation model is discussed in section 5, and finally the conclusions are presented in section 6.

Description of the appel chain

The research has been restricted to the export of Dutch apples to Germany. In 1992, almost 490.000 tons of apples were picked in the Netherlands. The main apple species are Elstar (143.000 ton) and Jonagold (135.000 ton). From the total amount of apples, about 50% is used for the inland consumption, about 10% is further processed by the industry and about 40% is exported. Half of the amount of exported apples goes to Germany. (ZMP-bilanz, 1990 en PGF, 1992)

But how are the Dutch apples distributed from the Dutch producers to the German consumers? *Figure 1* shows the different possibilities.

The apple chain consists of some successive links starting with the producers and ending with the German consumers. The producers have two possibilities to distribute their products. They can either be a member of an auction and deliver all their products to this auction, or they can sell their products directly to the merchants. When the products are merchandised through an auction (which happens with 75% of the apples), the products are bought by exporters (64%), wholesale dealers and multiple shop organisations (24%), industry (4%) and retailers (7%) (CBT, 1991). In general, the actual purchase is done by so-called commission-agents, who buy the products for the merchants for a certain commission. Most of the apples are distributed to Germany via exporters, who sell these pro-

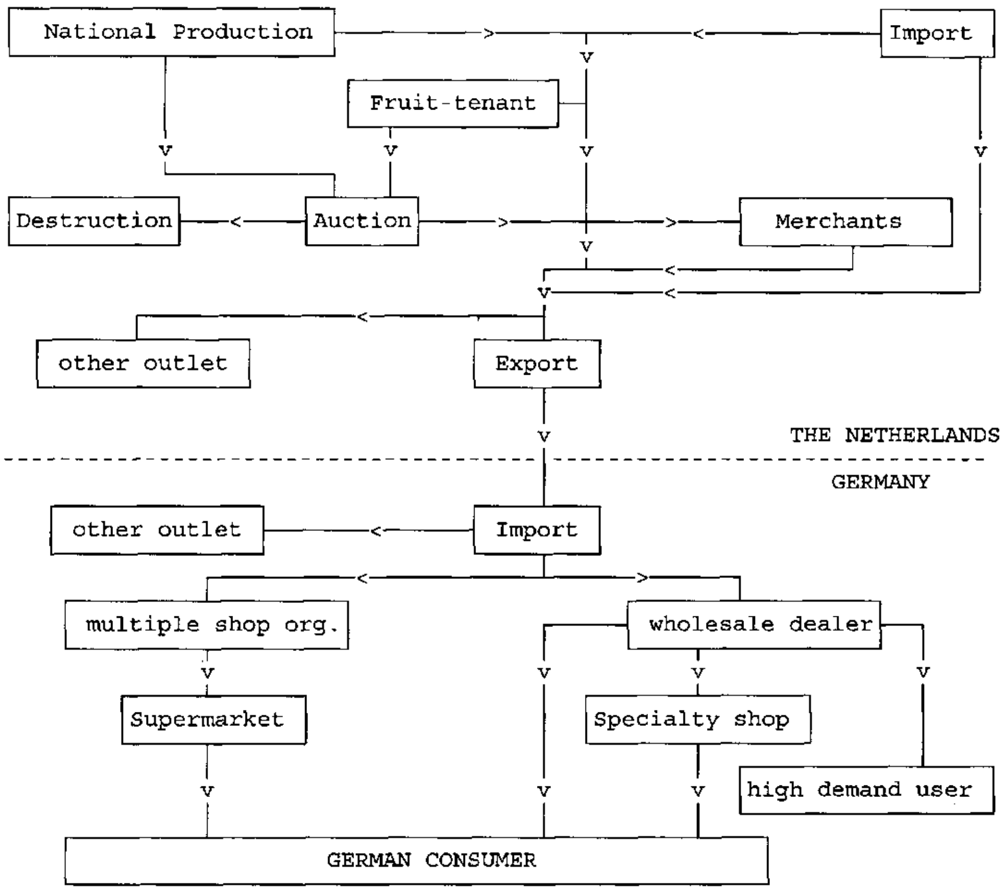

Figure 1. The structure of the apple chain.

ducts to German multiple shop organisations or wholesale dealers. Finally, the apples reach the consumers via supermarkets or specialty shops.

Logistical processes

In order to obtain more insight in the logistical processes that take place in the distribution chain, the activities of the different participants are briefly discussed.

The producers

The picking of the apples starts in August, with the summer species, and ends in October. The apples are usually gathered in boxes of 325 kilograms, sometimes in wooden crates of 20 kilograms. After the harvest, the producer has to decide whether he will store the apples (only for the preservable species) or market them. Apples can be stored at the auction or at the farmer's house, depending on the storage facilities of the producer. In practise, about 60% of the apples is stored at the producer's farms and 40% at the auction. There are three different storage possibilities (IKC-fruitteelt, 1989):

1. cold storage
   The temperature is dropped by mechanical cooling until 1 à 2 °C. In addition the air humidity is sometimes raised.
2. cold storage with controlled atmosphere (CA-storage)
   Besides the low temperature, the oxygen-percentage is dropped until about 16% and the carbon dioxide percentage until 5%.
3. cold storage with ultra-low-oxygen (ULO-storage)
   This is a form of scrubbed CA-storage were the oxygen-percentage is dropped until about 2%.

The months after the harvest, the stored apples must be merchandised and taken out of the storage cells. In which month this happens depends on the remaining quality and the price setting of the apples. When the apples come out of the storage cells, they have to be sorted and packed. The evacuation of a complete storage-cell takes about two to three weeks. The sorting of the apples (which can take place at the farmer's home or at the auction) is based on the measurements colour, weight, size and quality of the apples. After the sorting the apples can be packed in different packages: the most important packages are the wooden crate (60 x 40 cm, 12 kg) or the cardboard box (60 x 40 cm, 12 kg or 40 x 30 cm, 10 kg). Finally, the apples are transported either to the auction or directly to the buyer (usually the exporter). This transportation can take place in conditioned and in unconditioned vehicles.

Auction
There are several ways to market the apples through the auction. The traditional way is to sell by auction and actually deliver the products at the auction. The apples are then 'blocked' and sold for the clock. Other ways of distributing the apples are all through mediation by the auction. By most of these methods, the buyer of the products is known in advance. The producer prepares the apples (sorting, packaging) by the wishes of the buyer, and delivers them sometimes directly to the buyer.

The apples arrive at the auction in the afternoon or evening the day before auction takes place. After the inspection (which is a control of the sorting) the apples are blocked and positioned in the auction hall. During auction, uniform blocks of apples are being offered. The buyers can take a number of crates of apples out of the blocks for the price set by the clock. After auction, the apples are taken out of the blocks and are grouped at a dockside for each buyer. If the packaging does not satisfy the buyer, he can repack the products (at the auction or at home) and put them in another packaging. Then the wooden crate is mostly replaced by the cardboard box.

Exporters
There are two kinds of exporters, the fruit-exporter and the packet-exporter. The fruit-exporter only deals in fruits, the packet-exporter mainly deals in vegetables with fruit as an addition to the packet. The exporter buys his products at several auctions and/or directly from producers to get the right assortment. In general, all these products are transported

to a central place, where they are regrouped depending on the next buyer. It's also possible that the exporter does not have a buyer yet, but that he wants to speculate with the products, i.e. he stores the products and waits with selling them until the price increases. This cold or unconditioned storage can take place at the exporters company or at the auction.

German buyers

Buyers of the Dutch apples in Germany are the wholesale dealers or the multiple shop organisations. The transportation from the exporter to Germany, which can take place conditioned or unconditioned, is most often done by professional transporters. Over 80% of the amount of apples are distributed by the multiple shop organisations. The remainder of the apples reach the retailers by way of the wholesale trade market (De Kleijn, 1992 and Heisters, 1988). With both ways, the products can (and probably will) be stored, repacked and transported again, before they reach the final buyer, the consumer.

Conclusion

When you closely look at the successive logistical processes that take place during the distribution of the apples, you will notice that these processes consist of a repeating cycle of three handling: storage, (re)packing and transportation. For each of these processes, there are several ways to carry out the process. Storage can take place for several months or weeks and under several conditions, (re)packing can be in several packages and transportation can be over different distances and under several conditions.

Quality in the apple chain

As stated in section 1, delivering products with a high quality standard is a necessity to survive the tough competition in international agricultural markets. Competition is not only based on the price, but also on the quality of the products, especially in a satiated market. 'Quality of the delivered goods' is defined as the degree in which the performance of the supplier satisfies the expectations of the buyer. The performance is primarily evaluated on grounds of specifications of product-quality, quantity and costs (price) and secondly on the delivered service. Based on interviews with participants in the apple distribution chain, several critical moments or aspects are localised with regard to the product quality. They refer to the next points:

1. The picking moment.
   To get a homogeneous group of apples, the producer should have several picking-times for each specie. Each time only those apples should be picked that are sufficiently ripened at that moment (IKC-fruitteelt, 1989). In practise, this is not sufficiently done.
2. Storage.
   Often, the take-in and take-out time of the apples out of the storage cells takes too much time. These periods have to be as short as possible to preserve as much of the quality as possible. Especially, on these moments are the environmental conditions far from optimal. Apples have to be stored under optimal conditions.

3. The auction hall.
   The period in which the fruit is waiting for the auction and for the transportation is often too long and under non optimal conditions.
4. The lead time.
   The lead time of the apples through the chain (and through the separate links of the chain) is often much too high. It can take up to two months after long-time storage before the apples reach the German consumer.
5. Conditions in the chain during distribution.
   To deliver the apples in Germany with an optimal quality, the products should be in a conditioned environment at all times during distribution. There are too many moments in the apple chain in which this condition is not met.
6. The retail store.
   There is hardly any quality control by the wholesale dealers and retailers. While the apples are only a small part of their business, there is often little product knowledge and therefore also more quality-decay.

The simulation model.
It is hardly possible to express all distribution chain dependencies in mathematical relations, as a lot of factors interfere. However, it is not always necessary to formulate all these dependencies; often the modelling of only the most important factors can give a good insight in the problem. Prior to the formulation of the model, some assumptions have to be made. These assumptions are summarised in the next section. Section 3.2 and 3.3 concentrate themselves on the basis resp. the functioning of the model.

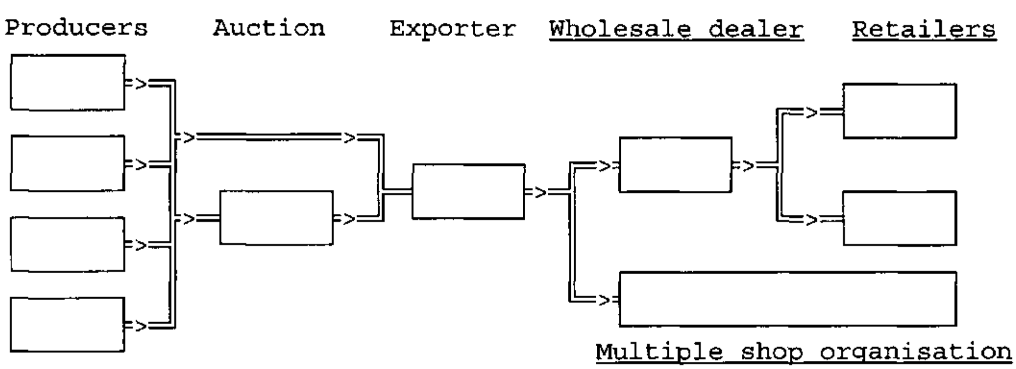

Figure 2. The modelled distribution chain of apples (the German participants are underlined)

Assumptions.
As explained in section 2 there are several distribution paths that lead from producer to consumer. In this explorative research, we have chosen to model the distribution chain, that provides the greatest throughput. Based on interviews with participants in the apple chain (producers, auctions, research institutes) the following chain has been selected:

The modelled chain consists of five participants c.q. actors, namely the producer, auction, exporter, wholesale dealer or multiple shop organisation and retailer. The producers pick the apples and sell them, after a certain storage-period, at the auction or directly to an exporter. The buyers from the exporters are the wholesale dealers or the multiple shop organisations, who distribute the apples further to retailers resp. chain stores. This last link in the distribution chain aims to represent the wishes of the consumers with regard to quality, quantity and packaging.

Assumptions

1. Number of actors per link.
   The model has been formulated for only one possible behaviour per link. Decisions that have to be made in a link (for example, when are we going to pick the apples?) are taken the same way for all the apples. You could say that each link has only one actor: there is only one producer, who sells his products to one exporter, etc.
2. Logistical processes.
   We concluded section 2.1 with the statement that the logistical processes which take place in the apple distribution chain consist of a repeating cycle of three handling, namely storage, (re)packing and transportation. In section 2.2, we concluded that especially the *moments between* two successive handling influence the quality-decay. For example, the time in which the apples are standing in the unconditioned auction hall. We assume that these moments always take equal time, and therefore result in the same quality-decay. This quality-decay is added by the handling the moment belongs to.
3. Distribution.
   First of all, we assume that all apples are picked at the same time. Furthermore, we assume that the long-term storage cells (cooling cells, CA- or ULO-cells) can only be opened at the beginning of each month, where short-term storage (not conditioned or cooled) during distribution can take place for zero, one or two weeks. The exporter can store for zero or one week, the wholesale dealer for zero, one or two weeks. This means that the apples, which come out of the storage cells at the beginning of a month (with an, for the stored apple specie, optimal temperature), are distributed during the four weeks of that month. The simulation c.q. optimization also takes place per month. As the smallest time-unit is one week, we assume that packing (in wooden crate or cardboard box) and transportation (conditioned or not conditioned), both a matter of hours, cost no time at all.
4. Capacities.
   We assume that there are no capacity-restrictions. All apples can be stored, transported and packed at all times and in all links.
5. Quality.
   We assume that all apples have the same quality at the time of the picking. In practise, quality-variations in a parcel of apples appears during the distribution of the apples. We assume that there are no variations in quality in a parcel which has followed the same successive logistical processes.

6. Costs.
   The total chain costs are minimized in the model. These are not the actual chain costs, because we are only looking at those costs which are decisive for the selection of a possible logistical handling. Costs as profits, production costs, etc. are not taken into account while we assume that these costs are equal for all possible distribution chains. Therefore, the total chain costs should be considered as an indicator of the differences between possible distribution chain arrangements and not as actual chain costs.

The basis of the model.
The simulation model is based on a decision tree. This tree is a graphical reproduction of all the successive decisions that have to be made within the distribution chain. A decision consists out a choice out of a number of possibilities, whereby each possibility affects the state of the products. In our case, the decisions reflect the logistical processes in the apple chain. *Table 1* summarizes the successive logistical processes being modelled.

As can be seen, the first decision reflects the long-term storage at either the producers farm or at the auction. The second decision reflects the sorting and packing of the apples, etc. Each decision contains a number of possible ways to carry out the logistical process. For example, long-term storage can take place in unconditioned, cooling, CA- or ULO-

Table 1. The logistical processes which have been taken along in the model.

Decision	Logistical process.
1	long-term storage at the producers farm or the auction.
2	sorting and packing of the apples at the producer's farm.
3	transport of the apples to the auction or to the exporter.
4	short storage by the exporter.
5	repacking by the exporter.
6	transport to the wholesale dealer or the multiple shop organisation (MSO)
7	short storage by the wholesale dealer or MSO.
8	repacking by the wholesale dealer or MSO.
9	transport to the retail trader or chain store.

Table 2. Different possibilities for the logistical processes.

	logistical process	possibility 1	possibility 2	possibility 3	possibility 4	possibility 5
1	long-term storage	unconditioned	cooling cell	CA-cell	ULO-cell	
2	sorting and packing	wooden crate	cardboard box			
3	transport to exporter	unconditioned	isotherm			
4	short storage exporter	none	1 wk uncond.	1 wk cooled	2 wk uncond.	2 wk cooled
5	repacking exporter	none	cardboard box	small packaging		
6	transport exporter	isotherm	cooled			
7	short storage wh.dea-ler none	1 wk uncond.	1 wk cooled			
8	repacking wh. dealer	none	cardboard box	small packaging		
9	transport wh. dealer	isotherm	cooled			

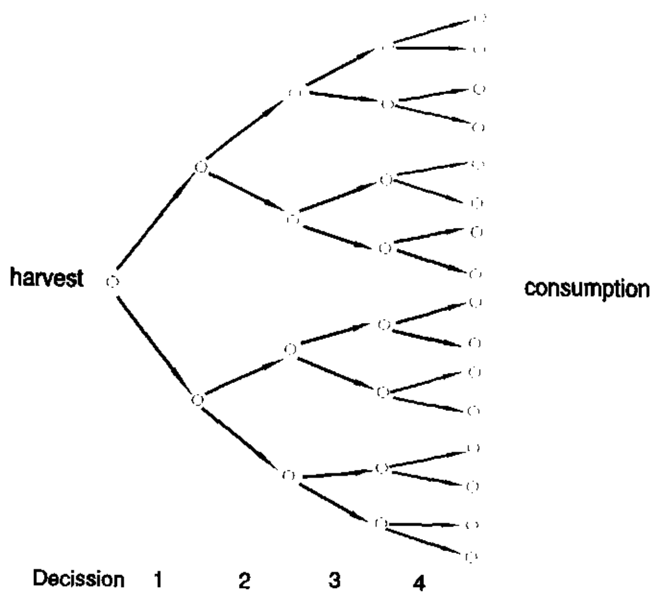

Figure 3. A decision tree with 4 successive decisions, each having 2 possibilities

cells. In *table 2*, the different possibilities for the nine logistical processes are summarized.

With Table 2 we can set up the decision tree for the apple chain. This tree consists of nine successive decisions with each at the most 5 possibilities. *Figure 3* gives an example of a decision tree with 4 successive decisions, each having two possibilities.

This tree represents the apple chain, through which the apples float from the producers (on the left side) to the consumers (right side). There are numerous ways for a parcel of apples to be distributed from the producer to the consumer. The chain starts with a certain state in which all the apples occur. The state of a parcel of apples at any moment during distribution is determined by quantity, quality, packaging and time. After each decision, the state of the parcel is changed. For example, if 50% of the apples are stored in a cooled cell for one week, the quality decreases, the quantity halves and the time increases with one week. The original 100% picked apples is divided over several parcels of apples which float in different ways through the decision tree (from the left to the right) and are therefore submitted to different logistical handling. At the end of the chain, also the right side of the tree, the state of the different parcels of apples has to satisfy the demands of the consumers. At a certain time there has to flow a certain quantity of apples, which posses a certain quality and packaging, out of the tree.

The functioning of the model.

Each 'path' through the decision tree results in different states and costs. In the mathematical notation of this problem, it is possible to formulate these product flows with flow-variables and equality equations. In each one of these equations, the balance is made up

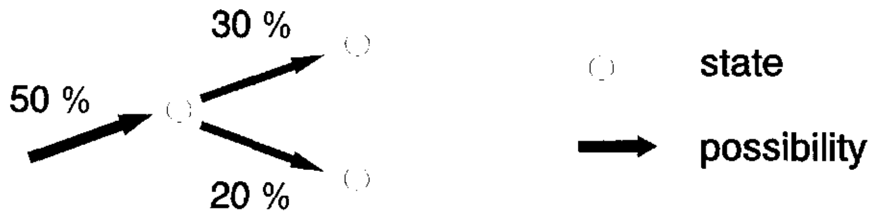

Figure 4. Graphical presentation of a decision with two possibilities of a certain logistical process; 30% of the original 50% of apples are submitted to possibility 1 and 20% to possibility 2

for the logistical process the decision reflects; the total quantity of apples that is submitted to one logistical handling (also a decision) is divided over the several possibilities of this handling (*Figure 4*).

When a possibility is chosen for a certain quantity of apples, the state changes according to the given influence of the handling. In addition to these balance equations, there are demand equations. In these equations, the states of the apples at the retailers have to be equal to the demanded quality, quantity and packaging by the consumers. In order to formulate the problem mathematically all the branches in the tree (i.e. each possibility of each successive decision) are numbered. In this way, it is possible to formulate all the balance and demand equations in an uniform way.

The mathematical notation of the model is implemented in Sciconic. The program consists of a main program, a subroutine, several data-files and a report-writer. When the model is activated by a user, following algorithm is executed:

1. The user of the model can select his own distribution month, distribution country (Germany or the Netherlands) and long-term storage place (auction or the producers farm). Different input-dates are taken, dependent on the choices the user has made.
2. Because the influence of each logistical process (each branch in the tree) on the state of a parcel of apples is known in advance, we can calculate the state of the parcel for any branch in the tree. This is done in the subroutine. Now, we can compare the final state of the apples, at the right side of the tree, with the demanded states by the consumers. If these states for a certain 'distribution path' do not harmonize with each other, this path is excluded for the optimization.
3. Finally, a linear optimization takes place for the remaining 'distribution paths' where the total distribution costs are being minimised. This results in an optimal 'distribution path' for each week of the selected month and for each demanded state of the apples.

With this model, alternative distribution routes can be compared for their costs and appearing quality-decay. It is possible to measure the influence of the different logistical processes on the distribution costs and the states of the apples.

In the research a case-study has been carried out, using estimated data. In this study, the quality of the apple was reproduced by the constipation of the apple, as most data with regard to the quality concerned this apple characteristic (Cramwinckel, 1991 and De Jager, 1993). Therefore, we can present some possible outcomes of the model:

- When the apples are longer stored, the total distribution costs are higher. This is, besides the higher storage costs, due to the higher quality-decay. During the remaining distribution period, higher costs (more cooling) must be made to preserve enough quality. For example, all the transportation has to be under conditioned circumstances. The longer the storage period is, the better a total cooled distribution chain has to be reached.
- When the apples are stored at the auction instead of at the producer's farm, more quality-decay takes place. This is so, because most of the times the sorting is done at the producers farm and therefore the apples remain more time in an unconditioned environment. Therefore, the sorting should take place near the storage-cells.
- The total distribution costs depend on the total allowed quality-decay. If more quality-decay is allowed, less costs have to be made during the distribution to satisfy the customer's demand. For example, the apples can be transported in unconditioned vehicles.

The present model shows, that modelling of a distribution chain is possible and can give additional insight in the arrangements of the distribution chain. However, there are still some shortcomings in the model. The most important ones are discussed in the next section.

Quality and decision making in the apple chain

The presented simulation model forms the bases for a larger model which could support the strategic decision making in the apple chain. This model will allow us to evaluate strategic alternatives on their effects. First, the presented model should be expanded. Considering the assumptions (section 3), we choose to concentrate on the quality(decay) and on the situation with several active actors per link in the chain. Section 4.2 discusses the quality and quality-decay during distribution and section 4.2 discusses the decision making in the various links of the chain.

Quality and quality-decay.

We have defined 'Quality of the delivered goods' as the degree in which the logistical performance of the supplier satisfies the expectations of the buyer. Focusing on the product-quality, we can define the product-quality as the degree in which the characteristics of the product satisfy the user. All of these characteristics have to satisfy a certain minimum demand; a satisfying quality at a certain moment means that the whole of quality characteristics satisfies the whole of quality demands at that moment in the chain (Saedt, 1989).

The question, however, is which of the apple characteristics determine 'quality'? Therefore, several participants of the apple chain have been interviewed and asked for their definitions. This resulted in the following apple quality characteristics: colour, ground-colour, constipation, size and purity of the apple. The colour and the size are not affected during distribution, whereas the other characteristics are. During the interviews, it turned out that the successive participants in the chain do not have the same demands for all of these characteristics. For example, the producer is more concerned about the colour, largeness and the constipation, whereas the retailers give priority to the purity of the apple.

During the distribution, not all the apples are exposed to the same environmental conditions. For example, apples on the outside of the tree are exposed to more sunlight then the ones in the middle. Also storage-cells contain a certain dispersion in temperature and gas-composition. Because of these dispersions in environmental conditions that occur at all logistical handling, an ever greater variation in quality occurs when the apples are distributed (Meffert, 1991).

In the present model, the quality parameter is expressed by one of the above mentioned quality characteristics. In order to catch the real quality-life during distribution in the model, it should be possible to take more quality-characteristics and the occurring quality-variation along. In the model, both expansions can easily be made applying probabilities.

Decision making in the various links of the apple chain

The quality of the produced products and of the finally consumed products are affected by the decisions taken in the successive links of the chain. Therefore, we have to give some attention to these decision making-processes. In practise, there are three factors which play an important role in the decision process; quality, quantity (availability) and costs (price) (Van den Berg, 1991: 197). During the distribution, a number of decisions are taken that are decisive for the progress of the product stream. These decisions based on the three mentioned factors affect the state of the apples. Each actor bases his decisions on the available information. Because the available information can vary for different persons (due to different information sources) and because every person interprets the available information in his own way (due to different backgrounds, educations, etc.), differences can occur in the decisions taken by different persons (Steenkamp, 1986). The present simulation model incorporates only one possible behaviour (decision making) per link (see section 3). In reality, there are many possible behaviours per link. Each different combination of these behaviours results in a different product stream, i.e. a different distribution chain, and different lead times within its chains. Our model, which encloses the greatest product stream, allows to simulate these different behaviours in the distribution chain. Probably, it is also possible to model these different behaviours per link applying probabilities.

Status of the present simulation model

The present model optimizes the total distribution costs for a chosen month, taking into account the restrictions set by the final consumers on quantity, quality and packaging. The model can be used to compare and evaluate various ways to carry out logistical processes (storage, packing and transportation) in the distribution chain, with respect to their impact on quality and costs. The result of the model is a distribution chain for which the best way to carry out each logistical process is presented.

However, there are still some shortcomings in the model. For example, only the largest product stream is modelled, only one participant per link is taken along and the model operates with fixed storage periods. Furthermore, the quality-life of the apples is not taken along conform the reality and the model does not give any indications about profits (which are often decisive for a certain decision). But these shortcomings do not decrease the applicability of such a model. With some expansions of the model, it will be a close description of the reality. The main problem of the functioning of the model at the moment is the availability of reliable input data. A lot of data concerning the costs of logistical handling and of the quality-decay that occurs are not available yet. Even a sophisticated model can not replace the lack of reliable input data.

Conclusions

In this paper a model is described which can help the strategic decision making in the apple chain. With the model strategic alternatives can be evaluated on their (positive and negative) effects. The present model calculates the optimal way to distribute the Dutch apples to Germany, i.e. with minimal costs and satisfaction to demands concerning quality, quantity and packaging. Although this model does not completely reflect the complex reality, it shows that such models can give insight in complex situations and in the effects of different strategic alternatives.

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Modelling of the quality of food: optimisation of a cooling chain

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Abstract
The kinetics of food spoilage reactions are important for the optimization of food chains. It is shown that with a limited number of literature or experimental values, insight in the rate of spoilage can be acquired. A procedure to solve a simple optimization problem is given. Some possibilities for expanding modelling techniques into decision support systems are given. Predictive models, kinetic data, expertise, logistics, and simulation and optimization routines can be combined to support decisions in production, distribution and product development.

Introduction: Food Quality

Definition
Food quality can be defined as the sum of the characteristics of a food that determine the satisfaction of the consumer and compliance to legal standards. Food quality is a combination of numerous factors, such as organoleptic properties (e.g., texture, taste, flavour, smell, colour), nutritional value (e.g., caloric content, fatty acid composition), shelf life (e.g., microbial number), and safety conditions (e.g., presence of pathogens, toxins, hormones). Some of these (e.g., microbial numbers) can be relatively easily quantified, while others are very difficult to assess (e.g., taste). To determine total food quality, quality indicators are needed and must be weighted, since their relative importance depends on product, trends, producer, and market.

Significance
Food quality attracts ever more attention. Prediction of the rate of quality loss is important for the following reasons:

The food market is subject to saturation in most cases, therefore, quality becomes more important than quantity. There are new quality attributes which are highly appreciated by the modern consumer. Consumers show an increasing interest in convenience foods with the appearance and taste of fresh products and in food quality aspects such as flavour and (assumed) health aspects. Distribution routes have become longer due to more open borders in the EU, and therefore, there is a need for an increased shelf life. This increased shelf life is also desirable since consumers do less frequent shopping. In some areas there is a rather rapid product development and formulation of products may be different in different countries or regions. Therefore, it would be useful to know the effect of different compositions on the shelf life, to avoid each formulation requiring a laborious shelf-life test.

New procedures are being developed to meet these quality demands, such as new technologies (e.g., microwave heating, ultrahigh temperature (UHT) processes, modified atmosphere packaging, supercooling, irradiation), and new strategies (e.g., logistics and modelling).

Quality loss along a chain

Quality loss can result from microbial, chemical, enzymatic, or physical reactions. Various factors influence quality loss, such as the composition of the product, and the processing and storage conditions (temperature, time, packaging material, gas atmosphere, machinery). From the past there are many dried, salted, frozen, sterilised products, while nowadays chilled and intermediate-moisture foods are becoming more important. Furthermore, there is a trend to use less additives, like preservatives. These trends largely increase possible bacterial deterioration of foods.

Quality is often assessed during production and distribution by taking samples of a product somewhere along the chain. This can give valuable information about long term quality changes and bottlenecks in the line. However, this gives only little information about the combined effect of all process steps in the production and distribution chain on the final quality. Therefore, it is important to get insight in the kinetics of spoilage in each step in the process.

Modelling can be a useful tool to get insights into the importance of factors in any part of the production and distribution chain, and is based on quantitative predictions of the rate of spoilage. Such modelling allows prediction of the quality or shelf life of products, detection of critical points in the production and distribution process, and optimization of production and distribution chains by combining cost models with the spoilage models.

Predictive modelling

Significance

Predictive modelling is a promising methodology in food research, to be used to optimize food chains. Models are used to describe deterioration under different physical or chemical conditions such as temperature, pH, and water activity (a_w). After the deterioration reactions have been modelled the models must be validated with quantitative data. The model parameters can then be estimated.

Firstly, sometimes deterioration reactions can be excluded. For example the micro-organism *Escherichia coli* can grow between pH 4.4 and 9.0. If the pH of a food product is 4.0, growth of *Escherichia coli* can be excluded. If the physical and chemical conditions of the product allow a specific deterioration reaction, an estimate can be made of the kinetics of the reaction. If the pH of a product is 4.6, *Escherichia coli* can grow in that product, but not very fast (and slower than at pH=5). This is all (important) qualitative reasoning.

To predict the kinetics of the various deterioration processes more quantitatively, models describing the effects of different conditions are essential. Several models are known

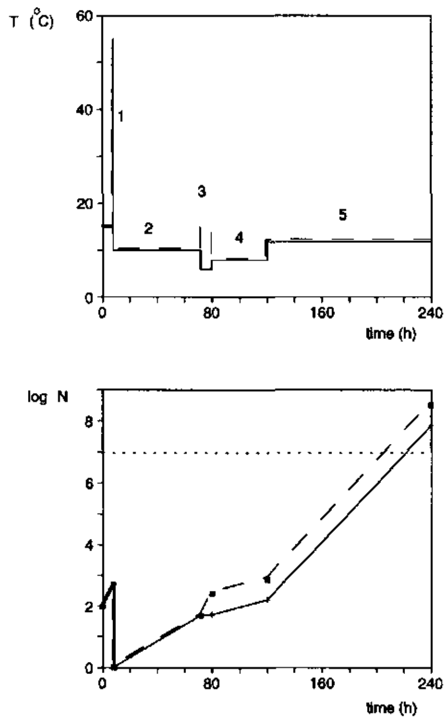

Figure 1. Temperature history (example) and calculated development of the number of organisms (N) with different temperature conditions during distribution (1= production and pasteurising; 2=storage; 3=distribution (chilled and unchilled); 4=retail; 5=consumer storage). Solid line: chilled transport; dashed line: unchilled transport; dotted line: spoilage level.

to predict deterioration reactions. Examples are given by Ratkowsky et al. (1983) and Zwietering et al. (1991) to describe the effect of temperature on microbial growth. The resulting quantitative estimation can be used to predict the shelf life.

With a model for the effect of temperature on bacterial growth, microbial spoilage in a product can be predicted if the temperature in a production and distribution chain is known (*Figure 1*). Moreover, an estimate can be made of the effect of changes in the process, for example of unchilled transport. The difference in product quality, and the difference in the shelf life can be calculated easily (*Figure 1*). Furthermore, it can be seen easily that quality is mainly lost in this case during storage by the consumer. This insight into kinetics is a great advantage of the modelling procedure compared to fragmentary sampling for quality control.

Types of models

In order to build and/or validate models, large amounts of experimental data must be gathered. In *Figure 2* an example shows how a model can be derived for the effect of tem-

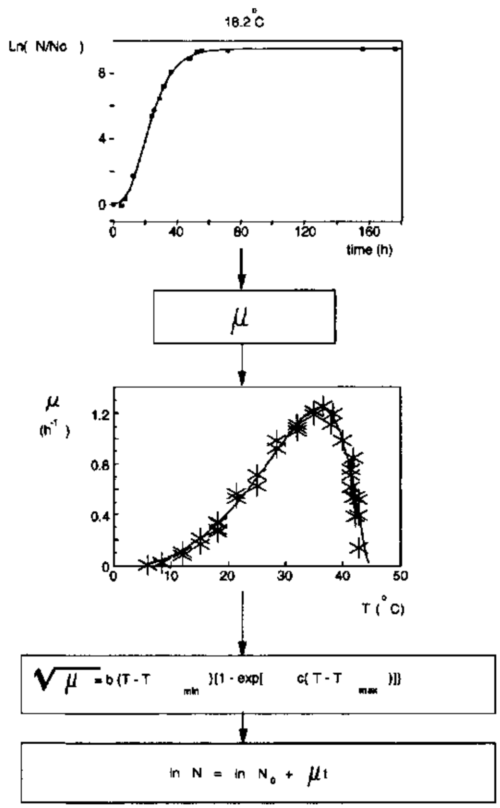

Figure 2. Pathway of model building for bacterial growth as function of temperature (N=number of organinisms; μ=growth rate; b,c,T_{min},T_{max} are Ratkowsky parameters).

perature on microbial growth. First a number of growth curves has to be measured at different temperatures. Then these growth data are analyzed using a growth model. In doing so, the values of the kinetic parameters (e.g., the growth rate (μ)) are estimated. Then these parameters of the growth curves at different temperatures can be used to select a model that describes the effect of temperature on these parameters. In *Figure 2* the Ratkowsky model (1983) is given as an example. This model then can be used to predict growth rates at any temperature, and graphs such as Figure 1 can be calculated. The same procedure can also be used for other variables like pH and a_w. In this way a total model can be developed for microbial spoilage.

Use of models (an example)

If we are interested in the deterioration of chicken, we have to determine the main spoilage reaction. Chicken is mainly spoiled by *Pseudomonas*, therefore the growth rate (μ) of these bacteria is of importance. If the product should remain unchanged, i.e. pH, water content, antimicrobial agents etc. are fixed, the temperature is the variable left to control the spoilage. The square-root model of Ratkowsky et al. (1983) can be used to describe the effect of temperature (T) on the growth rate (μ):

$$\sqrt{\mu} = b \cdot (T - T_{min}) \cdot (1 - \exp[c(T - T_{max})]) \qquad (1)$$

Since the product will be stored at low temperatures, the second part of the equation can be neglected, resulting in (Ratkowsky et al. 1982):

$$\sqrt{\mu} = b \cdot (T - T_{min}) \qquad (2)$$

Now the growth rate of *Pseudomonas* at various temperatures has to be determined, and the parameters T_{min} (minimum temperature of growth) and b (regression parameter) can be calculated by linear regression. Specific growth rates at different temperatures were taken from literature data and from own data. The square-root of the specific growth rate is plotted versus temperature, and the data are very well described by a straight line (*Figure 3*). This is very promising for the use of predictive models, since these data were from different laboratories, with different strains, on different media, and they all agree very well. The Ratkowsky parameters of this curve are given in Table 1.

Table 1. Ratkowsky parameters of Pseudomonas on chicken.

b ($C^{-1}.h^{-0.5}$)	T_{min} (C)
0.030	-6.0

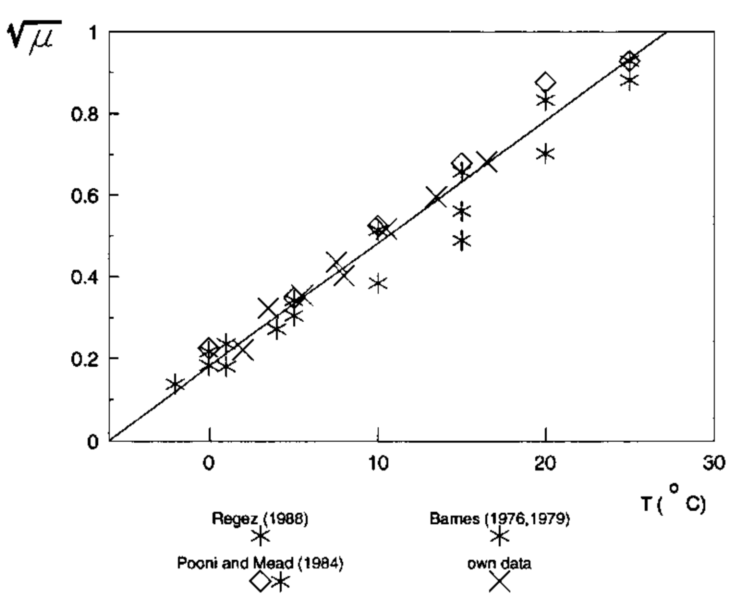

Figure 3. Ratkowsky plot for Pseudomonas on chicken.

For simplicity exponential growth of the micro-organisms is assumed:

$$\ln\left(\frac{N}{N_0}\right)=\mu\cdot t=0.0009\cdot(T+6)^2\cdot t \qquad (3)$$

Equation 3 gives the microbial load (N) at any temperature between 0°C and 25°C, at any time during storage, if the initial spoilage level (N_0) is known. Furthermore, the shelf life () can now be calculated at any temperature, if the maximum allowed spoilage level (N) is known:

$$\Theta=\frac{\ln\left(\frac{N_\Theta}{N_0}\right)}{\mu}=\frac{\ln\left(\frac{N_\Theta}{N_0}\right)}{0.0009\cdot(T+6)^2} \qquad (4)$$

If the spoilage level of chicken is $5\cdot10^7$ and the contamination after production is 10^3 and the temperature during storage is 0°C, the shelf life can be calculated with equation 4 to be 14 days. In the distribution chain it is difficult to retain a temperature of 0°C. If a producer has control over the distribution during the first 5 days and keeps the temperature at 0°C, the number of bacteria can be calculated with equation 3 to be $5\cdot10^4$. If the product is then kept at 4°C (e.g., during retail display) the remaining shelf life can be calculated to be 3 days. So the total shelf life is reduced from 14 days to 8 days and the shelf life during retail display is reduced from 9 days to 3 days. This can also be shown graphically (*Figure 4*). This kind of calculations can be used to show the importance of supercooling to all parties participating in the food chain. With these examples it is shown that with relatively little experimental effort, or even with literature data only, a simple model can be constructed which can be used for (preliminary) shelf life prediction and optimization.

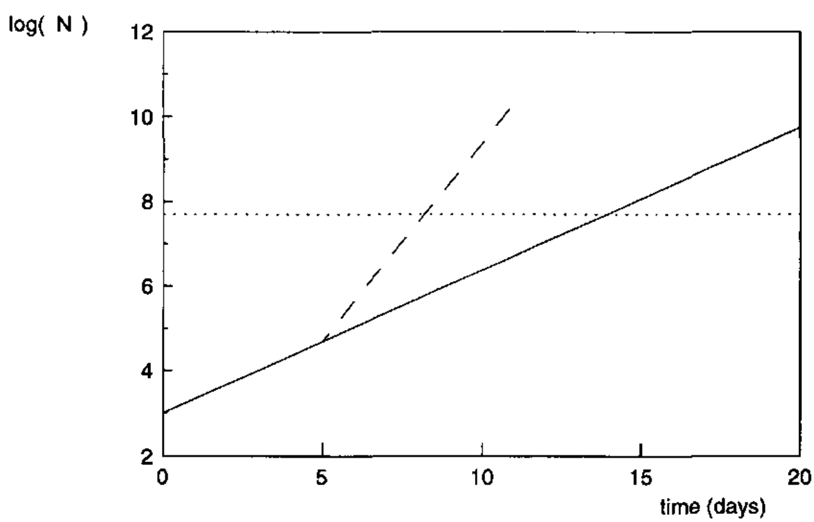

Figure 4. Spoilage of chicken at 0°C, and spoilage of chicken after 5 days at 0°C and the remainder at 4°C. Solid line: 0°C; dashed line: 5 days 0°C, then 4°C; dotted line: spoilage level.

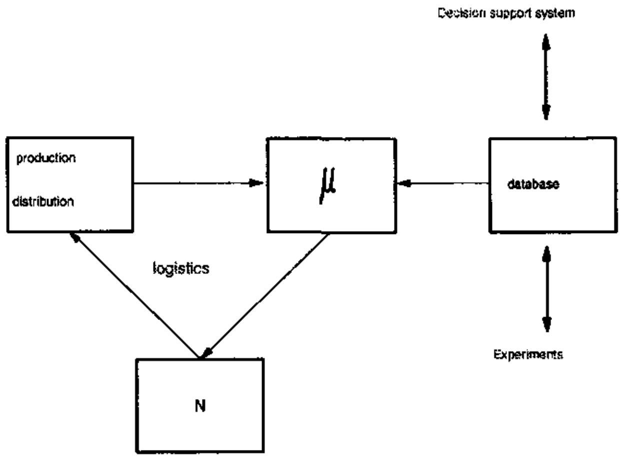

Figure 5. Optimization cycle of bacterial numbers.

Optimization of a cooling chain

From the process variables (e.g., temperature) in food production and distribution, the growth rate (μ) of the organisms can be predicted (see Figure 5). With these growth parameters the number of organisms over time can be predicted, and feedback can follow, resulting eventually in some changes in production or distribution (e.g., the temperature during distribution). This cycle of prediction and feedback can be repeated many times.

It can also be worthwhile to incorporate logistical sojourn times in this procedure, so that not only the effect of changes in physical parameters of the process can be evaluated but also the effect of changes in duration of the different stages. Furthermore, the effect of variation in several variables can be evaluated, such as variations in raw material contamination, storage time in the retail display, temperature, etc. Furthermore, these models can be combined with models for the costs of cooling in various stages, for purposes of investment decisions.

A procedure to minimise the cooling costs, with a certain lower bound for microbial quality as constraint, is developed. As an example a simplified chain is investigated, with three stages. In this chain three temperature variables can be chosen: the temperature at factory storage (T_1), during transportation (T_2) and at retail display (T_3). Several sets of temperature (T_1, T_2, T_3) can fulfil the same constraint (*Figure 6*).

The energy costs as function of the temperature in stage k (k= 1,2,3) can be estimated, taking into account the energy to cool the product (depending on T_k and T_{k-1}) and the energy losses in that phase (depending on T_k). In order to be able to estimate these energy losses numerous parameters are needed, like the dimensions of the cooling unit, thickness of the insulation, dimensions of the door, frequency of opening of the door, etc. The state of the system in stage k can be characterised by S:

$$S_k = \begin{pmatrix} N_k \\ T_k \end{pmatrix} \tag{5}$$

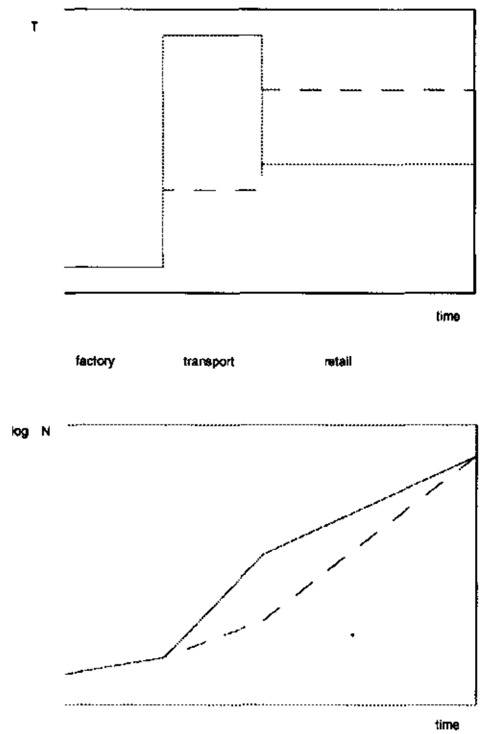

Figure 6. Different combinations of temperature that fulfil the same constraint.

The bacterial growth in phase *k* can be calculated:

$$\ln\left(\frac{N_k}{N_{k-1}}\right) = \mu_k \cdot t_k = b^2 \cdot (T_k - T_{min})^2 \cdot t_k \tag{6}$$

with t_k the sojourn time in phase *k*. Thus the state in phase *k* can be calculated from the former state (*k-1*):

$$S_k = \begin{pmatrix} N_k \\ T_k \end{pmatrix} = \begin{pmatrix} N_{k-1} \cdot \exp[b^2 \cdot (T_k - T_{min})^2 \cdot t_k \\ T_k \end{pmatrix} \tag{7}$$

The costs *G* are depending on both the actual temperature and the temperature in the former phase: $G_k(T_k, S_{k-1})$, due to eventual cooling of the product. This results in a deterministic dynamic programming problem, which can be solved by the recurrent Bellman relation (Hendriks, Van Beek, 1991):

$$V_{k-1}\,(S_{k-1}) = \min_{T_k}\,[G_k(T_k, S_{k-1}) + V_k(S_k)] \tag{8}$$

To solve equation 8 the problem was discretised, in a finite number of temperature levels (0,5, and 10°C). Thereafter, the problem could be solved backwards.

For a cooling chain of milk, representative parameters (dimensions, sojourn times, etc.) were chosen. The optimum temperatures were calculated to be T_1=0°C (t_1=24 h), T_2=0°C (t_2=26.5 h), and T_3=5°C (t_3=50.5 h). The total costs of cooling were fl. $2 \cdot 10^{-3}$ (dutch guilder) per kg of milk. It is shown that within a certain cooling chain the costs of cooling can be estimated in the various phases, which increases insight. Furthermore, the total costs can be minimised. It should be noted that the problem was simplified by taking only three temperature levels. Further fine-tuning is necessary in order to find a more realistic optimum.

In the future this project will focus on validation of these results, and on continuous solution of the problem (non-linear programming). Furthermore, the effect of statistical variations will be determined (stochastic dynamic programming).

Decision Support Systems

As can be expected a large number of parameter values are needed, such as the physical parameters of different foods, and the growth parameters of bacteria as function of the physical parameters. Therefore, a large number of data must be collected. There is an enormous number of different food products and micro-organisms, therefore, for practical purposes it is impossible to have a database with all necessary information. That is why it could be useful to incorporate also knowledge in the database.

A large amount of work is done on the modelling of deterioration of food. Yet, many cases are left without enough quantitative data. In other cases general qualitative knowledge is present, resulting from experience. In conclusion, there is a broad range of information, from qualitative to quantitative. Therefore, methods should be developed to combine quantitative and qualitative data with predictive models. When this is done in a structured manner it can be used to predict product quality in the best possible way. Possible deterioration reactions can be determined and a prediction of the kinetics can be made. Effects of different processing conditions, or product formulation can be evaluated. This can be an important tool for process optimization and product development.

A method has been developed to combine qualitative and quantitative information to predict possible growth of micro-organisms in foods (Zwietering et al. 1992). The pH, water activity, temperature and oxygen availability of foods are coupled to the growth requirements of micro-organisms. A database with characteristics of foods and a database of kinetic parameters of micro-organisms is built. A method is developed to make an estimation of the microbial growth kinetics on the basis of models. This is done by introducing a growth factor, which can be calculated on the basis of readily available data from literature. Finally, qualitative knowledge is added (Figure 7), in order to improve the predictions.

Conclusions

Modelling can be an important tool to predict the shelf life of products, to optimize production and distribution chains, and to gain insight about important variables that determine product deterioration. Predictive models, kinetic data, expertise, logistics, and simulation and optimization routines can be combined to support decisions in production and distribution, and product development. This can help to determine possible spoilage

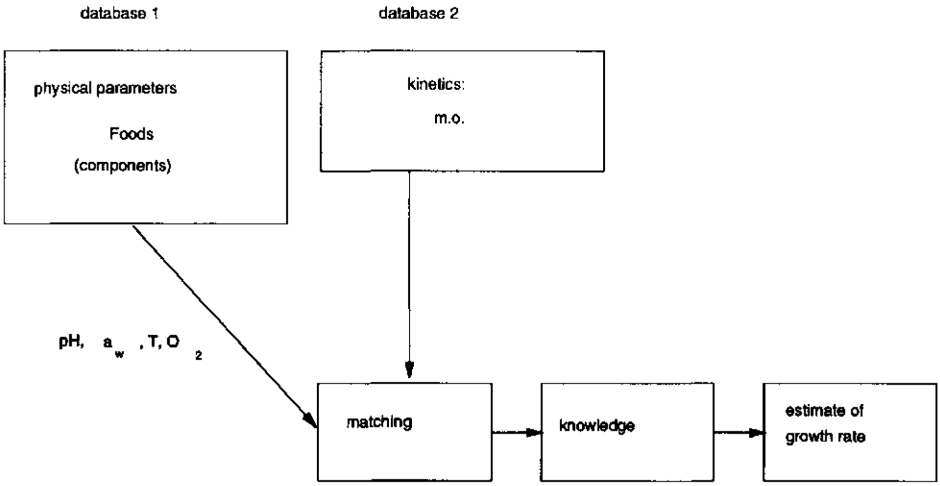

Figure 7. Structure of the decision support system

organisms, and changes in growth rates of organisms can be estimated, when the physical properties are changed.

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Privatization of the Russian agri-food chain: management contraints, underinvestment and declining food security

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Key words: bilateral monopoly, Commonwealth of Independent States (CIS), Nash equilibrium, opportunism, quantity restriction coefficient, Russia, transactions costs, vertical coordination

Introduction

The transition from the command system to a market system has been particularly difficult for Russia and the other countries of the Commonwealth of Independent States (CIS). The difficulties associated with liberalizing these economies have been compounded by inflationary increases in the money supply (Wanniski, 1992). Both rising prices and reductions in the reliability of supply are generally observed. When this deterioration is manifest in sectors where a consistent and reasonably priced flow of commodities to consumers is considered essential, such as food or energy, governments may feel pressured to slow down the pace of liberalization or to re-impose elements of the command system.

This paper provides a formal model of a link in the Russian agri-food chain. The results of the model seriously temper the optimism associated with market-based reform. The problem lies in the institutional structure inherited from the command system which has dictated the creation of bilateral monopolies as the mechanism for vertical coordination in the food production and distribution system. The model is important because it suggests that, even in the absence of monetary inflation, automatic efficiency gains in the Russian food supply system should not be expected. Major investments in transaction cost-reducing market institutions will be required as a co-requisite to the deregulation of prices and privatization if an efficient system which can provide a basic level of food security for consumers is to evolve.

Vertical Coordination and Transaction Costs

One can visualize the processing and distribution systems of command economies as a series of independent 'chains' which moved agricultural commodities from farms, through the various stages of processing, terminating in local distribution monopolies supplying consumers (Considine and Kerr, 1993). In the former Soviet Union, with its great distances and where there are large concentrations of consumers in areas which are geographically separated from food producing regions, these chains were often both long and complex. While inefficient, the command distribution system did function at a sufficient level of vertical coordination to provide a reasonable degree of food security for most consumers.

Neoclassical economists tend to think of markets in the abstract. Markets, and other means of facilitating vertical coordination in production and distribution systems, are real institutions with associated costs of operation. Hence, markets must be examined explicitly when the liberalization of command systems is contemplated. To deal directly with the question of vertical coordination it is necessary to think of firms as well as markets, contracts, joint ventures, etc., as problems of 'governance' rather than 'ownership.' That is, different costs arise under alternative methods of governing or organizing economic activity. This approach has its roots in Ronald Coase's 1937 article on the 'Nature of the Firm' which attempts to answer the question: What determines the size of a firm, where size is taken to mean the number of vertical coordination activities internalized within the firm's structure? Conversely, the question is: At what stage will markets – or some other mechanism – replace within-firm managerial orders as the means of moving products through the production and distribution system?

When considered within this framework, vertical coordination based on command and central planning represented a totally integrated system in which markets played no part. Vertical coordination was accomplished through two levels of managerial orders. Plant managers coordinated the movement of food commodities within administrative units which we will call 'command' firms while bureaucrats in the planning authority coordinated movement between command firms. Command firms were tied to both their suppliers and buyers (Pryor, 1991). Therefore, they were not allowed to seek out alternative suppliers in cases where their designated suppliers failed to furnish the correct quantity or quality of inputs. Similarly, they were not allowed to seek alternative customers when surpluses were available or when the designated downstream command firm could not utilize the quantity stipulated by the planners.

In a fully developed market economy, the structure of the production and distribution systems are determined, ceteris paribus, by the method of vertical coordination which proves to be the most efficient. The combination of governance instruments which minimizes the total of processing, distribution and transaction costs will constitute the most efficient system. Where managerial orders are the most efficient mechanisms for vertical coordination, firms will be the form of governance; i.e., transactions will be coordinated within a firm. Where markets prove more efficient, firm-to-firm transactions will take place.

Fledgling markets can, in some circumstances, provide the vertical coordination mechanisms between ex-command firms. Markets, however, require both a means of information exchange and a sufficient number of buyers and sellers to provide the competitive pressure to ensure efficient volumes of exchange and low transaction costs. In the short run, neither of these is likely to be manifest in the former command economies. First, the number of ex-command firms operating in any market is likely to be small because the command system stressed large production units and geographic monopolies for distribution.

Second, information costs are likely to be high in the former command economies. Part of the reason lies in the absence of much of the technology which is taken for granted in modern market economies, but the primary problem is the absence of market institutions. One of the major reasons why information costs are so low in the agribusiness sectors of market economies is the revolution in electronic technology, including some very standard features such as the telephone. On a daily basis, price discovery is often accomplished through price quotes between buyers and sellers gathered by telephone. For many agricultural commodities, this has removed the necessity of physical market places which brought buyers and sellers together to gather market intelligence and consummate exchanges. For special orders, listings of suppliers can be purchased commercially or are publicly available through the yellow pages. However, even Moscow does not have a telephone directory. In a command economy, organized as a number of independent processing/distribution chains with sellers tied directly to buyers, there was no need for even these simple means of reducing information costs. Of course, western agribusiness has come to rely on much more sophisticated electronic technology for the inexpensive provision of information. The problem of information costs is particularly acute in Russia where suppliers of agricultural commodities are widely dispersed and often separated from final consumers by great distances. The evolution of a functioning, not to mention efficient, system for the exchange of market information is likely to be a long and arduous process.

To expect an efficient market system to arise instantaneously and spontaneously is to court disaster, since the requisite large number of firms and mechanisms to exchange information are absent. Unlike agribusiness in the West, in the CIS there will be no luxury of a slow laissez-faire evolution. For the immediate future, exchange will, for the most part, be conducted in the absence of the competitive forces which markets provide. In areas where food production and concentrations of consumers are geographically contiguous, physical markets are developing to facilitate direct exchange of primary foodstuffs between farmers and consumers. When processing is required, however, or distances are considerable, privatized ex-command firms will be faced with undertaking exchanges via bilateral contracts. Initially, this is likely to be with other privatized ex-command firms to which they were tied in the vertical coordination mechanism of the previous command structure. In essence, every privatized ex-command firm will be placed in a bilateral monopoly bargaining position with both its suppliers and purchasers. According to Gady and Peyton (1992: 1180), in the CIS and Eastern Europe:

> Many of the large state monopolies still exist. Consequently, there is little competition to bring about many of the operating efficiencies that need to occur. Furthermore, many of the existing monopolies have been able to raise prices to punitive

levels because of lack of competition, making life difficult for businesses having to buy or sell to these monopolies.

The interactions between ex-command firms in bilateral monopoly situations need to be better understood. Cooperative game theory suggests that firms in bilateral monopoly situations may develop efficient contracts where the surplus is split between firms in accordance with their bargaining position (e.g., threat points). Ex post bargaining will not generate efficient volumes of exchange when information is asymmetric (Myerson and Satterthwaite, 1983) or when specific investments are involved but, even in such situations, efficiency can typically be restored via an appropriate, possibly complex, ex ante contract (Tirole, 1988: 21-29). For the CIS the prognosis of efficient contracts, however, is overly optimistic. In the absence of an efficient and effective legal system to enforce such contracts, there are likely to be many examples of opportunism where firms strategically renege on contracts (Williamson, 1975) (Klein et al., 1978). In Russia and the other countries of the CIS, where mechanisms to enforce contracts have not yet developed, it seems highly unlikely that efficient levels of inter-firm trade will be the norm in bilateral transactions. In the model of a non-cooperative bilateral monopoly which is developed in the following section of this paper, efficient volumes of exchange do not arise even when problems of asymmetric information and specific investments are absent.

Quantity Restriction Coefficients as Instruments of Market Power

For simplicity, we examine the extreme bilateral-monopoly situation where a single seller (or monopolist) confronts a single buyer (or monopsonist). In order to focus the strategic interaction of the buyer and seller on the single market in which they transact, we temporarily assume that the buyer and the seller behave competitively on all other markets. Let C(q) be the seller's cost function and let R(q) be the buyer's revenue function, where q denotes the quantity transacted between the seller and the buyer. It will be assumed that the underlying technologies limit the quantity transacted to non-negative values. Suppose that the marginal cost function for the seller's output, C'(q), and the marginal revenue function for the buyer's input, R'(q), intersect at the unique, strictly positive quantity, q*, which is shown in *Figure 1*. Such a volume of exchange would be an equilibrium if the firms were able to commit themselves to an efficient contract or if they were to behave competitively. In order to avoid unnecessary complications, we will concentrate our discussion on the situation where the seller's marginal cost function is positively sloped and the buyer's marginal revenue function is negatively sloped (i.e., $C'' > 0$ and $R'' < 0$ for all q).

Allowing the possibility of non-cooperative behaviour in a bilateral monopoly situation where a single seller confronts a single buyer poses an interesting game-theoretic problem. On the one hand, there are clearly difficulties associated with having the two non-cooperative agents try to simultaneously choose the one price or the one quantity that will prevail on the market. Thus, it is necessary to have independent instruments for the buyer and seller. On the other hand, arbitrary asymmetries between the buyer and the seller are also a problem. Suppose that one agent, say the seller, chooses the price while the other agent, say the buyer, chooses the quantity on the market in question (see Spengler, 1950 and Tirole, 1988: 174-177). In this case, the assumed asymmetry in instruments immediately causes market power to be concentrated exclusively in the hands of the price-setting

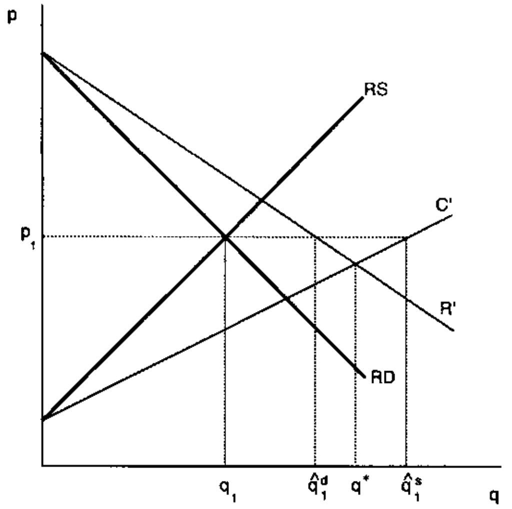

Figure 1. Demand and supply with quantity restriction

agent. In order to avoid this arbitrariness, the instruments of market power which the buyer and seller wield should be symmetric as well as independent. The quantity restriction coefficients of the buyer and seller to be defined below are both independent and symmetric instruments of market power.

The exercise of market power will ultimately involve both the buyer and the seller reducing quantity below an efficient level in order to manipulate price.

(1) $q^s = (1-a)\,\hat{q}^s$ where: $p = C'(\hat{q}^s)$

(2) $q^d = (1-b)\,\hat{q}^d$ where: $p = R'(\hat{q}^d)$

Here, q^s and q^d are the actual output of the seller and the actual input of the buyer, $\hat{q}^s$ and $\hat{q}^d$ are the corresponding efficient quantities which are determined where price is equal to marginal valuation, and 'a' and 'b' are quantity restriction coefficients. The actual quantity for either firm implicitly depends upon the price as well as its own quantity restriction coefficient.

(3) $q^s = S(p,a)$ $S_p = (1-a)\,/\,C'' > 0,\ S_a = -\hat{q}^s < 0$

(4) $q^d = D(p,b)$ $D_p = (1-b)\,/\,R'' > 0,\ D_d = -\hat{q}^s < 0$

As Figure 1 shows, the seller's restricted supply function (RS) is positively sloped and the buyer's restricted demand function (RD) is negatively sloped. The larger is the seller's (buyer's) quantity restriction coefficient, the larger is the proportional inward shift of its restricted supply (demand) function relative to its marginal cost (revenue) function.

The demand and supply functions can be solved simultaneously in order to determine a mutually consistent quantity and price contingent on the two quantity restriction coefficients.

$$(5)\quad q = Q(a,b) \qquad Q_a = -S_a D_p \setminus \Delta < 0,\ Q_b = -D_b S_p \setminus \Delta < 0$$

$$(6)\quad p = P(a,b) \qquad P_a = -DS_b \setminus \Delta < 0,\ P_d = S_b \setminus \Delta > 0$$

Here, $\Delta \equiv S_p - D_p > 0$. In Figure 1, the mutually consistent quantity and price are q_1 and p_1 respectively. An increase in the seller's quantity restriction coefficient results in a reduction in the mutually consistent quantity and an increase in price, while an increase in the buyer's coefficient causes a reduction in both quantity and price.

Strategic Behaviour and Nash Equilibria

Since equations (5) and (6) dictate that a mutually consistent transaction will generate P(a,b) Q(a,b) in revenue for the seller and costs for the buyer, the profits of the seller and buyer are as follows.

$$(7)\quad F(a,b) = P(a,b)Q(a,b) - C(Q(a,b))$$

$$(8)\quad G(a,b) = R(Q(a,b)) - P(a,b)Q(a,b)$$

Each firm maximizes its profits by choosing its own quantity restriction coefficient contingent on the coefficient of its opponent. In so doing, each firm must strike the optimum balance between harmful direct effect of quantity restriction and the beneficial indirect effect on price.

An optimum for the seller is illustrated in *Figure 2*. For simplicity, the buyer's restricted demand and marginal revenue curves coincide because the buyer's demand restriction coefficient is assumed to be equal to zero. The first-order condition for the seller requires that the marginal revenue from the restricted sale of its product, RMR_s, be equal to the marginal cost of its product, C'. Similarly, for the buyer, the marginal revenue from the restricted purchase of its input must be equal to the marginal input cost.

$$(9)\quad F_a(a,b) = [P(a,b) + \frac{Q(a,b)}{D_p(P(a,b),b)} - C'(Q(a,b))]\, Q_a(a,b) = 0$$

$$(10)\quad G_b(a,b) = [R'(Q(a,b)) - P(a,b) - \frac{Q(a,b)}{S_p(P(a,b),a)}]\, Q_b(a,b) = 0$$

In Figure 2, the seller's optimal quantity restriction coefficient, $a_0 = (\hat{q}^s_0 - q^s_0)/q^s_0$, pivots the restricted supply curve inward to RS_0 from the marginal cost curve, C'.

The first-order conditions given by (9) and (10) are reaction functions in implicit form. In *Figure 3*, the reaction function of the seller is AA and that of the buyer is BB. If only the seller were to exercise market power, it would set its quantity reduction coefficient equal to a_0. Likewise, if only the buyer were to exercise market power, its wedge would be equal to b_0. If either firm were to set its quantity restriction coefficient equal to one

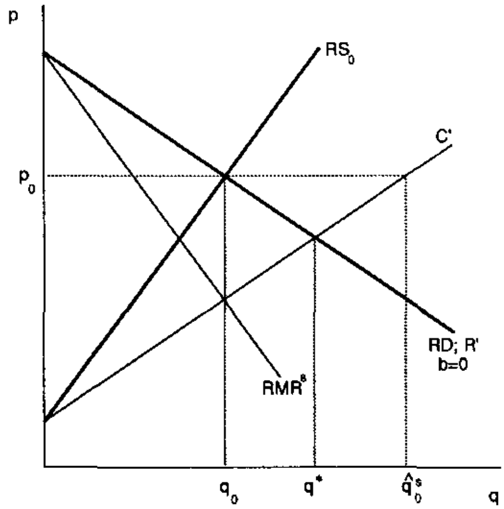

Figure 2. Optimal supply restriction (with b=0)

(100%), all transactions would be eliminated. Thus, all points from $b_z = 1$ to Z to $a_z = 1$ in Figure 3 lead to a volume of transactions that is equal to zero. The efficient volume of exchange arises at point E in Figure 3 where neither country restricts output (i.e., where a = b = 0).

A Nash equilibrium in quantity restriction coefficients requires that each firm sets its coefficient optimally conditional on the coefficient of its opponent. For the moment, assume that both firms cover their variable costs at position N in Figure 3 where the reac-

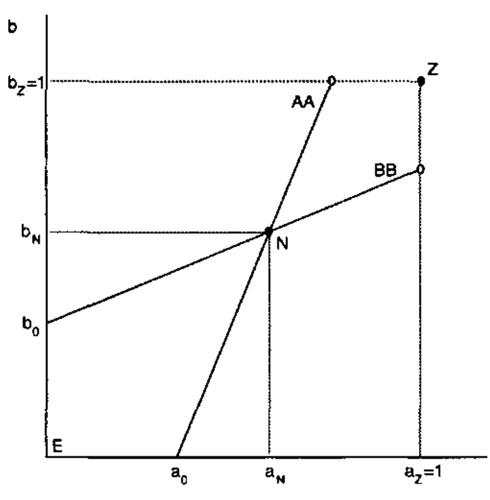

Figure 3. Nash equilibria in quantity restriction coefficients

tion functions of the seller and buyer intersect. In this case, position N is a Nash equilibrium. At such a Nash equilibrium, both firms exercise market power by setting positive quantity restriction coefficients. Consequently, the volume exchanged by a non-cooperative bilateral monopoly is strictly less than that which would prevail under perfect competition or an efficient contract. Nevertheless the quantity transacted at position N is positive because it would never be optimal for one firm to set its coefficient high enough to cut off firm-to-firm trade if its opponent had not already set a prohibitive coefficient.

The reaction functions of the buyer and seller are typically positively sloped as shown in Figure 3. For example, consider the seller's optimum response to the situation where the buyer has increased its quantity restriction coefficient and driven the price down. In order to reduce the extent of this adverse price movement, the seller's optimum quantity restriction coefficient rises, but it rises to a smaller extent than the initial increase in the buyer's coefficient. With the typical configuration of quantity restriction coefficients, shown in Figure 3, the quantity restriction coefficients are strategic complements and position N is a stable Nash equilibrium (see Bulow et al., 1985). Further, the total reduction in the quantity transacted at N is in excess of that which would prevail if only one firm exercised market power while the other behaved competitively.

It is important to observe that there is another less benign Nash equilibrium at position Z in Figure 3. Here the quantity restriction coefficients of the two firms are independently prohibitive and no exchange takes place. Neither agent regrets its own prohibitive coefficient given that its opponent has a prohibitive coefficient. If both firms cover their variable costs at position N where there is a positive, albeit inefficient, quantity transacted, it is reasonable to expect that the players would focus on that equilibrium. Nevertheless, if one of the firms is unable to cover its variable costs at position N, this intersection point would not be an equilibrium because such a firm would prefer to play a prohibitive quantity restriction coefficient and shut down, at least for the period in question. Thus, it is important to emphasize that there are situations in which the only Nash equilibrium involves no exchange.

To this point we have ruled out chains of bilateral monopolies by heroically assuming that the buyer and the seller act competitively on all other markets. Such chains, however, are important in the liberalizing command economies. It is well known that chains of product-market monopolies can give rise to a multiple-margin phenomenon as each firm exhibits a positive price-cost margin on its output market (Spengler, 1950) (Tirole, 1988: 144-177). The introduction of chains of bilateral monopolies into the current analysis would add to the severity of this multiple-margin problem because each firm would typically have a positive wedge between price and marginal revenue on its input market as well as its output market.

Conclusion

Unlike collusive oligopoly situations, cooperation among firms serves a society's interest at least in the case of pure bilateral monopoly. Nevertheless, the model presented in this paper indicates that such cooperation need not automatically arise even in the simplest bilateral monopoly situations where information is symmetric and there are no specific investments. As in other economic "games," cooperation is more likely to be sustained in situations where the game is repeated at a low discount rate and/or where there is a legal apparatus to enforce contracts at a relatively low cost. Of course, both of these conditions are typically present in advanced market economies. In Russia and the other CIS countries, however, economic relationships are in a state of flux and there is no history of contract law. Consequently, cooperative solutions to bilateral monopoly situations are, at best, highly problematic.

Since bilateral monopoly situations are an endemic transitional feature in the liberalizing former command economies, it is highly unrealistic to expect the nascent market systems to generate major efficiency gains overnight. While there will often be a Nash equilibrium that involves a positive, albeit inefficiently low, volume of transactions, there is always a Nash equilibrium that involves the cessation of exchange. Moreover, the constriction of distribution channels reduces the impetus for investment and growth by reducing the return to capital. This under-investment aspect of the bilateral monopoly problem attenuates the difficulties caused by obsolete capital equipment and makes foreign investors more wary. Meanwhile, for consumers at the end of a distribution chain, with no obvious alternative sources of supply, even short-term localized supply disruption could be catastrophic.

One can easily imagine the predicament of a local food distributor in the Siberian oil fields far from any local sources of supply whose upstream supplier fails to fulfil a contracted order. The actual disruption in supply may have been many stages back up his supply tube. In a modern market system this predicament would probably be solved by a few simple phone calls to locate alternative suppliers, to make a deal, to organize transport and to arrange payment. The Siberian distributor may well have a telephone but will have no means of locating a supplier in European Russia; directories simply don't exist even if the geographic location of potential suppliers is known. If it happened that a deal were struck, it would be extremely difficult to locate or arrange transport given the virtual absence of an independent trucking industry. Even if trucking could also be arranged, the banking system is not likely to be able to arrange payment for a distant supplier. If it were possible to arrange for payment, the buyer would have no legal protection if the seller failed to honour the deal. Hence, even if the local Siberian distributor were willing to attempt to organize alternative sources of supply, he may not be able to do so. Consumers have no assurance that the market system will provide a reasonable level of food security. Even in the fortuitous case where such short-run disruptions do not occur, the quantities that are available will be restricted and final prices to consumers will be high.

While the effects of having created bilateral monopolies have been somewhat obscured by the problems associated with uncontrolled monetary growth, they may be becoming more transparent (Sominskii, 1992). Indeed, the impairment of the production and distribution system because of bilateral-monopoly problems appears to have exacerbated the already rampant price inflation. In early January 1993 the Russian government reimposed price controls on a range of basic goods including bread, meat and milk. *The Economist* (January 9, 1993: 34) reported that the return to increased state intervention in the food distribution system was motivated by the belief by Russian policy makers:

> that the main source of inflation is not the growth in the money supply but structural factors, like the ability of monopoly companies to jack up prices as if consumers did not matter. If this were true, then administrative controls on monopoly profits (which are great in the food industry) might possibly succeed in reducing inflation.

While this statement may be somewhat extreme, the macroeconomic as well as microeconomic implications of the reductions in the volumes of goods transacted at all stages of production and distribution should be taken very seriously (Nello, 1992).

In contrast with other work that cites market power as an important problem, the analysis of this paper suggests that there is a real danger in a cavalier 'monopoly-busting' policy. It is well-known that ex-command firms in Russia and other former command economies tend to be too large by comparison with much more efficient firms in the same industries in fully developed market economies. Undeniably, in such over-sized firms there are many significant problems with internal governance, incentives for managers and workers, etc., which are beyond the scope of this paper. Nevertheless, if such large units are mechanically subdivided in an arbitrary and hasty manner, new chains of bilateral monopoly relationships could well be created and the bilateral-monopoly inefficiencies discussed in this paper could be seriously compounded. In some sectors, increased rather than decreased vertical integration may even be at least temporarily advantageous.

Two key policy implications arise for both the governments in the CIS and for offshore aid donors and advisors. First, far more attention ought to be paid to the development of the legal apparatus needed to enforce contracts and allow firms to commit to efficient levels of exchange. In a recent article, Bromley (1993) has elaborated on the need to promote the development of the legal system in order to facilitate the operation of markets. Second, the development of business communications infrastructure should be a high priority because the associated reduction in transaction costs will enhance competition via the broadening of markets. While such competition-enhancing policies will themselves promote the gradual break-up of over-sized firms, a gradual and careful implementation of direct anti-trust policies will also be necessary. Without these changes it will be very difficult for the CIS food distribution system to escape from the inherently monopolistic agri-chains bequeathed by the command system and to make the transition to a modern, efficient agribusiness sector.

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Changes in the verical coordination of the transforming agribusiness: the Hungarian case

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Vertical coordination is an especially complicated issue while harmonizing the agricultural supply with regard to quantitative, qualitative and timing aspects. In the majority of market economies the agricultural (market solutions are also combined with the State regulations (in some cases with the self-regulation of the producers' organizations). This coordination was performed in a hiararchyc (etatism) way in the previous Eastern-Central-European systems. This was valid even if the Hungarian agro-food system having the most market elements. However, the transition to the market economy's system is uclear also with regard to vertical coordination. At the same time, it would be of high importance from the point of view of adjustment capabilities of the agribusiness. This paper reviews the contradictory transformation of the coordination mechanisms of the Hungarian agro-food system on the basis of the empirical studies carried out until now.

Introduction

Market-oriented reforms of the late eighties affected the Hungarian agrarian economy in a contradictory way. On the one hand, measures – promising radical changes – were taken with regard the agricultural markets:

- liberalization: price liberalization concerning the producers', the whole-sale and the consumer prices; and liberalization of the foreign trade within certain limits;
- abolition of administrative limits to market entry;
- privatisation: ownership changes in the agricultural production as well as upstream and downstream organizations towards the market system (*Table 1*).

Accordingly, number of market actors was multiplied, their behaviour has undergone remarkable changes, in parallel new commodity turnover channels have appeared.

On the other hand, transformation toward the market economy took place in such a way, in which market and financial institutions, adjusting themselves to the agricultural peculiarities, were missinq. Thus, though several factors, limiting the independent entrepreneurial actions and being in contradiction with the operation of the market, were destructed, those market institutions and market regulation methods were not established, which are characterizing the agrarian sector of the advanced market economies or that in countries with medium level of the market economy.

Table 1 Estimated Breakdown of Stae-owned and Privately owned organisations (based on 1993 ownership relations and 1992 net sales revenues)

Description	State-owned asset (%)	Privately owned assets (1)(%)
Meat and fish processing	54	46
Poultry processing	32	68
Fruit and vegetable proc.	35	65
Vegetable oil production and processing	0	100
Dairy products	64	36
Milling products, fodder processing	63	37
Bakery products	40	60
Sugar production	50	50
Sweet products	5	95
Alcohol and alcoholic drink production	13	87
Beer production (2)	30	70
Tobacco products	6	94
Wine production	30	70

Note:
(1) Together with co-operative ownership
(2) In sugar and beer production part of the company is owned by both the State and private owners

Table 2: Comprehensive Data on the Hungarian Economy

	1988	1989	1990	1991	1992
	Number of business organizations /1000/				
Legal entity	10,7	15,2	29,5	52,8	69,4
Non-legal entity	21,3	17,3	27,6	44,3	60,8
Other	8,3	6,8	6,5	7,9	9,8
Private undertaking	290,6	320,6	393,3	500,0	606,2
Budgetary and non-profit	28,5	31,2	38,3	43,3	49,0
	Volume indices /1988=100/				
GDP	100	101	97	86	82
Industry	100	98	90	74	67
Agriculture	100	99	94	87	75
Investment	100	104	94	83	78
Retail trade turnover	100	99	88	80	75
Foreign trade turnover					
exports	100	100	96	91	92
imports	100	101	96	101	93
Employment	100	99	99	96	86
Consumption of population	100	102	99	93	90
Prices: industrial producer	100	115	141	187	210
agr. procurement	100	119	153	152	167
Consumer	100	117	151	204	251
Registered unemployed /1000/	14	28	80	406	663
Convertible debt /billion USD/					
gross	19,6	20,4	21,3	22,7	21,4
net	14,0	14,9	15,9	14,6	13,1
Dept service	3,3	3,4	4,0	3,7	4,3

As a result of these circumstances and the macroeconomic conditions (*see Table 2)* of the transformation (i.e. simultaneously sharpening equilibrium tensions and strong recession) increasing market distrubances have emerged in the agrarian economy:

- solvent demand has decreased (first of all this is valid for the domestic demand; convertible exports' revenues have increased in 1991 and 1992, however, in connection with the sharpening of the financial difficulties of the agrarian sector, often exports with losses occured, possessing price level not covering even the variable costs, indicating the possibility of the necessary drop in the future exports, as it was the case already in 1993);
- market-oriented development has been contradictory (consumer prices are increasing continuously along with the sometimes sharp price competition among the producers; monopolistic behaviour can be observed often despite the expansion of market actors' number and that of marketing channels);
- there are also anarchic trends in the market contacts (unvisible market situations, unfollowable commodity pathes etc.)

Along with the increasing market disturbances, transition has also resulted in brutal income losses for the agricultual producers. In effect, important institutional conditions for the agricultural income realization were missing, and, these shortages were not identified neither by the agricultural policy, being involved in ownership settlement based on ideological bases, nor by the agricultural interest representing organizations struggling with legitimacy confusion.

Thus, also with regard to the above conditions the present, deepening crisis of the Hungarian agriculture – basis of which is manifested in a latent, structural crisis, having been started one or one and half decade ago, and, stemming from the rapid, but not market-based agricultural modernization as well as from the polarized farm structure – has been fundamentally an institutional crisis (*see Fig. 1*):

- market transparency is missing because of the lack of market institutions; monopolistic positions have been maintained or they have been privatized; bargaining power of the agriculture is disadvantageous;
- basic institutions of the agrarian economy were questioned without entering of workable forms in their place.

Hungarian government – feeling the tensions and the increasing non- satisfaction of those concerned – promised to establish an agricultural market regime (AMR) for the comprehensive regulation of the agricultural market, relying upon a sample provided by the CAP of the EU instead of a complex crisis managing program and related measures.

Of course, transition from the public (State-controlled) methods of the vertical coordination to those usual in the market-driven private economy is a difficult process in Hungary and in the other Eastern-Central European countries. However, transformation towards the agricultural market regulation of the OECD countries is the main developmental line.

Constructions of AMR until now

AMR has an aim to promote the equalisation processes with regard to prices and quantities. The until now not completed institutionalization of AMR has two stages:

Distorted or undeveloped agricultural market institutions
- information gaps
- strongly limited market transparency
- monopolized input-output ties, unfavourable agricultural bargaining power
- non-dynamic export regime, rigid import

Short-term decisions dominate, short-term speculation is characterizing

Fluctuations of food supply and input demand are increasing

Consequence: cyclical or temporary overproduction and shortage

Figure 1. Agricultural market institutional disturbances and their impacts

- attempt to establish a comprehensive market regime, but not regulated in detail (1991-93);
- adoption of the Act of AMR in February of 1993, then the gradual – until now not completed – building up of the new system.

Until recently the system established at the beginning of 1991 has been operating. Agricultural Market Regime Coordinating Commission (AMRCC) was its central element, comprising the representatives of concerned ministries and agricultural interest representing organizations.

Fundamental elements of the original construction:
- price regime: free prices as a main rule; administrative price as "minimum price" (for coarse and soft wheat, coarse corn, slanghter cattle and pig);
- possibility of intervention, however, complete lack of mandatory intervention, being automatic, when the minimum price is reached;
- export and import regime: (licensing system, tariff system, normative export subsidy; possibility of extra export subsidy on the basis of tender or that of export levy).

Basic elements of the 1993 AMR construction:

- regulation with differing intensities ("directly", "indirectly" regulated or "affected" market fractions covering different commodity groups, severe and less severe regimes);
- price regime: free prices; guaranteed price as administrative one – along with quota – in the "directly" regulated market fractions (soft wheat, coarse corn, milk; slanghter cattle and pig since 1994); declaration of target price to orientate the market actors;
- quantitative regulation: quota (limitation prescribed by the State) and self-limitation by the producers;
- intervention system: (mandatory intervention – to the extent of quotas – at the level of quaranteed prices; occasional intervention in the case of market disturbances, i.e. commodity surplus or deficit);
- export and import regime: (licensing system; tariff system; normative or obtainable – on the basis of tender – export subsidy; export or import levy in the case of declaration of "treshold" price or "sluicegate" price);
- system of institutions: (spheres of authority at the ministry; interministry committee for decision preparation; produce councils (*see figure 2)*, bodies uniting the partners of individual commodity markets, having proposing and decision making sphere of authority; a "Jolly Joker" role is intended for them).

No.	Name of the production council	Under organization	Applying for recognition	Statutes published	Officially recognized
1.	Apple	x			
2.	Poultry			x	
3.	Potato	x			
4.	Sugar	x			
5.	Snail		x		
6.	Ornamental plants		x		
7.	Tobacco		x		
8.	Red pepper	x			
9.	Cereals		x		
10.	Mushroom	x			
11.	Herbs		x		
12.	Fruit	x			
13.	Onion		x		
14.	Fishing		x		
15.	Sheep			x	
16.	Canned cucumber		x		
17.	Vegetable oil	x			
18.	Organic	x			
19.	Spirits	x			
20.	Grapes and wine	x			
21.	Milk			x	
22.	Feather			x	
23.	Beef cattle and meat	x			
24.	Seed		x		
25.	Vegetable			x	

Figure 2. The current position of the produce councils

Practice of the actual agricultural market regulation

Balance of the actual operation until now of the system, promising a wide-ranging regulation, is disillusioning. Market disturbances were deepening along with the dynamic market regime rhetoric, being not understandable for the majority of those concerned, and, through which the leaders of the agricultural policy promised the easing the tensions always in the context of the future. Neuralgic points of the actual operation of the system are as follows:

Non-workability of the "mimimum prices"

Minimum prices – sanctioned only legally, though declared without intervention – did not improve, in effect, the realization (sale) security. Some individual market prices (e.g. grain and pig prices in 1991) dropped below the minimum prices several times. In 1991 – after harvesting a record grain crop the declared minimum prices were decreased. In such a way, corn exchange has become workable again (namely, deals at lower price would be legally invalid), however, confidence of the concerned market actors was shocked. At the same time, "minimum prices" were set at such a low level, that they could not affect the market processes. (And, where they possibly could have cause legal difficulties, the great procuring organizations could have avoid the prescriptions through the small mediating organizations.)

Modest advance to a regulation accomodating istelf to logic of the market

A certain shift to the regulation based on the market can be observed in comparison with the practice of the former period. Interventions have been made public. (However, sometimes short time limits and complicated conditions make the active participation not possible for the majority of market actors in individual cases.) In addition, cooperation among the participating – in the AMRCC – parties has changed. Concerned partners (including also the business interest representing organizations) already looked for compromises and consensus instead of representing the former rigid positions.

Unclear market policy goals, inconsistent and contradictory practice

Hecause of the increasing tensions and the need for comprehensive and rapid treatment, the agricultural market regulation strived after the operative removal of daily tensions. However, fundamental agricultural market policy goals were not made clear. Improvizations dominated in the interventions in the lack of conceptional professional strategies for the individual branches of production.

Inverventions and reactions of the concerned market actors reflected high- degree uncertainty. It was also the lack of information, that interventions – in individual cases – increased the market disturbances. (E.g. maintainance of prohibition for grain exports and parallel unsaleable grain stocks or predominating pig market intervention and price fluctuation of unprecedent extent in 1991 etc.)

Limited sources for intervention, incalculable actions

Financial possibilities of Hungarian market regime lag behind those of market regime applied in advanced economies with orders of magnitude. Decisive part of the sources is a sum estimated by the Act of Budget. Since levy system did not operate and it does not operate also nowadays, own revenues of the system de facto are not formed. (Disregard-

Table 3: Agricultural Subsidies (1993-1994)

Titles to Subsidy	1993. approved budget	1994 approved plans
Agricultural export subsidy	25,000	23,000
Agricultural market subsidy	9,000	5,000
Reorganisation programme	4,000	7,500
Agricultural production	0	10,000
Other corporate subsidy	900	1,225
		of which: interest subsidy due to drought: 600, agr. interest subsidy: 100, others: 300, epidimic subsidy: 200, small railway: 25
Agricultural Development Fund	4,000	6,000
Land Based Subsidy (TEFA)	1,500	1,500
Filed and Infrastructural investments	1,000	1,100
		of which determination: 800, new developments: 300
Agricultural structural target programme	1,000	1,000
Forest plantation	450	600
Forest damage climination	100	100
National Forestry Fund Contribution	0	200
Total	45,950	57,225

ing the deposit fees in the case of individual export or import tenders.) Decisive part of the estimated sums is represented by export subsidies (*see Table 3*). Sums available for intervention purposes are greatly lagging behind the requirements of actions necessitated by the actual market tensions.

In effect, intervention outlays were directed to the harmonization of market processes only in a smaller part of cases. Share of interventions, based on income policy considerations, increased. Strong destruction of the agricultural subsidies was at the same time accompanied by structural transformation of subsidies: differently from the internat~onal trends, decisive part of the Hungarian (strongly narrowed) subsidization system, about 70-80 per cent, is represented by market – characteristically export – subsidies. However, this source – only because of its order of magnitude – is not suitable to provide actual income guarantee.

It seems, that some governmental organizations regard the funds of the market regime as a sort of a "house-hold money safe", a disposable source to avoid every tension in the agrarian economy. (E.g. subsidization for use of irrigation water, repayment af gazoline excise tax, easing the damages caused by the draught etc.) That is, a certain part of the estimates, registered as agricultural market sources, was utilized not for the promotion of the market equilibrium. Though the regrouped subsidies probably ease actual tensions, even more moderate sources remain for the treatment of the serious agricultural market tensions.

Not complete and uncertain market informations

This is one of the neuralgic points of the Hungarian AMR. Insufficient informations result in numerous disadvantageous effects. System of statistics is inappropriate to follow the market changes. In such a way, one cannot judge with a sufficient accuracy, whether surplus or deficit do prevail in the individual market fractions. Lack of informations might interpret the contradictory measures, moreover, the disinformations and the manipulations according to the interests of certain market actors. Even the available informations – probably – are not utilized. In such a way, measures are taken primirarily not on the basis of objective signs, but as a result of pressures on behalf of certain participants or external factors (mass media, individual politicians).

Constructional faults of the AMR and question marks around its operationalization
AMR, declared by the Government – after long delay – at the beginning of 1993 in the form of a frame Act, has fundamental construction weaknesses as follows:

- emphasis was put – instead of building the market – on the rules limiting its operation;
- in the Hungarian conditions the guaranteed prices can represent the possible most expensive and least of all the real solution with regard to realization (sale) security;
- quotas (management of which takes place with several difficulties even in the EU possessing consolidated agrarian structure) seem to be unapplicable; ability of produce councils to operate is doubtful, they can become new forms of market substitution and of saving the monopolistic positions;
- information basis – necessary for operation of the system – is missing, thus one can reckon with further inconsistent and professionally not well established measures;
- financial fund necessary for the operation of the system is neither available nowadays, nor in the foreseeable future.

Act of AMR resulted in great (in effect not justified) expectations among those concerned. During the period passed after the adoption of the mentioned Act, creation of the actual operation conditions for the system – in not a surprising way – has not come nearer. Agricultural market rules – representing the basis of the durable orientation – were not declared until the end of 1993. There are more and more doubts with regard to actual viability of guaranteed prices and quotas as well as to representativeness and real ability of produce councils to operate. Ideas on the budget for 1994 do not offer opportunities for wider-range price guarantees possessing real content. Sources being large with order of magnitude would be necessary for these guarantees. Infrastructural and institutional conditions for the system are also missing to a large extent. Thus the contradiction is more and more sharper between the ritual repeat of the market regime phrazeology and the actual agricultural market conditions.

Market regime without operating market?
Agricultural market regulation can be built upon real, operating markets, differentiated system of market institutions in the advanced – and in the less developed – market economies. On the contrary, the Hungarian system, operating in many respects instead of market, tries to simulate the efficient market operation. Because of the deficiency of the market institutions, model based on the self-regulation of the agricultural market could operate only with unacceptable large distrubances and socio-economic costs. Mostly individual (occasional) interventions continue to take place in order to avoid the market disturbances or to treat them.

Lasting uncertainty around the transformation of the agrarian sector increases the problems of the regulation of the changing equilibrium positions (deficits and surpluses), the market fluctuations of great oscillations and of cyclical events emerging in a fostered form. However, if the emphasis is put lastingly upon the market limiting intervention, advantageous effects expected from the establishment of agricultural market (and of an adequate regulation system) could prove illusion definitely. All this can discredit the AMR – regarded still with great expectation – in the eyes of the interested market actors.

At the same time, interventions not justitiable by the market regulation requirements increase the incalculability of the operation of the system.

Numerous interventions do not rely upon adequate market informations. Thus, the interventions rather depend on the pressure performing ability of those interested, than on the actual market situation. Therefore, not adequate timing of the intervention is not surprising. Occasionally, interventions enhanced the market disturbances still further. That is, market regime cannot replace the real, operating market, nor the market building, generating the missing frame conditions for the market.

Basic peculiarities of actual operation of the agricultural markets

In addition to the direct effects of the market regulation, though not independently from them, remarkable contradictions and distortions characterize the whole operation of the Hungarian agricultural markets.

Excessive price fluctuation, non-stable demand and supply

Instead of rigid price system of the former order, we can observe already actual (real) price movements and demand-supply-price equilibrium interrelations. Price differentiations are remarkable in time and regionally.

At the same time, the extent of price differences and price movements (*see Table 4, 5 and 6*) fairly surpasses that in the advanced market economies. (E.g. procurement price of slaughter pig moved between 55 and 110 Hungarian forints (HUF) per kg.) The underlying cause behind this fact is first of all the lack of the market transparency along with the faults of the State agricultural market regulation.

Market transparency is limited by the lack of information as well as that or insufficient operation of market institutions, (wholesale markets, live-stock markets) making possible the efficient discovery of equilibrium prices. This institutional gap leads to allocation disturbances and losses.

Market uncertainties are of great extent. Certain groups having especially strong market influence sometimes perform conscious misleading actions. However, incalculable, sometimes panic-like reactions of some market actors represent the decisive causes of the uncertainties and the related disturbances, along with unstable State agricultural market regulation. For example, demand for inputs (for instance fodder) of the small-scale producers (mostly part-time units), representing the majority of the meat production, and, their output are rather uncertain.

In some regions simultaneously numerous producers – first of all small-scale ones – start for instance to keep pigs, then they give up. Such conditions move the fodder market prices strongly. The result manifests itself in remarkable regional alterations. In the background of this event we can observe, rational business calculation does not represent always the basis for the producers' decisions. In addition, share of non-specialized (i.e. not

Table 4: Procurement Prices

	1988	1989	1990	1991	1992 (HUF/kg)
Wheat	3,93	4,83	6,08	5,50	6,80
soft	3,88	4,77	6,03	5,60	
coarse	3,58	4,25	5,83	5,17	
Barley	4,44	4,86	6,14	5,60	5,90
fodder	3,55	4,17	5,68	5,54	
beer	5,04	5,31	6,73	7,08	
Corn /without hybrid seed/	6,34	7,20	8,63	6,71	7,10
Sunflower	10,01	11,52	15,13	15,08	12,60
Sugar beet	1,06	1,21	1,86	1,82	1,93
Potatoes	8,10	6,50	11,80	12,80	12,40
Apple	6,90	8,80	10,40	13,80	9,90
Wine grape	11,40	14,30	13,80	13,70	11,40
Slaughter cattle	49,10	64,80	75,50	64,10	65,80
Slaughter pig	46,50	54,60	70,50	64,50	80,00
Slaughter sheep	107,20	144,40	172,30	176,60	187,80
Slaughter poultry	40,80	49,90	60,70	70,30	73,50
Milk, liter	8,10	11,00	14,20	14,40	15,60
Eggs, pieces	2,10	2,40	3,00	3,70	4,40
Wool	132,20	130,70	58,10	31,00	

Table 5: Procurement Price Indices of Agricultural Products

	1988	1989	1990	1991	1992
			Previous year = 100		
Crop and horticultural products	100,0	114,2	135,0	96,3	105,1
Live animals and animal products	106,4	122,8	124,4	101,5	112,5
Total	103,6	119,1	128,5	99,1	109,7
Price scissor	104,0	98,9	113,3	141,2	98,5
			1980 = 100		
Crop and horticultural products	137,4	156,9	211,8	204,8	215,2
Live animals and animal products	134,5	165,0	205,3	208,4	234,5
Total	135,8	161,7	207,8	205,9	225,9
Price scissor	110,3	109,1	123,7	174,6	171,8
			1988 = 100		
Crop and horticultural products	100,0	114,2	154,1	149,1	156,6
Live animals and animal products	100,0	122,8	152,6	154,9	174,3
Total	100,0	119,1	153,0	151,6	167,8
Price scissor	110,3	98,9	112,0	158,2	154,4

lastingly devoted) farms is high. Thus, *Hunqarian agricultural market is segregated* in many respects. This fact is *generally neglected* by international experts and investigations.

Growth of the number of the market actors – a welcome change in itself – also enhances the uncertainty. Since the institutions of market-conform coordination are still missing, the numerous market actors sometimes "multiply" the market demand, that can enhance further the market instability and cycles.

Table 6: Market prices

	1988	1989	1990	1991	1992 (HUF/kg)
Coarse wheat	6,30	7,60	9,80	10,60	8,80
Coarse barley	5,70	6,80	8,50	9,60	8,10
Corn	6,60	7,70	10,40	11,60	9,20
Potatoes	12,70	10,40	12,60	20,70	21,50
Apple	16,60	16,80	20,50	29,90	32,20
Wine, liter	35,00	40,00	53,00	42,00	
Young bull	63,30	74,00	89,60	80,10	90,20
Slaughter pig	46,70	61,00	73,74	65,90	88,00
Young sheep	66,00	91,00	98,40	70,00	91,00
Slaughter chicken	61,30	72,20	88,40	99,50	110,00
Eggs, pieces	2,50	2,90	3,30	4,40	7,20

Controversial foreign trade liberalization

Steps towards the export and the imqort liberalization promoted to surpass the artificial separation of the domestic and the foreign trade. Exports and imports – though not without limits – have become real factors of the competiton. Imports stimulated the innovation (for instance in the dairy industry), while the possibilities to export offered to the agricultural producers more favourable realization alternatives, than the domestic one. This option is especially remarkable there, where raw material producer should meet procuring unit having relative or absolute monopolistic position (e.g. in vegetable oil processing industry).

However, or anic linking up of the domestic and external markets does not operate. "Hand-management" continues to prevail in many respects. Producers cannot rely upon longer run export opportunities; these ones depend on decisions made by the responsible inter-ministry committee on the basis of judgement with regard to market situation. However, lack of informations, in some cases manipulated informations, as well as, excessively numerous coordination duties make the activity of this committee difficult. In effect, it has to perform almost ab ovo hopeless task; it is no wonder, its functioning is strongly criticized (e.g. with regard to export licensing or defence against imports).

Import licensing system can be criticized from trade policy aspect. At the same time, market defence system coordinated by the market logic and also satisfying the GATT prescriptions has not operated until recently. Thus, "squeezing out effect" can be clearly observed in the markets of products, being regulated to a lesser extent and saleable, in general, with higher profit content. (Hungarian products are squeezed out by strongly subsidized ones, which are imported almost without an import burdens.(Export possibilities, in trun, are determined – to a remarkable extent – by the decisions of the managing bodies of the market regime and by their judgement of the market situation. (Detailed foreign trade data are shown in *Table 7* and *8*.)

Growth in market actors' number

Existence of numerous, independent from each market actors – in the individual stages of the agri-food chain – is a necessary precondition for the intensive competition. In principle, this always prevailed in the agriculture.

Table 7: Foreign Trade of Food Economy Products

	1988	1989	1990	1991	1992 (billion HUF)
			Imports		
Transforming and non-market economies	7,3	7,7	100,0	9,8	7,9
Market economies	26,4	29,8	31,3	39,8	43,8
Advanced countries	10,7	14,6	15,2	22,9	28,0
Developing countries	15,7	15,2	16,1	16,9	15,8
Total	33,7	37,5	41,3	49,6	51,7
			Exports		
Transforming and non-market economies	49,2	52,3	58,7	69,3	85,0
Market economies	53,2	71,4	80,6	122,5	117,4
Advanced countries	48,2	62,9	75,0	115,2	112,8
Developing countries	5,0	8,5	5,6	7,3	4,6
Total	102,4	123,7	139,3	191,8	202,4

Table 8: Structure of Food Economy Exports to transforming and Non-Market Economies /%/

	1988	1989	1990	1991	1992
Agricultural products	42,9	43,2	30,6	32,9	50,0
Grain	24,1	24,1	15,7	16,2	39,8
Fresh fruit, vegetable	6,6	6,1	5,1	4,6	4,8
Oil seed	2,3	0,8	0,8	1,3	1,1
Raw coffee, coca	-	-	-	0	0
Legumes and other crops	1,8	2,3	2,3	4,9	1,6
Live animal and animal products	8,1	9,9	6,7	5,9	2,7
Food industrial products	57,1	56,8	69,4	67,1	50,0
Milling, baking industrial products, pasta	1,5	1,7	2,0	3,8	6,2
Fruit and vegetable /tinned/	14,5	12,0	10,7	5,5	5,9
Vegetable oil	2,6	2,9	3,9	9,2	9,4
Sugar and sweets products	2,0	4,4	0,6	5,5	6,3
Beverages, tobacco	10,2	11,7	9,4	6,3	10,8
Meat, poultry and dairy products	26,3	24,1	42,8	36,8	11,4
Total	100,0	100,0	100,0	100,0	100,0

Number of entrepreneurships operating in the food processing and distribution increased dramatically due to the liberalization in the economy. Decentralization of some State-owened food industrial companies has played a certain role in this process. There was a more influental factor, i.e. market division by the former trusts and later on by the already independent companies ceased to exist. Thus really independent from each other companies, possessing remarkable business influence have appeared in the market. Numerous, anew established small food processing undertakings played decisive role in the growth. They appeared also in such spheres (e.g. poultry processing), where small firms were almost completely missing formerly. Several small companies were established with the participation of the foreign capital especially in the vegetable and fruit processing.

Market structure has been transformed to the largest extent in the whole-sale and the retail trade. Anew established entrepreneurships – especially in the foreign trade – have become really significant ones (e.g. in the imports of dairy products). Decentralization simultaneously with privatisation improved the locally and regionally fairly well monopolized structure of the retail trade.

However, the – in principle – free choosing the marketing channels is limited by more factors:

- gaps in marketing logistics and infrastructure (e.g. only major companies possess grain and sunflower-storing capacities);
- capitalization (supply with capital) of the individual industry partners differs to a great extent, while a liquidity crisis prevails in the agriculture (therefore agricultural producer burdened by financial difficulties might be forced to sell – at a lower price – to a procuring organization capable to pay quickly);
- ownership or other business interest interweaving might prevail among the formally separated procuring firms (e.g. obtainable share of individual firms has a ceiling in the export and import tenders, therefore dominating large firms established smaller mediating entrepreneurships);
- professional deficiencies (skilled foreign trade experts are concentrated at companies having large capital, while necessary skill sometimes is missing at the smaller firms).

Augmentation of the number of market actors does not necessarily result in a proportional improvement of the market power relations. The latter requires – in addition to other factors – companies able to compete with each other also with regard to infrastructural and financial conditions. If new units (firms) are established exclusively due to the regulation sphere (system of export or import tenders), this leads to confused, distorted power relations, and, entrance of mediators, not required otherwise by the turnover processes, increases the costs and ultimately the prices. All this influences the agricultural producers, having limited market bargaining power, in an especially unfavourable way. Along with augmentation of the number of market actors there was a deepening in the vertical coordination disturbances.

Trends of the business competition

As a result of alterations, more and more definite competition does emerge in many fields. At the same time, certain institutional and infrastructural conditions of the competition are limited for the future, too.

Among the causes of the intensifying competition outstanding role can be attributed to privatisation (market behaviour of companies having foreign business interest and that of private processors and distributors perceptibly differ from the usual "State behavior"), and, threat of bankruptcy – according to our impressions – stimulates the managers of the companies to perform stronger efforts even in the State-owned sector. (Price competition is especially strong among some food industrial companies.)

Seemingly increasing importance of illegal competition-advantages deserves attention. Illegal processing and distribution (marketing) units do not act according to hygienic and environmental protection prescriptions, they do not pay tax, and they are virtually "uncatchable" also for the State market regulation.

Utilization of power differences is a characteristic feature while determining the terms of payment. Powerful (having more capital) processors and distributors can offer even lower purchasing price, because they can perform quick and sure payment. At the same time, number of processes initiated by the Competition Office – because of misuses of power advantage – is relatively few, probably due to the defencelessness of the business partners. Unilateral shifting the risk and unilateral alteration of the procurement prices are characterictic features in the agricultural market contacts, mostly for the disadvantage of the agricultural producers.

Agricultural market institutions first steps in the development

Efficient operation of the agricutural markets requires an adequate institutional background. However, a huge backwardness can be observed in this sphere.

Markets capable to concentrate demand and supply could have an especially great importance. Only one vegetable-fruit whole-sale market operates (in Budapest), but it cannot rely upon a network of regional markets. Regional live-stock markets can develop in such a way as to become whole-sale ones in a longer run, but, for the time being, they deal only with breeding and farm animals.

Grain and meat sections of the commodity exchange develop in a contradictory way: while exchange turnover of the meat is negligible, almost 10 per cent of the total grain production is sold. Price signalling and price influencing role of the grain exchange are very remarkable alread nowadays. As it is usual also in the advanced countries, exchange price is put as a basis for other transactions outside the exchange. In some cooperatives, exchange price of a given quantity grain is put as basis for the rental of the tenancy; this price is the basis also for the prefinancing of production costs; in addition, companies of the milling industry also determine the due procurement price in a given percentage of the exchange price.

More extended use of storehouses probably would be necessary for the efficient operation of the exchange. At the same time, regulation of commodity exchange through legal act and technical improvement of its operation are also indispensable.

Utilization of commodity exchange is relatively rare among the agricultural producers for the time being. Producers, possibly offering commodities, rather regard the exchange to be a physical market, than a basic instrument of risk treatment and price safeguarding, as usual in the advanced countries.

Pricing in the vertical coordination

In the following we discuss the agricultural market organization transformation in general. But we must stress, market organization of the major agricultural sectors is in different transformation stage. Here we indicate – briefly – the dairy sectors position with regard to decreasing consumption trend and pricing issues in connection with the vertical aspects. *(See Table 9 and 10 as well as Figure 3 and 4.)*

Alterations in the distribution channels. Distribution system of the agricultural products have undergone profound changes during the recent years. New distribution channels were established, relative share and importance of former marketing paths have altered. Some stages, mediators were left out of the system, while new stages were built in.

More actors of the previous distribution system were squeezed out, because they have lost their interests or opportunities in the participation. For instance, producers' cooperatives, State farms formerly integrating the small-scale production have lost their interest in maintainance of the mentioned contacts after abolition of the related subsidies. Moreover, they more and more regard the small-scale production as competitor in the conditions of the narrowing demand. Otherwise, their financial difficulties make the integration impossible, first of all from financing and loan-providing points of view.

That is, squeezing out of certain distribution stages (levels) took place in a forced way, as a result of the disintegration of theprevious system(operating – by the way – with re-

Table 9: Per capita Consumption of Dairy Products in Hungary 1989-1991

	1989	1990	1991 (liter, kg)
Milk	10,3	9,6	9,8
Flavoured liquid milk porducts	14,4	8,4	8,0
Sour milk products	2,7	2,7	2,9
Cream, sour cream	8,2	7,1	6,8
Butler	2,7	2,1	1,8
Cheese	4,1	3,5	3,3
Curd /fresh cheese/	4,4	3,8	3,7
Ice cream	0,4	0,4	0,5
Powdered milk products	1,3	1,0	0,8
Evaporated milk	0,4	0,4	0,4
Total Consumption of Dairy Products Expressed in raw milk	190	170	165

Source: Statisztikai évkönyv 1989, 1990 and estimates

Table 10: Share of individual stages in milk consumer price /1987-1991/

	1987	1988	1989	1990	1991 (HUF/liter)
Procurement price	7,46	8,14	11,10	14,05	14,29
Processor's margin	4,31	4,19	2,08	2,86	4,66
Whole-sale margin	0,38	0,54	0,78	1,42	1,81
Retail margin	0,99	1,40	1,59	2,17	2,54
Subsidy for producers and consumers plus cunsumer price	13,14	14,27	15,54	20,50	23,50
Subsidy for producers	2,90	2,90	0,90	0,00	0,00
Subsidy for consumers	2,64	2,17	1,84	2,50	2,50
			per cent		
Producer	56,8	57,0	71,4	68,5	61,3
Processor	32,8	29,4	13,4	14,0	20,0
Whole-saler	2,9	3,8	5,0	6,9	7,8
Retailer	7,5	9,8	10,2	10,6	10,9
Total	100,0	100,0	100,0	100,0	100,0
Subsidy for producers	22,1	20,3	5,6	0,0	0,0
Subsidy for consumers	20,1	15,2	11,8	12,2	10,7

Source: Dairy Industry Association

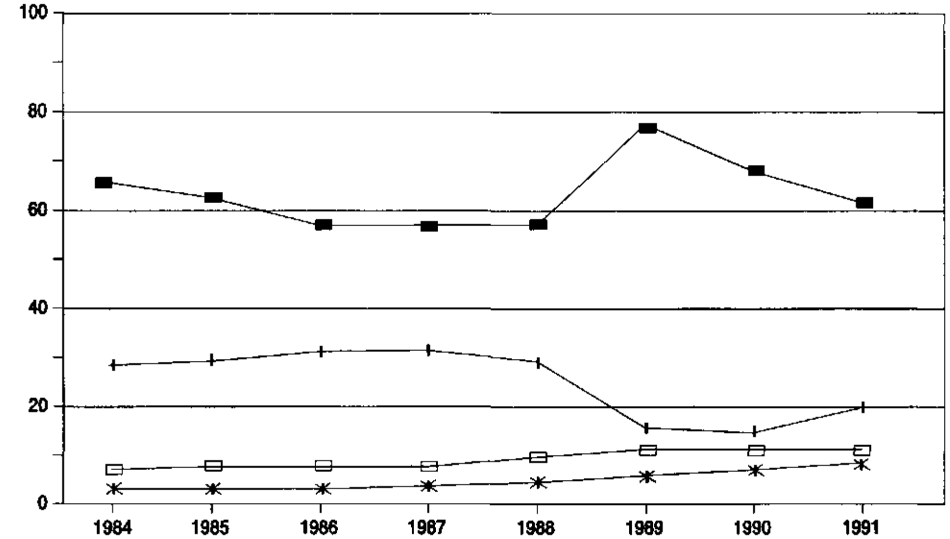

Figure 3. Share of individual stages in the milk consumer price (1984-1991)

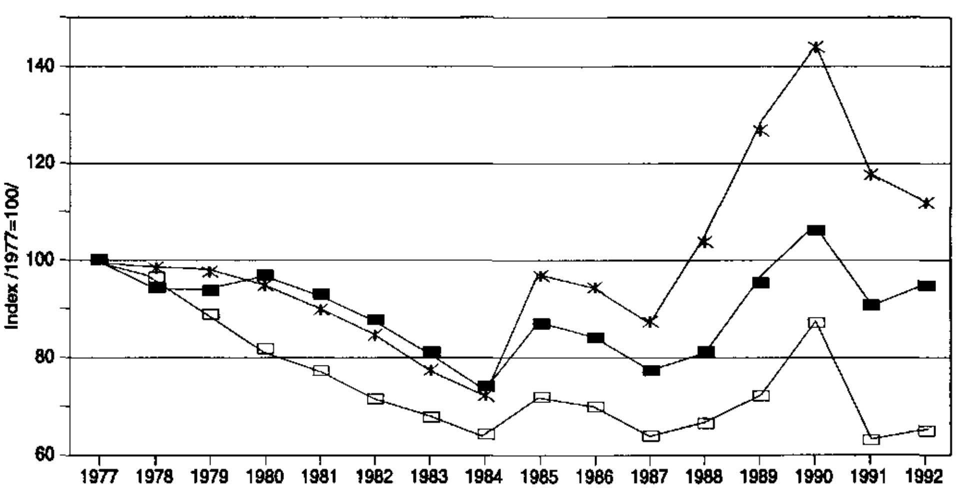

Figure 4. Real consumer prices of milk, cheese and butter (1977-1992)

markable losses). Nevertheless, simultaneous attempts can also be observed, which are directed to rationalization of commodity pathes on the basis of cost efficiency consider-were established, relative share and importance of former marketing paths have altered. Some stages, mediators were left out of the system, while new stages were built in.

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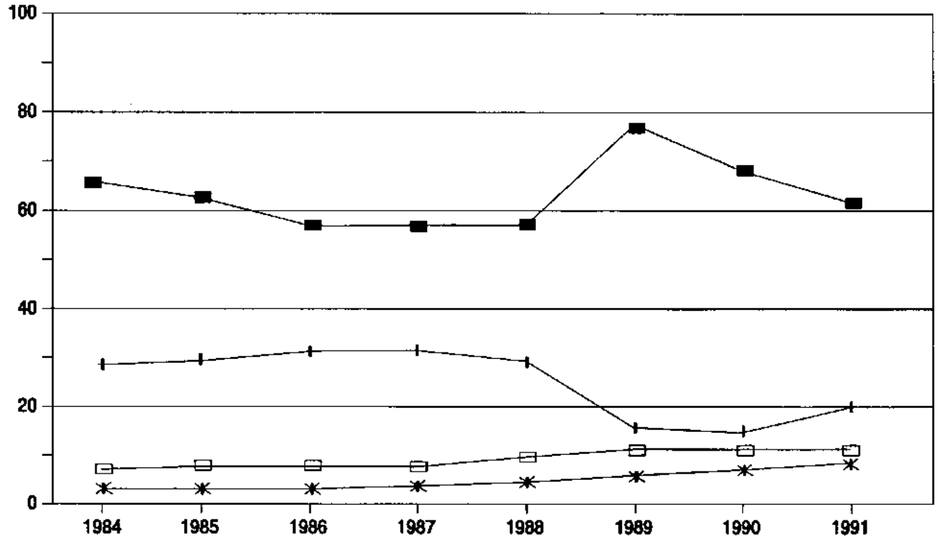

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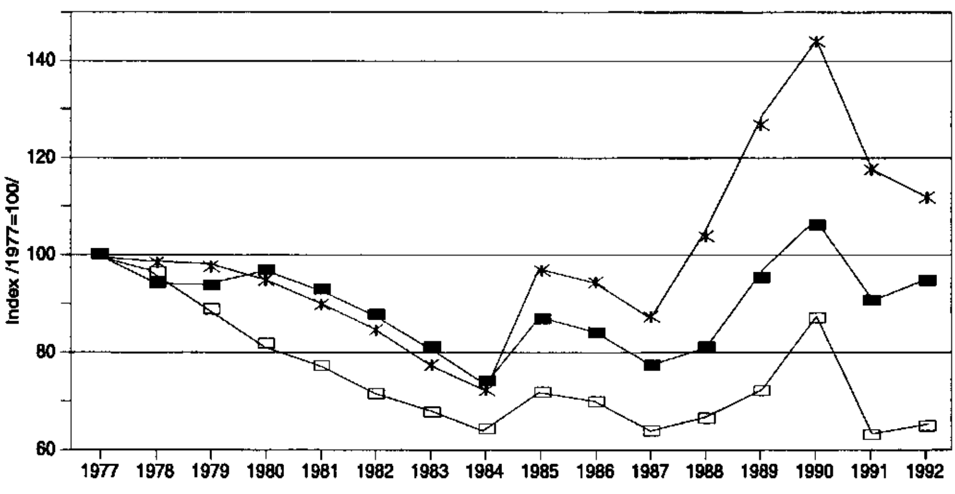

Figure 4. Real consumer prices of milk, cheese and butter (1977-1992)

markable losses). Nevertheless, simultaneous attempts can also be observed, which are directed to rationalization of commodity pathes on the basis of cost efficiency considerations. Most remarkable attempts in the latter case are as follows: diffusion of the direct realization by the producers (e.g. meat, milk); slow shifts (changes) in the whole-sale distribution of the processed foodstuffs.

Neuralgic points. Vertical coordination is especially unfavourably affected by the following factors:

- Gaps in the food whole-sale distribution. Up-to-date distribution systems and modern methods of the logistic management are missing to a large extent.
- Logistic costs are high even in international comparison. (This situation probably will change as a result of appearance of some networks having foreign business partners.)
- Complete disintegration of the previous integration chains. (E.g. breeding material allotment by producers' cooperatives and processing companies; fodder assignment; prefinancing of the agricutural production.)
- Permanent disturbances in the financing due to the undercapitalization of the whole agribusiness and the banking sphere, as well as to the lack of financing institutions and techniques fitting to peculiarities of the agrarian economy.

Administrative coordination versus market anarchy? Previous distribution system, possessing de facto one channel, operated with remarkable efficiency losses, it covered almost completely the commodity turnover processes. At least in principle, there was a possibility of a sort of the vertical coordination in this system. Liberalization and growth of the number of the market actors – regarding these processes on the surface – necessarily led to market uncoordinatedness. "Excessively numerous" market actors multiply the actual market demand, the transmit false signals to the producers unwillingly, and, in such a way, the feed extra instability and cycle into the agricultural production. Of course, the real problem is not the fact, that excessively numerous actors participate in the market. In effect, source of the above mentioned difficulties can be observed in the fact, that liberalization of the agricultural market took place in such a way, that simultaneously the preconditions for the ability of the liberalized market to function were not established (i.e. first of all transparency and institutional guarantees of the agricultural bargaining power).

Unfavourable market position of the agricultural producers

Production of the agricultural raw materials represents a decisive stage within the food economy output (and in the export marketing). However, in effect, market position of agricultural producers has worsened further.

Major factors determining the market position of the producers are as follows:

- Lack of market transparency. Informations necessary for market transparency are missing with regard to trends of demand and supply, transport and storage facilities and their costs, regional structure of demand and supply, as well as to stocks and capacities. Those organized markets are also missing, which otherwise do contain the possibility, that markets tending to equilibrium prices should be formed.
- Unfavourable market bargaining power. Forms, serving the institutional improvement of the agricultural bargaining power, are not established yet, even this was not declared as goal. In the practice, local or national monopolistic or (oligopolistic) organizations have business contacts with the agricultural producers. Processing and distribution interested in the agriculture are missing still. Promotion of this interest

was not given attention in the privatisation processes. At the same time, majority of the agricultural producers still did not realize the importance of the direct realization, and, that they might improve their bargaining position through their better informations.

- Price gap. Procuring and marketing organizations can also effectuate unjustified high price gap in given conditions. This leads to income loss in the production of the agricultural raw materials, while the numerous mediating organizations – in addition to covering their unjustified costs – take away remarkable income from the agriculture.
- Export subsidization system. System of subsidies provided for final products for export benefits the exporter organizations.
- Limited transparency of the State actions. Transparency is a basic requirement also with regard to State measures regulating the market. On the contrary, tenders, containing with difficulties understandable conditions or even unimplementable at all for the most part of the market actors, are characterizing the practice of the AMR until now. Further related features are the gradually available informations (e.g. on intervention decisions, which are received by those "privilegized" offering financial benefit for them), and deadlines unimplementable for the significant majority of the market actors.
- Lack or low level of collective marketing programs and export promotion actions. Subsidies devoted for actions with regard to the creation and the strengthening of conditions of distribution and of image of national food supply are not trade-distorting ones from GATT point of view. Specific outlays can be utilized perhaps just in these areas. However, a system similar to German CMA was not established yet, and, specific subsidization of marketing actions amounts only to a fraction of that in the case of the foreign competitors.

Conclusions

Missing agrarian market institutions have to be diffused during a rather short period. Active role of the State can be hardly avoided in the initial stage of the market institutionalization. It is indispensable to weigh the socio-economic costs of the transformation. Advantageous impacts expected from the market economy will not prevail, if institutional gaps will be maintained. Corner points of the building of the agrarian market are as follows: active market exploration (along with the active state economic diplomacy); building up the market regime; development of market institutions. Examples for the successful market economy transformation from the collectivized agrarian structure are not abundant. However, successful transition is of immense importance. Without it we might reckon with the irreversible decline of the agriculture in the Eastern-Central-European region as well as economic and social tensions, remarkable losses in material and cultural capacities. It seems to be reasonable, that the most advanced countries should regard the development of agrarian market and financing institutions in the countries of this region as a central part in their assistance provided for the agrarian transformation. It would have a multiplication impact and it would represent an efficient short term or longer term help even in the case of restricted resources.

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Structure and Strategy: The seed industry structure and firms strategies

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Introduction

The debate on explaining firms' performance by market structures and market behaviour in the last three decades showed dubious results. Industrial organization theorists, emerging as a branch of micro-economics, indicated relationships between market structure and market performance. However, the Bain paradigm on Structure, Conduct and Performance was could not stand empirical evidence (Scherer, 1980).

The behaviourists suggested that behaviour variables, such as collusion, pricing strategy, product strategy, efforts on R&D or advertising, could explain performance, measured by industry profitability, growth in output, or technological advance, although controversy remained over the interpretation of the findings. Using game theory these scholars claim that maximal performance depends on the communication between the market actors and their intentions.

The pro-active behaviour of firms is not envisaged in this paradigm, while it is easy to suggest that firms in their competition with others affect industry structure and conduct of competitors as well.

The Chicago school economists still question whether the relationship between concentration and profits, for example, demonstrates confirmation of the market power or efficiency-of-larger-firms hypotheses.

Nonetheless, the importance of the industry structure for the explanation of the behaviour of the firm was accepted widely:

In formula:

$$P = Pi + (P - Pi)$$

meaning the profitability of the firm (P) is equal to the profitability of the industry (Pi) to which it belongs plus the difference in profitability between the firm and the industry. The second part emphasizes the competitive advantage of the firm (Douma, 1993). The profitability of the industry depends on the rivalry in the industry, according to Porter (1985). He states that five forces influence the industry rivalry. Using Porter's framework on the forces driving industry competitiveness, a large number of factors are to be dis-

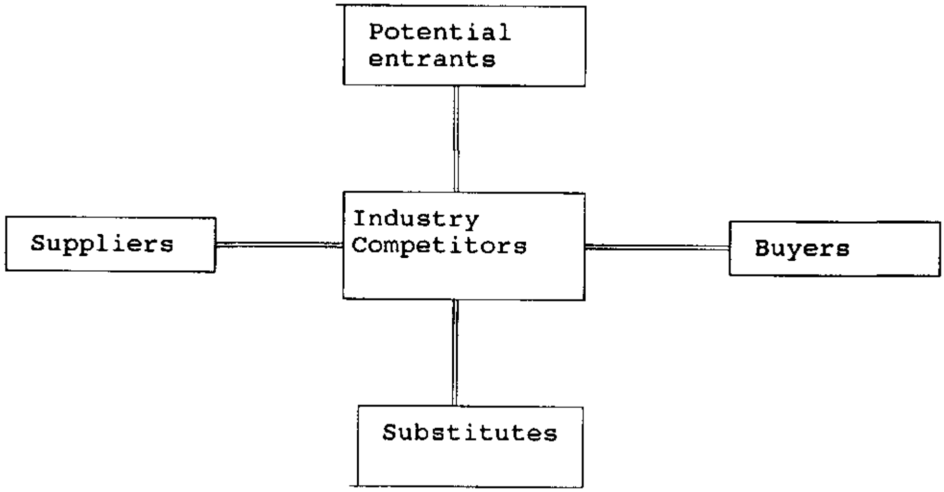

Figure 1. Forces driving industry Competition (Porter, 1980)

cerned that can potentially have an impact on industry competition. The five broad competitive forces provide a context in which all firms in an industry compete (*Figure 1*).

Intensive rivalry is the result of numerous or equally balanced competitors, slow industry growth, high fixed costs, lack of differentiation, capacity augmented in large increments, diverse competitors, high exit barriers and high strategic risks.

A number of companies operating in the same market can form the basis for intense rivalry. The competition among each other to get a share of the market, will press all of them to stay ahead. In this way competition among companies will keep them sharp and constantly looking for a competitive edge. Thus developments can take place on many aspects such as low production costs, better service and innovative products. In this way rivalry makes a company aware of its strengths and weaknesses, and develop/improve them. Thus it follows that intense rivalry in the domestic market can enhance competitiveness in the international field (Porter,1990).

Following the intensity of rivalry some strategic options may enhance the competitive edge of firms further than others. The strategic management perspectives, such as the Porter model, opened new avenues to research to unlock the black box that contains market and firm conduct in neoclassical economic theory and the traditional Industrial Organization paradigm.

Adding the richness of strategic choice certainly complicates the theory of the firm but allows a much more broader scope of performance and behavioral processes of organizations.

The major hypothesis we address in this paper, is whether the strategic choice is reduced, the more concentrated the industry is. This hypothesis is based on the notion that in mature industries where the concentration is high, the rivalry declines and by that increases the profitability of the industry (Scherer, 1980).

The profitability is assumed to be the result of strategic decisions taken by the firms. Some strategies will contribute more to profitability than others (Brealey and Myers, 1988). However, all the firms in the industry are left with a rather thorough knowledge of the implications of strategies for risks and market value. Hence, the strategic room to maneuver will decline, the more concentrated the industry is.

In this paper we shall explore the relationship between structure and strategies of seed firms in Europe. Specifically, we shall deal with the question what impact the concentration in the Dutch and Italian seed industry have for the strategies deployed by the seed firms in those markets.

We shall use data from an international research programme on the vegetable seed industry, conducted by the Department of Management Studies of the Wageningen Agricultural University. These data refer to national studies in Italy, France, Spain, The Netherlands, The United Kingdom, Denmark and Hungary.

The global seed industry

The vegetable chain

The figure below visualizes the role the seed sector plays in vegetable production. No specific national situation is described here, therefore foreign trade is not taken into account.

The figure puts the seed company firmly at the start of the vegetable production chain. This implies that the basis of the production and marketing of vegetables is formed by seed reproduction.

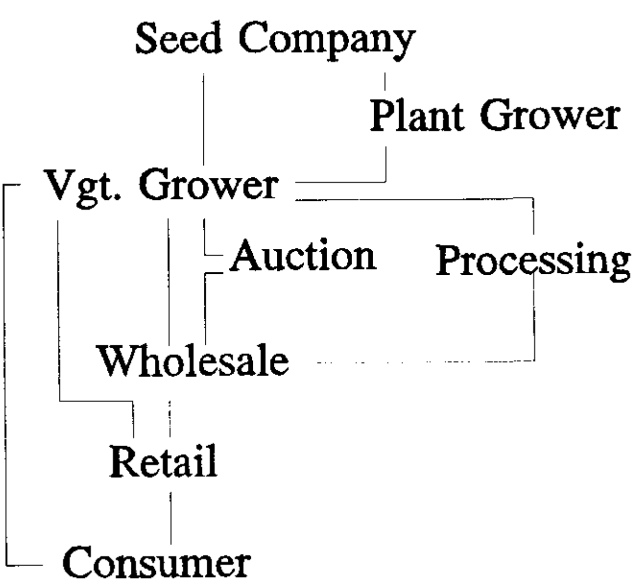

Figure 2. The vegetable production chain

The chain should also work the other way around. Which means that the basis of the breeding programmes of the individual seed companies should lie in consumer preferences. This type of information trickles up and down the production chain. However seed breeding faces a long term production cycle. While consumer preferences are subject to swift changes. So the seed sector has to put up with an imperfect response to the informationflow.

World vegetable demand and supply

The following two tables will give a broad idea of what happened in world agriculture and horticulture over the past decade. The regions have been divided according to the FAO structure.

In arable farming the world has seen no rise in the total cultivated area. Losses in the Developed world have been compensated by reclamations in Africa and Asia. Both in area and production volume the power of the Far East is significant. In both areas it takes roughly 40% and equals North America, Europe and the USSR combined!

The production figures of the past decade show astounding growth figures in the Asian region. Especially the Far East saw a steep rise in productivity. Africa follows closely with rising output figures. In the Developed world, only Europe was able to break the doom and gloom.It shows an overall production increase and a rise in productivity on world average. The table also shows that rising production is generally followed by rising exports.

In vegetable production the world saw a handsome 6.6% increase in cultivated area. However this was followed by a 26.6% increase in production, mainly instigated by the Far East. North America strongly follows the rise in production and even more in productivity. Oceania has put out even better figures, but fails to make an impact.

The whole of the developing world show strong growth in vegetable production. Growth in area can be found mainly in Africa and the Far East. Where Africa has a lot of catching up to do. Both in area and production volume the power of the Far East is significant. On 36% of the area, almost half the worlds vegetable production is grown. Thus a 40% growth rate makes quite an impact on world production figures.

Table 1 Changes in global arable farming 1981-1991 (%)

	Area	%	Production	%	Import %	Export%
World	876,666	.0	2,621,499	15.8	1.1	0.4
North America	109,739	9.8	416,244	0.8	73.4	15.7
Europe	74,500	5.6	393,026	9.1	22.6	34.5
Oceania	14,421	12.4	21,068	9.6	168.0	16.5
USSR	116,745	12.8	238,583	6.7	12.9	82.7
Rest Developed	8,744	20.0	32,282	8.8	12.9	78.8
Africa	106,701	26.5	214,087	42.8	20.3	137.3
Latin America	76,137	2.8	185,167	15.0	6.6	11.2
Near East	44,190	10.2	89,129	67.3	38.9	204.7
Far East	335,990	1.7	1,057,129	28.7	23.6	90.5
Rest Developing	250	11.6	1,749	14.5	62.5	69.6

source: FAO
area in 1,000 ha; production in 1,000 tonnes

Table 2 Changes in global vegetable growing 1981-1991 (%)

	Area	%	Production	%	Import %	Export%
World	13,303	6.6	452,336	26.6	30.0	29.8
North America	581	-1.0	34,288	26.0	61.8	18.8
Europe	2,010	-10.4	68,530	8.2	31.7	16.4
Oceania	52	15.6	2,089	45.7	-97.6	61.2
USSR	1,661	-3.7	31,412	1.7	23.6	—
Rest Developed	348	-0.3	18,076	2.4	-61.0	38.6
Africa	784	38.3	19,315	48.3	11.5	63.7
Latin America	1,103	9.3	21,668	25.4	16.3	94.2
Near East	1,936	-0.2	43,715	25.7	36.7	45.2
Far East	4,830	20.1	212,805	40.6	96.7	9.1
Rest Developing	2	0.0	438	31.1	7.9	-81.8

Source: FAO
import/export of vegetables comprise of tomatoes and onions.
area in 1,000 ha; production in 1,000 tonnes

World vegetable trade balance

Unfortunately the data presented in *table 2* only allow general statements as the import-export figures comprise of tomatoes and onions. Onions are durable and can thus be stored during long periods of time or transported over large distances.

Most other vegetables do not allow for this without conservation in one way or the other. Therefore vegetable growing generally takes place around the main consumption centres. This restricts foreign trade to a mere regional level, among neighbouring countries. A higher off-season price would pay for high inputs of technology or transportation required by global vegetable trade. In this way Kenia has built a strong position in exporting vegetables to Europe in wintertime.

Improvements in technology or production of more durable varieties in effect cut down the total transportation time to consumption centres. This increase the potential production area of this consumption centre, making the world a smaller place as it were.

European Demand and Supply

In order to get an idea of the nature of the seed demand it would be wise to take a closer look at the state of agriculture in Europe. *Table 3* below give a picture of the developments in the agricultural structure over the past years. One should note that after 1990 the former East-Germany is integrated in German statistics. That is why 1990 has been chosen as the year of reference.

Large arable areas can be found in the larger countries. Spain and France supply the largest areas, followed by Germany, Italy and the UK. A small country like Denmark has a remarkably strong position in arable farming. Over the period 85-90 little changed on a European scale when the arable areas are considered. The only sizable decline in arable area took place in the UK and Denmark.

The total number of arable farms is the largest is Italy, with an average size of some 7 hectares. Greece and Portugal have a similar situation. Large scale arable farming traditionally takes place in the UK, Denmark and France.

The number of arable farms in Europe show an average annual decline of 2%, whereby numbers of Irish farms plunge quite dramatically. Only Greece and the Netherlands have

Table 3 Changes in agricultural structure 1985-90 (%)

	Arable				Vegetable			
	Area	Change	Holdings	Change	Area	Change	Holdings	Change
EC-12	67,371	-0.4	4,432		1,693	0.6	1,030	
Belgium	711	-4.2	52.5	-13.1	31	2.7	12.7	-26.6
Denmark	2,507	-4.1	76.6	-11.6	15	-2.5	3.1	-31.1
Germany	7,382	2.1	518.2	-12.4	49	3.5	25.5	-20.3
Greece	2,925	0.0	430.9	-5.3	135	-2.0	116.9	1.9
Spain	15,560	-0.6	668.7		469	0.6	319.3	
France	17,753	1.4	668.3	-10.0	276	1.5	85.2	-29.2
Ireland	1,029	-6.4	59.9	-47.9	5	0.0	1.1	-82.0
Italy	8,917	-1.7	1,294.6	-8.9	411	-0.6	357.7	-34.1
Luxembourg	55	0.0	3.1	-11.7	0	-15.1	0.1	-42.9
Netherlands	897	4.9	62.5	-5.5	65	0.5	18.8	-26.6
Portugal	2,906	0.0	406.0	82	-2.3	71.6		
UK	6,589	-5.9	130.6	-9.4	142	0.8	18.0	-19.6

source: Eurostat
Area in 1,000 Ha, number of Holdings in 1,000.

1% per year drop numbers. When the arable area remains constant, a drop in number of holdings means a larger scale of farming. A very small decline or growth, could then mean either intensified cultivation or stagnation.

In vegetables, large areas can be found in Spain and Italy, smaller territories are in France, Greece and the UK. Drastic changes in area over the past years have not been taking place.

The total number of vegetable producing farms is highest in Spain and Italy, leaving Greece the runner up with half the number. The average size of farms differs widely, again the large scale farms can be found in the UK, Denmark, France and the Netherlands. The southern European countries have a below average scale.

In the number of holdings a noticeable decline of 4-6% per year on average took place. Greece was the only country here to show growth. This would imply a rapidly growing scale of production in vegetable production across Europe.

The total change in production volume in the EC amounts to zero over the five-year period. However between productgroups this is hardly the case, as there is no country without double digit growth figures. Pulses and oilseeds have benefitted the most, the EC-agricultural policies of the time would explain a large part of the growth. Within cropping plans vast changes can take place rapidly. Therefore the recent agricultural reforms will undoubtedly have left their impact on the division of production among productgroups.

France is easily recognized as the main arable producer within the EC, with Germany coming second. Considerable growth takes place in Denmark and the Netherlands. Productivity in arable farming is highest is the northern EC-members, foremost the Netherlands, and lowest in the south, especially Spain.

One should note that the Danish Bureau of Statistics stopped collecting horticultural data in the years 1990/91. This would explain the "collapse" of the Danish horticultural production.

Table 4 Changes in arable production volume 1985-90 (%)

	Volume	Change	Cereals	Pulses	Rootcrops	Oilseed
EC-12	338,862	0.0	-0.9	66.9	2.6	52.7
Belgium	11,446	2.3	-3.8	220.0	3.4	78.6
Denmark	31,078	46.8	20.8	5.4	-2.5	1,556.4
Germany	63,431	-4.4	-0.1	41.6	-9.3	87.4
Greece	8,850	4.6	2.0	1.7	5.5	26.3
Spain	33,674	-5.0	-10.5	-21.6	0.3	42.9
France	102,703	-0.8	-1.5	225.7	-9.7	53.9
Ireland	4,715	6.0	0.7	600.0	10.4	7.1
Italy	33,800	9.0	-2.6	-25.3	15.7	295.9
Luxembourg	179	3.5	12.1	-	-37.5	400.0
Netherlands	17,428	16.7	20.4	-8.8	16.7	-7.9
Portugal	2,648	-3.0	0.9	0.0	-9.1	62.1
UK	39,125	-0.2	0.5	90.8	-6.2	40.6

Adapted from Eurostat
volume in 1,000 tonnes

Table 5 Changes in horticulture production volume 1985-90 (%)

	Volume	Change	Cabbage	Leaf	Fruitvgt	Root	Pulses
EC-12	44,553	1.9	-5.4	19.8	-1.9	-1.9	-7.3
Belgium	1,136	11.3	-13.8	13.0	57.7	-15.2	-9.1
Denmark	18	-93.7	-87.6	-92.6	-32.7	-100.0	-100.0
Germany	1,479	-3.1	-9.8	12.5	26.9	34.3	-22.7
Greece	3,841	-10.8	11.5	8.8	-14.7	2.7	-13.5
Spain	11,496	21.0	-1.1	50.0	29.2	-5.2	-3.9
France	5,472	-1.2	-17.3	5.2	-0.4	-7.6	-6.4
Ireland	227	3.1	-15.8	10.0	-14.0	-0.1	-4.3
Italy	12,246	-6.2	4.5	16.8	-15.3	21.0	-16.3
Luxembourg	3	-13.3	-80.0	-30.0	—	-70.0	—
Netherlands	3,479	26.9	12.3	12.7	31.1	34.8	-0.3
Portugal	2,120	6.9	1.2	6.7	8.1	-2.1	-16.7
UK	3,579	1.2	-5.1	25.8	26.2	-5.9	-0.1

adapted from Eurostat
volume in 1,000 tonnes

Overall vegetable production is stagnant in the EC, nevertheless growth figures differ widely among countries. Total growth is highest in the Netherlands and Spain, while Greece shows a decline of over 10%. Major producers are Spain and Italy, France coming second with half the volume, Greece, UK and the Netherlands complete the picture. When volume and area are compared, the Netherlands have a clear productivity lead of double the EC-average.

Among productgroups only among leaf- and stalkvegetables (lettuce, celery, etc) a strong growth is shown. Spain and the UK benefitted most from this, while France lagged behind in growth. An overall decline is registered in the production of pulses, this is a small sector in terms of volume. Other sectors show a diverse picture with strong growth and decline. However the best overall performance is given by the Netherlands. In general the southern EC-members have an emphasis on fruitvegetables and leaf-/stalkvegetables, while the northern states concentrate on cabbage and rootcrops.

The European seed industry structure
The structure of an industry can be typified by several indicators:
- degree of collusion or concentration
- product differentiation
- growth of demand
- cost structure
- intensity and size of investments and
- over capacity of production means.

The first indicator we present here is de demand side of the seed industry.

Seed demand and supply
Patterns in demand for seed in general follow production patterns. This is easy to conclude, as there will be no production without seed. The demand for vegetable seed on a global scale could therefore be derived from the figures of table 3. The problem arising here is that crops, varieties, spacing of sowing, productivity and the number of harvests per year may differ from one country to another. This means that an estimate of seed demand can hardly be computed from these data. A rule of thumb would be that large production areas imply high demand of seed.

The above will also be true for the EC-countries. Thus Italy and Spain should have the highest demand, followed by France, Greece, the Netherlands and the UK. In the figure below the production volumes are compared to the value of the vegetable seed markets. These values are estimates compiled by LEI-Rabobank in a previous study.

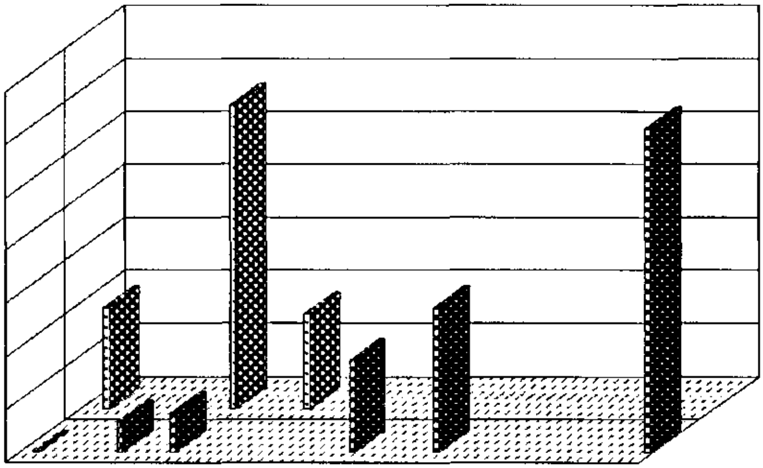

Figure 3. Vegetable productionvolume and seed value in Europe, 1990

The figure shows a striking disparity between volume and value where Greece, Spain and to a lesser extent the UK, are concerned. For all three countries the value of the seed market has a lower estimate than expected according to production figures. To avoid the conclusion that the estimates of the value of the seed market cannot be trusted, it is best to assume all figures to be correct. This implicates that the larger part of vegetable production in Greece and Spain is generated by farmer-saved seed instead of commercial seed. This is supported by the results of the Spanish national studies performed in 1993.
An indication of the supply of vegetable seeds is given by the following figure, showing international trade flows. It becomes clear that there are tree major trade centres in world: USA, France and the Netherlands.

These figures are a bit murky as there are sizable re-exports and re-imports.

Concentration in the seed industry
A characteristic of the industry structure, we use here, is the degree of concentration. Concentration is influenced by two factors: the number of companies in the industry and the relative size of the companies. In general it is said, that the less companies and the less larger companies, the higher the concentration within the industry.

Concentration can be measured by various means, like the C4, being the total turnover or market share of the four largest companies in the industry, the H(erfindhal)-index or the Entropie of Theil-index (E-index). The H- and E-index take into consideration the market shares of all the actors in the market. The intercorrelations between the three are high (Scherer, 1980).

In our study we base our findings of the modified C4-indicator.

Thus one should take a look at the companies in the industry and the estimated turnover per company in vegetables.

If 10 million Guilders turnover in vegetables (4.3 mln ECU) or more is taken a large enough size, it is possible to compare rivalry within several countries.

The table shows strong rivairy can be expected on the French and the Dutch market. Taking a closer look at the annex, it follows that 4 companies appear more than 3 times, totalling 13 out of 32 appearances. This means that they are large enough to keep up the competition at home and abroad. The companies involved: Groupe Limagrain, S&G/Sandoz Seeds, Royal Sluis and Asgrow Seeds.

The table also indicates that competitive rivalry will show some stability with some dominant firms within the domestic markets. This stability occurs in growing markets.

However, because the slower growth in the domestic markets, as shown before, rivalry increases: the firms have committed themselves in keeping up the market shares. In this

Table 6 Number of large vegetable seed firms and national market value

	Nr of Companies	Marketvalue
Spain	3	32.5
France	10	86.5
Italy	7	129.8
Netherlands	11	69.2
UK	1	47.6

market value in million ECU

situation conditions prevail for co-operative behaviour, expressed by merger, acquisition and alliances.

In the seed industry in Europe, this concentration process has been going on already for about two decades. Some examples:

Italy
The intensity of the competition in the seed industry in still increasing in Italy. The most important competitors for most of the companies in Italy are:
- Royal Sluis S.R.L.
- Peto Italiana S.R.L.
- Asgrow Italia S.P.A.
- Sluis&Groot/Sandoz Italia S.P.A. and
- Clause Italia S.P.A..

France
The major players in the vegetable seed industry in France are Limagrain, Clause (owned by Rhone-Paulenc and Orsan), Caillard (owned by Sandoz), Plan, Royal Sluis, GSN Semences, Asgrow France, André Blondeau and TOP Semences.

Limagrain, the largest group in France, was created by successive purchases of well known companies, such as Vilmorin (1975) and Tezier in France, Ferry Morse and Advance Seeds (USA), Flora Frey (Germany) and Nickerson-Zwaan in 1990, that before that event participated in the Shell group, that acquired A.R. Zwaan en Zoon in 1973.

Some other recent developments are the formation of the joint-venture with the Danish DLF-Trifolium for fodder-crop seeds (1990), the joint-venture with the co-operative Union du Cher on biotechnology,

Clause has a long-standing position already in the vegetable seed market.

The take-over by Rhone-Paulenc and Orsan, the growth in the professional market has increased rapidly. Acquisitions played a part in this development.

Asgrow France, owned by Upjohn (USA) bought Bruinsma (The Netherlands) in 1992.

Petoseed Europe bought van Waveren, a subsidiary from KWS on seeds for vegetables for the canning industry.

Sweden
In 1993 the two major Swedish companies Svalöf and Weibull merged to enlarge their efforts in, among other businesses, the horticultural industry.

Spain
Now, there are 35 companies active in the vegetable seed market. Twelve firms are subsidiaries of foreign firms and three are joint-ventures with foreign firms.
The main Spanish firms are:
- Semillas Fito S.A.
- Semillas Battle S.A.
- Intersemillas S.A. and
- Ramori Arnedo S.A.

Since the 70's and early 80's many foreign seed companies entered the seed market directly, because of the growth in the vegetable industry.

Concentration processes have been induced since then by those foreign based firms. Petoseed and Clause are the major players in this market.

The Netherlands

Structural concentration also took place in The Netherlands.

A.R. Zwaan en Zoon was established in 1942.

Cebeco-Handelsraad acquired a majority participation in Rijk Zwaan in 1989.

As mentioned before, A.R. Zwaan en Zoon, was acquired by Nickerson Seed Specialists in Rothwell (U.K.), being a subsidiary of Shell in 1973. Nickerson- Zwaan, the name adopted in 1980, took over D.van der Ploeg Seeds in 1981 and Supergran (Belgium) in 1979. Limagrain took over Nickerson- Zwaan in 1990.

De Ruiter Zonen, one of the major tomato seed firms , took over Gebr. van den Ploeg in the eighties.

Bejo Zaden is a merger of two companies in 1978: Jacob Jong and C.Beemsterboer, both pioneers in open air vegetable seeds.

Nunhems Zaden was taken over by Hoechst in 1986 to lead the seed division of this German chemical conglomerate.

Rijk Zwaan was taken over in 1986 by the petro-chemical company B.P. Nutrition. However, B.P. stepped out the seed business in 1989 and sold Rijk Zwaan to Cebeco-Handelsraad.

Bruinsma, one of the first pioneers in hybrids, was taken over by Asgrow in 1988.

Sluis&Groot/ Sandoz already has a long history (established since 1887).

The firm has a rather consistent pattern of autonomous growth for a long time.

In 1963 the Co-operatieve Zaaizaadvereniging West-Friesland.

In the eighties some major changes occurred.

In 1980 the firm was acquired by the Swiss based chemical giant Sandoz.

After that, the firm developed internationally by take-overs and new ventures.

Royal Sluis is the second eldest firm, originating from 1868.

Autonomous growth also in this case is the device for decades. Take-overs are recently new and contain some specialist groups, like on tissue-culture.

Koninklijke VanderHave Group, now involved in onions, rape and grass,
was established in 1979.

In 1977 the co-operative Suiker Unie took over the company. VanderHave acquired in 1990 Leen de Mos, a medium-sized tomato, lettuce and cauliflower expert.

Considering the number of employees, six firms employ about 80% of all employees of the eleven largest firms.

United Kingdom

The concentration process had dramatic consequences for the U.K. seed industry. Very few firms still remain (Andrews, 1993, in Seed World april).

The major players:

Nickerson, being a part of Limagrain.

According to Market Assessment 1990 Sutton Seeds has a total market share in the U.K. market of 39%. Sutton is owned by Svalöv & Weibull.

Samuel Yates Ltd. is owned now by Yates Australia.

Nutting and Sons is now french owned.

Sharpes International Ltd. has been acquired by VanderHave Group.

Considering the major firms in France, Spain, Italy, The Netherlands and United Kingdom, active in vegetable seed, the major five companies Limagrain, S&G/Sandoz, Royal Sluis, Nunhem and Clause make out 60.7% of the total turnover in these countries.

The findings show an overriding concentration process in the European seed theatre.

Petro-chemical companies were rather active in the take-overs in the seventies and eighties. However, some of them pulled out of this business, selling their seed interests to larger international seed companies.

This horizontal integration is slowing down in the nineties.

This proves the next point, firms with strong domestic competition are likely to perform well in the international arena. To keep up the struggle, companies are looking for a wider scale of operation to cash in on the efforts that have been put in. This means that internationalizing is a logic option, a company already knows (and developed) her edge, and can stick to it.

As far as the comparison concerns between the Dutch and Italian seed industry, we may conclude that in both cases the industry is highly concentrated.

Firm's strategies

Concept of strategy

Strategy is a coherent, unifying and integrative pattern of decisions as a response to external and internal developments to achieve a long-term sustainable advantage over competitors.

Typology of strategies.

Competitive advantage is to be measured by the total revenues collected by the buyers' payment for the firms' output. Added value is created whenever the buyers' contribution exceeds the total cost resulting from the completion of all the activities in the firms' value chain. The margin is the difference between the total value generated and the aggregated cost of the value activities. The margin directly contributes to the competitive advantage.

To Porter (1985) two basic ways of achieving competitive advantage are cost leadership and differentiation. Cost leadership requires the construction of efficient-scale facilities and sustainable cost reducing activities. Differentiation calls for creating something that is perceived by customers or clients as being unique by technology, customer service, image or other dimensions. Market scope consist of concentrating on a segment or geographic market. It may be broad or narrow.

Putting these generic strategies together, Porter emphasizes the importance of the following strategies showed in *figure 4*.

Going a little bit further we may assume that seed firms will likely be interested in value added strategies at a similar or somewhat higher price. if the aim is to get higher market share uniqueness in products and services should be perceived by customers/growers in the relevant market segments. depending on the financial return of the purchase of higher priced/higher value added seed the customer/grower may be convinced. On the other hand, if the market prices of vegetables stabilizes the grower will not expect a

		Competitive advantage	
		Lower cost	**Differentiation**
Market scope	**Broad**	Cost leadership	Differentiation
	Narrow	Cost focus	Differentiation focus

Figure 4. Generic strategies (Porter, 1985)

higher return and will look for another more advantageous price/value added clue in his purchasing process.

For the international firm, value added/higher priced strategies are a hard ball game to play, because of the specific customer needs in the fragmented or differentiated international markets. A Dutch cabbage doing well in Belgium, may not flourish in southern Spain because of different clima-ecological conditions.

Cost leadership is feasible for most firms to achieve. Experience curve effects can be achieved in all firms. Learning to do it better to a lower cost level is feasible for all seed firms in principle. However, the competitive advantage becomes marginal if and when all firms deploy cost reduction strategies and drive down costs in areas as research and development, overhead positions and sales forces.

The highest possible cost reduction target is close to shut down the firm!

So are there alternative routes to achieve competitive advantage?

Yes there are. From a product-market point of view the seed firm may select for the specific product groups the most suitable strategies (*figure 5*).

The seed firm always is able to withdraw from a market, for instance if the value of the product-market combination exceeds costs on a permanent basis or if the market changes considerably over time, implying hugh risks. For determining whether withdrawal is a adequate recipe, the firm deserves cost and market monitoring systems in the first place.

Some seed firms may partially withdraw from a market by licensing the rights to other organizations and/or to specialize on the market of basic seed. This partial withdrawal is highly advantageous for instance if market opportunities are crumbled by lack of proprietary rights protection.

		Product	
		Present	**New**
Market	**Present**	Withdrawal Consolidation Market Penetration	Product improvement New product development
	New	Market development	Diversification forward development or backward

Figure 5. Product-market strategies

Consolidation in growing markets is attractive a strategy because of the expected high return low cost consequences. In mature markets consolidation provides strategic challenges. In face of the competitors positions, the consolidating firm puts emphasis on quality, increasing marketing activity or cost reduction through productivity gains or higher capital intensity, which often is hard to achieve in the seed business. In declining markets consolidation may require more severe cost reductions and/or increasing market share of competitors leaving the market.

Market penetration in growing markets builds upon the desire to increase market share. "Belong to the dominant market players" sets out a device for aggressive market penetration in growing markets. To the contrary market penetration in static markets is much more difficult to deploy. Market leaders already have established their position, preventing others with lower market shares to grow. For low market share players fine tuned tactics may do well, for instance by using reputation as niche leader, by allying with others to fight dominant complacent market leaders or by using price tactics.

For seed firms product improvement is connected directly with their basic competence. The long enduring process of new product development lacks behind the advantage of product improvement. Although also that process is susceptible to time consuming processes of testing, registration, multiplication and product introduction. More successful product improvement seed firms will tailor their products to market needs, build on the firms' core competencies and have organized the processes of product improvement internally on product management basis.

Market development builds upon the existing range of products while venturing into new markets. Specifically, because of the high capital investments in seed development the firms' assets might be specifically devoted to exploit the product by new market development. In particular, when existing markets are saturated theses seed firms incline to expand businesses in new markets. To the process of internationalization we shall come later.

Diversification brings the firm away from its present products and markets at the same time. Still, the diversification may lie within the confines of the firms' competence. The direction of diversification may be backward or forwards. Backward diversification is well known in the seed industry. Seed merchants having taken over seed breeders. Vice versa, forward diversification meaning seed firms acquired merchants. In that sense the seed industry showed many examples of vertical integration, being the combination of backward and forward diversification. Most seed firms are nowadays engaged in breeding, multiplication and distribution. Still, processes of vertical integration slow down, if the transaction costs and experience curve effects lose their positive contribution to the firm and negative implications flourish, like growing bureaucracy, less flexibility, higher overhead costs and massive inertia. In that stage of industry development new entrants may step in and externalization of the vertical integrated firm activities starts up.

Examples of horizontal integration are also well known in the seed industry. In particular in the seventies petro-chemical and pharmaceutical companies acquired seed firms, because of the expected complementarity between seed technology and seed products on the one hand and biotechnology, pesticide and insecticide products and distribution channels on the other hand. Synergy may be the result of related diversification rooted in technology, products or marketing and distribution competencies.

As we have seen before, acquisitions, mergers and alliances are specific ways of supporting strategies. Mergers and acquisitions tend to go in waves. In the seed industry the last thirty years these phenomena are widely shown. Mergers are the result of organisations coming together voluntarily on an equal basis, while acquisitions always show asymmetry in power, capital or other resources.

Evident reasons for acquisitions are: cost efficiency by building up economy of scale and/or geographical scope, expanding market share by taking over low share value firms, entering new markets by piggybacking on the acquired firm or the expanding competence because of lack of knowledge or resources internally.

In the seed industry many of these factors have played a major role in the acquisitions in the past and present times.

Alliances support the firms' strategy in a more open way. Allied firms cooperate to share some assets of each of the firms through a mechanism of mutual advantage and trust. Examples are alliances in distribution, when firms are distribution capabilities to lower costs and share a broader product assortment exposure. Another example is research and development. Seed firms engage in alliances by sharing biotechnology capabilities that each of the individual firm can not permit himself directly. Allying is sharing risks and synergy at the same time, without losing the firm identity and autonomy. Licensing, as we have seen before, is a particular expression of an alliance. Giving the right to produce seed granted for a fee gives both partners a sustainable advantage. Some forms of subcontracting also share the characteristics of the alliance. In the seed industry coating of seed for instance is subcontracted to the coating firm on a permanent basis. This may lead to far going arrangements in which the seed firm and the coating firm may build up competitive advantage over other alliances.

Summarizing, in this paragraph we have looked at strategic options open to seed firms to deploy. There are no arguments yet why this general framework could not fit in the strategic arena of the seed industry.

In this paper we shall now discuss the strategies the Dutch and Italian seed firms have adopted and the relative changes of the strategies over time.

Strategies of Dutch and Italian seed firms

We asked 11 Dutch firms to the strategies deployed in 1985, 1990 and preferred for 1995 and 2000. The range of options given to the respondents, were aggregated and ranked (1= mentioned often to 5 = mentioned not often).

Table 7 gives an ample evidence for the emerging drive for customer service.

The earlier described saturation of the seed market pushes seed firms to improve customer relationships on a sustainable basis by a differentiation strategy, containing methods like better service, higher quality and control and better product image.

The product innovation drive comes second in the row. Remarkable is the finding that increases in the R&D budget are not preferred that much as a strategic method. This means that product innovation largely will be built on existing resources, possibly not giving that much of an outlook on increased in-depth investments in biotechnology research.

From a product-market strategic perspective, firms do not perceive stronger drives for entering new markets. This, coupled with the former mentioned product strategies, means

Table 7 Strategies deployed in 1985 and 1990, and preferred in 1995 and 2000 by Dutch seed firms.

Strategies of firms	Deployed		Preferred	
	1985	1990	1995	2000
Durable relations with clients	2	2	2	1
Enlarge customer service	2	2	2	1
Best service support	4	3	2	1
Quality guarantee and control	3	2	2	2
Distinguish product from competitor	2	2	1	2
Improve product/market image	3	2	1	1
Develop new products	2	3	2	2
Improve/ renew existing products	4	3	3	2
Strive for unique product	4	3	1	3
Bigger product assortment	2	3	3	3
Product in higher price segments	4	3	2	3
Products in lower price segments	4	5	5	5
Lowest cost per product unit	5	5	3	3
Lower prices than competitors	5	5	5	5
Higher R&D expenditures	4	3	3	4
Innovate production process	4	3	3	3
Enter new markets	4	3	3	4
Control production flow	5	5	3	4
Enlarge reliability of supply	5	4	3	3
Shorten delivering time	5	5	5	5
Strong influence on distribution channel	4	4	5	4
Innovation of distribution process	4	4	3	3
Innovation of marketing instruments	4	4	4	4
Adapting of organization structure	4	4	4	5
More attention for higher educated personnel	5	5	4	4

that most firms expect to choose for market penetration and product improvement. Theoretically, not unexpected, taken the development of the seed market.

Also remarkable is the finding that more emphasis on improvements on internal operations and logistics is not expected to increase. Cost reduction strategies are not perceived as that promising. Cost leadership apparently is not sought for by most firms.

How does these findings compare with firms in other countries ?

In our study we focused also on Italy and asked eleven firms, engaged in vegetable seed, to rank their strategies deployed in the past and preferred for the future.

In *table 8* we give a ranking of the strategies being deployed in 1985 and 1990 and preferred for the year 1995 and 2000.

The dominant feature of the strategies over time is the increase of customer and market orientation of the firms. Customer relation and service, a focus on quality, by using better distribution and marketing instruments should give room for higher prices in better market segments. This rather ambitious perspective goes hand in hand with smaller product assortment and a stabilizing expenditure for R&D. The differentiation strategy is not focused on the product as such giving the unique dimension to the firm competitive position, but on customer relationship, strengthened by value added, service and delivery in time.

Table 8 Strategies deployed in 1985 and 1990, and preferred in 1995 and 2000 by Italian seed firms.

Strategies of firms	Deployed		Preferred	
	1985	1990	1995	2000
Durable relations with clients	1	1	1	1
Products in lower price segments	2	4	1	1
Quality guarantee and control	2	1	1	1
Improve/ renew existing products	3	2	1	2
Develop new products	3	2	1	1
Shorten delivering time	3	1	1	1
Bigger product assortment	3	3	4	4
Distinguish product from competitor	3	1	1	1
Control product flow	3	3	2	2
Enlarge reliability of supply	3	2	2	2
Strive for unique product	4	4	4	4
Product in higher price segments	4	3	1	1
Improve product/market image	4	2	1	2
Enlarge customer service	4	2	1	1
Higher R&D expenditures	4	4	4	3
Innovate production process	4	3	3	3
More attention for higher educated personnel	4	2	1	1
Strong influence on distribution channel	5	3	2	2
Innovation of distribution process	4	3	2	2
Innovation of marketing instruments	4	3	2	2
Adapting of organization structure	4	3	2	2
Enter new markets	4	4	2	2
Lowest cost per product unit	4	4	3	2

Cost leadership does not really get that much of attention now; however the importance increases over time according to the preferences of the firms.

Comparing the findings of the Italian study with the Dutch study reveals a lot of correspondences. Differences concern a stronger Italian emphasis on:

- products in lower price segments
- logistic improvements (delivery time, reliability and product control)
- smaller product assortment
- more attention for higher educated personnel
- new market development.

Although a comparison should be handled with some necessary care, we incline to the idea that the Italian firms also agree on the product differentiation strategy as such, by customer service improvements and product development, but also stress the importance of strengthening internal factors, like logistics and personnel. Apparently these firms still have some room for improvements internally, whether because they rank below the Dutch competitors, or because they believe these internal factors are crucial for surviving in the business.

Summarizing, the seed firms, engaged in vegetable seed, in The Netherlands and Italy all have a rather thorough perception view on the actual and future seed market. The keywords are differentiation by a high committment towards customer and market orientation. According to many firms this strategy deserves investments in customer service, improvement of product quality and control and improvement in distribution and marketing. Many firms opt for a smaller product assortment and will invest less in R&D accordingly.

The attention for cost leadership is less apparent.

The European integration stimulated many firms to make an European strategy. Dutch and Italian firms strive for differentiation and market leadership. Only Dutch firms opt for foreign direct investments, apart from increases in exports. Italian firms focus on export increases in the first place.

Structure and strategy in the Dutch and Italian seed industry

Our findings leave us to conclude that the in the highly concentrated seed industry, a convergence is taken place in the strategies of the seed firms over time. In the past ten years, the differences in strategies employed, are evident. However, for the years to come strategies of Dutch and Italian seed firms tend to converge, emphasizing the customer relations in the first place.

According to our findings we face some interesting questions.

First, if concentration in one geographical market, being The Netherlands and Italy, is high, one might theoretically expect a weaker rivalry. The weaker the rivalry the higher the profitability, one might assume. This relationship is validated in most American studies, although the profitability gains are not reported that high. In other countries these findings sometimes are reconfirmed (De Wolf, 1982) or not found, like in Belgium (Jacquemin e.o., 1980).

From strategic management point of view, taking into consideration the American studies just mentioned, one might hypothesize that the higher the concentration in a geographical market, the more strategies are focused on increasing market value. This would suggest that increases of market value certainly would best be enhanced by the differentiation strategies, supported by relative low investments in R&D.

One might also expect that high concentration, invites firms external to the industry to enter the industry. There is ample evidence that the petro-chemical companies entered the seed industry to exploit the high profitability of the industry in the seventies and eighties. This, in turn, changed the industry relationships, the contestability and jeopardized the co-operative behaviour of the larger companies to maintain the status-quo. On the other hand, one might expect, based on the fact that the Dutch and Italian seed market does not show off growth, a tougher competition between the few, lasting seed companies.

This might explain why Italian firms prosper the strategy of lowering cost.

There is ample of evidence that the increase in concentration in The Netherlands and Italy, is due to the expansion strategies employed in the eighties, when the firms enjoyed the relative high growth in the vegetable seed market. Due to differentiation advantages the Dutch firms contested the Italian firms and achieved in gaining a relative high market share.

In The Netherlands the industry concentration emerged because of other forces, such as the higher investment needs of the seed firms. This allowed new entrants to acquire Dutch firms. By doing that these new entrants supported the seed firms in their capital needs.

So, industry concentration in The Netherlands apparently is the result of the technological breakthroughs and capital requirements for investments in R&D, while in Italy the concentration is caused merely by the new entrants raping off the profits to be made in the italian seed market.

Evidence for this exploratory hypothesis, can be found in the findings on the strategies of the firms.

Up till now, the seed industry in Italy have achieved a new status quo, with a high concentration. The firms adopted strategies that shifted from expansion to further penetration, using price strategies.

In The Netherlands the seed industry faces a rather new status quo, with a high concentration. The firms adopted strategies that shifted from high investments in R&D to expansion into new markets.

The difference between the two situations can be interpreted by the following reasoning.

The take-over of the Italian market by the Dutch firms, is a part of a broader expansion strategy of the larger Dutch firms to enter international markets and build up market share. The low contestability of the seed market in Italy offered low risks and high gains for the Dutch entrants.

Conclusion and discussion

The conclusion of this study is that high concentration induces firm to converge their strategies. This hypothesis has been validated by comparing the Dutch and Italian seed industry.

Strategic choice behaviour apparently, is not merely a function of internal competencies (Hamel and Prahalad, 1990) or unique differentiation abilities or skills (Porter, 1985), but strongly influenced by developments in the industry.

There are, however, several complexities in the explanation.

First, the industry structure is a far more complex concept as normally accepted.

Firms in the same industry may not supply substitutable products. In fact, they may sell their products to quite different sets of market segments. Since industry data are often used to test implications about market behaviour, there are obvious difficulties in doing empirical research.

In our study we also faced a second complexity in defining the industry.

In the concentrated seed industry the process of strategy formation and implementation is done differently by the firms. Some firms conduct highly centralized processes of strategyformation, while others prefer highly decentralized patterns of strategic decision-making.

Third, the cross border complexity in the industry concept, deserves a clear distinction between levels of analysis. In the European market the seed industry should be analyzed from a different perspective, compared with the national seed markets. This leaves open the question how the dynamics between national and regional markets can be catched, using a comprehensive paradigm or theory.

Fourth, the relationship between structure and strategy still lacks a thorough theoretical understanding. The assumed causality between structure of the industry and strategic choice behaviour is still based on the Bain theory. From an theoretical point of view it still is a challenge for research how to analyze the dynamic character of the relationship between the two entities.

The implications of the findings for practice, are abundant.

For firms in maturing industries, concentration favours the profitability on the long run, after the processes of merger and acquisition. If the entry and exit barriers are high, the firms left in the industry, may prosper and use the capital for expansion in new geographical markets, so broadening their scope.

However, if the expected profitability will not increase, after the turbulent stage of merging and acquisition, the contestability of the industry at large is at stake.

New firms may enter the industry, exploiting new assets, such as cost advantages, higher service levels or quality that better fits the customers.

In the European seed industry, the profitability of the firms increasingly depend on the success by which firms already have entered non-European markets.

The maturing European market will not offer higher levels of profitability to firms focusing on that market only.

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Cooperatives in changing market conditions

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Introduction

Agricultural cooperatives in Western Europe are being confronted with a number of economic and social trends which demand a revision of cooperative strategy. In many cases adaptation of the strategy will need to go hand in hand with investment and extra financing requirements. Furthermore, these developments put special demands on the boards of directors and executive boards of cooperatives. Discussion on these issues must be entered into in the light of the objective of the cooperatives. This article will explore, in general terms, the position of sales cooperatives, with certain exceptions or modifications which apply to particular sectors.

Trends

The first trend concerns the saturation of the agricultural market in Europe. Consumption of cereals and potatoes per head of population is falling; total demand is being kept in check by population growth. The use of sugar is stable whereas the use of artificial sweeteners, which is more beneficial on purely economic grounds, still has potential to increase, depending on how EU agricultural policy develops. Use of vegetable oils and fats is still rising.

Total poultry consumption is rising in Europe whereas pig meat and beef are more or less stable as is total dairy product consumption. The consumption of butter and low-fat milk powder is on the decline but the consumption of cheese, particularly special varieties of cheese, fresh milk products and desserts is on the rise.

Indeed there are opportunities in a number of sectors to export outside the EU. The degree will vary per sector; for market regulated crops such opportunities are adversely influenced by the reduction of export subsidies resulting from the GATT agreement.

The Western world appears to be witnessing stagnation in the sale of primary agricultural produce whereas processed products show a clear growth market. In terms of total consumer spending on foodstuffs, the share enjoyed by primary agricultural produce is gradually decreasing in favour of food with a further added value. In the United States the share of the marketing bill, including added value in further processing, retail and consumption away from home, is three times as high as that for the basic produce.

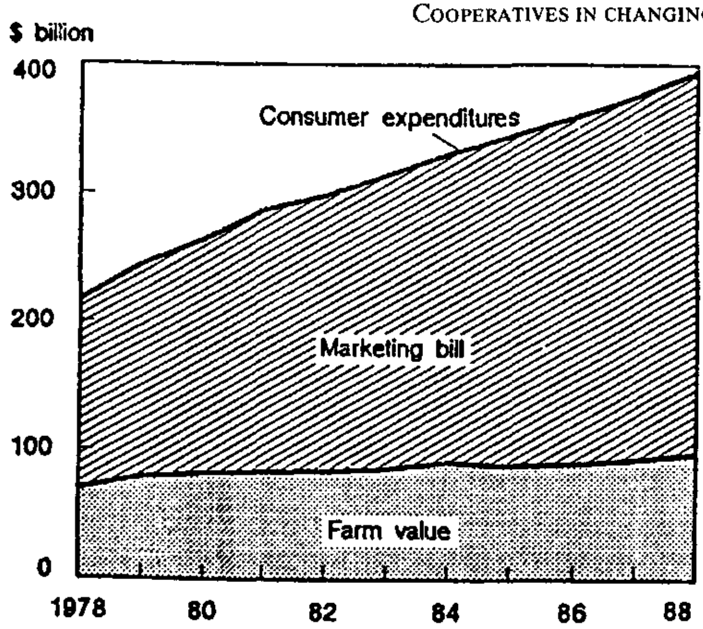

Figure 1. Distribution of consumer food expenditures in the U.S.

The second development which confronts agricultural cooperatives is the increasing power of the retail trade, achieved through the process of concentration, which is helping the chains to acquire an even stronger position compared to the food and beverages industry. This is also apparent from the growing strength of 'private labels'. In most EU countries between 3 and 5 supermarket chains account for around 50% of the turnover. This concentration pattern is continuing.

The objectives of cooperatives

Before highlighting potential strategies for agricultural cooperatives to deal with the trends referred to above, it is useful to first reiterate the objectives of agricultural cooperatives. These objectives differ from those of private enterprise and are central to the strategy to be followed.

In general it can be stated that the goal of a sales cooperative is the achievement of the highest possible revenue from (a) the total production of its members, in both (b) short and (c) long term. These three aspects may at times conflict with each other, thus creating some tension in trying to achieve the best prices in both the short and the long term; in many cases short-term investment is necessary for longer term pricing, and this will affect the current purchase price. The duty of a cooperative to sell the entire production of its members means that it is not exclusively high profit margin production which is sold. The strategy to be followed will be determined by the interplay between the objectives.

Strategic options
The following developments all have consequences for the strategy to be followed.

Market saturation
As mentioned above, the sale of agricultural products is stagnating in the Western world whilst processed products are enjoying clear market growth. If cooperatives wish to realise their objectives, they will have to exert, or try to exert, as much influence as possible on the production chain. This can be done by attracting to the cooperative as much as possible of the added value in the production chain. By so doing the strategic position which the cooperative occupies in the chain would be strengthened, and this is crucial in order to retain access to sales markets. In addition, a strong position in the chain facilitates a clearer profile in the market, and may result in higher profit margins in some cases.

The supply of products with a higher added value also involves higher costs and requires further investment in the market. Such extra costs must be earned back if this is to become a viable option.

In fact, cooperatives will not be able to process the total production of their members into products with a high added value. For the other products it is important to continue to compete at a low cost price. Since the objective is to sell the entire production of its members, only processing those products for which a high added value can be realised is not an option which the cooperative can take.

If demand for certain agricultural products is insufficient, regardless of whether or not they are in processed form, the members will be aware of this in the payment price. The cooperative is unable to absorb losses due to a fall in the market price which is not passed on to the members. The members have a vested interest in the cooperative occupying a strong position and in signals from the market being promptly fed back to the members via the price.

To achieve both added value improvements and low cost price, it is important for the cooperative to have sufficient capacity, performance and solvency. This will be considered at a later stage in this article.

New markets outside Europe may be open to exploitation by a number of sectors. To do so, the higher costs of transport and the investment required to develop sales channels must be earned back. In most cases this means that products with a high added value offer the best potential to offset the cost of transport and marketing.

Increasing power of the retail chains
The increasing power of retail chains can be responded to in two ways.

a) To negotiate on a par with the retail chains the cooperatives must become larger entities. In this respect it should be noted that the relationship between the retail chains and the food and beverage industry is not only characterised by negotiations on prices and margins. An increasing degree of computerisation, particularly in the retail chains, is enabling better insight to be gained into the cost structure in the product chains and into the possibilities for cost saving. This will help to result in more efficient logistics and shorter order and delivery times. This will, in turn, allow partnerships to be created between cooperating companies which communicate intensively with each other through information networks. Cooperatives in can indeed be good partners in the further implementation of efficiency in the product chain, and this is an area in which they have already proved themselves in the past.

b) To stimulate the demand for own products cooperatives could following a 'pull' strategy by creating a direct link between the consumer and product through the selling of brand articles and through consumer advertising. In many cases this strategy will lie in the prolongation of selling products with more added value. Brands will have to be visibly distinct from bulk products, and induce the consumer to pay more for them. However, it is very expensive to develop a brand. A pull strategy also makes demands on the company's size, solvency and performance.

Increase in scale
Cost price efficiency, investment in added value, market development and the build up of market power demand sufficient scale. It is in itself possible for a relatively small company only to produce products with a high added value. This may, however, be possible for a number of smaller cooperatives with a special product, provided that these products continue to be well-differentiated in the market. In addition, it should be clear whether the strategy has a secure future, and what will be the effect of a fall in demand on these products.

However, in general the supply of the members' products is so large that a minimum size of the cooperative is necessary to achieve cost price efficiency and to spread the costs of investment in more added value across a greater volume.

Internationalisation
Internationalisation may provide a solution to the need for increases in scale. In a number of sectors this appears to be unavoidable if sufficient capacity is to be acquired. The process may involve acquisitions such as the recent takeover of Südmilch by Campina-Melkunie. Joint cooperative ventures or cross-border mergers between cooperatives may also be considered. Such moves are in line with the objective of the cooperatives, namely to obtain the highest possible value for their members' products.

The blurring of national borders is a central feature of today's Europe. This is true from both a commercial point of view and in terms of the members. A Dutch dairy farmer in the south of Brabant probably finds himself more attached to his Belgian colleague just across the border than to his colleague in east Groningen who, in his turn, has more in common with his Niedersacksen counterpart. Internationalisation of cooperatives will in practice often lead to regionalisation.

Core business remains central and potential forms of cooperation, merger or acquisition must ultimately tie in with the objectives of the cooperative. Activities foreign to the core business put a disproportionate burden on the management whilst, at the same time, requiring the use the limited amount of equity available.

Strategic management
The developments outlined above place high demands on the management of cooperatives. Well-qualified management in the executive boards must provide leadership on a daily basis and develop policy initiatives, whilst the board of directors focuses on general

policy. This has already been achieved in a number of sectors. In other sectors a further delegation of responsibilities to the management remains to be implemented.

The demands made on the executive boards of cooperatives are more or less the same as those made on the directors of private enterprises of similar size. The specific objectives of cooperatives and the additional need to communicate with the members requires additional abilities in communication.

In order to find directors who can meet these demands, they must be rewarded commensurate with the demands imposed on them. Investment in good management is profitable in the end.

Investment and financing

The necessary investment in cost price efficiency, added value, market development and increase of scale put heavy pressure on the financing capacity of the cooperative. The risk-bearing capital of the cooperative has traditionally been provided by its members, the advantage being that the members fully retain their influence on policy. The disadvantage, however, is that such a structure limits the size of risk-bearing capital.

To be able to deal with this problem, risk-bearing capital from third parties can be attracted, if required - for instance, by issuing shares on the stock exchange. The disadvantage to this solution is that a conflict of interests may occur between the providers of risk capital, who require the highest possible return on their investment, and the members who want the highest possible revenue for their product. The latter will continue to remain the main objective of the cooperative. This conflict of interest therefore makes it difficult to attract risk-bearing capital from third parties if the cooperative objective is not to be compromised.

In a preliminary unpublished study entitled "Farms and food industries in European dairy cooperatives" by drs. A Zwanenberg, a distinction is made between investment in dairy cooperatives related to members' products and investment which does not relate to members' products. According to the author it is desirable for members themselves to continue to provide risk-bearing capital for investment in activities which directly concern their own products. This might involve new technologies, product renewal, market development, logistics and replacement investment.

Investment not related to members' products could be partly financed through risk-bearing capital from third parties. This might include investment for internationalisation and the spreading of risks. In fact, this involves strategic related investment (the building up of market power, for instance), rather than investment directly concerned with the members' products.

A similar distinction between types of investment and related financing would also appear to be relevant for other sectors.

For all enterprises, including cooperatives, the available risk-bearing capital for developing new initiatives is limited. In order to promote the interests of the members, this limited capital must be employed in the first instance to strengthen the core business.

In this respect it is worth reiterating that the primary sector has a vested interest in its own sales and must invest in these activities, which are carried out by its cooperative. It must do so, firstly to keep sales channels open for its own products and secondly to enable farmers to receive the highest possible share of consumers spending.

Members of the cooperative now have to be more attentive than they were in the past to the market position of their own sales organisation. If the payment price is too high, the apparent short term gain will be outweighed by the limitations imposed on the position of the sales cooperative and its ability to achieve better longer term pricing.

In terms of financing the cooperative, the current financial position of a number of cooperatives appears to be an obstacle to larger investment. If the cooperatives are considered as extensions to the primary sector, this problem can be modified somewhat. In general there is a noticeable difference between the solvency of cooperatives and the solvency of the primary sector. An example is vegetable farming. In 1992 the average solvency of the vegetable auctions amounted to some 15%, clearly on the low side. Auctions wishing to invest in product development and/or market exploitation are in a stronger position if their own capital is 30-35%. In order to bring the solvency of the vegetable auctions up to this level, their own capital will have to be increased by 150-175 million guilders. A single contribution of 150 million guilders to the auctions would reduce the average capital of the horticulturalists by 1.1% to 56.2%, still an acceptable percentage for this segment. However, in current market circumstances this might result in financial difficulty for individual horticulturalists. A number of auctions have therefore opted for another model whereby own solvency is increased over a period of years by introducing a member account coupled to a liquidity levy which helps strengthen the guaranteed capital.

In other sectors the solvency is higher than in glasshouse horticulture. In 1992 the solvency in agribusiness ranged from an average of 69% in the pig meat and poultry sector to an average 79% in arable farming. It should be remembered that these are averages; the situation per business can vary tremendously. As with glasshouse horticulture, the readiness of farmers to invest in their cooperatives is dependent not only on solvency but also on their own profitability. Indeed the members of the cooperative will have to be compensated for making capital available, and at rates comparable with those which members can obtain from banks.

If the risk bearing capital of cooperatives is strengthened, in this way their ability to attract foreign capital under normal conditions increases considerably.

Conclusions

It is sometimes claimed that the cooperative is an outmoded market formula. The contrary is in fact true. However cooperatives must constantly adapt their business operations to changing market circumstances.

Sales cooperatives in Western Europe are facing saturation in Western markets for agricultural products and an increasing concentration in the retail trade. Based on the objective of achieving the highest possible revenue price for the members' products both short and long term, an answer must be found to these developments.

It is important that the cooperatives exert as much influence as possible on the production chain. In so doing they will be able to use their strong position to retain access to the sales markets. They will also be able to differentiate themselves in the market, leading to higher profit margins in a number of cases.

The achievement of a strong position in the chain may mean that the cooperative itself produces much of the chain's added value. This will not, however, be possible for the entire production of the members; cost price efficiency will continue to remain crucial.

New markets outside Europe can be considered for a number of products but in view of the need to recoup the higher costs of transport and marketing, this will in most cases only be a possibility for products with a high added value.

In order to compete with the increasing power of retail chains, sufficient size is essential. In the relationship between the food industry and the retail trade, partnership is becoming increasingly important. Within such partnerships collective discussions take place concerning the most efficient organisation of the production chain. Cooperatives can play a significant role here. An alternative option is to create a direct bond with the consumer through brand policy.

Sufficient size is essential for all strategic options. Internationalisation or regionalisation is often a possibility and sometimes a necessity.

The necessary investment in added value, cost price efficiency and the establishing of market power put pressure on the cooperative's financing capacity. It would appear desirable for members to remain responsible for the provision of risk-bearing capital for investments concerning their own products. The primary sector has a vested interest in investing in its own sales organisation, even when incomes are under pressure. Investment not related to members' products could also be financed through the risk-bearing capital of third parties.

The need to respond to the developments described above and to develop policy in cooperation with the membership makes heavy demands on the boards and directors of cooperatives.

II. Informatics

Computer integrated agriculture: an essential element in agricultural chains

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Abstract
Consumers attach great importance to safe and clean products. This requires market oriented production in which quality, environment and animal welfare are considered. New integrated tools in management to fulfil these requirements require more information and a better information flow between different production phases. The objective is to develop a competitive modular and open IT system for the new generation of management tools in agriculture. This will be achieved by adapting knowledge, concepts and solutions from Computer Integrated Manufacturing (CIM) technology.

To realise such a system the CIA project is carried out in which the main business processes in agriculture are defined, an architecture is designed and information is described in a detailed information model. An inventory is made of communication technologies, and a selection will be made for the different levels of communication in the agricultural production system. The developed models, definitions and protocols are submitted to international standardisation bodies.

This paper describes an architecture for the agricultural production control in the primary sector. The architecture is based on different levels of architectural generalization as described in the CIM-OSA concept. As such the generic parts are applicable in all branches of agriculture. In this paper especially the control of production processes will be highlighted. The most important objects associated with production control that are relevant for data exchange between the different production levels and production organisations will be discussed.

An important aspect of the integrating infrastructure is the communication technology. The possibilities for application of the Manufacturing Message Specification (MMS), the application layer used in the MAP standard, on the process control level in agriculture is investigated.

Introduction

Consumers attach nowadays great importance to safe and clean products. They are not only concerned on composition and possible residues, but they consider also the method by which is produced. Production methods must be save for the environment and animals should be kept on a sound way.

This requires that the outlet to the consumer can control and eventually prove that the stated production methods are followed.

The cost of production must be competitive in a open international market. This last aspect requires optimal adjustment of production between the different organisations within a production chain.

This requires market oriented production in which quality, environment, animal welfare and cost are considered. New integrated tools for management are developed to fulfil these requirements. They are able to optimize the level of product input based on more objectives, like profit, labour saving, environmental protection, etc. Production control will be focused on achieving a well specified quality of produce. These management tools require more information and a better information flow between different production phases.

The CIA project

A European research project is started within the ESPRIT III CIME programme with the objective to develop a competitive modular and open IT system for the new generation of management tools in agriculture. This project "Computer Integrated Agriculture" is carried out by the Danish Agricultural Advisory Centre and Land-Data from Germany, both producers of agricultural software, three manufacturers of process computers; LH-Agro specialised in control equipment for crop production and Skiol-Datamix and Skov specialised in control equipment for pig production. All three come from Denmark. The Agro Telematic Centre and the Department of Agricultural engineering and -Physics of the Wageningen Agricultural University are the partners from the Netherlands in this project.

The development of an open IT system will be achieved by adapting knowledge, concepts and solutions from Computer Integrated Manufacturing (CIM) technology as it is under development now in the industry. To realise such a system the CIA project is carried out in different phases for analyses, design and selection of technology. These are;

- definition of the main business processes in agriculture production,
- design of an architecture,
- description of information in a detailed information model
- inventory of communication technologies and
- election of technology for the different levels of communication.

Implementation will be realised by;

- communication interfaces for on-farm and external communication,
- a system wide data base,
- a farm application manager for crop and pig production,
- a plot manager for crop production and
- integrated production control.

An important aspect of the project is the validation.

The developed models, definitions and protocols are submitted to international standardisation bodies, particularly ISO/TC23/SC19 that deals with agricultural electronics on farm equipment and installations.

The scope of the project is limited to crop and pig production, but the chosen and developed technology is intended to be valid for all agricultural branches.

Architectural framework

A reference architecture is to be provided for the agricultural production sector that must fulfil the following requirements.

- The models must reflect enterprise decision making, the organization, the business processes, the activities, information interchange and material flows.
- The models must be flexible to reflect a changing environment and it must be possible to built implementations on an evolutionary manner.
- The models should guide the user in a wide variety of production branches.
- The models must assure system consistency.
- The models must support a system wide information interchange.

These requirements can be fulfilled by adopting the architectural framework as described in the CIM-OSA approach. Central in the CIM-OSA is a three dimensional description of the whole framework;

- the architectural levels,

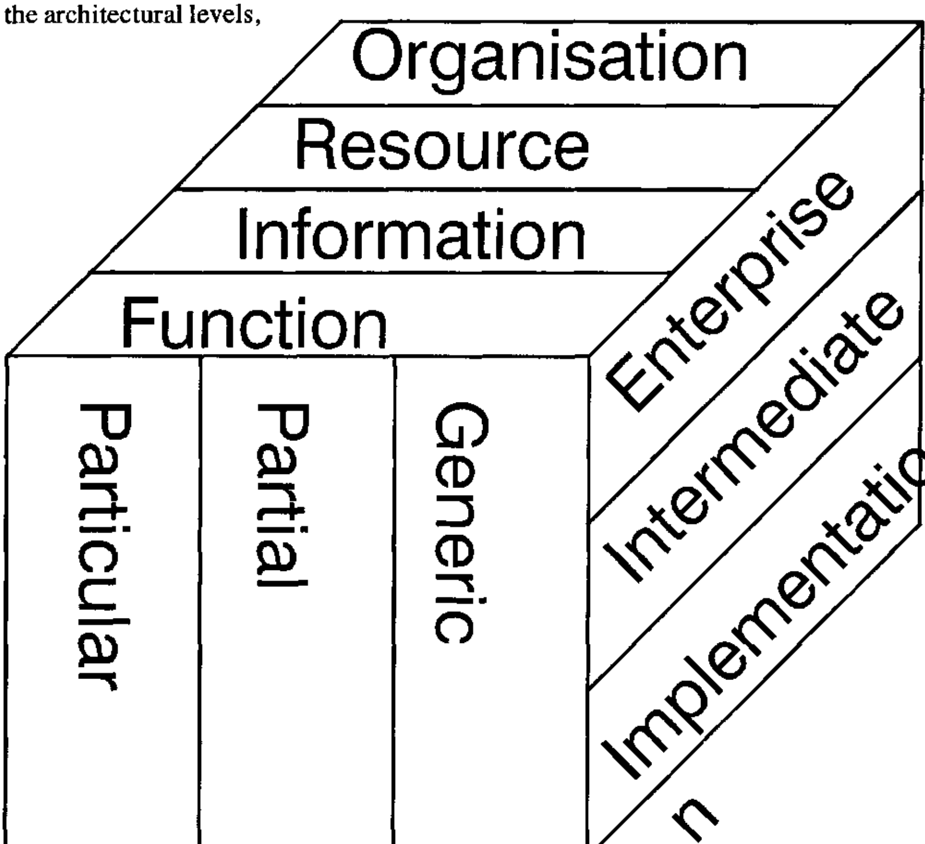

Figure 1. The CIM-OSA Architectural Framework

- the modelling levels and
- the CIM-OSA views. (*Fig. 1*)

Architectural levels.
The architecture has three levels of generically; the Generic Level, the Partial Level and the Particular Level.

- The Generic Level is a reference catalogue of generic building blocks (for components, constraint rules, terms, service functions and protocols), which are not specific for a particular production sector.
- The Partial Level creates a particular architecture for a particular category of production enterprises.
- For the creation of the Particular Level Architecture Instances both the Generic and the Partial constructs are used.

Modelling levels.
Three levels are distinguished in modelling; the Enterprise-, Intermediate- and Implementation Modelling Level.

- The Enterprise Modelling Level contains a number of fundamental business aspects which are expressed in views. It includes the requirement definitions.
- The Intermediate Modelling Level considers all enterprise constraints (business and system capability related) and provides a globally optimised set of enterprise requirements.
- In the Implementation Modelling Level contains system descriptions (Component Specification)

CIM-OSA views.
The distinguished views are the Function, the Information, the Resource and the Information View

- The Function view describes a set of hierarchically structured business processes.
- The Information view gathers all information defined and contained in the enterprise.
- The Resource view contains relevant information on resources.
- The Organisation View describes the different responsibilities in the enterprise.

The approach followed by the consortium.
It was from the beginning onwards felt that an object oriented approach would be the appropriate one to follow in this project. Much of the arguments in favour of a object oriented technology such as modularity, reusability, extendibility and reliability (Meyer, 1988) are applicable for the project. However at the start of the project there were practical reasons not to follow object orientation consistently. Some of them were;

- lack of experience with an object oriented technology by most of the partners,
- no proven wide accepted methodology for object oriented analyses and
- because of above mentioned reason no case tools to document object oriented analyses.

It was decided that the technique of structured analyses following Yourdon (1989) would be used in the analyses phase of the project to describe business processes and enterprise activities. Entity relationship diagrams following Chen (1976) are used for description of the information. Eventually an object oriented methodology would be used in the design face and following implementation. This would be based on the structured analyses methodology. Later it was decided not to follow the object oriented methodology for the system wide data base to be set up by the German partner. The reality is that a medium sized enterprise can't base his most important tool, the data base, on a new, not proven technology as object oriented data-bases. An object oriented design and implementation is also not used on the lowest process control level in crop production, where cheap micro controllers are required for economical reasons.

Farm management software will be designed and implemented following an object oriented approach. This approach will also be used by the Department of Agricultural Engineering and Physics for an experimental set up of a process control system in crop production. In such an experimental set up cost aspects for commercialisation are not considered. Object orientation will be used in stationary process control up to a certain level in the hierarchy, as will be discussed under the MMS communication system.

The CIM-OSA architectural framework is regularly used as a reference for the work in the CIA project. It is referred to as a concept, but at the starting time of the project hardly any implementation technology was made available.

The CIA information model

A number of organisations, enterprises and manufacturers of components and software are involved in Computer Integrated Agriculture. To be able to develop an open system there must be a common representation of the "world' they are working in. Such a common description is made in the CIA project by formulation of an information model.

It is the intention of the consortium to describe one information model that is valid for primary agricultural production in Europe.

Branch organisations to promote information technology in agriculture in the Netherlands started to built branch specific information models for the primary production sectors. (Siplu, Situ, Siva, Sivak, Taurus) One of the problems faced with these models when used as a starting point for the work in the CIA project was that notwithstanding all used the same methodology (Information Engineering), they show differences in describing functions and information which they have in common. In Germany and Denmark mixed farms are more common then in the Netherlands and software houses are less branch specific. General enterprise activities as maintenance of durable equipment, personal administration and bookkeeping must be uniform. For a software house it is efficient to treat activities as stock keeping uniform for all branches of agriculture.

Information model as base for standards.

The CIA information model will be used as a bases for international standardisation of communication in agriculture. For communication on the different levels in the agricultural chain there must be a common model that is shared between the partners that interchange information. Information exchange can take place on different levels of model instantiation (*Fig 2*)

Communication on the industry (production branch) level is of interest for comparison of enterprise performance.

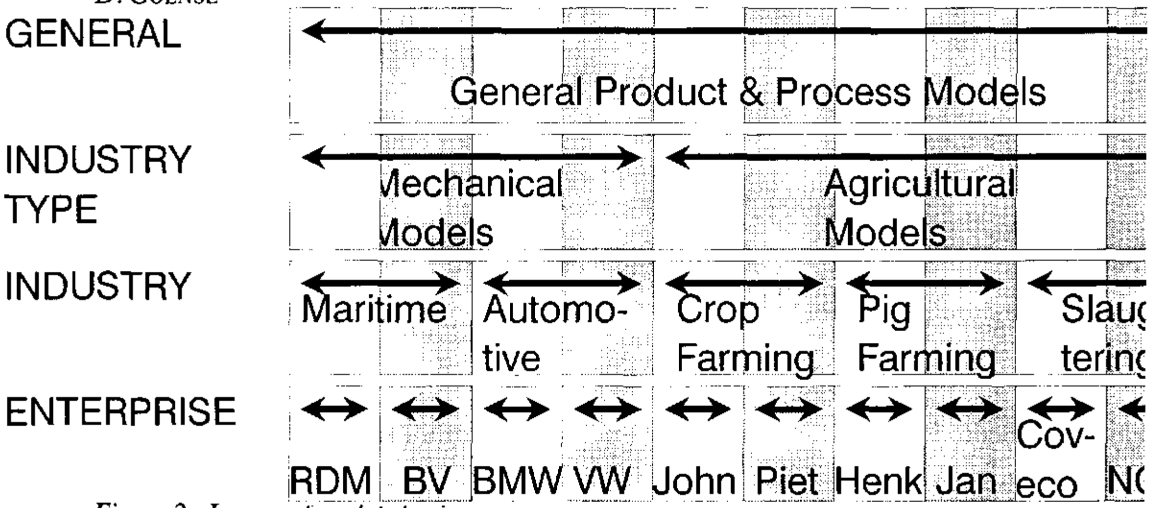

Figure 2. Layers of model sharing

Figure 2 shows that pig farmers and Slaughterhouses need at least a common agricultural model to exchange data, but as soon as transporters, which are also active in other industry types, are involved there is a need for more general models. Aspects of process control and measurements will also need general models when process controllers and intelligent sensors are involved. They are not manufactured for a particular industry type.

Description of Business processes.

Business processes describe that what is required to achieve a particular enterprise objective. It can be expanded in a hierarchy of business processes and a Business process cluster of lower level process activities (Enterprise Activities) required to carry out the tasks. (CIM-OSA). As such Business processes are comparable with the Functions in Information Engineering (Martin 1989)

The business processes for Computer Integrated Agriculture are described as processes in the top of the hierarchical structure of the Data Flow Diagrams.

Wether on the top of the hierarchy a division must be made between production sectors like crop production, pig production, dairy production and contracting, or between functions in the control concept like strategic-, tactical-, operational-planning, execution and evaluation took some time for discussion.

Because the Business Process "Scheduling" has to deal with activities from different sectors in a mixed farm enterprise the choice ultimately came to a division based on a general control concept.

Here a similarity can be found with the structured description of processes in an agricultural production chain. Here also an early division can be made in functions connected to the different production organisations or in the management control functions of the chain as a whole.

Object model.

The need for a common object model.
It is possible that manufacturers agree on standard communication techniques for data exchange between the different levels from sensor to farm controller. In these standards the functionality of ISO-OSI layer 1 through 7 will be covered, and information expressed in abstract objects like variables and files are exchanged.

In computer integrated agriculture it are the applications that must be integrated. Characteristics of the produce like an animal for slaughtering, a box of beef, a lot of ornamental plants, a lot of potatoes or a bag of frozen French fries must be passed to the other organisation which is responsible for further processing or resale. The Device Controllers, the Tool Controllers or the Intelligent Sensors calculate or measure the characteristics of the Product/Produce during primary production or processing. These controllers also measure the Specifications such as process data and used products during the operations on the produce itself or on the objects like animals and crop area's where the produce will be harvested from.

Different organisations within an agricultural production chain might have their own specific object model to describe the relevant objects in their enterprise, but for communication in an integrated agricultural production chain there must be a common description of the objects on which information is exchanged.

Within each enterprise there is equipment, computers and software from different vendors that is used to plan, realize and control the production. These vendors sell on many different enterprises. Especially in the primary agricultural production sector these resources include the application programs for production control. For communication between the resources of different manufacturers there is also a need for a common object description.

Objects in primary farm production
There is a clear distinction made between the management of resources like workers and equipment and the control of processes with their specifications in the description of the objects in primary agricultural production.

Operation
To produce crops, raise animals and maintain equipment there are *Operations* performed on *Account Objects* like *Cultivation*, *Animal Group*, *Animal*, *Equipment* and *Building*. The operation describes the change in the condition of the object that must be (or is) realized following a *Specification*. Such a Specification might either be an amount of product that should be used or is harvested (*Consumption Yield*) and/or includes *Process Data* such as for instance a working depth or a milling grade and it can eventually also exist of *Measuring Data*. (*Figure 3*) Specification reflects the object as a whole. For smaller units within objects like animal groups and fields there are special measures.
The Operation has a status variable which indicates whether the operation is;

- An optional operation, Which indicates that the operation can be carried out in a certain time period following a particular specification. It is up to the production planner and scheduler to choose between optional operations to realize a particular production function.

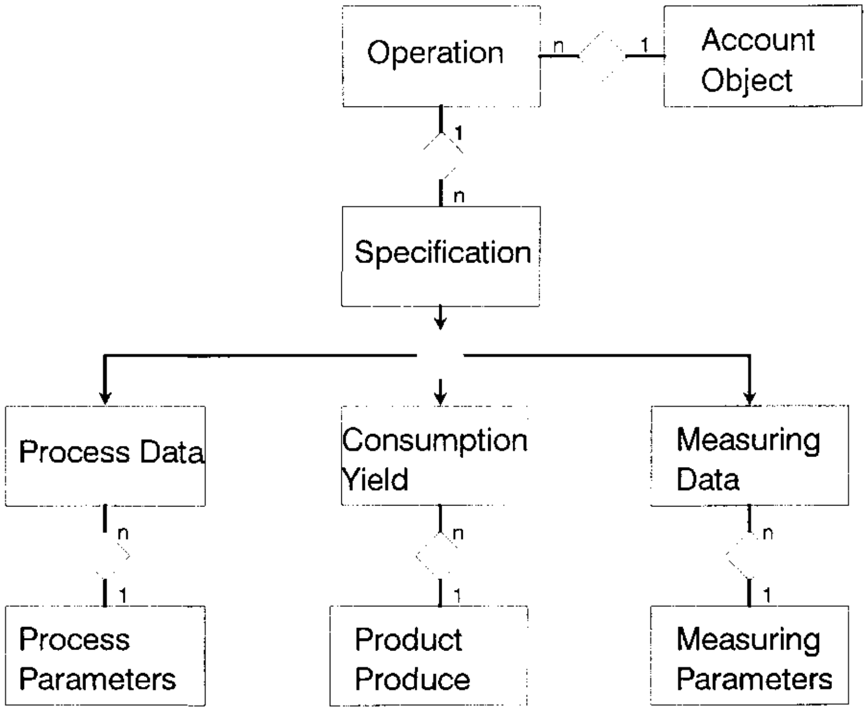

Figure 3. ERD Diagram: Operation

- A planned operation as the result of the scheduler to be carried out within a certain time period.
- An Operation in execution.
- An interrupted operation when the work is partly finished and has to be continued.
- a realized operation which is finished.
- a terminated operation which is partly finished and will not be continued.

Job and Task

Resources as workers, powered vehicles, implements and installations are required to realise the work. An operation following a specific specification can be carried out by different working methods, i.e. how it is organised. Sometimes operations depend on each other as is the case with harvesting, transport and loading a storage. Sometimes it can be executed in parallel or separately, like for example harrowing and planting. It is up to the scheduler to choose the way in which the work will be organised in respect of availability of the resources.

All the resources working organisationally together to realise one or more operations on the same object form a gang and execute a *Job*.

Resources that are physically linked together form a work-set and execute a *Task*. Such a task can exist out of more operations like harrowing and planting executed at the same time in crop production and milking and concentrate feeding executed at the same time in

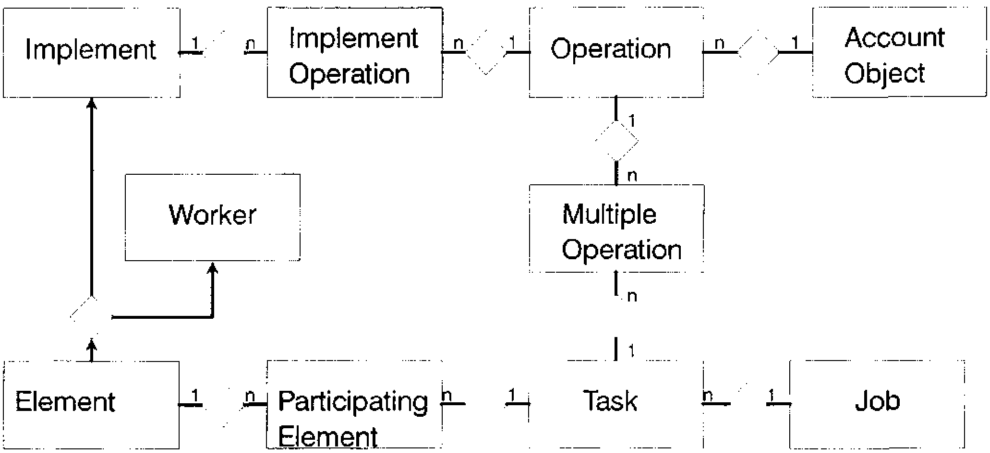

Figure 4. ERD diagram: Task-Job

dairy farming. On this manner a Job exists of one or more Tasks and both can have the status; planned, in execution, interrupted, realised or terminated. (*Fig. 4*)

The information collected on Tasks and eventually Jobs is restricted to management data, such as Participating Element that specifies the time that a resource was active in task and for equipment the time of eventual breakdowns. On a task also the time can be measured in more or less detail, depending on the requirements of the specific enterprise.

In a lot of cases there will be one operation for each Task and one Task for each Job, so the need for a distinction between Operation, Task and Job will not always be felt and therefore not found in present day agricultural software.

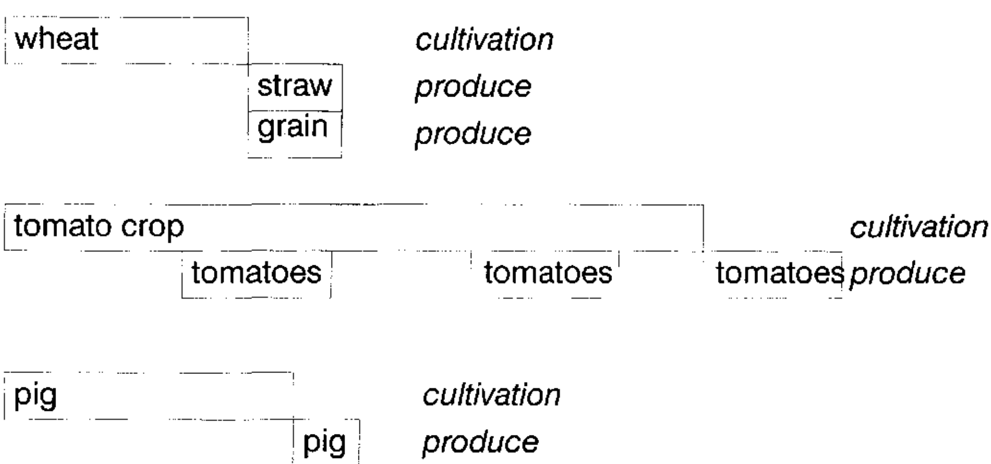

Figure 5. The conversion of Cultivation to Produce

Cultivation and Product/Produce.

The most important objects in agricultural chains are the Products used in a production process and Produce as the result of it. A division is made between the object that is used for bringing forward a Produce, the Cultivation, and the Produce itself.

Wheat growing on a particular field is a cultivation that can bring forward two produces; the straw and the grain. A cultivation of tomato plants results periodically in a batch of tomatoes as produce. With ornamental plants or pigs the same physical object of plant or pig is converted from Cultivation to Produce at the time of collection for delivery. Potatoes are a produce that at a certain time will be a product used as input for a next cultivation. (In the model there is no distinction between product and produce) (*Fig. 5*)

Registration of the process parameters, amounts of products applied and status data can take place on a Cultivation during operations, which might be pure measurements. Because operations as cooling sorting and disinfecting can also be performed on the produce itself there are also registrations on the produce.

An operation as sorting has one product as input and two or more products as output, while in animal production a new product will be produced by milling and mixing two or more products.

Small units.

Operations are executed on objects like fields and animal groups, but more and more a differentiation in the specification is required for smaller areas within a field or individual animals within a group. Positioning systems and identification systems make this feasible. The specification for each to distinguish unit is given as an absolute or relative value of the referred Specification for the whole object.

In an agricultural chain it might be of interest to the whole chain to keep smaller units of produce separated and individually treated. With animals and produce stored in containers this should not be to much of an effort, but in crop production where present harvesting, transport and storage equipment is based on treatment of the whole field this will require high additional investments.

The farmer and the following logistic part of the chain can only be encouraged to do these investments when the price of the produce is a non-linear function of a to distinguish characteristic of the produce.

Architecture for farming.

The proposed production architecture is described for crop production and its specific aspects. The architecture is however also applicable for animal production.

The farm controller is on top of the hierarchy and incorporates processes as operational crop/animal/contract planning and scheduling. The job controller is responsible for control of all the resources that work organizationally together and the task controller is responsible for the resources that work physically together in realising one or more operations. The device controller is responsible for the coordination within the device that on itself can be divided in different tools like flow control valves and booms which have their own closed loop control. On the lowest level intelligent sensors and actuators will be used. (*Fig. 6*)

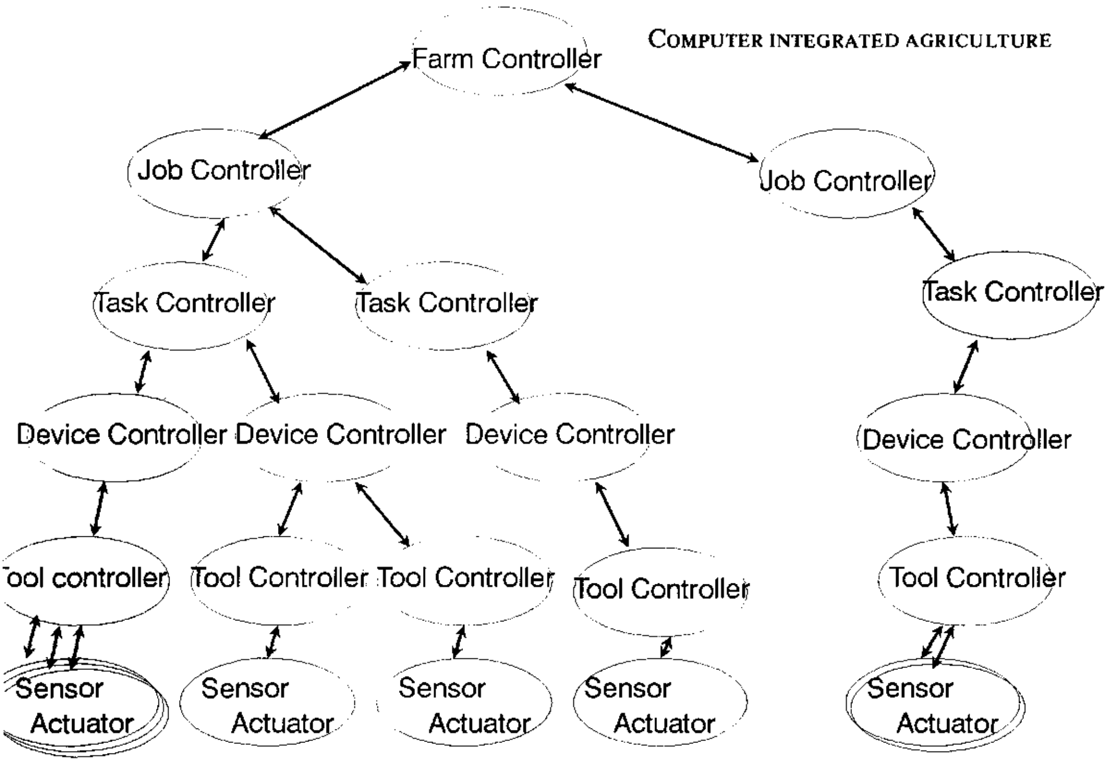

Figure 6. A controll architecture in primary farm production

Communication.

The controllers mentioned in chapter 5 are functional units which can be implemented on different platforms and platform types. The lines drafted in figure 6 represent information flows that need to be communicated. In an open environment with different manufacturers this communication has to be standardized, even when they are located in the same computer system. The techniques that are appropriate will be determined by the physical distribution, the data volume and eventual real time aspects.

The Job Controller in arable farming can be located at the home base and than it can be located in the same computer system as the Farm Controller, but it might also be possible that it is located in the same computer system as the task controller on one of the work-sets in the field. In dairy farming or horticulture it can be located more near to the work place. In that case a communication link is required between those two systems.

Present standardisation activities.

ISO/TC23/SC19, the subcommittee on farm electronics developed the Agricultural Data Interchange Syntax (ADIS) as a protocol for information interchange between Management information Systems (Farm Controller) and the process computers (remote Job Controller and Task Controller). This protocol specifies the format of an ASCI file by which messages are interchanged. The content of a message is specified in a so-called D-line by a listing of data dictionary numbers out of a application specific data dictionary. The values are given in one or more subsequent V-lines.

WG1 (mobile applications) and WG2 (stationary applications) of mentioned subcommittee are formulating data dictionaries for their respective applications.

Within WG1 standards are drafted for communication between mobile process computers on farm equipment. This standard will be compatible with the ISO standard for Truck and Bus and uses the CAN protocol. Messages for the agricultural application have still to be specified. The CIA information model will be used as a basis for the data dictionaries.

Manufacturing message system, MMS.

The communication technology is an important aspect of the integrating infrastructure. The possibilities for application of the Manufacturing Message System (MMS) on the process control level in agriculture is investigated.

MMS, that is part of the application layer used in the MAP standard, has the objective to control and monitor remote applications by means of loading programs, starting and stopping programs, reading and writing variables, etc.

MMS uses the concept of the virtual manufacturing device VMD, which describes the external behaviour of a device and contains a representation in the form of objects of the resources and the functionality of the device.

Objects used to describe such a system are: variable, domain, program invocation, event, semaphore, journal. A number of appropriate services are defined for these objects such as read, write, download, etc.

A sprayer described as VMD.

An agricultural sprayer can be described by a list of terms as nozzle, open/close section, mixing bin, pump, control valve, product, folding section, water bin, chemical bin, etc.

How such an agricultural sprayer can be described as a virtual manufacturing device is shown in *figure 7*.

The device has a number of VMD specific variables, such as NumberOfProductBins, NumberOfFlowControlSections which are specific for an agricultural sprayer. Apart from the specific variables it has the generic VMD variables such as Name, Status, ListOfCapabilities.

A program invocation object represents a program that realises particular functions of the VMD. In a sprayer there can be programs to control the height and balance of the spraying boom, a programm that controls the product application, and one that deals with cleaning of the equipment at the end of a task.

Within the VMD a number of domains are specified which describe specific data structures for an application. They can be seen as objects used within the VMD and have their domain specific variables.

Events represent an occurrence that is the sign to start a specific action. By starting such actions the VMD can come in different states like Power Up, Transport, Idle, Ready, Operating, Filling.

There can be different classes of sprayers. Some sprayers require that placing in/out transport is done manual, other can do that automatic. Some sprayers are able to dose different products simultaneously, others are not. This is specified in the list of capabilities and there is a correspondence between capabilities and the domains, program invocations, variables and services that must be present in the VMD.

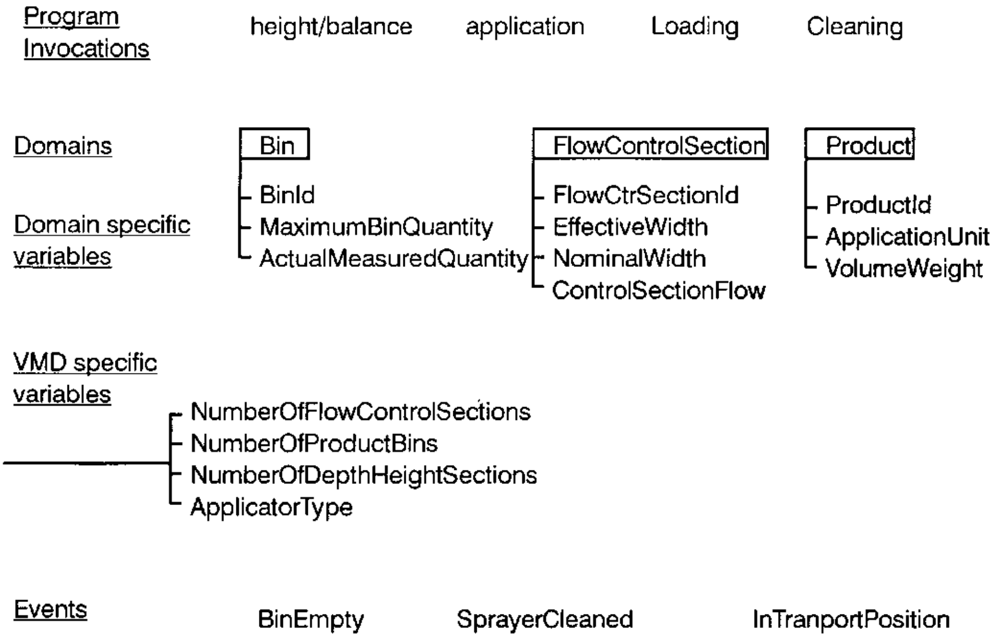

Figure 7. An agricultural sprayer descibed as a Virtual Manifacturing Device

MMS in agriculture.

The main reason to use MMS in agriculture is because it provides a standard method to communicate with devices which is independent of the location of the device and eventual applied communication technology. This means that an application process can "talk" with an other application process by means of MMS primitives, without even knowing wether the other process is located in the same computer platform or located on an other one and must be reached by a communication protocol. The big advantage is that it is a ISO standard applied in the production industry and that MMS compatible tools and software will be available.

The original place of MMS in the MAP communication system will not be acceptable in agriculture because of the large overhead in the for MAP defined OSI layers 1-6. It is possible to use the principle of MMS with a simpler communication protocol and this is also done in the industry.

It must be investigated to which extend MMS can be applied in real time control loops. The software overhead of MMS in combination with the applied low priced hardware in agriculture will have its limitations.

Experiments will be carried out with a mobile application, but stationary applications in agriculture might be more appropriate.

Communication in agricultural chains.

Often the impression is given that communication between enterprises in an agricultural chain is trough the computer system that handle the management of the enterprises. Central computer systems can eventually have a role in this communication.

In the future also computer systems that are lower in the hierarchy will have to communicate. An example is the board computer of a truck that is hauling milk and communicates directly with the cooling system on the farm to pass actual data on the milk. An other example is the controller of a manure injection system that directly gets his data on manure composition from the truck that delivers.

This means that apart from technical standards for such communication also the data which is used near to the process level in the different enterprises must be uniformly defined.

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Information systems Architecture: creating links in the chain with IT

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Introduction

The rapid evolution of information technology enables new opportunities and optimization of processes in the production chain. The production chain is an area of enormous potential for integrating various information systems. Besides system integration of single entrprises, cooperating networks in the product chain require external integration. This requires an adjustment of the semantic and pragmatic concepts, which are applied by the involving enterprises. It will be argued that the construction of models for the product chain can be conducted by integration of selected components from enterprise information architectures. The planning and implementation of these architectures is likely to cut across existing departemental boundaries and orgzanizational biases may raise political issues and concerns. Information architecture, despite its widespread usage, has no standard definition. Much confusion surrounds the information architecture concept. To my opinion practical guidelines are necessary for the involved business for going through the organizational and IT labyrinth. Architecture planning is better not undertaken unless it can be done right, using staff whose credibility and prestige are high within the participating businesses. The purpose of this paper is:

- to clarify the context within which various relevant architectures are developed and interact
- to examine important IT trends that may have consequences for the way we exchange information in the product chain
- to illustrate essential components that support the construction of chain models based on information architectures of separate enterprises in the chain

Therefore an in-depth analysis of the fundamental components for the construction of these architectures is given.

Metamodels for complex systems

The modelling of complex information systems, like interorganizational systems, requires that a large number of issues to be dealt with. Various frameworks to model infor-

	what	how	where	who	when	why
product chain						
enterprise						
system model						
information technology						

Figure 1. Applied framework

mation systems have been proposed. Among them are those of CRIS , CIM/OSA and Zachman and Sowa. *Fig. 1* shows the framework adapted for this study.

In these frameworks a different number of dimensions and a different subdivision of these dimensions in perspectives or aspects is proposed. The CRIS approach and CIM-OSA use as one of their dimensions the life-cycle of information systems. For projects where this system development phases are not considered, or when applying an evolutionary develoment method instead of the waterfall cycle, this dimension is not recognizable for the projectmembers.

More useful is a dimension representing a number of abstraction levels each related to the perspective of a major interest group. The second dimension illustrates the system aspects that can be distinghuished: data, function, network, people, time and motivation. Therefore the framework of Sowa Zachman is adapted, fig. 1 gives an overview of the relevant aspects represented in the columns, the perspectives of interest groups as distinghuished in this study are shown in the rows of this table. The data aspect deals with what information is required. Function refers to how the processes in the businesses are done. We will give repesentations of the dynamics in the time column (when). The network describes where the relevant locations are. Authority and responsiblities assigned to agents are represented in the who column. Purpose and objective are formulated in the motivation column, answering the why question. The basic model for each column is actually a generic metamodel. Each row represents the models for the related interest group. Their perspectives will mostly emphasize different constraints. Constraints are additive. In practice a constraint in a lower row might be inconsistent with a model in the next higher row. In practice the interest groups who stand for the model must speak about these constraints and decide what must me changed to ensure consistency with models of contiguous rows. The adapted framework is suitable for constructing information architectures and may be uses as a checklist in composing project scenarios.

Well-known modelling techniques are applied in the metamodelling approach, where the resulting components of these techniques are adjusted, balanced and checked. The

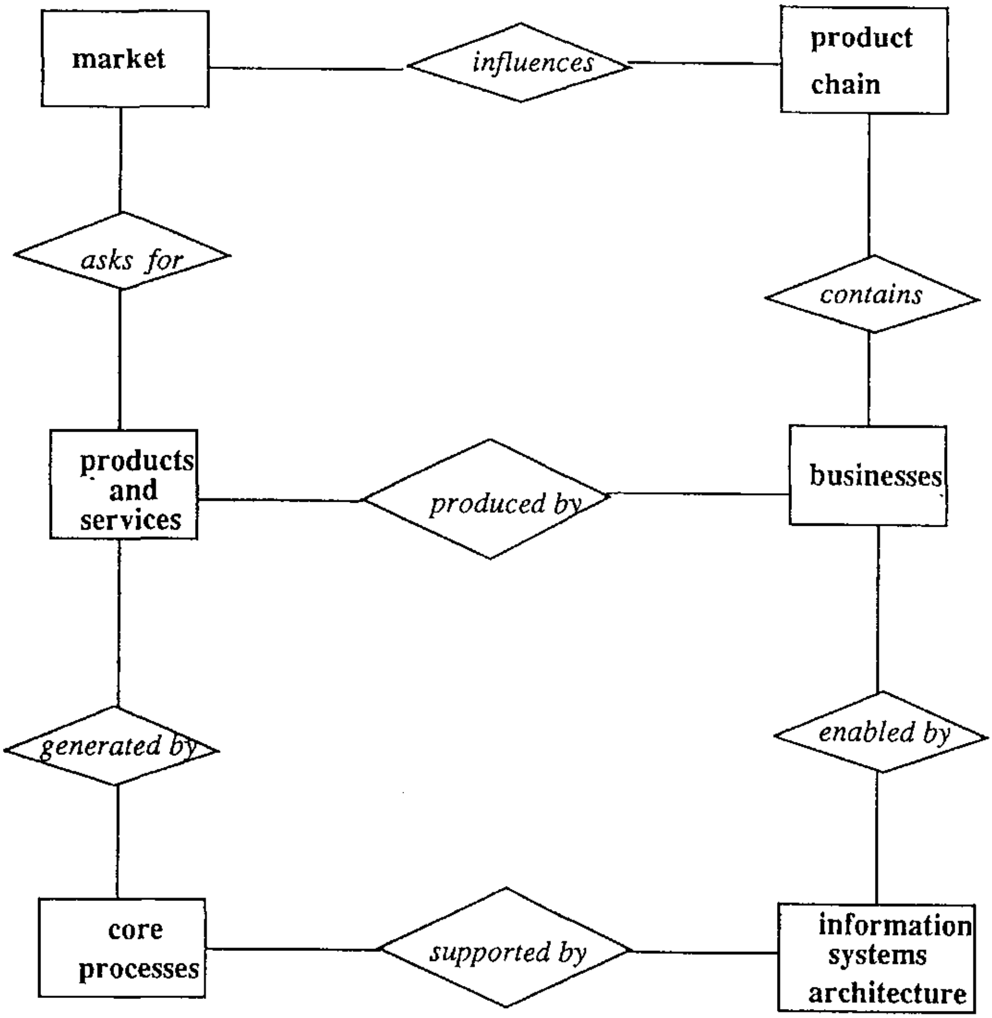

Figure 2. Meta datamodel of the product chain

basic model for each column is mentioned a generic metamodel. It is generic because it is the same for each cell in the colomn The meta-datamodel of *fig. 2* shows what important entities in the product chain are highlighted in this study. A meta-activity model will present how architectures in enterprises may be constructed in a way that they are tuned with relevant concepts of the product chain. In this approach we will reuse components of reference-models.

Reference-models

During the second part of the former decade several reference-informationmodels for the agricultural sectors as dairy, pigs, poultry and horticulture were developed in The Netherlands. Such a model, is a frame of reference for every one involved in building agricultural management information systems. The construction of the models was a joined effort of the branch organizations and agricultural researchers.

Partial models, which are reference models for a specified line-of-business, may be composed. These models may focus on one aspect of this framework, e.g. data in the approach which is advocated in. A special kind of information model is a reference-information model. Common information requirements and decision processes in a particular line are identified. Information systems planning studies which we conducted by using these reference-models showed that the duration of the studies can be shortened. In a meta-activity model illustrates how the planning studies can be accelerated using reference informationmodels.

Especially for small and medium business the use of reference models appear to advantages. It is often (economic) impossible to carry out a informationplanning study or to develop tailor-made information system for a small business. The use of reference models stimulates standardization of information technology, for instance supporting the electronic data interchange (EDI). The models for information planning studies are usually represented by means of natural language descriptions, charts, matrices and various other diagrams.

The use of reference models on the level of a line-of-business can be instrumental in the coordination and stimulation of a well-balanced introduction of information-technology.

We extend the framework from fig. 1 with a 3rd dimension: genericity. This level is concerned with partially instantiated models applicable to a specific category of enterprises.

Enabling information technology

The lowest row of fig. 1 refers to the information technology that enables enterprises to increase their efficiency and effectiveness of the core processes and to be more competitive with their products and services on the market. In order to be a valuable instrumentarium for the product chain some basic requirements on information technology may be defined:

- the decisions of the management, analyzing bottle-necks and opportunities, must be illustrated and supported by tools and simulation;
- reuse of specifications and software should accelerate the design of interorganizational information systems;
- large volumes of data about e.g. the market should be distributed in a fast and reliable way.

The role of standards

The amount of coordination is increasing as the interconnections within the production chain become more sophisticated and their dependencies grow. This raises the need for an understanding of standards. No single policy vision coordinates infrastructure development today. Nor could any centralized decision process posibly guide such a complex engineering today. Standards arise from either official acitivity or by the force of practice. For instance the Open Systems Interconnection (OSI) standards are official, or de jure standards, while DOS is a de facto standard for operations systems on Personal computers. A de jure standard might be more rigorously defined as a publicly available document voluntarily agreed upon as a result of public consultation. Cooperation may be described in terms of succisevely deeper levels of underlying processes. Many coordination processes require that some decision has been made. Group decision require members of the group to comminicate in some form, and this communication requires that some messages have to be transported in a standard language. In this setting standardization plays the dual role as constraint and as coordinator.

Object orientation
Object-oriented system development claims to improve software design for reliability and maintenance. Further claims are that the development process is made more efficient by reuse. In an approach shows how reference-information models can be transformed to object oriented systems. The major steps of the object oriented part originates the methodology OMT (Object Modeling Technique). In specifying objects we distinguish static and dynamic aspects. Static concepts concern the attributes of the objects and the relationships between objects. Object orientation attempts to satisfy the needs of the end-users as well as those of the developers of software products. This is accomplished via real-world modeling capabilites as shown in exampes of applying these techniques to the fruit growing enterprises .

Object orientation provides better paradigms and tools by constructing reusable components and easily extensible libraries of specifications and software modules. As a consequence we don't have to recode everything from scratch when software for comparable functions within the product chain is constructed.

Prototyping
A prototype is the partial implementation of a system built expressely to learn more about a problem or a solution to a problem. The creation of a prototype has been a standard practice in many engineering and manufacturing industries for decades. The benefit of building a prototype instead of the actual object is that the risk of manufacturing and development is reduced. Promising technology in this area are CASE (Computer Aided Software Engineering) tools. Case technologies have demonstrated their potential for conceptual modelling and as vehicle of communication. There are two distinct types of software prototypes described in the literature: throwaway and evolutionary. A throwaway prototype is built as quickly as possible and the implementation is focused on the requirements that are poorly understood. After the prototype is complete, the specifications are extended with what was learned. Throwaway prototypes work very well in isolation to verify relatively small parts of a complex system. In contrast to a throwaway prototype, an evolutionary prototype is built in a quality manner. Confirmed requirements are implemented into baseline software products. In short time, a collection of useful changes and enhancements are taken to configuration management. The development team will incorporate the new features in a quality fashion into the evolutionary prototype, creating a new baseline.

Client server architectures
Modern distributed information systems are today based on client server architectures. A client server computational model implies a relationship between two processes in which one makes requests to the other. This organization allows a decomposition of function-

ality in complex interorganizational systems. Parallel databases can cope with large volumes of data and parallel hardware offers more processing power to ensure a good performance. This is a good alternative to conventional mainframe technology, small and unexpensive components can be used to build high performance systems.

The data highway
There is little disagreement about the benefits of a data highway. Extending the present infrastructure of fiber-optic strand, radio waves and satellites should ultimately result in better and faster links from enterprises, universities and homes to the communication backbone. Applications facilitated by the highway, such as videoconferencing, document sharing gives consumers a wide choice of services. It's in the details that opinions start to diverge, and these difference could have a major effect on how the information infrastructure will be further elaborated. Because contributing parties (telphone companies, cable distributors, computer manufacturers, publishers) may have different technologies and views, the forecasting of the ultimate form and function of the data highway requires examining these conflicting perspectives. Therefore we run the risk that it becomes increasingly difficult to manage the vast inventory of information resources without a clear, global understanding of their existence, location and role as well as the dynamic relation among them.

Reviewing IT
The methods, techniques and tools provided by todays information technology, should be maintained carefully. The mapping of the required technology products, methods and techniques is defined as the IT companionship. In the review of IT trends we may use the following quality factors:
- Verifiability is the ease of preparing acceptance procedures and procedures for detecting mistakes
- Robustness is the ability of specifications and software to function even in different locations and conditions
- Extendibility is the ease with which specifications and software may be adapted to changes.
- Reusability is the ability of specifications or software to be reused, in whole or in part for new environments.
- Correctness is the ability of software to perform the tasks as defined by the specifications

If the product chain demands more processing power and storage capacity for handling information, information technology offers products, methods and techniques that enable enterprises to innovate their processes and products:
- The decisions support for the management is stimulated by prototyping tools and alternatives can be verified by simulation. Prototyping may reveal issues positioned in the who and why cell of the technology row of fig. 1. Next to it, prototyping can illustrate relevant data for the agents.
- Reuse of specifications and software is enhanced by object oriented technology, which offers robust and extensible deliverables. The data, function and time columns of the framework are covered by object oriented technology.

- The distribution of large data volumes is possible using client-sever architectures and networks, replying to where issues.

Towards aligned architectures

The development of modern computer-based information systems started with file-oriented systems. The resulting computer programs suffered from redundancy, inconsistency and were not flexibel. In order to overcome these shortcomings a three-level schema architecture is advocated by standardization committees: they contain internal models, conceptutal models and external models. As a consequence of the data independence concept we realized that data rather than the proces structure in the applications were principal to model.

Architectures suggest synthesis, putting many relevant aspects into a whole to meet an artistic or functional need. It suggest a global view or scheme, representing the component parts fit together.

Definitions of information architectures

According our view architectures play a vital role in information management within enterprises and within the enterprises of a product chain. The following definitions are stated:

- Zachman gives the following general definition of an architecture: 'An architecture is a logical construct for defining and controlling the interfaces and the integration of all of the components of a system'.
- The Diebold Group filled in some more detail, with special reference to information architectures: 'An information architecture is high level map of the information requirements of an organization that shows how information requirements relate to business processes and how the information categories and functions must be defined, implemented and interconnected with appropriate facilities and technology to support decision makers'
- Brancheau and Schuster: 'an information architecture is a personnel and technology independent profile of the major information categories used within an enterprise. It provides a way to relate business functions and data classes and document their relationships.'
- Teng: 'a high-model of a set of databases configured to support the organization's value adding business processes. The model may be portrayed in graphical, tabular, or narrative form and is independen of technology and current organization structure'.

To be aware of the importance of informaton architectures consider the analogy with the transportation area. To make effective use of automobiles, roads needs to be built. After a period during which automobile use expanded dramatically, it became obvious that great bottle-necks would arise if each local jurisdiction were left to build only the roads which were neede by the residents.

Planning architectures is a decision-making proces, by which management gives direction to the development of a strategy for information services. This concerns the formulation of a strategy, creation of an architecture plan and an information projects plan. The framework of fig. 1 is used as a springboard for the planning of architectures. Planning work within which information systems, organizational units can be placed in the context, with interrelationships clearly understood. Moreover, interactions among the activities of business architecture, systems architecture and IT architecture takes place as feedback-loops and feed forward loops. An IS plan should no longer be separated from the business plan and vica versa. The organization is concerned with organizational and skill related issues that are necessary for the enterprise to be in balance with the information technology it uses and with the organization structure implemented.

Alignment with IT architecture
The technical architecture us an insulating layer separating business requirements for IS (systems architecture) from the set of products and components that cooperate in providing computing support to the information needs. Moreover the technical structure includes a definition for an environment and infrastructure that are necessary for the integration and cooperation of different applications. Finally the organizational structure emphasizes the mutual dependencies between an organization and IT and the emergent properties derived from the interaction between them.

The use of benchmarks
As the benefits of planned information systems are often difficult to quantify because there may be a lot of intangible factors there is a need for other instruments. Benchmarking has proven to be an adequate technique that can contribute to the improvement of decision processes . Benchmarking is a process which measures the performance of some key elements of a business, in order to compare these measured results. Some lessons learned from conducted benchmarks are:
- commitment of topmanagement is essential
- attention has to be paid to training and understanding of the involved projectmembers
- communication and documentation should be well prepared

As fig. 3 illustrates, we distinghuish three kinds of benchmarks:
- product benchmarks: characteristics of IT products are determined resulting mostly in a short list for selection of a product.
- competitive benchmarks: some key ratio's are determined and compared with other organization.
- internal benchmarks: enterprise functions within one organization are measured and compared.

Linking information architectures in the product chain
The components introduced in this paragraph are restricted to which they do contribute to the modelling of relevant aspects of the product chain. A product chain represents how businesses are linked to each other by the supply of goods and services.

For the construction and integration of a model representing the relevant aspect on the chain level, we may ask ourselves if it is a suitable approach to add and reshuffle the functions and data classes of the involved separate businesses. The major disadvantages of this approaches, which is illustrated in *fig. 4*, may be:
- integration of data schemas gives semantic problems

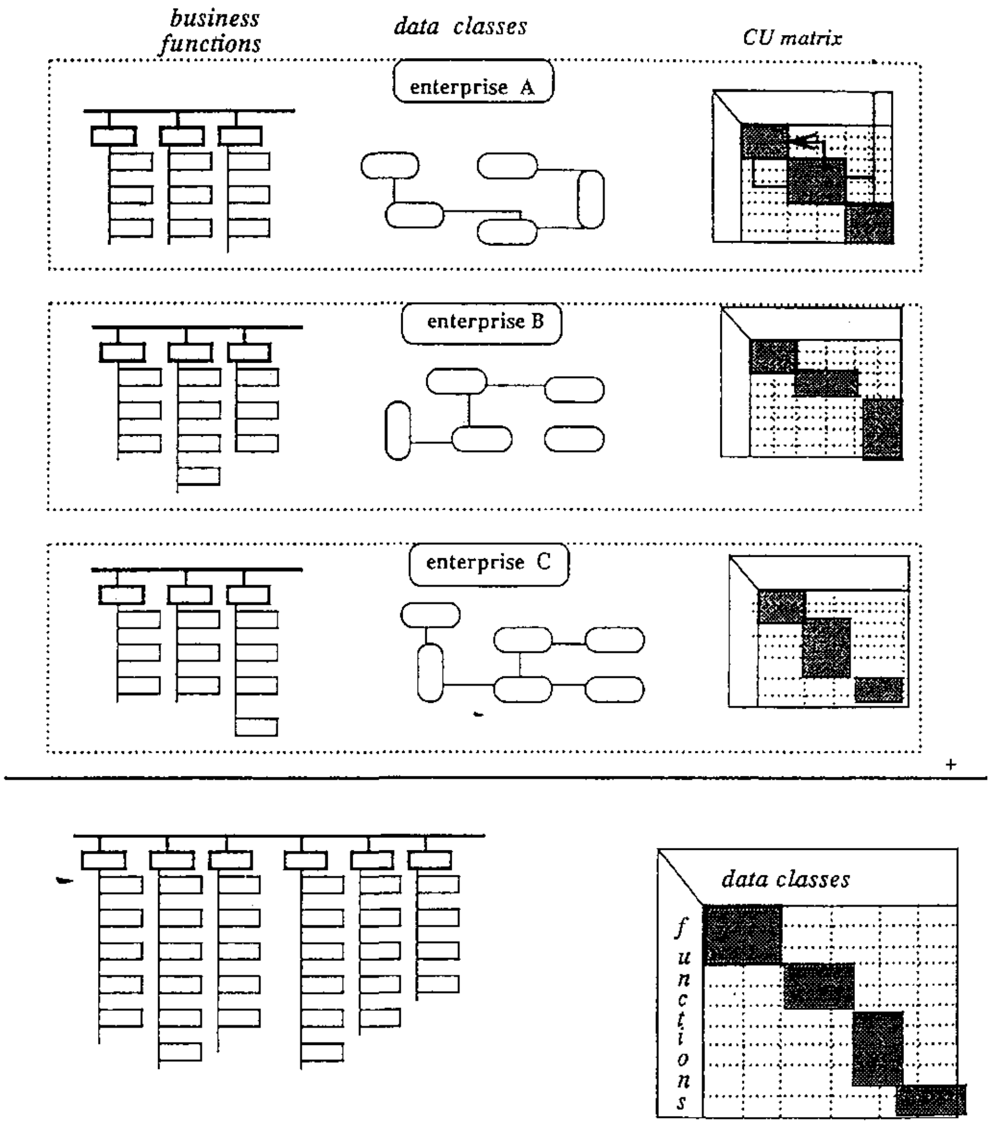

Figure 4. Is construction of a information model for the product chain an aadition sum with some reshuffeling?

- participating businesses can not easily recognize their contributions to the product chain within the resulting model colossus
- maintencance of the resulting whole chain model will be a problem, partly as a consequence of the functional decomposition.

Construction of chain models by events

The aim of the research is to develop a chain information model that explicitly integrates relevant components of the different aspects as they are represented by the columns of fig. 1. Dynamic relationships among enterprises in the product chain may be explicitly specified through events. For the process aspect, events can be made explicit by associating minimally two events with each process: a start-event that is associated with the triggering of the proces and a completion event that signals the termination of the proces. While an elementary process is conducted local to an entity and just gives a possible way to handle the entity, an event characterizes two forms of dynamic interaction between two or several entities of enterprises. Firstly, by grouping the set of processes to be triggered when a particular situation occurs, an event expresses synchronization.

Secondly, as processes may induce state changes of entities that in turn generte events, the sequencing of events makes clear the cascade of entities transformations due to the initial signal.

In bringing together the data- and procescomponents of the information systems architecture the event component plays therefore a central role.

An example. The event 'order delivery' for a client may trigger:

- the proces 'request payment' conducted by the financial department
- the proces 'taking out' done by the people at the storehouse

The second proces (taking out) induces an internal event 'out of stock', when the present quantity is lower than the replenishment level. Related to the mentioned processes are updates of data about Account, Product stock and Supply orders.

The advantages of the event concept are as follows:

- static and dynamic phenomena are selected for the construction of a chain model
- object encapsulation is realized by including the events and processes to the entity definition.
- if optimization of chain processes is requested, e.g. improving the terms of delivery, we get a good overview of relevant data and processes.

Consequences of this latest argument will be elaborated in the next section.

Definitions of business reengineering

To create adequate management of product chains enterprises have to think about how to rework their business. An interesting concept with regard to design or redesign of processes is the concept of business reengineering . Business reengineering seeks to redesign work processes to enhance productivity and competitiveness. One major instrument that can be used in business reengineering is Information Technology .

Some other definitions of business proces redesign:

- Davenport and Short: 'the analysis and design of work flows and processes within and between organizations'
- Hammer: 'reengineering is the fundamental analysis and radical redesign of business process to achieve dramatic improvements in critical measures of performance'
- Alter: 'business reengineering is a methodological process that uses Inforamtion technology to radically overhaul business process and thereby attain major business goals'

- Venkatraman: 'business proces redesign involving the reconfiguration of the business using IT as a central lever. Instead of treating the existing business processes as a constraint in the design of an IT infrastructure the business process itself is redesigned to maximally exploit the available IT capabilities'

With regard to product chains reengineering involves the whole chain of companies from the production of raw materials up to the end-products for the consumer. Some interesting developments in the production area are forms of cooperation like co-designership and co-makership, value contracts between more then two chain participants, giving mutual insight in inventory levels by supplying and consuming companies, etc.

Conclusions

There is currently a growing awareness that architectures can be a very effective instrumentation for information management, it provides:

- a flexible platform for tuning the infrastructure in the product chain
- a roadmap for planning IT applications
- a basis for redesign of enterprises, taking into account issues in the product chain
- an effective way to decide and controll investments, using benchmarks.

An information architecture provides a proactive basis for the developement of interorganizational information systems, as opposed to the reactive backlog approach, enterprises should prioritize the construction of these architectures.

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Global reference information models for product chains in agriculture: A case of apples and pears

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Introduction

The importance of collaboration in the agricultural product chain.
There are growing demands towards companies with regard to quality, delivery time, assortment and product life cycle of products. One of the decisions available to companies is to collaborate more with their suppliers and with their customers to improve performance. By making agreements about product characteristics and delivery conditions with other companies they try to better satisfy customer demand and increase efficiency in the chain. Hereby they hope to gain competitive advantages within their branch.

In recent years there is a growing interest in extending these agreements to other parties in the production column, parties which are not direct suppliers or customers of the companies involved. As a result we see an increase in collaboration in product chains, collaboration that spreads out from companies that produce primary raw materials to companies that produce consumer products.

This growing interest in chain collaboration already has lead to many projects in the field of chain management. E.G. in the porc meat chain projects are carried out regarding integral chain management (in dutch:IKB). Through IKB a system of integral quality assurance and environmental assurance has been developed for the biggest part of the chain.

IKB in this chain has lead to adjustment of the production processes of the chain participants and the exchange of product data (partly with EDI).

In this paper we define an agricultural product chain as a sequence of economically and/or legally independent companies that perform a necessary role in the different stages of the production column, who produce together an end-product for a consumer market. Basically there is a market between any two succesive stages in the production column.

Information exchange between organizations in the agricultural chain

A basic aspect of collaboration between organizations is the exchange of information, information associated with the receiving, processing and selling of materials and products. Porter (1985) argues that the use of information technology may lead to competitive advantages of the companies involved; advantages with regard to new forms of relationships with customers, new product characteristics, quality and delivery time of the product and services, etc.

In agriculture the involvement of chain aspects in information management becomes increasingly important. Specific characteristics of the sector that have to be reflected by the information systems are the dynamics and uncertainty in the goodsflow and quality-aspects of the products (Trienekens, 1993). Because of these characteristics collaboration in agricultural chains is often aimed at guaranteed quality of products, and also at quality of the production process (usually taking into account social, legal and environmental constraints). Quality information, about the products ánd about the production process, therefore is of major importance.

Information modelling

From experiences in organizations in the agricultural sector it is learned that information models have a structuring effect on the initiation and execution of information system projects (Beulens, 1991).

In an information model the information system of an organization is described. It consists of a datamodel, in which the data are described that are used or produced in the organization; and of a process model in which the activities are described which take place in the organization. For every process is specified what data are used and what data are created by the process.

Information models can be used for:

- identification of information systems
- standardisation of data for the development of information systems
- integration of information systems for different organizational functions

Information modelling usually is aimed at individual companies, as a part of information strategy planning. The most important use of information models until now was in the field of identifying (and developing) informa-tionsystems for single enterprises.

Information modelling in product chains

Because of the structuring effects of information models on the design of information systems for individual companies, it seems obvious to develop these models for product chains as well. An information model for a product chain would then describe the processes and the data that are relevant for chain management.

The key issue with regard to collaboration between organizations in the agricultural product chain seems to be exchange of information between companies. It therefore is obvious that collaboration in chains has everything to do with integration and standardisation of information systems. In the process of developing information systems for product chains, standardisation and integration are key issues. They lead towards more 'openess' of information systems, i.e. towards better cooperation between systems of the collaborating companies.

This can even lead to automatically collaborating information systems of partners in the chain (e.g. the linking of operational systems via EDI).

The process of developing an information model takes a considerable amount of time and money. To improve the use of information models, it seems therefore appropriate to develop models that can be used for more then one situation in practice. In doing this we seek affiliation to the so-called branch-information models that have become available in Dutch agriculture the last 8 years; these are socalled reference information models that describe the data and processes of an 'average' farm in a specific branch (e.g. poultry or dairy farm) (Beers and Udink ten Cate, 1993).

They have partly proved to be a valuable tool to design specific information systems for a farm (e.g. they have been of the utmost importance for certain EDI projects in which a class of farms cooperates in exchanging information with the auction).

So, to make available more general knowledge and experience about information use in a product chain, we aim in our research project at reference information models (Greveling, 1988).

The research project

The research project aims at a method for developing reference information models for product chains.

Research questions

The most important research questions in the process of information modelling for product chains are:

- What is the object system for the information modelling process; i.e. what has to be the contents of the chain information model?
- How can we make reference information models, information models that apply to more then one occurrence of a product chain in practice (generalizations with regard to the same class of products, with differing partners; or even generalizations with respect to differing classes of products and partners that are different but have the same role within a chain).

So in our project we try to find answers with respect to contents and applicability of reference information models of product chains. In searching for these answers we aim at formulating a method for designing these models.

Research method

We used different kinds of research methods. On the one hand we did theoretical research by studying literature and organizing discussion meetings between scientists. During this process we used the knowledge and experience from the development projects for reference information models for individual farms.

On the other hand we performed empirical research by extensively interviewing the participants of the chain for apples and also interviewing experts in the field of interorganizational information exchange within the sector involved.

Because of the new field of science we were dealing with, this combination of research methods proved to be very fruitfull.

The case of the product chain for apples

The test case we use in this paper is the apple chain. In this product chain, an increase in collaboration must lead to better quality, delivery conditions and prices of apples for the end consumer. Also it helps the fruitgrowers to cope with environmental constraints that have an impact on the use of crop protection means and on the use of fertilizers.

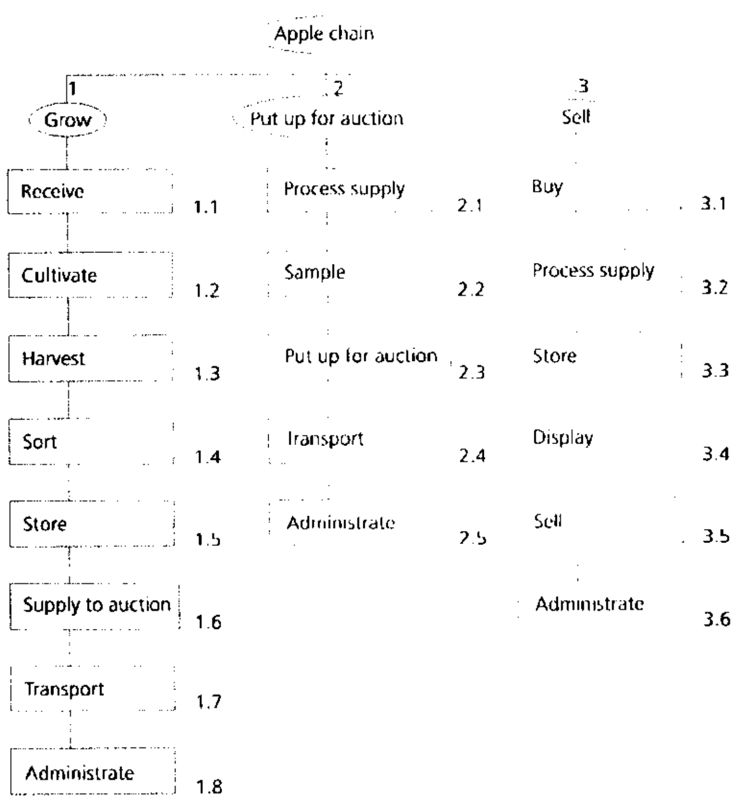

Figure 1. Processes in the apple chain

Contents of information models for product chains

The field of interest of information models for chain management
As described above, information models can be used to understand the information system of an organization in a structured way and can be used as a basis for the development of (automated) information systems for the organization. In fact they describe the information required to manage an organization. Information models for individual organizations describe the integral information system.

The aim of the development of chain information models is to support chain management. Because of the complexity of an information model that would describe all processes and data of all participants in a product chain, we aim at developing information models that can be used for issues regarding chain management, and not issues that are important for the management of individual chain participants only. We therefore seek to describe typical chain processes and data that are to be used for chain management.

[Because of this 'limited' interest with regard to processes and data in the chain, a very important point with regard to the design of chain information models is that during the design process we have to think about interfaces with the information models of the individual chain participants. However, we will not deal with this question in this paper; further research will have to give answers to that problem. Here we will confine ourselves to the description of the two major issues of chain information models, contents and scope (reference aspects).]

Applicability of chain information models
An information model can be used for many different management purposes, for which we often use only part of the model. For example if we are talking about optimizing product quality in chains, we may be less interested in issues of profit distribution in the chain. If we are interested in optimizing the use of personell and machine capacities in the chain we may not, or less, be interested in deliverytimes of products between chain participants. Or if we are dealing with some strategical issues (product development, competition, etc.) we may less be interested in interorganizational financial aspects.

So there can be different areas of interest regarding product chains, areas of interest that will match with certain domains in an information model.

We believe that a chain information model should apply to all the important questions regarding chain management. The character of a chain information model therefore has to be of a general nature.

A disadvantage of designing general applicable information models, is that they tend to become very complex. This depends on the level of detail that is chosen. If the level of detail of a general model is to low, then more detailed models concerning certain object areas can be deduced from such a general model. In that case the general model may guarantee the consistence, coherence and coordination between the various types of detailed models.

So, we search for a model with processes and data that are of importance for chain management (as we have seen in section 4.1) and which is general applicable. There are different roles and processes with associated information needs in a chain. Our first choice is to ensure that the information needs associated with the coordination and collaboration of vital primary processes throughout the chain, are involved in the process of developing the information models. Primary processes seem to be the basis for information exchange between chain participants.

Reference aspects of information models for product chains

In the previous section about the content of a chain information model, we restricted the modelling process on the one hand to the processes and data that are relevant for chain management, and on the other hand we wanted to design multi-purpose information models. So in the modelling process we have to take into account all management aspects and in the same time we have to minimize the processes and data to be involved to those that have to do with chain management. We concluded that primary processes should be taken as the starting point for the selection of relevant processes for our chain information models.

With regard to the reference aspect of information models we have to take into account some other demands. With a reference model we should on the one hand be able to describe all possible chains that deal with a specific product; and on the other hand the level of detail should not be too abstract, so that the model can be used in practice.

Structural differences between chains

Information models for individual organizations contain all processes and data which are relevant for the organization (e.g. Martin, 1989). A reference information model is an information model designed for an 'average' organization, i.e. a model that can be used by more then one organization, usually organizations from a certain branche (e.g. dairy farms). As we have seen before, these models already exist in Dutch agriculture.

To design a reference information model for a product chain however is of a different nature. There not only exist differences between individual companies, e.g. one chain store can be different from another, but there are also differences between the number of participants in chains (that produce the same end-product). *Figure 2* shows an example of two different apple chains.

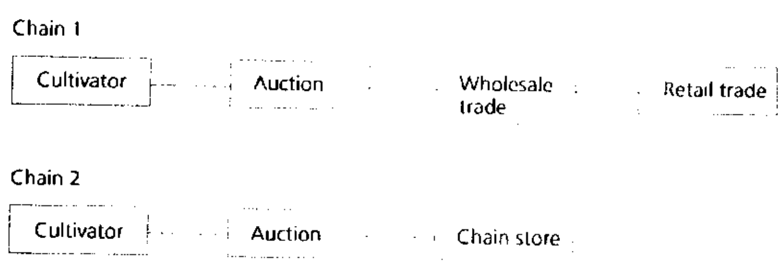

Figure 2. Different structures of the apple chain

With regard to the reference aspect of chain information models, the difference between the organizational structure of chains with the same product leads to an important question:

- How to describe chain-processes of chains independent from the participants in particular chains?

The answer to this question could be to distinguish the chain participants from the chain processes. This means in our case that we have to find the processes that are the same for every apple chain, regardless of its structure. So the description of processes for the production of a certain defined product should be the same for all chains who produce this product.

Primary and secondary processes in product chains

The primary processes in different chains with the same goal (in our case the production of the apple for the end-consumer) seem to be the same in nature. They always concern processes like purchasing, receiving raw materials, producing the product, storing and conditioning the product, selling, delivery and service.

From the figures 1 and 2 we can learn that though the number of participants and therefore the number of processes differs for the two chains, the nature of the primary processes is the same.

On the other hand most secondary (management) processes seem to be different for every chain. This is in the first place caused by the many differences between the management of individual companies with the same end-product. This problem was also encountered during the earlier projects for the development of reference information models for individual companies. For the development of chain informationmodels the problem is even bigger because of the different (number of) participants with each their own end-product in every chain. Examples of differences between chain participants are to be found in production planning systems, financial systems, the personell function, the marketing function, etc.

To determine the processes that have to be part of the reference model, we therefore aim in the first place at the primary processes. So, as we have seen them as the basis for the contents of a chain information model (section 4), they are also the basis with regard to the reference aspect of reference chain information models. With regard to the secondary processes we have to decide which of them are of importance for chain management. However, first we have to describe the different nature of primary and secondary processes, in order to get clearer definitions to work with (see also Beers and Beulens, 1993).

For this purpose we use the management paradigm of de Leeuw (de Leeuw, 1982), which is strongly based on Blumenthal (1969). De Leeuw makes a distinction between management processes (executed by a 'managing system') and managed processes (in a socalled 'managed system'). Management processes are processes that plan and control other processes (e.g. production planning, finances, personell). Managed processes are processes that are planned and controlled. The primary processes as described above are managed processes and belong in terms of de Leeuw to the managed system. Secondary processes however can belong to a managing organ, but also to a managed system, because they also have to be managed.

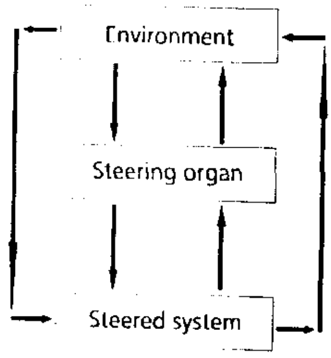

Figure 3. The management paradigm of de Leeuw

As described earlier the relevant processes for our project are in the first place the primary production processes, which are managed proces-ses, of the organizations involved. For us it is clear however that a lot of information produced by secondary processes (management processes) is also relevant at various places in the chain. Thus they cannot be left out of the information model. The management processes which are of interest for our project have to be connected to the goal of the chain which is the end-product. Processes of a certain participant in a chain are only of interest for another participant in sofar as they have consequences for their production process. So, the management (secondary) processes we are interested in are the processes that aim directly at managing the primary processes (e.g. production planning and control to transform input for the process into output). So, we leave out the secondary processes which are not directly connected to primary processes (e.g. parts of personell management, financial management, etc.). These last secondary processes often have to do with structuring the individual organization and not with the day to day operations.

So we can decide to the processes to be involved in the informationmodel: all primary processes and those secondary processes which directly manage the primary processes.

What we still need however, to find a clear and distinct definition of 'primary processes', is a broad definition of the product, the processes to produce, transport and service that product, and the information required for and incorporated in these processes. Further research has to find answers to these questions.

Apart from this distinction we learn from the model of de Leeuw that we also have to take into account environmental aspects of chain management (governmental regulations, law, etc). Therefore information about the product or the production process, from or to parties outside the chain should also be part of the chain information model.

The model of de Leeuw proves to be very usefull to understand and describe the behaviour of organizations and also of chains of organizations.

The minimal model

In this section we will give a first draft of a model which can possibly be used to decide on what processes and data have to be part of a reference information model of a product chain. We call it 'the minimal model'. First however we will start with a recapitulation of the findings of the previous sections.

Demands to the minimal model
As described in section 4 we put the following demands with regard to the contents of a chain information model:
- a chain model only has to take into account these processes and data which are of importance for chain management.
- a chain model has to be a multi-purpose model. Detailed models of certain management areas or from a specific chain perspective have to be deduced from a multi-purpose general model.
- the processes which are of interest for chain management are primarily the primary processes. These processes directly aim at the goal of the chain, the defined end-product. Other processes of interest support these processes and can be deduced from these processes.

As described in section 5 we put the following demands with regard to the reference aspects of the chain information models:
- the primary processes in the chain have to be described independent from the chain participants (the primary processes in chains with the same product are the same in nature).
- management (secondary) processes which can influence directly primary processes should be described as well.
- influence from or to the environment of the chain, with regard to chain management, should also be taken into account. It determines the constraints of output- and process-conditions to be satisfied.

Components of the minimal model
The demands as stated in the previous section lead to the following components of the model:
1. Regarding to system theory (de Leeuw, 1982, in 't Veld, 1975) every system can be described as a black box with input and output. Management is not primarily interested in the contents of the processes, but rather in their behaviour of transforming input to output. They are primarily interested in the 'what' of the process and not in the 'how'. Every process has its constraints that set the scope within which the process has to be or can be performed. The primary processes thus describe the behaviour of the product chain within the constraints set to the processes. In the description of the product chain we then have to take into account primary processes, regarding their possible behaviour, with their input and output.
   For the information modelling process we are only interested in input and output in terms of information. This information is directly linked with the product or the goodsflow.
2. As we have stated before we also need to include management (secondary) processes of chain participants which can influence directly (other) primary processes. The information output of these processes can be used as information input for steer-

ing and control of primary processes. Examples of these processes are demand forecasting, inventory planning, etc. However we are not interested in these processes themselves (contrary to the primary processes), but merely in their information output as far as this is of interest for the primary processes. This also concerns information with regard to the behaviour of the process within certain limits (e.g. the specifications of the productionprocess for a certain product given by a customer to an enterprise).

With these processes we have completed the general system model as described in *figure 4*: a process with input, output and steering information.

Based on our empirical research and our experiences with product chain information modelling, we found out that also other, different types of information can be identified.

On the one hand this is information that can be considered as output information for the primary processes (reporting), and on the other hand we distinguish information that can be considered input of the primary processes (conditions to the processes).

3. Information output of processes, partly meant for management or for parties outside the chain, has to be taken into account as well (e.g. products in stock, the use of herbicides, legal/environmental information, tax reporting, etc.). The output as described above (under 1) is related to the product of the process. Therefore we will need another output factor which we will call 'report'. This is informa-tion about the (changing) status of the primary process: the materials used in the process, the process steps, the production means. (This status may for instance determine the ability of the process to perform jobs in the future).
4. Collaboration between chain participants means that one participant makes agreements with others and therefore places conditions upon the process of the others. (e.g. in the apple chain, chain stores place demands on the packaging materials of their suppliers). Downstream through the chain we have to do with information associated with the product being delivered, and upstream we have to do with requirements in order to satisfy customer demand and constraints. Also conditions can be placed upon chain participants from parties outside the chain. Think about governmental regulations (e.g. with respect to environmental issues, welfare of animals, etc.) or regulations of branch organizations.

   Preferably the conditions are in the form of constraints on by-products, raw materials and the processes and do not specify how these constraints are to be satisfied.

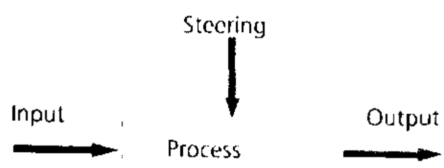

Figure 4. The system model

Because of the importance of these conditions to understand the behaviour of the primary processes and thereby the behaviour of the chain, we believe that they have to be taken into account in the information modelling process. Indeed, by the conditions the chain participants structure a great deal of their collaboration.
[The conditions are not the result (output) of other primary processes. Sometimes they are steering output of secundaire processes; e.g. a specific order for a certain product with certain conditions included. Often however they are output of tactical management processes that are of a different nature then the secondary (steering) processes as described above. So maybe in order to make a clear distintion between types of processes, we have to define a third class of processes like policy making or negotiating between partners (for basic agreements).]

This brings us to an extended system model as described in *figure 5.*

To illustrate the model, we will analyse and describe in the next section several processes that are part of the appple chain.

The minimal model applied to the apple chain

We illustrate the minimal model with two examples of processes: the primary processes of sorting apples at the cultivator, and of invoicing at the auction.

The information categories we recognise are input, steering and conditions, as input factors; and output and reporting as output factors (see *figure 4).* The figures speak for themselves.

Conclusions and further research.

In our research project we developed a modelling approach to describe the processes and data and their relations which have to be part of a reference information model for a product chain. The approach is called 'the minimal model' approach. It describes which processes (primary and secondary) in a product chain are relevant to be taken as part of a reference information model and it consists of a system model for these processes (a process with input, output and steering), which is extended with 'conditions' as extra input factor and 'reporting' as extra output factor. Input and output factors have to be understood as information flows.

We described several processes from the apple chain with the minimal model approach.

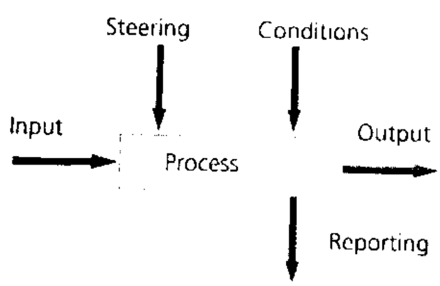

Figure 5. The minimal model

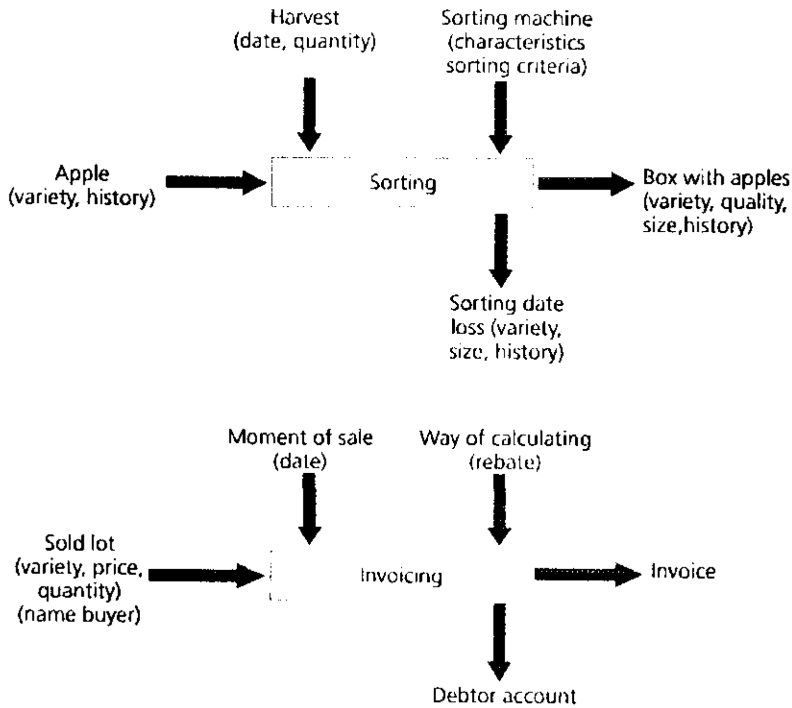

Figure 6. The processes of sorting apples and invoicing

As with most explorative scientific research, more questions were raised then answered. Although we have found interesting answers to some of our questions, a lot of them still remain unanswered.

The most important questions still to be answered are:

- is it possible to make all-purpose reference information models for chains? If so, can we deduce more detailed information models from these all-purpose models?
- can we find a solid method for selecting processes that are important for chain management and processes that are not; what criteria can we use in the selection and decomposition process?
- for this selection process: how do we define the borders of the different processes; e.g. can we find a strict definition of 'primary process'?
- The question to the validity of the minimal model

Further research has to deal with these questions. Besides more theoretical research, attention has to be given to the testing of the model and the use of the resulting reference information models in practice. By doing this we will come closer to the final goal of the project which is to develop a method for designing useable reference information models for product chains.

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Towards an electronic flower auction?

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Introduction

In this article we focus on the Dutch floristry chain or flori-chain. We define the flori-chain as the set of activities which add value for the customer to a flower product or service. For a detailed description of the Dutch flori-chain see appendix 1. The flori-chain is a dynamic entity. Customers are changing their preferences and organizations in flori-chains react and change their activities and/or their linkages toward those new preferences. Tuning of demand and supply of flowers are undertaken in the auction process. Effective communication and decision-making between organizations might speed up those reactions and changes. New Information Technologies (IT) like Electronic Data Interchange (EDI), multi-media, or telecommunications may help to improve the reaction time of organizations in chains. Electronic linkages across organizations occur (Konsynski, 1992).

Some IT applications were introduced in the flori-chain. Not all introductions of IT were successful. For example the introduction of image auction in the auction hall was not accepted by wholesalers. Other IT applications, like EDI and image databases, are slowly diffusing into the flori-chain. One of the latest business scenarios introduced, is the concept of information auctioning. This concept is presented as a step towards an *electronic flower auction*. At January 11, 1994 this concept became operational at Verenigde Bloemenveilingen Aalsmeer (VBA). After some weeks problems were reported (Agrarisch Dagblad, 1994). At that time the project leader of the information-auctioning project said in interview: 'The failing of the info-auction is hanging like a sward of Damocles above the floristry industry' (Uitentuis, 1994).

From a practical and theoretical perspective it may be interesting to study those introductions of IT in a flori-chain context. From a practical point of view we want to learn how to introduce IT in an effective way and how IT may improve chain management. From a theoretical point of view we want to learn what theories can (or can not) explain (and sometimes predict) those successes or failures. Both sides of the same coin are discussed in this article.

[1] This article deals with one of the projects within the ELECTRONICAL FLOWER MARKETS research program. This program will be executed by members of the Emory University (Atlanta, USA), New York University (New York, USA), Erasmus University (Rotterdam, NL) and Wageningen Agricultural University (Wageningen, NL).

The problem we address in this article is under what conditions an electronic flower auction might be successfully implemented in the Dutch flori-chain. The *objective* of the article is (1) to present a critical review of recent business scenarios around the auction process linking buyers and sellers with IT applications by identifying critical success factors, (2) to present critical success factors in other industries which implemented so-called electronic markets (3) to formulate hypotheses which define conditions and design characteristics of an Electronic Flower Auction (EFA). An electronic flower auction is a type of *electronic market*. Bakos (1991) defined an electronic market system as an inter-organizational information system that allows participating buyers and sellers to exchange information about market prices and product offerings. It represents an investment in multilateral information sharing with the goal to establish bilateral buyer-seller relationships (Bakos 1991:33). In general, markets are important in our society because 'under most circumstances markets are extremely efficient in facilitating the movement of products from the lowest-cost producer to the consumers who place the highest value on them. Organized exchange thus effectively advances human welfare' (Smith and Williams, 1992). Markets differ from networks and hierarchies. In market transactions the benefits to be exchanged are clearly specified, no trust is required, and agreements are bolstered by the power of legal sanction (Powell, 1990).

In section 2 we describe three different business scenarios which, at present, link buyers (wholesalers) and sellers (growers) to each other. The first scenario is the traditional clock sale. IT applications around the traditional clock sale are described. The second scenario is the mediation office. In the last years more transactions between sellers and buyers are succeeded by the mediation office. IT applications, like image-bases and electronic supply information systems, are discussed. The third scenario is the information auctioning concept. We discuss in this scenario two IT applications. The first one is the introduction of image auctioning at Bloemenveiling Holland. The second one is the introduction of information auctioning at Verenigde Bloemenveilingen Aalsmeer. One conclusion about those two systems will be that both systems not include a real information auctioning concept. There is no complete decoupling of physical floristry flows and the price discovery process. It is better to speak about pseudo-information auctioning. We will identify why both systems failed by using practical and theoretical literature.

In section 3 we focus on the discussion of developing electronic markets in other industries. For example, in the financial sector electronic bond and stock markets are implemented sometimes successfully. In the commodity markets (cotton, pigs) electronic markets are introduced. What can we learn from their experiences?

In section 4 we elaborate on the concept of the electronic flower auction as a new, fourth, business scenario. We will discuss features of it. Hypotheses will be formed dealing with conditions and design characteristics of the electronic flower auction.

In section 5 we formulate our conclusions and specify further research. Research will be carried out in a joint research program ELECTRONIC FLOWER MARKETS, executed by members of Emory University, New York University, Erasmus University and Wageningen Agricultural University.

Business scenarios between growers and wholesalers and their IT applications

In this section we describe three different business scenarios which, at present, link growers and wholesalers via the auction process to each other. Direct linkages between growers and wholesalers are not taken into account, because in the Netherlands those linkages hardly exist. The presented scenarios are the traditional clock sale, the mediation office and the pseudo-information auctioning concept.

Traditional clock sale
At this moment most floristry products are sold by traditional clock sales. Within the traditional clock sale concept we discuss two systems. The first one is the small lots auctioning. The second one is the large lots auctioning.

Scenario description
When floristry products are ready for auctioning the grower fill in a paper supply letter. With own or collective transport the products and the supply letter are sent to the auction. During the evening and night the products are inspected on quality and hold in buffer. The information of the supply letter will be typed in the auction computer. In the morning floristry products are transported to the clock, where the products are auctioned. The buying process and price determination occurs electronic by Dutch auction. After the auctioning process, the products are distributed to the wholesaler. The day after the transaction the grower receives a daily transcript with the price information. Paper documents forms the most important information carrier in the traditional clock sale. At this moment only a few growers send electronic their supply letters to the auction with the help of EDI. Price information can be asked electronic with videotext. This information can be processed if necessary in the yield registration of the grower. Larger lots auctioning is a clock sale process with large numbers of units. This system was introduced to handle logistic problems. The objective of this system was to receive high volume transaction. One starts the day by auctioning the large lots, afterwards the small lots will be auctioned.

Mediation office

Scenario description: Support by database
In contrast with traditional clock sale, mediation officers mediate in forward markets. Negotiations supported by the mediation office (MO) about delivery specifications occurs during the day. The grower sends a couple of times per week a supply list to the MO, who transmits this to the wholesaler. The information consist of floristry products specifications, lots and the offer price. The wholesaler wants complete, actual en reliable supply information and can get this information on paper, on disc and by electronic connection to the supply information system. Fax and the phone are important media to communicate. At Verenigde Bloemenveilingen Aalsmeer (VBA) small transactions and small wholesalers are not supported by the MO any more. In the near future MO pursuit to use EDI for messages, which do not ask negotiations and give more standardization. The supply information system can be connected with an order processing system.

Scenario description: Support by image database
Recently the mediation office of Bloemenveiling Holland (BVH) is busy to connect supply information with electronic product images. The wholesaler will be able to observe the aata as well as the images on his PC. The, so called, Holland Aanbodsbank (HAB) is comparable with an electronic sample house. The wholesaler use the images for his sell-

ing process. Advantages for retailers at a long distance are speediness and cost reduction (De Boer, 1993). BVH developed their own open system, where all wholesalers can observe the images at the same time. As a result of the one to more relationship, more transactions can be made at the same time in the same system. An other advantage of the system is the concentration of the supply (data and images) (De Boer, 1993).

Pseudo information auctioning
Within the pseudo information auctioning concept we discuss two IT applications. The first one is the introduction of image auctioning at BVH. The second one is the introduction of information auctioning at VBA.

Scenario description: Image auctioning
One of the first projects who intended to decouple the physical floristry flows and the price discovery process was the Vidifleur project. This project was initiated by BVH. In this project visual displays are developed for use in the auction hall. On a large screen, which can be programmed, information in different formats was presented. On the screen also a clock was displayed, which was synchronized with a digital auction clock in the pot plant hall. Product images, information about the grower and of the product quality were displayed. The screen included the lot being auctioned as well as lots that were coming up for auction.

Scenario description: Information auctioning
Since January 11, 1994 information auctioning became operational in the VBA. Information auctioning replaces the system of large lots auctioning. The products are auctioned by using information representing the physical flower products. The information is presented on a display with the physical presence of a sample of the product. The grower sends before 15.00 hours his clock supply for the next day to the auction. The minimum supply is three trolleys. The electronic supply letter (EAB) is compulsory. At 16.00 hours the auction has processed the total supply in the supply information system (AIS). Wholesalers observe the AIS and discuss with their retailers which orders they needed. The next morning products are auctioned. During the transaction, the wholesaler mention the delivery specifications. The auction sends an (EDI) order to the grower, who confirms this order and makes the product ready as accomplished in the order confirmation. The product, combined with a paper supply letter is transported to the wholesaler. In the evening the wholesaler receives and checks the product. The product is made ready for transport to the retailer, where it will arrive the next morning (VBA, 1993).

After some weeks using this information auctioning business scenario problems were reported: less growers (sellers) and wholesalers (buyers), then expected, were using the information auctioning system. The result was lower product prices, which resulted in less sellers and buyers etcetera.

Discussion
In this section we try to make clear why IT applications are slowly diffusing in the auction. For each of the non-traditional business scenarios (mediation office and pseudo information auctioning) we identify the critical success factors related to IT.

Mediation office

The following weaknesses of the image database could be identified (De Boer, 1993):

- Wholesalers still have questions about the representation of the lot by the image. They still need a physical lot for their buying process;
- There are little efficiency improvements for the wholesalers;
- Responsetimes to get the images from the database are too long;
- In the selling process of the wholesalers one needs specific supply information. There is need for general available supply information;
- Due to a lack of standardization of flower products there is no need for an electronic exchange system including automatic order processing.

Pseudo information auction

The Vidifleur project (BVH) was stopped after some months of use in the auction hall. The following reasons could be distinguished, see for example (Automatiserings Gids, 1994):

- Images on the screen representing the flower sold were unclear;
- High costs to prepare the images;
- The auction-clock on the screen was unclear;
- The screen was implemented in a normal auction hall with normal clocks. Wholesalers had difficulties to concentrate on the screen.
- Wholesalers were suspicious about the level of representation of the image on the screen and the real quality of the product.

The following reasons could be identified explaining the problems of the information auction project. These reasons are:

- The concept is not a real information auctioning concept because growers still have to send a sample trolley. The consequences of this concept is that there are new physical flows sample trolley flows in the auction hall and that the sample trolleys are auctioned twice: as a sample of the lot and as a lot itself.
- Sample are not trusted by wholesalers as representing the lots.
- One of the possibilities in the system is that wholesalers can indicate delivery specifications of the products. Growers have fulfil these delivery specifications. Wholesalers complained that there are not enough specification possibilities.
- After the flowers are auctioned, growers have to prepare the sold lot with the ordered specifications. No extra charges are paid to the growers for these special preparations.
- In this concept products bought by wholesalers are delivered the late evening or the next morning in stead of right after the transaction. Products have to be transported from the growers address to the wholesalers. Wholesalers can provide the products to their clients only the next day in stead of the same day.
- It is only possible to supply three or more trolleys for information auctioning. Therefore this scenario was only interesting for large wholesalers and growers.
- New fee tariffs are introduced dealing with trolleys, lots and volumes. Therefore, mostly larger wholesalers become interested in the concept.
- During the first weeks of using this concept product prices went down. This is in general the case when the market becomes more transparent, see Bakos (1993). The

result was that growers supplied their products to the traditional clock sale. Wholesalers are also going to the traditional clock sale because there is little supply supported by information auctioning.
- The results of this introduction seems to underline the conclusion of Bakos (1991). He argued that electronic markets are likely:
  - For buyers to reduce the costs that they incur to acquire price and product information;
  - For buyers to enjoy lower prices because of the increased competition among sellers;
  - For buyers to be better informed about the available products and thus may choose sellers that better suit their needs.

In general we may conclude that:
- In the different business scenario's there are problems reported dealing with product identification, standardization of the quality and quantity of floristry products, representation of a lot, representation of product images. The used systems are not been able to specify the products in a reliable, actual and complete manner.
- Growers still got no clear insight who is actually the consumer of their flower or pot plants.
- Images seems to be useful in the selling process of the wholesalers in stead of the buying process of the wholesalers. One reason can be the difference in suffering risks. Wholesalers bear risks over a retailer's rejection of their offer. For this reason the wholesaler will first see the products to overcome this risk. In the selling process to retailers, wholesalers try to distinguish their self in relation to other wholesalers. Therefor an image data base (with standard products) where every wholesaler may have the same supply information is not necessary. However, retailers seems to accept electronic product images as samples (special products).

In other countries one developed also new alternatives to link growers and wholesalers to each other. For example, in Denmark a supply information system (DAMOT) became operational. In this system the wholesaler place an order to the grower. The input of the data system is done by the growers. This system is owned by the six largest wholesalers in Denmark. The growers have agreed to fulfil the agreements and they will be excluded as they fail to keep their promises. An advantage of the system is the customer orientation, the link between grower and wholesaler is short, efficient and direct. A disadvantage in contrast with the Dutch supply systems is the price-making by the grower. The price is not market orientated, because the lack of price determination by the auction clock. In the Netherlands MO transactions are still related to the clock price, which reflects the optimal price. However, DAMOT is still successful, because 80% of the Danish trade occurs by this system (De Boer, 1993).

Electronic markets in non-flori chains

In this section we discuss some examples of developments of electronic markets in non-flori chains. For example in the financial sector much knowledge and insight was gained about the introduction of electronic markets. Theoretical research is already employed in this sector. We present also examples of electronic markets dealing with jewels, cars and pigs. In the discussion we answer the question what we can learn from the implementation of electronic markets in non-flori-chains.

Electronic Securities Markets

Practical examples

On the New York Stock Exchange the automatization of many manually floor processes including electronic order routing, execution reporting and the electronic specialist book are developed last years. Computer-based trading systems automate order matching between buyers and sellers. For example CATS (Computer Assisted Trading System) in the Toronto Stock Exchange is a well-known example. A major advantage of CATS is that orders can be entered by investors located anywhere in the world. Another example is NASDAQ (National Association of Securities Dealers Automatic Quotation), described by Riess (1989). It allows market makers to store quotes in a computer and display them on a widely distributed electronic billboard system. NASDAQ by its very nature closely matches the commonly stated requirements for worldwide trading. It is a geographically decentralized, highly automated system tying together competing markets and market-makers in a highly-visible and efficient way.

Theoretical research

Cohen and Schwartz (1989) believe that, if properly structured, an electronic based trading system should result in far better market performance. They designed an electronic call market called PSCAN. Its specific objectives are fourfold: (1) enable geographically dispersed traders to respond to floor information as the markets forms, (2) encourage traders to reveal their orders, (3) facilitate the entry of large orders and (4) find clearing prices that comprehensively reflect trader's desires to buy and sell shares. The key structural feature is a price scan procedure. Clemons and Weber (1991) compared two alternative trading mechanisms for securities markets using laboratory experimentations and computer simulations. One mechanism is the floor-based specialist auction (hoekman in dutch) and the other is an electronic alternative employing automatic order matching. They conclude that transition from the established floor-based exchanges to potentially superior electronic alternatives is possible, despite the inertia resulting from the experience of benefits investors trading in active markets and that current proposals for electronic markets are not demonstrably superior on generally accepted criteria used to assess market quality (Clemons and Weber, 1991). They conclude that 'since the benefits to systems innovators will frequently depend upon adoption, and since adoption of strategic innovations is frequently dependent upon decisions of a group of potential users acting without external coordination, valuing such systems innovations has been extremely difficult and uncertain'. Weber (1991) examines the possibility that today's security markets will be displaced by lower-cost electronic trading systems and discusses the importance of two necessary conditions for adoption of an alternative trading system. First, in the absence of regulatory intervention, an alternative trading mechanism must be capable of competitively drawing volume away from an established market; i.e. there must be a *feasible* transition path to a new trading mechanism. Second, it must be demonstrated that a proposed electronic market design does in fact improve recognize measures of market quality such as bid-ask spreads and transaction-to-transaction price variance. A new trading system must be *desirable* and improve the functioning of the market. The observed outcome is that transitions to alternative trading mechanism are feasible, but the electronic market design considered - an open order matching market - is *not* desirable to most traders or by important market quality measures in comparison to the specialist and limit order book market structure in use on the major U.S. stock exchanges (Weber, 1991:242). He concluded that if an electronic trading system were developed that offered lower costs and whose design provided demonstrably improved market quality, the evidence suggests that transitions away from an established market would be possible. Smith and Williams (1992) found that institutional rules governing trading play a crucial role in market efficiency. They tested how well price levels and trading tracked changes in the theoretical equilibrium under three sets of rules. The first one is called the *double continuous auction*. In this system any buyer or seller announced a bid or a offer to the entire group and a transaction occurred whenever any buyer accepted an offer or any seller accepted a bid. The second system is called the *posted-offer price*. In this system sellers set a price an buyers decide how many lots, if any, to purchase. The third system is called the *double sealed auction* in which traders prepare bids and offers, and a third party executes the appropriate trades. Post-offer pricing leads to market dislocations, but might interesting for large and stable markets, especially those in which each transaction involves small sums. The dampening effect of post-offer pricing on trading volume and its inability to track a shifting equilibrium are outweighed by the fact that it does not impose any negotiating costs (Smith and Williams, 1992). Doubles sealed auction set prices as effectively as the double continuous auction, but its transaction costs are lower. Smith and Williams (1992) suggest that stock, bond and commodity markets working to implement computerized trading procedures might do well to consider the double sealed auction in place of the double continuous model that has served them in face-to-face transactions.

Electronic Jewel Markets

Practical example: AGMS

The American Gem Market System, AGMS provides an integrated information, communications, grading and trading network in the gemstone industry (Warbelow, 1988). Many retail jewellers used the system to display international stone inventories to their customers. The possibility of incorporating images into the system was investigated. Stone images that could be merged with images of custom mountings are shown. Rather than transmitting a stone's actual image, a 'simulated' one could be constructed based on the information. The images could be processed by the computer and matched against a database to locate stones similar with the simulated one. Price variance could be reduced by a well-disciplined and efficient computerized market. The grading became more uniform and the sales could be increased. The mystery of the gemstone should be cleared. Dealers felt that the mystique should be lost when the stones were reduced to a few numbers on a computer. Jewellers could buy cheaper in the U.S.A. Dealers who go overseas buy better, in bulk and regularly and are able to give retailers a better buy. Stones have to be bought by looking at them. AGMS was convinced that by pushing for acceptance of grading standards and going direct to the retail jewellers, resistance at the dealer level could be overcome. With a dominant and profitable position in the gemstone industry, new comers would not be able to dislodge AGMS from its monopolistic position (Warbelow, 1988).

Electronic Car Markets

Practical example: AUCNET
Warbelow and Kokuryo (1989) presented the AUCNET case. The TV Auction Network system was designed to create a centralized wholesale market in which cars were sold using images, data and a standardized inspectors rating. A car sold by AUCNET remained at he sellers location until the transaction was completed. Afterwards the car was delivered direct to the buyer, where he or she saw the vehicle for the first time. In the auctioning process buyers and sellers remained at their business. Each was equipped with a PC linked to AUCNET computer. A laser disk player and TV screen were attached to the PC. Images of the cars to be sold were stored on laser disc and retrieved to a TV screen at the appropriate time by an AUCNET command. Information about the car and the auctioning process were sent over the phone and overlaid the image. Buyers entered bids by pressing a button. The auction was controlled by the AUCNET computer and operator.

Cost and ease of use are key factors to start this network. By using a proprietary terminal with the program in ROM and buying in volume, the cost were kept low. Participants leased the necessary equipment. AUCNET paid most of the communications costs. AUCNET had purchased a satellite transponder and planned to shift the laser disk based images into a satellite feed and upgrade service. The system implementation was like a rocket, it took the most energy to get off the launch pad, to keep it going it took less energy. A high minimum of terminals had to distributed quickly, otherwise the system lost its reputation. If it succeeded, the trees and grass were attributed to it. It was a snowball effect. Either it succeeded big or failed big.

Electronic Commodity Markets

Practical examples: HAM
Neo (1992) described the realities of Singapore's Hog Auction Market (HAM). Neo (1992) showed that HAM changed the fundamental nature of pig trading in Singapore (1) from one based on private negotiations between importers and buyers to an open market bidding system. (2) Prices under the HAM system are determined by supply and demand, not independently by the importers. When HAM was introduced, prices dropped an average of 15% in the first two months of operation, and varied by as much as 40% in the same period. (3) HAM provides market information back to farmers more quickly and more precisely and indirectly forced suppliers to offer better quality pigs. (4) HAM has reduced the need for middle men, the importers and changed their role drastically. Farmers can bypass the importers to sell their pigs directly by HAM. HAM charges lower rate of commission, so it became relatively attractive for farmers to switch. Neo (1992:285) argued that the key issue for successful implementation of electronic markets like HAM is not necessarily the enforcement of mandatory use, but the planning of strategies to obtain a critical mass of early adopters so that the system will be given a fair chance of having the intended effects.

Theoretical research

Lee (1993) investigated the concept of intelligent electronic markets for commodity auctions in detail. Within the taxonomy of market structures (direct search market, brokered market, dealer market, auction market) he adopts the auction as the market structure for an intelligent electronic market. An auction market refers to a centralized intermediary where buyers and sellers trade with each other without specialists. Auction markets provide the most cost effective trading structures because traders do not have to pay broker commissions or bid-ask spreads. There are two types of auction markets: continuous trading and periodic call trading. Some financial and commodity markets start the day as an periodic call trading and change during the day into continuous trading. Intelligent electronic markets accumulate buy and sell orders over time and match those aggregated orders in a way that (1) not only maximizes total exchanged volume within bid and ask prices (2) but also satisfies the qualitative preferences of buyers and sellers (Lee, 1993). In the flower markets context the qualitative preferences over product attributes or delivery conditions are important. Lee (1993) employed social choice theory to satisfy these qualitative preferences in commodity markets.

Discussion

The following lessons can be learned from implementations of electronic markets in non-flower chains:

- Different electronic markets systems occur, each with their specific market structures and business scenarios. For example, the doubles sealed auction seems to be worthwhile to investigate. No clear insight could be identified under what conditions electronic markets could be developed successfully;
- Order matching and price determination are new features which are supported in electronic markets;
- Some electronic market systems became fully automated - not in the sense of taking judgment out of the process, but in the sense of fully integrating automation with human judgement in the total routing, market-making, and clearing process (Riess, 1989:223);
- Global trading became possible by the introduction of the electronic market concept;
- The role of floor-based specialists is of decreasing importance. Electronic markets feature direct access between sellers and buyers.

Towards an electronic flower auction

In this section we combine the weaknesses of the current business scenarios (described in section 2) with the lessons learned in non-flori chains (described in section 3). The result of this combination is a new business scenario: the electronic flower auction (EFA). We will discuss features of it. Hypotheses will be formed dealing with conditions and design characteristics of the electronic flower auction.

Features

Central in the concept of an electronic flower auction (EFA) is the decoupling of the physical flower flow and the price discovery process in the auction hall. IT provide several features to overcome problems dealing with the decoupling. Lee (1993:119) distinguished several features of intelligent electronic markets. We use them in the business scenario of the electronic flower auction. EFA provide the following features:

- On-line transaction
  The electronic flower auction enable sellers and buyers to obtain uniform prices through periodic call trading. They are able to exchange quickly through on-line transactions.
- 24-hour global market
  Screen-based trading might be done 24 hours a day. For all sellers and buyers around the world it might be in potential possible to place orders.
- Transaction cost-effective trading
  Electronic flower auctions may charge lower trade commissions.
- Electronic audit and surveillance
  There are surveillance and regulatory advantages to trading systems that provide an electronic audit.
- Maximized transaction volume
  The periodic call trading mechanism determines optimal transaction pricing so that sellers and buyers can maximize their transaction volume. Using the suggestion of Smith and Williams (1992) that stock, bond and commodity markets working to implement computerized trading procedures might do well to consider the double sealed auction in place of the double continuous model that has served them in face-to-face transactions. The physical (floristry) flows are hereby not considered.
- Satisfaction of qualitative preferences on product attributes
  Sellers and buyers can specify their preferences on the characteristics of products. The trade matching mechanism enables them to exchange goods with preferred trading partners on the best combination of their qualitative preferences.

The EFA business scenario seems to be useful in a global context, for full standardized flower products. Growers, wholesalers and retailers can easily be connected by IT to the price discovery process. Transports of the perishable flower products will directly go from grower to wholesaler/retailer.

Design strategy
Bakos (1991) identify that the best strategy for sellers is to control the type of system eventually introduced by (1) a system emphasizing product over price information may allow sellers to keep much of their monopoly power while giving buyers access to the allocation efficiencies and buyers can be charged user fees for using this system; (2) to compensate for the effect of the systems by making it difficult for buyers to extract price information or to compare alternative product offerings; (3) to increase the differentiation of product offerings, possibly using the technology to help differentiate what would normally be a commodity product. Buyers obviously have the opposite incentives and would like to encourage an electronic market place that facilitates comparisons among sellers' prices and products (Bakos 1991:43). We think that also in the electronic flower auction all three design strategies might be useful. In the design process of this business scenario buyers and sellers have to negotiate on specific design characteristics. Special attention in the development of IT have to be given to the early phases of the development life cycle.

Contracting management and design management seems to be crucial success factors, see Van Heck (1993).

Hypotheses

To summarize our conclusions we formulate hypotheses for further research. We used the framework of Weber (1991) to structure our hypotheses.

H1 If the electronic flower auction will be capable of competitively drawing volume away from an established market i.e. there must be a feasible transition path, then it will be adopted.

H2 If the electronic flower auction improves the functioning of the market i.e. it is desirable, then it will be adopted.

More specific hypotheses are:

H3 If transactions in EFA are auctioned by double sealed auctioning then EFA will be capable of competitively drawing volume away from an established market and improve the functioning of the market.

H4 If qualitative preferences on product attributes can be specified and product quality can be standardized in EFA then EFA will be capable of competitively drawing volume away from an established market and improve the functioning of the market.

H5 If EFA links growers with wholesalers and retailers around the world then EFA will be capable of competitively drawing volume away from an established market and improve the functioning of the market.

H6 If EFA enables to bypass wholesalers and links growers and retailers directly then EFA will be capable of competitively drawing volume away from an established market and improve the functioning of the market.

H7 If EFA enables to force growers more market orientated then EFA will be capable of competitively drawing volume away from an established market and improve the functioning of the market.

Conclusions

In this section we formulate our conclusions. In this article we answered three questions.

What sort of business scenarios link growers and wholesalers and how are they supported by IT applications?

We identified different business scenarios. A steady growth of the floristry industry in the Netherlands caused logistical problems around the auction halls. IT was used to speed up the traditional auction process by using faster auction computers and EDI applications like the electronic supply letter. There was a shift from the traditional auction towards transactions supervised by the mediation office. IT was implemented to support mediation office transaction. For example, the image database was set up to provide buyers more service. Finally, auctions are working to implement so-called pseudo information auction systems. In those systems there is a pseudo-decoupling of physical flower flows and the price discovery process in the auction halls. Problems were reported with the pseudo information auctioning concept. We could explain those problems. We think that the pseudo information auctioning will not be suitable for grower and wholesalers in the near future.

What can we learn from implementations of electronic markets in non-flori chains?
In different non-flori chains electronic markets were developed the last years. Market structure, characteristics of transactions and the transacted products, characteristics of sellers and buyers seems to be essential for the structuring of the electronic market.

Design characteristics dealing order matching and price discovery are introduced in financial electronic markets. Effects were reported dealing with decreasing market prices and decreasing monopoly power of sellers, bypassing middle men and floor-based specialists. No clear insight could be identified under what conditions electronic markets could be developed successfully. Global trading is one of the important features of electronic markets. Special attention have to paid to the market structure and specific features of an electronic market.

What are features of an electronic flower auction and what sort of hypotheses dealing with the design of an electronic flower auction have to be researched?
Weaknesses of current business scenarios and lessons learned from introductions of electronic markets in non-flori chains formed the bases of a new business scenario called the electronic flower auction (EFA). In this scenario there is a decoupling of the physical flower flows and the price discovery process. Specific features of EFA are on-line transaction, 24 hour global market, transaction cost-effective trading, electronic audit and surveillance, maximized transaction volume and satisfaction of qualitative preferences on product specifications. Hypotheses have been formulated dealing with essential design characteristics of EFA. These hypotheses specify important aspects as the double sealed auction concept, global trading, qualitative preferences and standardized quality attributes, bypassing wholesalers and direct linking with retailers and forcing growers toward market orientation.

Overall, we think that there are advantages to introduce the electronic flower auction business scenario in a *global* context. A lot of questions still exist. The scenario has to be developed in more detail. Further research has to be employed in cooperation with growers, auctions, wholesalers and retailers in the Netherlands and abroad. Simulation techniques to forecast effects on market quality seem to be essential. Studies combining experimental economics and computer simulation provide useful results, see for example Weber (1991), Smith and Williams (1992) and Lee (1993).

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Appendix 1: The Dutch flori-chain

One of the most competitive sectors of the Netherlands is the floristry industry. The floristry sector comprises the cultivation and trade of cut flowers, pot and bedding plants. Pot plants and cut flowers have an almost 80% share of the world trade in ornamental plant products. In the last decade the industry was growing fast. Significant changes are occurring in the competitive floristry relationships worldwide. European integration, democratization in Eastern Europe and the liberalization of world trade in the context of the GATT negotiations will have consequences for the national and international cultivation and trade. A number of 'traditional' markets are going rough and displaying signs of saturation. This has been caused by the low conjuncture and the increasing competition from foreign countries. The exchange rate problems and the increasing of the tax-tariffs in France are of great importance. The sales to the most important client Germany is still going profitable. However, the price determination is still under pressure.

In the Netherlands logistical problems are dominant, resulted from the ever-increasing supplies brought to the auction centres. The shifting from a supply market to a demand market is pushing through. The increasing competition from foreign countries force the Dutch floristry industry till strategic management. All this affects profit margins and the power relationships in the floriculture chain. The many changes make it difficult to obtain a clear insight into the prospects for the floristry industry, while this is essential for making a timely response to opportunities, threats, strengths and weaknesses. The use of new Information Technologies (IT) is mentioned as one of tools to overcome this problems.

The linkages and the chain pattern of the Dutch floristry industry are showed in subjoined figure. The connections between the linkages show the direct information and physical flows. Foreign production is included while the cut flowers and pot plants trade have the Netherlands as their intermediate or final destination.

Suppliers

Suppliers deliver products to national and international growers. Examples of goods are plant material, fertilizer, crop protection and technical equipment.

Growers

More then 2100 companies with pot plant culture have a areal of approximately 1300 ha. The areal of cut flower culture is the amount of 3600 ha accomplished by almost 6500 companies. The cultivation of floristry products is mainly concentrated in South Holland, particularly in the area known as the South Holland Glass District (ZHG); 42% of floriculture areal is grown in this area. There is also a production centre around Aalsmeer. Because of the lack of well-developed large contiguous stretches of land in these old centres, many new nurseries are springing up in the fringe areas around the ZHG en Aalsmeer. A number of growers opt for other regions for expansion because of the land size, infrastructure, water quality, land prices and labour market (Groen, 1993).

The growers regard each other more as colleagues than competitors. A widespread participation of growers in study clubs shows that they do not rely solely on their own intuition (Leeuwis, 1993).

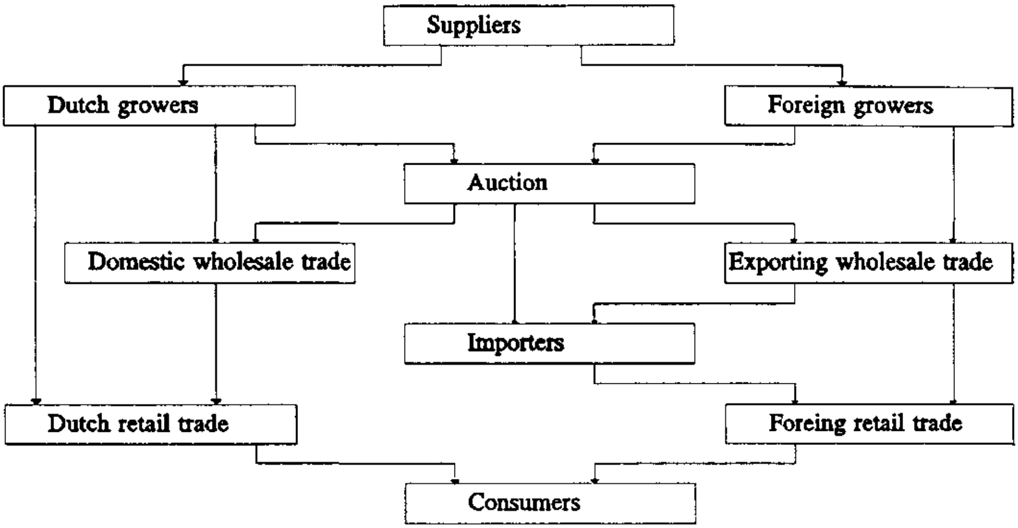

Figure 1. Actors and linkages in the Dutch flori-chain

Auctions
Floristry products are sold by seven auctions. The two largest auctions Verenigde Bloemenveilingen Aalsmeer (VBA) and Bloemenveiling Holland (BVH) account for 81% of the auction turnover in cut flowers and 92% of the auction turnover in pot plants. The auctions are sales cooperations of the growers. Their objective is to serve the interests of the members in particulary the sales of floristry products produced by the members. The trend towards strategic partnerships and mergers is continuing, enabling the role and power of the auctions to increase further.

Wholesalers
Domestic wholesalers and exporters receive their supplies by the auctions. Last year there were almost 1850 exporters and 350 wholesalers with domestic trade. The exporters can be divided into the scheduled delivery services and dispatch exporters. The former deliver their products directly to the foreign retailers, whereas the latter mainly deliver to wholesalers abroad.

Retailers
There is a widespread distribution network, with approximate 10.000 points of sale for flowers and plants. Most of the distribution to consumers takes place by flower shops (54%). In addition, there are sale by street traders (23%), grocery superstores (13%), garden centres (6%) and other channels (4%). Flower shops and garden centres have a gross profit margin of about 75%, street traders about 50% and the supermarkets and department stores around 65% (Haak et al, 1992).

III. Development of chain management

Chain-management: between cooperation and competition

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Introduction

The combination of the words 'chain' and 'management' suggests an optimism in the possibility to influence and control a flow of goods or services in a way that preset targets are met. 'Chain' stands for the system of stages that are linked through the process that aims at narrowing the gap between primary extraction and final use. 'Management' denotes the possibility to coordinate the processes that exist between these stages.

'Control' can be accomplished in different ways. From a governmental point of view, control can be accomplished through legal prespcriptions, that have to comply with rulemaking of the European Union (somewhat old-fashioned depicted as EC). Governmental control is not solely accomplished through limiting prescriptions but can be realised by incentives too. Incentives or directives can focus:

- the chain and the different stages in the process especially when subsidies or quality assurement aim at maintaining a flow of goods that is essential for the functioning of society;
- can pin-point the beginning of the chain, for instance as takes place in product-liability;
- can pinpoint the end of the chain, for instance to protect consumers' rights.

The *legal* framework limits the possibilities for individual enterprises to cooperate and/or to compete. From an *economic* standpunt of view, cooperation or competition that takes place within the legal framework can influence the (transaction) costs of entities within a chain. And moreover, between legality and economicality interdependencies exist, law can be viewed at 'from the perspective of the economist' (E.J.P. Mackaay, 1988).
Opportunities and limitations of chain management can be located in:

- the legal framework that provides the space and possibilities in which parties can operate;
- economic factors that provide positive or negative impulses for the bargaining process itself as is the case when contracting costs exist;

- legal impulses that have effects on the bargaining process and that can be restated in economic criteria, such as liability rules.

Studying chains is not a one way process. In gathering and analysing chains and presenting information about chains in a coherent and consistent manner, chains are object in a double sense. Through the gathering of knowledge about chains and the use of this knowledge, a spin-off of scientific findings to the companies that are linked in chains could be realized.

The question can be asked if there are limitations to the management of chains from a leagal perspective. If such hurdles exist, attention should be drawn to the limitations of chain-management itself, that is, in essence, cooperative action.

In this paper attention is concentrated on the following key-areas that are of importance in studying the possibilities to cooperate and/or to compete:

- national trade barriers and horizontal or vertical agreements between companies to reduce competition (par. 2);
- the assessment of quality and product specifications (par. 3);
- the joint effort to solve the environmental problem (par. 4).

On each of the above areas of possible interference with national and european regulations are considered. In paragraph 4 more than moderate attention is payed to chaining problems in the environmental-damage issue, as it is of special concern in future research. In par. 5 concluding remarks will focus on consequences for the direction of future research with regard to legal issues in chain-management.

Realising a european market: getting rid of trade-barriers

As the major goal of the european unification effort is to reduce limitations for competition within the European borders, all three named areas are of concern, as measures of individual states or companies can disturb a 'workable competition'. Rules against unfair competition (art. 85 - 90 of the EC-treaty) and against governmental barriers were created to enhance such circumstances (L. J. Brinkhorst/R. Barents, 1990 page 107).

So competition is enhanced by:

- the breaking-off of national trade barriers for the flow of goods over the borders (par. 2.1);
- a restrictive policy on agreements between individual companies (par. 2.2).

As the EC has created a autonomous judicial system (Van Gend en Loos, Court of Justice case 26-1962), that passes by national legistic efforts, chain management should not conflict but only be subsidiary to efforts to achieve a free EC-market (Simmenthal case, Case 106-1977).

Trade restrictons

A common markt encompasses not only the free transfer of goods (art. 30 -37), but also the free practice of professions (art. 48/52), of delivering services (art. 59) and of capital (art. 67). Import barriers can lie in prices (duties and taxes, art. 12) or quantitative import restrictions. The Dassonville-case has shown that any measures that can have the same impact as quantitative import restrictions are prohibited (Dassonville case; Court of Justice Case nr. 8-1974).

Intercompany agreements and economic power

In a competitive market profit margins are under constant pressure and producers are forced to innovate to create a temporary advantage. Paradoxally, protection that companies seek through mutual agreements, is motivated by competition itself, since in a perfect and liberal market any profit margin will diminish. As long as there is a difference between costs and selling-price more companies will join on the market.

Trade barriers on the other hand have a negative impact on real income of consumers.

Cooperative action of companies to protect prices and market shares can violate art. 85/86 of the Treaty, if the agreement possibly has a negative influence on trade between Treaty-countries, even if the horizontal agreements exist between companies that are located in only one EC-country (VCH-case, Court of Justice case nr. 8 - 1972; compare H.W. de Jong, 1990). According to art. 85,1 common market objectives can be frustrated if agreements, decisions or coordinated behaviour can diminisch trade between Treaty-countries and aim at or result in an obstacle for competition. Such agreements should be reported to the Commission that can grant examption from the prohibitions of art. 85. Examption can be granted if cooperation aims at technical improvement of products or (economic) progress. Art. 85,3-b however states that such examption may not result in or aim at eliminating competition for an important part of total production.

Article 86 concerns the *disuse* of economic power, for instance as a consequence of take-overs (Case 6-1972, Continental Can).

Under dutch law, the Ministry of economic affairs should be informed about the agreements on price or market regulations (art. 2 ECA, Economic Competition Act) which can be generalized (art. 6 ECA). The measures against agreements on the basis of the dutch Economic Competition Act (ECA) can concern (generic) annulation after suspension. This measure focuses on the agreement itself (art. 23 ECA) and is primarily a horizontal instrument. The publication of information (art. 19/24) however aims at mobilising public opinion and is therefore a vertical instrument. The ECA can be used against specific clauses in horizontal agreements that frustrate public interest, and can for the same reason be used against economic dominance in a market (art. 24 ECA).

As dutch law concerns only those regulations on competition and economic power positions that have negative consequences for *public* interest (particularly when a situation occurs that can be characterized as unfair competition), it is possible that dutch policy violates EC-regulations that are based on the principle of *prohibitive* regulation. It should be noted too, that under dutch law there should be a formal agreement between companies before government interference is applicable, while on the European level even coordinated action between organisations can lead to measures from the European Commission on the basis of EEC's provision nr. 17 (RUG, 1992, page 87).

Cooperation in the chain

Horizontal agreements between companies operating in the same branche can have vertical implications. This is of importance: for understanding transactions between companies vertically in a chain, apparently agreements on cooperation horizontally matter.

Market structure can stimulate the realisation of horizontal agreements in a vertical-upward direction. Referring to the pork meat-chain, constant pressure on transfer-prices for pork between retail trade and delivering companies cannot be met by quality improvement alone, since such quality improvement will only lead to lower prices (for the consumer) or larger profit margins (for the super market chains). The constant pressure on prices, that is a consequence of oligopolistic tendencies in the retail-sector, and strong competition in stages upward the chain, leads to the shifting of pressure on margins upward, to the farmers, with possibly fatal consequences for Dutch companies in the near future. As downward the chain loss of margin on meat is compensated through gains on other products (companies have a highly diversified composition of products to offer) and the acquisition of products by customers takes place through 'package-deals' with retailers, specialisation upward the chain becomes a death-trap for which quality improvement givens no definitive solution.

Another 'inequality of arms' should be noted. Retailers have a freedom of choice between the delivering companies, but the same freedom of choice is not applicable upwards the chain because of cost- and capacity- and storage-structure. Cost-structure is important because realised long-term investments create inflexiblity in production; capacity-structure is important because the existing over-capacity aggrevates pressure on margins; ans storage-costs are important because the loss of clients is immediately translated in cost of capital that lies fallow.

Quality improvement has (as stated) only a positive aspect for the short run since it opens up markets abroad, it compensates in a sence the natural disadvantage that exists in the distance to the consumer abroad, and creates a temporary margin at home in a competitive market. At the home-market it helps to keep up with companies in the same branche. Of course quality improvement itself is a welcome result of competition, but for the companies involved it is only profitable if profit margins can be restored.

It may therefore be of importance for survival of companies in the dutch agri meat-sector to come to joint calculation schemes on product prices in relation to quality, but joint action violates the aim of disclosure of markets and is therefore of special interest for european monitoring agencies too.

Whereas european policy aims at enhancing competition, dutch law and practice are permissive despite recent measures of the Department of Economic Affairs to prohibit agreements on vertical price regulations (and perhaps necessarily is in the light of policy in other counties).

Quality improvement

Quality prescriptions can have a positive and a negative impact on competition. From a Hayekian point of view, as Hayek promotes a liberal economy that is totally different from the Netherlands' guided economy, economic policy should concern mainly the prohibition of cartels and the setting of qualitative non-discriminating requirements for new busineses and for products (B. Hessel, 1992, page 5). Since national quality prescriptions can conflict EC's primary objective, quality assessment from a european perspective aims at protection of end-users (Rau case 261-1981) and by the object of eliminating unfair competition.

Prescriptions on product quality and composition that are officially motivated by health protection on art. 36 (Sandoz case 174-1982) can come in violation with with art. 30 of the Treaty, if the measure has similar effects as a quantitative import restriction. From the Cassis de Dijon-case it follows that national rules to protect consumers' safety and health are not applicable if this protection is garantueed by the rules of the state of origin (L.J. Brinkhorst/R. Barents page 109).

For integral chain management it means that quality regulations downward a chain are prohibited if such regulations aim at frustrating EC-policy to open markets.

Environmental care

From a european point of view, environmental care is of special interest. On a global level no legal authority exists that can force national governments to diminish environmental pollution. On a mondial level the enhancement of environmental care can only be stimulated indirectly through the expression of recommandations. The formulation of rules by individual governments must be seen in relation with and subordinated to EC-rule making (L.J. Brinkhorst/R. Barents, page 210).

Art. 130,4 states that measures are taken on a european level only if through communotory better results an be realized than on a national level. Art. 130t leaves open the possibility for national environmental rulemaking to be more severe than EC-measures. According to art. 130t these measures must fit in the context of the Treaty.

From the primary objective of the EC as an economic community, the possibilities to alleviate rulemaking and rule-enforcement on a national level can therefore diminish. For instance the possibilities to cut down the number of enterprises that have to ask for special permission if enterpreneural operations create environmental risks under the 'Wet Milieubeheer' (General Environmental LAW, GEL), by the formulation of general rules as is possible under dutch law (art. 8.40 GEL), are narrowed by the EC-directive on Integrated Pollution Prevention and Control (J. Verschuuren page 107 - 108).

In dutch law there are three sources for legal restraints on the creation of environmental pollution. Apart from public law, that is based on specialisation in environmental sectors (air, water, soil, sound) and are linked to the GEL (with exception of the Water Pollution Act), environmental pollution and the behaviour that causes environmental damage, is opposed by criminal and civil law. In the following, attention will be focused on civil law, as tort law (especially art. 6:162 of the dutch Civil Code) is less vulnerable for conflict with efforts on the european stage than public law.

Civil law can take two extreme positions as to the question who exactly has to bear the loss that occurs on an incident with environmental damage. With the absence of any civil rules that hold the polluter responsible for environmental damage, its the pollutee that has to bear the loss. This does not necessarily mean that damage will *not* form part of the private costs of a firm, since victims might be willing to pay for preservation of their health and property. At the other extreme, under a system of strict liability, it will be the polluter that bears the financial consequences. This does not necessarily mean that the victim's role is a passive one, since through contracting and negotiations, polluters can come to an agreement on the costs of the damage caused.

Civil law therefore influences behaviour in a situation of strict liability, although ex post compensation is its primary objective. This is because compensation itself has an ex post and an ex ante aspect. From an ex post standpoint, compensation refers to the righteousness of the recouperation of any loss. The financial loss should be the burden of the actor that, in an enterpreneural setting, aimed at a profit in acting as he did. Ex ante it can bring about cost minimization and prevention efforts.

In dutch law, similar as in the american law system, there is a tendency towards strict liability when creating a risk for the property or health of others. Strict liability rules do not necessarily have to be effective from a society's point of view in reducing social costs, as will be argued further. The (effectiveness of a) liability rule is of importance since it has an impact on vertical chain-transactions. Before studying the influence of such rules, in the following subsection companies' behaviour is looked at.

Private effectiveness and environmental care
From a company's perspective, the development of a corporal environmental care system is one out of several strategies that can be adopted to meet environmental risk (see for instance P.F. Claes/H.J.J.M. Meerman page 110). In cooping with environmental risk, first a choice has to be made between between taking action and doing nothing. If a decision has been made to act, then a choice is due between risk-reduction and risk-compensation activities. Risk-reduction can be accomplished by the adjustment of activities, by investments (e.g. the implementation of a care system in the organsation) or by combination of these strategies. Risk compensation is estabilished by insurance or by creating financial provisions.

When meeting environmental risks in an active way, costs will occur. The costs an individual company will meet in producing for the market, consist of traditional production and marketing costs and will possibly be increased by risk reduction costs. In the following we exclude the problem of choosing betweene risk compensation and risk reduction assuming that I, the present value of risk reduction costs, equals present value of insurance premiums (P) and the present value of provisions (O). In all three cases a stream of cash outflows (Zt) will occur so that:

$$E(I) = PV\,[E(Pt)] = PV\,[E(Ot)] = PV\,[E(Zt)]$$

Risk reduction costs are the costs incurred by reducing environmental risk. If risk is not totally reduced, environmental damage may occur. Total costs of a firm may, but are not necessarily composed of traditional production costs, risk reduction costs and pollution costs. If total costs weigh in total on the firm, decisions have to be made as to what level

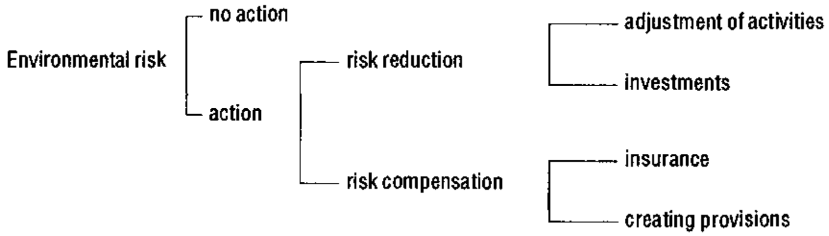

Figure 1. Risk strategies

risk will be reduced. Under the following assumptions the risk reduction level can be assessed positively (compare: R.W. Holzhauer/R.Teijl page 125):

- negative consequences of environmental pollution weigh upon the polluter solely.
- the chance on an incident that incurs pollution costs will be reduced by investments that in turn raise production costs;
- total operations of the firm will not be reduced in meeting environmental risk (as is the case in a short term situation);
- production takes place under perfect market conditions. There is no information problem for the management of the firm.
- the firm's goal in the short run is to reduce the environmental risk to a level on which total costs at a given activity level are minimal.

The following symbols are used:
Co : the traditional costs of current activities
Do : environmental damage
p : change for environmental damage
T : costs of risk prevention

As the chance for damage will be reduced by investing more money in prevention measures p = f (T). The company's total costs (C) under the specified conditions earlier will therefore depend upon D, p(T), T and Co. As Co isn't adapted on the appearance of environmental risks (or stated differently, as the activity level is supposed to be a constant), Co will not be a determining factor in assessing the optimal risk reduction level. An individual optimum occurs when marginal expected environmental damage equals marginal risk prevention costs.

In a perfect market with the same cost structure for all the companies on that market an optimal situation will be brought about. Thos means that total wealth is maximized. Under the circumstances in this subsection, a liability rule has not much to offer.

In the real world however, costs of pollution will primarily weigh upon pollutees because external effects occur.

External effects and the market

In the above example environmental damage is supposed to bring about internal effects, that is costs for the individual company, which stimulate to alter behaviour in a more profitable direction. If external effects exist, the burden of environmental pollution will weigh upon others than the enterpreneur, so that, apart from results of bargaining efforts, no stimulus to alter behaviour is brought about.

An externality is, 'a cost or benefit that the voluntary actions of one or more people impose or confer on a third party or parties without their consent' (R. Cooter and Th. Ulen, page 169). Externalities bypass the main instrument to internalise environmental pollution costs, namely the price mechanism.

The existence of externalities presuppose the beaconing of organisations to markets. A market functions as an instrument for competition. Agreements between actors on markets mitigate competition and favour organisation. Any volunteery agreement on pollution prevention and control, on quality or the use of marketing instruments (e.g. price, quantity produced, sold and its quality) reduce free competition between organisations and itself bring into existence organisation itself.

Markets link organisations that are involved in the propulsion of goods and ultimately link consumers to producers and polluters under circumstances (in the absence of government intervention) to pollutees. The division between markets and organisations is transparent and as O.E. Williamson (1975) argued, a result of economic behaviour itself, in particular by weighing of coordination costs and transaction costs, that is the costs of information gathering, negotiating costs and contracting costs.

The problem R.H. Coase aims at, concerns the transformation of external effects into private costs. As H. Demsetz (1988, page 14) and many others in concordance with Coase's analysis states, when transaction costs and income effects are zero, the initial optimal market situation will perpetuate no matter how property rights are distributed. In a situation of free negotions between polluters and pollutees, external effects will result in private firm's costs to a level that matches the willingness-to-pay . From a society's standpoint the thus created market situation is optimal in the sence that it minimizes costs. Two propositions R.H. Coase makes in his analysis are, first and extremely important, the absence of transaction costs, and second the absence of influences from welth redistribution.

D.W. Bromley (1991, page 74), P. Burrows (1979) and others have, as R. H. Coase (1960) had already argued, confirmed that transaction costs *do* matter. P. Burrows argues that in a zero-contracting costs situation, a Kaldor-Hicks optimal situation (Q1) will result from negotiations.

The negotiations that will take place between the parties will result in a redistribution of wealth and a shift in the allocation of resources. The shift, however Kaldor-Hicks efficient, is not neutral (compare: H.J. Simon, 1993). For instance, H. Demsetz (1988, page 59) states, referring to driver liability under perfect market conditions, drivers would avoid accidents and would negotiate with pedestrians if risk avoiding behaviour could be bought at lower costs. If pedestrians were liable for accidants, they would change their behaviour to avoid accidents.

The shift in wealth distribution in either liability situations is a consequence of the fact that under strict liability rules the pollutor pays to the pollutee, while in a non-liability situation the income stream flows in just the opposite direction. Under positive transaction costs circumstances the new equilibrium will be different too (figure 2), namely Q2 if polluters are held liable and Q3 with polutees' liability.

It is shown that the distribution of property rights (the ownership of a controllable stream of income that is linked with assets according to D.W. Bromley) is of significant importance for the results of negotiations. It should be noted that wealth distribution is a prominent political issue, and so is therefore the initial distribution of property rights. Outcomes of analyses on economic efficiency of liability rules under assumptions of neoclassical economic theory do not guarantee a fair and just distribution of wealth. Solutions for the environmental problem cannot therefore result from traditional economic theory alone.

Free competition can not only have undesired effects on income and wealth distribution, but on the environmental problem itself, since in a neoclassical model, an implicit assumption is made of a stream of inputs and outputs that can be repeted endlessly. Limi-

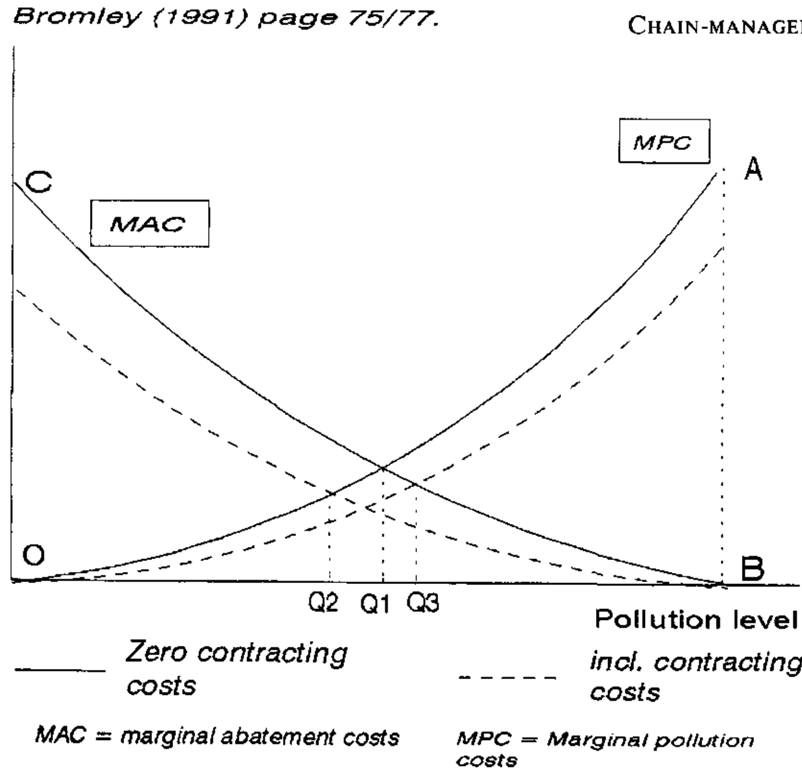

Figure 2. The influence of transaction costs on the market optimum

tations of the competitive model are breavely summarized by D.W. Bromley who states that the market is an inappropriate instrument (1991, page 20):

- if high transaction costs exist;
- if large and nonmonetary benefits and costs occur;
- in cases of high uncertainty over the future;
- with the threat of potential irreversabilities.

In looking for a liability rule that is effective from a societal point of view, one should bear in mind the disadvatages of neoclassical economic analysis. In environmental care often negotiations between victims and offenders are impossible as a consequence of high transaction costs.

Effectiveness in non-negotiation situations
One can ask if a single liability system exists that succeeds in minimizing social costs in non-negotion situations.

The appropriateness of a specific liablity rule can give information about tendencies towards cooperation on environmental care in chains and, as a by-product, on effectiveness of product-liability, which is in essence a vertical chain-problem. The assesment of a liability rule that is effective in minimizing social costs depents on the specific possibilities to create or imitate market situations (what R.A. Posner (1986) calls: 'mimicking the market'; see H.J. Simon (1993) page 31).

E. Mackaay (1990, page 141 - 147) compares the costs of (environmental) damage (D) with the costs of risk prevention of the offender (Co) and the cost of prevention of the victim (Cv). Mackaay argues that there exists no single liability system that is efficient under all possible combinations of D, Co, and Cv. The following analysis is presented (E.J.P. Mackaay 1990, adj.):

D, Co, Cv	Liability on negligence		Liabiliy on created risk	
D < Co < Cv or D < Cv < Co	1	Damage for victim	6	Damage on offender
Co < D < Cv	2	Precaution offender	7	Precaution offender
Co < Cv < D	3	Precaution offender	8	Precaution offender
Cv < D < Co	4	Precaution victim	9	Damage on offender *
Cv < Co < D	5	Precaution offender*	10	Precaution offender *

The liability regimes give non-optimal solutions under the specified conditions in cases 5, 9 and 10. In situation (5) the offender bears all costs (D Co so the offender had to take prevention maesures), of which the victim is capable at lower costs. In situation (9) the offender is held liable but costs to prevent damage are higher than damage itself. In situations (9) and (10) the victim is able to prevent damage at lower costs.

E. Mackaay uses the level of (possible) damage as an indicator for the level of precaution that should have been taken, the problem exists to get information about damage and prevention costs, information that is usually not available.

Criticisms on the above analysis may further focus the supposed independency of variables. Levels of care and damage are instead interdependent as higher levels of care result in the reduction of losses and injuries and the different impact on behaviour as to the risk aversion tendency of individuals.

A more thorough analysis, including some the mentioned factors is given by S. Shavell (1979). Attention is focused on he prevention of accidents. Results of Shavell's theoretical analysis are summarized below. First a unilateral case is egarded, that is a situation in which the polluter has the power to influence the level of (environmental) damage.

UNILATERAL CASE:	LEVEL OF CARE	LEVEL OF ACTIVITIES
I Accidents between strangers		
Negligence rule	Efficient	Too high*
Strict liability	Efficient	Efficient
II Accidents between sellers/strangers		
Negligence rule	Efficient	Too high**
Strict liability	Efficient	Efficient
III Accidents between sellers and customers		
IIIa customers have complete riskinformation		
Not liable	Efficient	Efficient
Negligence rule	Efficient	Efficient***
Strict liability	Efficient	Efficient

UNILATERAL CASE:	LEVEL OF CARE	LEVEL OF ACTIVITIES
IIIb customers misperceive risk		
Not liable	Not efficient	Not efficient
Negligence rule	Efficient	Too high/too low****
Strict liability	Efficient	Efficient

* No stimulance on reducing the activity level
** Costs of accidents are not integrally included in market prices
*** Custumers' perceived costs are product costs + expected damage
**** Customers' perceived costs are too high, too low; activity level is too low, too high

The general conclusion can be drawn that in unilateral cases, strict liability is efficient under all the named circumstances, wheras negligence is only efficient under (1) perfect risk information (2) with direct contact between seller and customer. Chain management will primarily be appropriate in cases where sellers and customers both can influence risks of accidents.

BILATERAL CASE:	LEVEL OF CARE	LEVEL OF ACTIVITIES
I Accidents between strangers		
Negligence rule	Efficient	Too high*
Strict liability with defense of contributary negligence	Efficient	Too high (victim)
II Accidents between sellers/strangers		
Negligence rule	Efficient	Too high
Strict liability with defence of contributary negligence	Efficient	Too high (victim)
III Accidents between sellers and customers (nondurables)		
IIIa customers have complete riskinformation		
Not liable	Efficient	Efficient
Negligence rule	Efficient	Efficient***
Strict liability with contributay negligence	Efficient	Efficient*****
IIIb customers misperceive risk		
Not liable	Not efficient	Not efficient
Negligence rule	Efficient	Too high/too low****
Strict liability with a defense of contributory negligence	Efficient	Efficient*****

* No stimulance on reducing the activity level
** Costs of accidents are not integrally included in market prices
*** Custumers' perceived costs are product costs + expected damage
**** Customers' perceived costs are too high, too low; activity level is too low, too high
***** Inefficient if goods are durables; frequency of use is not reduced

Consequences
Since there is no liability rule that guarantees optimal results under all circumstances, the problem arises to specify such rules under differing conditions. For chain management it would be important to analyse effects on behaviour since liablity rules for different kinds of external interference (products, hazardous substances etc.) are not the same.

Let us look at the consequences of the above analysis for cooperation on the environmental issue. For pollution problems that are unilateral (and many problems in fact are) strict liability is possibly efficient on the level-of-care issue and in influencing the level of activity.

In bilateral cases it may not be efficient at all in influencing the level of activity. Governmental restrictions on the level of activities however may lead to increased cooperation in a chain to alleviate pressure on profits. Cooperation and joint quality improvement may be induced by the tendency towards strict liability. This tendency is itself stimulated by inefficiencies of other liability systems. Cooperation may be stimultated too by the joint effort to reduce the level of risk, for instance in realising technical improvements.

In product liability, the producer that brought the product in circulation, is held liable under dutch (art. 6:185 - 6:193 of the dutch Civil Code) and EC-rules (dutch law is a result of the EC-directive on product liability). Risks however may be created by the use of products (e.g. faulty storage). In fact this means that a system of strict liability combined with contributory negligence may be efficient.

If customers are strangers to the original producer, activity level may not be efficient. This means that by narrowing the gap between consumer and producer, social effectiveness of product liablity may be increased. Integral chain management, by which the information gap between consumer and producer is closed, may have a positive impact on judicial effectiveness, and in the long run a positive impact on product improvement.

Research on chain-management

As the opportunities for vertical coordinated action can violate the basic principles of the EU, one can ask what sense it makes to study chaining activities. Why, in other words, are chaining activities of special interest since these activities can diminish competition by reducing the possibilities to enter the market by firms from abroad? That is because cooperation is possible, even under EC-law, but within boundaries.

First it should be specified where these boundaries are located, in a more exact manner than has been done in this paper. Secondly, research should focus on identifying legistic and private measures that are most effective within the boundaries of EC-law. And third, scientific research should focus on the specific consequences for individual companies within a chain as to strategy, logistics, production and product specifications in connection with legal constrains on cooperation. In doing so, scientific research on the management of chains can focus:

- horizontal research of branches (milkbranche, seedbranche etc.);
- vertical research on the flow of products;
- research on aspects of chains (quality, environment).

On the above analysis a special preference for one of these approaches can not be stated. In analysing vertical effects, information has to be gathered on horizontal agreements (par. 2). Research is necessary on the effects of product liability, since the original producer is held liable and operations in following chains are of special concern to him (par. 4.4). In quality-assesment, restrictions on horizontal agreements with regard to basic qualities of products and brands influence behaviour vertically upward (par. 3). The environmental aspects can be studied by looking at transactions between stages vertically and if such transactions cannot occur, the effect of legal prescriptions and liability rules on chain behaviour (par. 4.3). Studying chain management encompasses more than the processes that take place in a chain by following the product, since *cash flows go the other way around* (par. 2).

My conclusion is that studying chain management does not necessarily mean focusing on the chain itself.

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Integrated chain management in hortibusiness: a conceptualizing survey

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Abstract
Integrated Management of production and distribution chains in hortibusiness is a hot issue. On the one hand the sector is confronted with sector wide problems, that need to be solved on a sector level. On the other hand better tuning between chain activities promises big gains in financial, logistical and customer service performance compared to the necessary investments, while local improvements can only be achieved by large investments with a low return on investment. However, will integrated management be successful it needs to have a proper, consistent foundation. In this paper we present some recent insights in the integrated chain management process and apply these insights to Hortibusiness.

Introduction

Horticultural production and distribution systems have to deal with some special problems compared to industrial systems. Horticultural production is dependent on climate and soil, the quality of the produce varies in time and decreases more or less rapidly during the postharvest phase, and both production and distribution are characterized by a multi-site, multi-owner structure (Hoogerwerf et al, 1991). These characteristics of hortibusiness bring along a wide range of specific questions. The last decades research has developed many technological means to deal with the special product properties, and many of those findings are used in daily practice. The main aim of this technological intensivication is to decrease the dependency on ecological and biological properties of both the produce and its environment. Hortibusiness has, hence, changed from an ecologically based production and distribution system into a technologically based system. This technology is capital and knowledge intensive. Because of this, but also for general economic reasons, there has been a strong tendency towards upscaling of the business units; Hortibusiness is nevertheless still a multi-site, multi-owned system.

The technological developments, and the inherent increasing complexity for the management, have been noticed by management scientists and, hence, a lot of effort has been put into studies on how to manage horticultural technology (see f.i. Schoorl and Holt, 1985; Bots, 1991; Ziggers, 1993). A part of the research results on technology management has been put into practice, with an accelerating development in computer based management systems since the availability of the personal computer. Many production and distribution enterprises have been able to survive or even increase their profitability by improving their management. These management systems, however, are mainly dedicated to single aspect problems: climate control in glasshouses, administrative organization, transportation planning and -to a minor extend- production planning. Although the research efforts in the field of computer based management systems for multi-aspect problems were extensive, only a limited number of these type of management systems has been widely spread in practice for actual use (Leeuwis, 1993).

Although there is undoublty room for further improvement of local technology management, there is a general feeling that the significance of new developments in technology itself and in local technology management is contributing only marginally to the success of both the individual enterprise and the multi-site, multi-owned production and distribution system as a whole. It is assumed that managing the production and distribution system in Hortibusiness from an integrated systems viewpoint may be far more profitable (see f.i. Schoorl and Holt, 1990; Hoogerwerf, 1991; Saedt, 1991). This insight is not new, and is known from industrial production systems. In industry, one has tried to find new ways of technology management by introducing Computer Integrated Manufacturing (CIM). There has been a lot of theorizing research on CIM, and the concept is also implemented in a wide range of industrial sectors. During the last decade, CIM has developed from a company wide management concept (hence locally oriented) towards a business wide management concept including all companies contributing to a production and/or distribution chain of activities. It is then called Computer Integrated Business (CIB). In the CIM concept, and even more in the CIB concept, the production and distribution chain was defined as a system that has to be managed from an integral viewpoint, although it may be multi-sited and/or multi-owned. As it appears, significant advantages could be obtained from this integrated approach, also for small and medium sized enterprises (see f.i. Simons et al, 1991). Although Hortibusiness differs in many aspects from industry, it may draw lessons from Integrated Management concepts as being developed in other branches of industry.

In this paper, we will present the results of a qualitative desk study on the possibilities of Integrated Chain Management in Hortibusiness. We will start with a definition study on Integrated Chain Management. From this we will explore some basic elements of the managerial process and present possible solutions to tackle occurring problems. We will recompose these elements and the presented findings into a conceptual model for the Integrated Chain Management process, and draw some conclusions for future research on Integrated Chain Management in Hortibusiness.

Integrated Chain Management: A Definition Study

Integrated Chain Management may be seen as a systems approach to multi-aspect managerial problems concerned with multi-site, multi-owned production and distribution systems. Literature on systems approaches in Hortibusiness management is limited. Schoorl and Holt (1985, 1990) may be seen as front line researchers in this field, and more recently Hoogerwerf et al presented a systems view on horticultural distribution (1994a). While this systems approach is up to now primarily concerned with describing and analyzing a system, Integrated Chain Management (which will furtheron be referred to as ICM) aims to develop operational management tools from an integral viewpoint. These management tools may be computer based or not, and may target strategical, tactical or operational management problems. In our approach, integration has to be concerned with (i) the various aspects of hortibusiness (a.o. economics, logistics, product quality and environment); (ii) a comprehensible chain of production and distribution operations. Amongst others, Broekmeulen et al (1992) and Hoogerwerf and Simons (1994) published on the integration of aspects, with special emphasis on the integration of product properties and product quality behavior in postharvest distribution chains. Hoogerwerf et al (1994b) published on computer support systems for ICM. In this paper, we will focus at the management process that is concerned with production and distribution chains.

For clear understanding, we present the following definition of ICM:

ICM is concerned with the management of a (part of a) production and distribution chain (which may be multi sited, multi owned, and seen as a comprehensive set of activities) while taking into account all inter and intra relations of the (part of the) chain to be managed and a complete set of relevant aspects for the management problem under hand

We can illustrate this definition using the Systems Triangle as presented in Hoogerwerf et al (1991), see *Figure 1*. According to the above definition, ICM may either be concerned with the management of the total system from a position in the outside world, or it may be concerned with the management of processes and infrastructures within the system, taking into account the outside world. In the first case, ICM is concerned with what is sometimes called 'the management of the management' (Bots, 1991). The Chain Manager is in this case concerned with conducting individual operations in a multi-site, multi-owned system. In the second case, the manager is concerned with conducting his own sys-

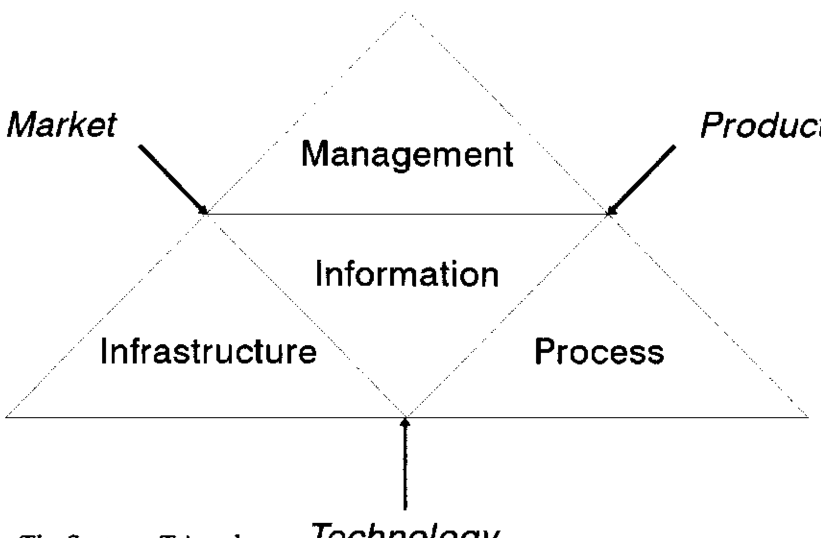

Figure 1. The Systems Triangle

tem from the viewpoint that he is only one link in a chain that has to perform optimally as a whole to enable his individual success.

Hence, ICM can be implemented on two levels. In this paper we will present a conceptual approach to Integrated Chain Management that is applicable on both levels.

A Systems View on Integrated Chain Management

Although the word Management has been defined many times, the differences in all these definitions are slight. We will handle the following condensed definition (Simon, 1966):

Management is the process of conducting a socio-technocratic system into a defined direction

From this definition we can draw three conclusions as to the character of management:

- management is concerned with humans and technology;
- management is concerned with the conducting of systems; this implies that the management process is an interactive process in which the means of the managing person or organization may vary;
- the management process needs to have a well defined direction; this implies that there need not be necessarily a well defined target to meet the standards of the above definition.

Note that this definition is a definition of management as such, and not of successful management. To be successful, the management process needs not only to have a well defined direction, but it also needs a well defined goal or target, and the means of the manager needs to be optimally tuned to this management targets. Also note that it is an interactive process, in which the managing person or system has to adapt both to the sys-

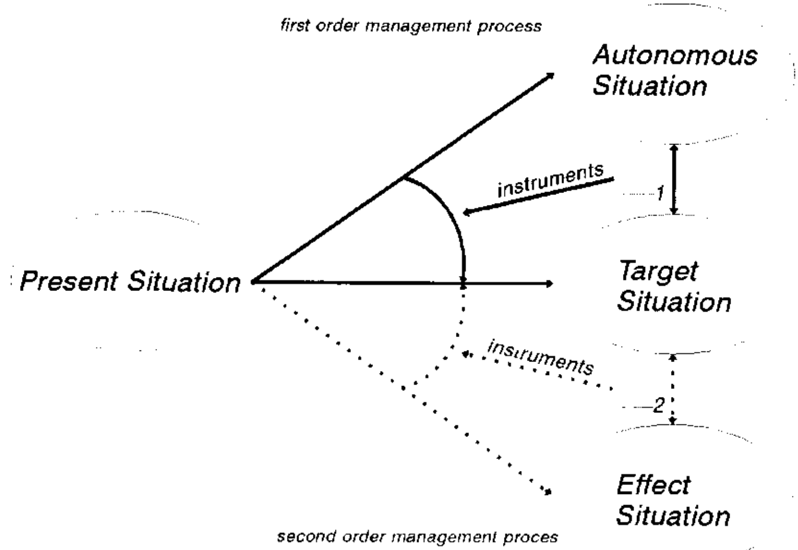

Figure 2. A conceptual model of the management process

tem(s) to be managed and to the outside world. Hence, we present a conceptual model of the management process (*Figure 2*).
In this model, the situation of the system at this very moment is indicated by the circle at the left, called present situation. We may assume that the management has certain targets, defined as a future situation that meet certain specifications. We will call this the target situation, and it is represented in the figure as the middle right circle. Without a dedicated management process, however, the system will develop into a new situation at a certain moment in time, represented by the upper right circle: the autonomous situation. This situation occurs when there is no conducting of the management towards a specified target situation. The task of the management is to press the autonomous situation towards the target situation by means of management instruments. The optimal management process can be described as the process that results in an effect situation that is identical to the target situation with the lowest possible efforts. In practice, however, the target situation and the effect situation may differ: a result of ineffective management. It may also be that the relation between costs and profit of the management process is not optimal: we call this inefficient management. And the efficacy of the management process may be suboptimal, indicated by navigation problems on the way from the present situation towards the effect situation (see also Hoogerwerf, 1984).

The decisional process
In any case, the management process is concerned with conducting a system towards a certain target situation. Up to now, the system that is subject to the management process has been constrained in most literature on horticultural management (Barneveld, 1993; Gaasbeek, 1990; Zuurbier, 1989) by single ownership structures. Recently, the insight has been presented that a production and distribution chain may also be seen as a system that can be subject to a management process (Simons et al, 1992; Broekmeulen et al, 1992; Hoogerwerf et al, 1993). Complicating factor is the multi-ownership situations in horticultural distribution.

The above presented conceptual model of the management process may be applied to single owned systems as well as to multi-owned systems. The present situation will develop into a new, future situation in any case, and this new, autonomous situation is determined by decisions that actors in the system will take. As the effect situation is defined as the autonomous situation as influenced by management instruments, the management process needs to be concerned with the decision making of actors in the attended management process. These actors may be members of a single owned system (an individual operation) as well as members of a multi-owned system (a production and distribution chain). In *figure 3* the place and role of the various chain managers is pinpointed. Both managers within the production and distribution system (local managers) and managers from outside the system (chain managers, e.g. from governmental organizations or from commodity boards) can manage the whole system or chain by using adequate management instruments and adept to the situations in other parts of the multi owned system.

We emphasize that there is no significant difference between managing a multi owned system as a whole from an external point of view or from an internal point of view. In any case, the manager has to interfere with the decisional process of chain participants. We will illustrate this by two examples.

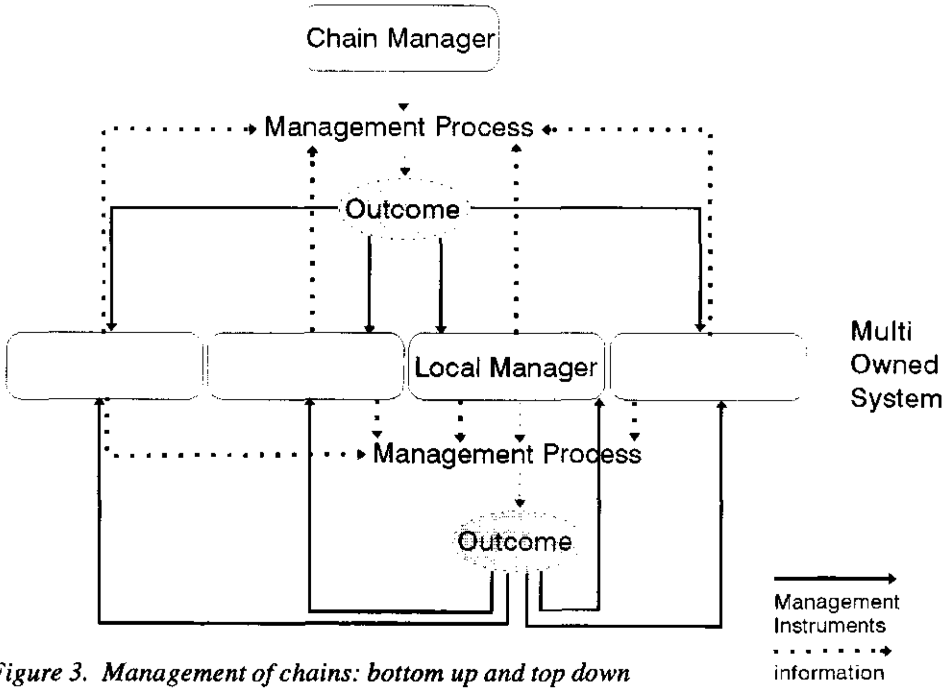

Figure 3. Management of chains: bottom up and top down

Example 1. Bottom up ICM

A manager of one link in a distribution chain, f.i. a supermarket, aims at delivering horticultural produce to his customers that meet certain standards of environmental security. For this, he contracts some growers and agree on the absence of chemicals and fertilizers during production. What the managers does, in fact, is influencing the decisional outcome of the growers decisional process by means of specific management instrument: the contract. In fact, he reduces the decisional alternatives of the grower from the moment on the grower has signed the contract. It is multi-aspect oriented: aspects under consideration are costs and profits, environmental effects, product quality, etc.

Example 2.

A policy maker from a central organization in Hortibusiness aims at strengthening the position of Dutch hortibusiness on the West European market by improving overall product quality. For this, he wants to have all the produce that is to be exported to be precooled before international transport. His management instruments are infinite, but he decides on the following alternatives: subsidizing the precooling process in hortibusiness or checking the product temperature at the national borders. Apart from the costs of the management measures and the bottlenecks for implementation, the managers problem is how the actors in the distribution chain react to his measures because he is, in fact, influencing the decisional process of the chain participants. The decisional alternative 'precooling' is becoming more attractive because the costs of precooling are lower when subsidized. Or the new risk of getting a penalty at the national border because of a too high product temperature is too large.

The way from present situation to future effect situation is the object of the management process. As said before, this is determined by the decisions that actors in the system take. This implies, that the managerial process is concerned with how to interfere with the decisional processes of the actors in the system in such a way, that the outcome of the various decisional processes are in accordance with the targets of the systems manager. When we simplify the decision making process of actors in a situation by using an extended Multi Attribute Utility Model (furtheron referred to as MAU$^+$-model), we may conclude that the outcome of the decisional process can be directed by influencing parameters or variables in this model, hence, conducting the actor in the management field towards a decisional outcome that leads to an optimal effect situation as defined by the systems manager. The management process is, hence, concerned with the decisional behavior of actors, but is targeted by the factual outcome of the decisional process. This means that the character of an Integrated Chain Management process is in itself cybernetical.

Integration of aspects

ICM problems may be concerned with management problems at any level, varying from strategic problems like market share and labor capacity to operational problems like determining the optimal installed temperature during transportation. Without any doubt economic and financial aspects play a role in any ICM process. In horticulture another aspect is relevant for any ICM case: the quality of the produce. And as horticulture is concerned with ecological systems, environmental aspects and ambient factors has to be taken into account in any ICM case. This may be illustrated by the following example:

In Dutch floriculture, approximately 58.7 PJoules are spent on the production of cut flowers and potted plants, while .5 PJoules is spent on the distribution of the produce (Rudolphij et al, 1993). The estimated value of the production at consumers level is US$ 5 billion. It has been calculated by Hoogerwerf (1994) that 7.7% of the production is lost during distribution because of improper postharvest care and handling. The resulting 92.3% decreases in consumers satisfaction because of an estimated loss of vase life of 28%. Hence, the financial loss can be calculated at US$ 308 billion at least and the environmental aspect can be expressed in a loss of over 20 PJoules of production energy. Avoiding the direct loss of 7.7% will translate in increased profits for the companies involved. Reducing the 28% loss in vase life will lead to improved competitiveness through an improved imago of the product, possibilities of product guarantees to the consumer, etc. This will contribute positively to the continuity of the sector in the long run.

From this example one may draw the conclusion, that financial and environmental aspects are of a second order nature, while product quality is a first order aspect: it initiates financial and energy losses. Quality losses, however, may be accepted when the costs of prevention do not meet the profits of the decrease in quality decay. Hence, this example illustrates the problem of causality between and consistency of the various aspects of managerial problems.

A lot of research has been executed into managerial problem solving. Although various studies take into account more than one aspect, the quest for causality and consistency of the various aspects that are of managerial concern has been neglected in most of the studies. Recently, Klok (1991) has applied a theory from Tacq (1984) to a certain type of managerial problems: the problem of causality and consistency in public policy. Kloks' application of Tacqs' theory can be of use in ICM processes as well and fits perfectly on our approach of situation modelling and transition routes. Tacq developed a theory on causal relations called the INUS theory. According to this theory, a situation may occur when a consistent set of aspects occur. Whereas each of them individually is Insufficient, but Necessary, the set as a whole is Unnecessary, but Sufficient for the result. Tacq illustrates this theory with the following example: a fire occurs (in our theory described in a situation model); for the occurrence of this fire (situation), a set of facts has to be present (i.e. fuel, heat and oxygen). This set of facts is unnecessary (it does not necessarily lead to fire), but when it appears, it is sufficient (to initiate the fire). The parts of the set are each for itself insufficient for a result (the fire), but they have necessarily to be there to complete the set that is in itself sufficient for the result.

When we apply this theory to our conceptual model of the management process, we may conclude that it gives a handle for the determination of relevant aspects, because it targets the manager at defining a consistent set of causal relations, from which a set of relevant aspects can be derived. We may illustrate this by a second analysis of the example as described above.

Let us state that the target situation of a system is a decrease in energy consumption of 20%, to be reached within five years from now and under the constraint that total turnover will not decrease and the total costs will not increase with more than 5%. We can identify the following aspects (parts of a set):

1. technology
2. product properties
3. energy costs
4. market properties

The target situation can now be described in terms of these aspects. For instance: an increased energy efficiency of the technology in use, a decreased or increased dependency of product quality on ambient factors as influenced by technology, decreased or increased energy costs or decreased or increased consumer requirements as to product quality. Hence, the relevant factors have to be specified in the target situation model and the targeted value as well.

From the specified aspects in the target situation model the manager can copy the aspects that has to be specified into the present situation model. From this point, the manager can calculate or reason the autonomous situation as it may be expected to be present on the relevant aspects at a defined moment in future. On the basis of discrepancies between autonomous situation and target situation he can fire management measures towards defined goals. Whenever effects occur that have not been described by the factors in the INUS-set, the manager may conclude that his set of aspects is not consistent and/or complete. Hence, he is initiated to reconsider his target situation model. Our approach may therefore be characterized as cybernetical for reasons of multi-aspect orientation as well.

The functionality of management instruments in relation to decisional behavior

As stated earlier, the success of the management process can be expressed by three indicators: effectivity, efficiency and efficacy. The indicator effectivity is concerned with the accordance between effect situation and target situation: a maximum effectivity is reached when these situations are identical. Efficiency and efficacy are concerned with the route from present situation to effect situation: the less it costs in relation to effectivity, the more efficient is the management process. And the straighter the way from present situation to effect situation, the higher is the efficacy.

We may assume that managers are in search for the most successful management process. Hence, they are in search for optimal instruments. It might be clear that the number of possible management instruments is enormous. To make our systems approach to Integrated Chain Management consistent, we need a typology of management instruments as a first step. From literature we can extract various typologies (see Hoogerwerf, 1993; Klok, 1991).

1. The discipline orientation: communicative, economic or legislative oriented
2. The domain orientation: individual or collective oriented
3. The decision orientation: constraining or enabling

We may state that both the discipline orientation and the domain orientation are concerned with the decisional process of the actors in the management field, but differ in their approach to this process. Hence, they also have a decisional orientation. This is not amazing as we already have concluded that the management process is concerned with the decisional process of the actors in the management field. When we stay to the representation of the decisional process as represented by the MAU-model, we can make a typology of management instruments by the way they influence this process:

1. changing the problem specification
2. changing the objectives
3. changing the number of decisional alternatives
4. changing the character of alternatives

In case of the MAU+-model, (iii) and (iv) can be done by:

1. changing the number alternatives
2. changing the number of attributes of alternatives
3. changing the utility of attributes
4. changing the weight of attributes
5. changing the value of attributes

Reducing complexity in managerial decision making

We may see the management process as a decisional process as well, aiming (efficacious) at deciding on the most effective and most efficient (set of) management instrument(s), due to the above presented instrument typology the decisional model of the manager will soon explode when he has to take into account all the decisional processes of the individual actors in full scale. We therefore need to simplify the model, and we do this by introducing a number of decision rules from sociological sciences. In literature, a number of decisional rules have been presented (see f.i. Raaij, 1986; for implementation of these decisional rules in Fuzzy models, see f.i. Chen and Hwang, 1992):

1. Act referral (a primary affective reaction determines which alternative is to be chosen)
2. Linear compensatorical rules
3. Non linear compensatorical rules

4. Conjunctive rules (minimum value for one or more attributes)
5. Disjunctive rules (select alternative on one superior attribute value)
6. Lexicographical rules (ranking according to score on most important attribute)
7. Semi ordered lexicographical rules ('Fuzzy' lexicographical rules)
8. Sequential elimination (eliminating an alternative on the basis of one insufficient attribute value)

These decisional rules are in most sociological and psychological publications presented as decision models. In fact, they apply a decisional rule to a basic decision model such as a MAU-model or a MCDM model, which are both decision tree models that only vary in the names of the branches. When applying these decisional rules to decision trees, the decision tree is substancially reduced in its number of variables as is illustrated in *figure 4*. The integration of extended decisional models and qualitative decisional rules may therefore be of good use to simplify the decisional process of the manager.

Towards total integration
From the above we may conclude that Integrated Chain Management is a management problem that can be characterized as multi-aspect, multi-actor oriented while both inter and intra relations play a role, seen from the system to be managed. Hence, an ICM problem is bound to explode when no proper measures are taken to tackle this. In our systems approach to ICM and in our approach to the management process, we have presented a

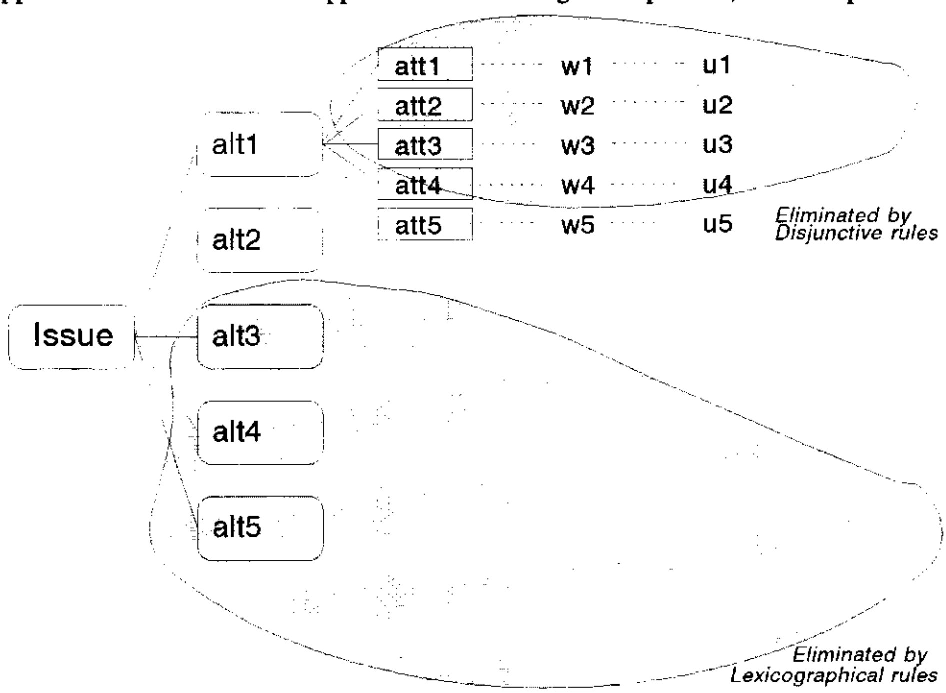

Figure 4. Reduction of decision trees by using decision rules

number of measures to simplify some elements of the management process. Summarizing:

1. to tackle the number of aspects under concern we introduced the INUS theory as a means of causal modelling
2. to tackle the number of decisional alternatives of actors in the management field we presented the integrated approach of quantitative decision tree models and qualitative decision rule models
3. to tackle the number of possible management instruments we introduced a decision oriented typology of management instruments.

We may conclude that due to those simplifying methods the managerial problem is dramatically reduced. ICM is nevertheless still a managerial problem of great complexity. Hence, a lot of effort has to be put into both scientific and applied research on integrated management problems. In the next paragraph we will try to explore the consequences of this conclusion for future research.

Research perspectives

The presented conceptual model of the Integrated Chain Management process is meant to make a start in the discussions on ICM as such and on the possibilities of implementing ICM. As it appears to us, ICM can be implemented bottom up (by integrating relevant signals from the systems environment into the managerial process of single owned systems) or top down (whereas ICM has a lot in common with managerial processes in public policy which is also concerned with multi-site, multi-owned systems). It may be concluded that integration is needed not only at implementation level, but also at research level. We can state that management research on ICM needs to be integrating by itself; hence, systems theory seems to offer good possibilities. Only multi-disciplinary approaches towards ICM will lead to research results that may diffuse into managerial practice.

As stated before, horticulture differs from industrial branches because of the rapid quality decrease after harvesting. Substantial improvements in hortibusiness can be realized when product quality is an integrated aspect of managerial decisions. We therefore state that physiological and technological needs to be an integrated part of research on ICM. Apart from this we may conclude, on the basis of the calculations as presented earlier, that quality management in horticultural distribution is of main importance for the success of Dutch hortibusiness in the coming years. Therefore, Integrated Chain Management research has to focus on the integration of postharvest product behavior in managerial decisions as a first step. This counts for ICM at any level. A second step should be the development of supporting systems for ICM problems at strategic level.

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Chain control from pig to meat cuts

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Introduction

Consumers are becoming increasingly critical as far as food is concerned. They want to know more about origin, composition and production techniques. At the same time the image and reliability of the quality of pork is becoming more disputable in the eye of the consumer. Both trends urge the formation of additional quality guarantees throughout the production chain (Hartog, 1992; Meys, 1977; Mannion, 1992 and Paardekooper, 1991). In the Netherlands a basic Integrated Quality Control system, IKB, was developed for the Dutch meat sector by the Commodity Board for Livestock and Meat, PVV (NRLO, 1993). This system is recently implemented. IKB is a quality system which entails the control and guarantee of the production within the pig meat chain, from breeder up to the slaughterhouse. The PVV/IKB pig regulations entail a number of basic requirements which must be met. Within this framework guarantees are given with respect to origin, feed and the use of specific medicines and accompanying withholding times in view of preventing the possibility of residues. Beside the regulations for the meat production chain research has been carried out on specifications for the supply industry, i.d. the feed industry. Research also has been performed on processing in the feed industry itself. This has resulted in quality control systems which have been implemented in this industry. Besides that a code for Good Veterinary Practice is being implemented for veterinary services.

In the meat production chain information is exchanged in two directions between various links of the chain.

The slaughterhouse can obtain specific information about the pigs delivered, for instance concerning health and origin. The pig farmer, on the other hand, receives the results of the veterinary inspection by the slaughterhouse. The slaughterhouse plays a prominent part in establishing and conducting the PVV/IKB chain. They take the end re-

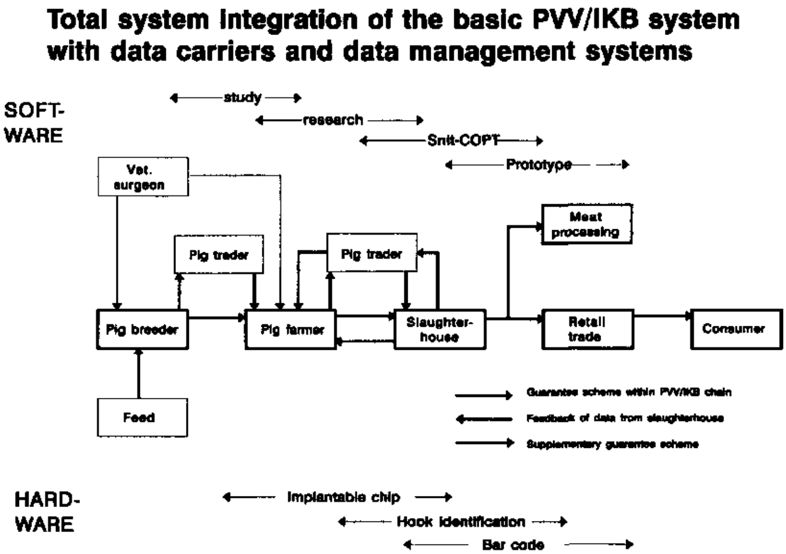

Figure 1. Total system integration of the basic PVV/IKB system with data carriers and data management systems

sponsibility for the preceding links as far as IKB is concerned. The IKB chain is superintended by a independent institution (TNO/ICM).

In this paper the attention is drawn to the benefits of a combination of this basic IKB system with the successive data carriers on the one hand and the successive chain information and control programs on the other (see figure). The IKB regulations can give the first impulse for a more efficient use of information : using the data as well for quality control as for reducing production costs and tuning supply an demand of the successive links. This approach is supported by the developments in data carriers which enable to transfer more information in a highly reliable way. In this way an integration of hardware and software in the production chain is achieved.

Information systems

Process control should be integrated with data processing. Throughout all the stages of the production chain, from breeding, fattening, cutting to selling the parts to the retail trade, a diversity of information is needed. A distinction can be made between information concerning the product (carcass classification, PSE/DFD, weight, costs etc.) and data on production (feed systems, operation procedures, planning, etc.). This specific information is important for the operational tuning between the various links of the chain, but also for chain control, financial overview, internal quality assurance, trend analyses, record keeping and the acquisition and preservation of knowledge. As production is more and more determined by consumers demand, the supply should be tuned to the demand throughout the whole chain. For the pig industry a well considered data management system for effective and efficient chain control is necessary.

Several information systems concerning Business Information System (BIS), Technology Information System (TIS), Management Information System (MIS) and Electronic Data Interchange (EDI) are in development or already in use. These systems are often only used within a specific part of the chain. The complete chain is therefore lacking optimal tuning and standardization. Also the nature of the information and the confidentiality may vary strongly among parts of the chain. However, an integrated approach to improve the efficiency of the whole chain is still missing. To that purpose TNO researches tuning of supply and demand between links in the production chain and developed software systems for minimizing of costs within the different links, aiming ultimately at a data management system for effective and efficient chain control. In this system data from all production stages can be used for efficiency of the production and at the same time for product quality (Stellingwerf 1990a/1994). By using the available information for several purposes, quality control and reducing production costs, the installation and maintenance of information and data exchange systems is more justified and necessary investments can be earned within a shorter period.

What is special about these information systems is that they are based on mathematical models, describing the production process within the link and the good flows between links (Logtenberg, 1992). A theoretical background for information systems, concerning cost optimization has been developed, but practical experience in controlling an agro-production chain is still needed. There has been several years of research on Decision Support Systems (DSS's) which has yielded a prototype for production planning in meat processing, a ready for use software system for the determination of profit optimal utilization of cutting capacity in the slaughterhouse (Snit-COPT) and a research report on optimal tuning between the delivery of pigs from the farmers and the demand of meat from the consumers.

The COPT-principle (Cost Optimal Production-planning Technique), upon which these systems are based, has been specially developed for the food industry (Paardekooper, 1992c; Stellingwerf, 1992). Its main idea is to make production as efficient as possible by reducing influenceable costs and maximizing added values (Stellingwerf, 1993). Current production planning techniques aim at effective planning. MRP 1, Material Requirements Planning, generates an overview of the required materials for the production orders. MRP 2, Manufacturing Resource Planning, calculates when which product must undergo a specific kind of processing to be ready for delivery or stock in time, regardless of costs. Unlike these production planning techniques, COPT aims at effectivity, combined with efficiency. For that purpose costs are made explicit and moreover planning is optimized upon these costs, taking into account the keeping qualities of the food products. Generating an efficient planning is complicated by the deterioration of food products. The Just In Time strategy (keeping no stock) is the simplest way to handle this problematic food characteristic. Unfortunately this strategy is unsuccessful in food industry in consequence of an other food industry characteristic; refusing delivery of a rush order is unacceptable. Because costs are made explicit using COPT, the consequences of producing for stock or for rush orders can be calculated. In summary, the special qualities of the COPT approach enable food industry to weigh production costs against storage costs. Besides reducing costs after making them explicit within the individual stages, the COPT principle can be employed to optimize the chain. Tuning supply and demand between successive links in the chain will improve the efficiency of meat production in whole.

The developments in applying the COPT-principle to stages and links between the stages of the production chain are in different phases (Stellingwerf, in prep.). Concerning the links, for the tuning of supply and demand between pig breeders and pig farmers an exploratory study is initiated, whereas a preliminary study concerning the tuning between pig farmers and slaughterhouse has been studied yet. As far as the *stages* themselfs are concerned, here the development from research up to a decision support system has made progress. For the slaughterhouse maximizing added value for cutting carcasses already led to a DSS-product (Snit-COPT). Research on production planning in meat processing has yielded a proto-type, which has been tested in practice with success and is now elaborated into a professional production planning software system.

For controlling the link between pig breeders and pig farmers first it has to be determined which information on the piglets is relevant (Driel, 1988; Weerd, 1989 and Sterrenburg, in prep.). A classification may be based on the results of this investigation. As soon as this matter is clarified, the tuning between supply of the breeder and the demand of the farmer can be subjected to closer investigation.

The deliveries from the pig farmer to the slaughterhouse are examined with regard to tuning to the consumers demand (Van Acker, 1993). The sales of the slaughterhouse are a derivative of this demand. Using Snit-COPT an optimal supply for the slaughterhouse can be calculated based on the selling orders (see figure). With this ideal supply the efficiency of the slaughterhouse would be optimal; no refused orders, no degradation of carcasses (sell as lower quality), no extra purchase.

In practice, most slaughterhouse don't have the disposal of Snit-COPT, and only limited control on the composition in quality types of the pigs which are delivered by the pig farmers. The composition in quality types of pigs differ from farmer to farmer (Weerd, 1989). Beside that the slaughterhouse wants a fixed amount of pigs delivered every day to make maximal use of the slaughtering capacity. By these means the slaughterhouse is often confronted with a discrepancy between the demand for different quality types of carcasses generated by their clients and the supply of different quality types of pigs from the pig farmers.

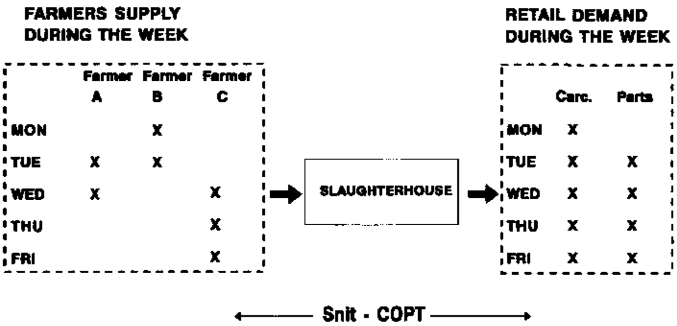

Figure 2. Discrepancy between demand and supply

This difference leads to costs for the slaughterhouse and can be the cause of loosing clients.The costs, corresponding with the discrepancy mentioned can be reduced by improving the flexibility in deliveries of the farmers. Usually the farmers can vary their delivery to the slaughterhouse only within a small time frame. A greater flexibility would be in the interest of the slaughterhouse. It will enable them to adapt sales to the demand of their clients. A serie of models is developed to weigh the costs of flexibility for the farmers (extra forage and extra pigsty utilization related to pigs occupying pigsty capacity longer than necessary) against the costs of inflexibility of the deliveries for the slaughterhouse caused by shortage/surplus of carcasses of a specific quality class (Van Beek,1985). Basically the above mentioned relates to short term flexibility. One might argue that long term flexibility can also be introduced based on for instance seasonal preferences of consumers related to for example slaughter weight and/or feed used by the farmer.

The slaughterhouse is confronted with a pull consumer market and a push delivery of pigs from farmers. There also is a fluctuating demand of the market for special parts of the carcass, while supply is in carcasses as a whole. Moreover the cutting problem is complicated by the subdivision of the carcasses in quality classes. Snit-COPT can optimize these problems in terms of profit (Dogger, 1993). The user-system Snit-COPT proceeded from the PIGLET project (Stellingwerf, 1990b and Krielaart, 1990). The present software system is for tactical and strategical use. The financial result of actual production planning can be analyzed and compared to the optimal "shadow" production planning. Investments in cutting capacity and added values of cuts can be evaluated. Snit-COPT is also able to advise on marketing; whether the sales of a product should be stimulated or discouraged. A project on simulation of carcass sorting using Snit-COPT to determine a profitable sorting procedure, is the first step in the development towards an operational control system in the slaughterhouse based on the COPT principle (Ringia, 1993).

In meat processing a prototype system has been developed for production planning based on the COPT-principle. Both line and batch processes can be handled by means of this system. The system generates a workable planning in which influenceable costs are minimized and if relevant added values are maximized. Influenceable costs are costs which are affected by changes in production sequence and production amounts. The most important kinds of influenceable costs which occur in the system are the costs caused by inefficient utilization of capacity, costs connected with the production sequence and warehouse costs. For each product a minimum and a maximum production amount is derived from the selling orders and the short term sale prognosis, taking into account the keeping quality of the product. Subsequently the total influenceable costs are minimized yielding production sequences and product quantities which are within the range of the minimum and maximum amount. A facility for insertion of rush orders in the production planning against minimal costs will be added soon.

As product data are relevant for production control; process data can be relevant for control of stock. New data acquisition techniques (identification devices like chips to which can be added information during the process) have been developed the last ten years (Paardekooper , 1992a/b). These techniques facilitate monitoring product qualities (microbial contamination, pH) and process quantities (temperature). Because the product is monitored throughout processing, its information is suited to, for instance, prediction of shelf-live. An improved prediction of shelf live may improve storage control and thereby product quality and efficiency in production (Stekelenburg, 1990).

Shelf-live of meat and meat products is often determined by time-consuming keepability tests or experimental experience. These methods, of course, are rather specific and not very accurate. Therefore, since a few years there is an increasing interest in the development of mathematical methods enabling calculation of the growth rate of micro-organisms under different circumstances. Some suitable models are already available, such as the Ratkowski model and the Schoolfield model. When a product's initial micriobal contamination, storage temperature and other shelf-life determining factors, such as water activity, pH and preservatives, are known its shelf life can be predicted rather accurately by using these models. Furthermore, these models offer the possibility to determine without extensive testing what effect changes in composition or storage conditions have on stability and safety. Also in development of new products, research related to shelf-life can be simplified considerably. Finally, predictive modelling can contribute to tracing and eliminating weak spots in, for instance, the cooling chain to obtain maximum keepability.

The temperature in the cold chain in relation with other preservative measurements has been and is an important development area (Paardekooper, 1993). The objective of this research has been the control of storage conditions through, amongst others, risk analysis. Several codes of practice have proceeded from this research. These codes are not restricted to the meat chain itself but are also applicable to, for instance, the industry of convenience foods and chilled ready-meals (Paardekooper, in prep.).

Data carriers

The product and its accompanying information can be localized through data carriers such as implantable chips, hook identification and bar codes or other codes on products and/or packaging materials like crates and boxes. An interactive implantable chip will be the logical successor of the transponder which is now being tested for use in practical environments in the Netherlands. The transponder is basically an electronic identification number incapable of data storage. To fully use the diversity of information gathered in all stages, an automated registration can be combined with a data transfer system (Paardekooper, 1990).

Several kinds of technological solutions have been elaborated in the past decade to link product data to a product. The main difference between these solutions is whether the identification code is readable by the naked eye or not. Some identification forms, like chips and barcodes, can only be read with the aid of technical devices, whereas screenforms admit direct access. The diversity in identification methods and the satisfying technical performance doesn't necessarily mean that introduction of identification methods in the production process will be easy. The production process may yield technical problems. Another problem that can occur is that the basis for introduction of the identification methods is insufficient on the side of the management and/or on the side of the people who have to work in practice with these identification methods.

To be able to use all the information collected/stored and linked to the ID code of the object in the different stages and locations an administrative system has to be implemented. This is necessary to ensure that the correct data are linked to the correct object and available at the appropriate time and place. Depending on the amount of data and objects the system could grow to tremendous proportions. The use of an interactive chip will connect the data physically to the object itself. In this way the object (e.g. a pig) becomes a data carrier which can be read at every moment necessary. This would reduce the size of the administrative (electronic) system considerably. A central data management system is still needed for feedback, statistical analysis, possible legal aspects and information processing and storage.

Introducing data carriers can only be successful if the cost reduction weighs against the costs of introduction. What proportion cost reduction and costs bear to one another if hook identification is introduced has been studied for a slaughterhouse (Van Dijk, 1991). Hook identification is one of the possible means to link the information from the slaughterline in a reliable way to the carcass. First the most appropriate code and way of fixing it to the hook were investigated. To be able to analyze costs and cost reduction, the flows of information within the slaughterhouse have been mapped, as well for the actual situation as for the integration of hook identification in the information flow. The effects of a simultaneous usage of implantable chips has also been taken into account. Subsequently was studied to what extent labour, connected with processing the information, becomes redundant or is simplified. With respect to the integration of the hook identification, it was investigated which information system matches with the existing information management. A configuration with a relational database and a specific interface, exemplified in the next figure, proved to be the best solution (see figure below).

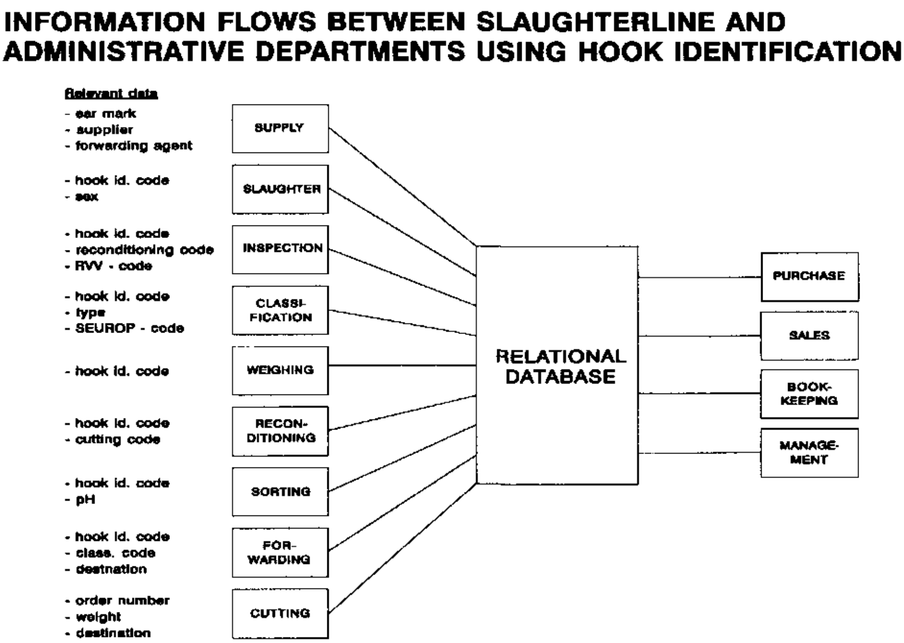

Figure 3. Information flows between slaughterline and administrative departments using hook identification

A distinction, within costs and within reduced costs, is made between costs that can be calculated beforehand and costs that have to be calculated in retrospect. Costs beforehand consist of the investments in software and hardware. Costs in retrospect are costs caused by adaptions in organization, initial problems, maintenance, training of personal, etc. Cost reduction beforehand are made up of economizing labour costs. Cost reduction in retrospect are due to improved efficiency and better control on the production process by speeding up the information transfer and increased information reliability. The costs and cost reduction have been worked out in detail. The cost reduction beforehand appears to be greater than the costs beforehand. The costs and cost reduction in retrospect still have to be investigated. On the whole it is estimated that the introduction of hook identification will be worthwhile.

The positive effect of hook identification on efficiency may be strengthened by future developments in cost saving which depend on a high reliability of the information (Paardekooper, 1988). These developments can be related to technological improvements (implantible chips, voice recognition), innovation in information systems or improving cutting strategy and marketing (Snit-COPT). Voice recognition can be implemented. It can be used, for instance, to record the results of ante-mortem and post-mortem inspection of the carcasses handfree. Speech is translated into alphanumeric data, which can be added to the hook identification code. The routing of the carcass is depending on the inspection results. Thus, voice recognition is a direct interface between human sensors and production process. An other advantage of hook identification is that it facilitates monitoring product qualities (microbial contamination, pH) and process quantities (temperature). When the product is monitored throughout processing, its information is suited to, for instance, prediction of shelf-live.

Passive electronic identification systems have a broad range of possible applications. Passive transponders that can be implanted easily, like an intramuscular injection of medication, will help to put these applications in practice (Aarts, 1989). As these injectable transponders will be available at low prices in the foreseeable future, research has been undertaken to describe the possible applications of such an identification system in detail and experiments are executed to find the most suitable injection site. The first possible application of the injectable transponders is the Dutch identification and registration scheme for pigs, a nation-wide aid to pinpoint the herds of origin and possible contacts with other pigs in case pigs with notifiable diseases are located. Another application is the identification of slaughter pigs, which is essential for a correct payment of the farmer according to carcass weight and classification.

Besides this, an electronic identification of all carcasses will enable an enhanced automation in the slaughter line. On a smaller scale the injectable transponder may be used in monitoring systems set up to improve the quality control from farm gate to consumer. On farm level the transponders may be used for individual feed supply and as identification tool for management systems. Under experimental conditions, passive transponders (dimensions: 4 x 30 mm) were injected in 4 week old pigs at different sites by means of an injection pistol. Serial slaughter showed that the transponders were soon covered with a thin layer of connective tissue. The best injection site appeared to be the base of the ear. The transponder did not migrate from that place and it could be removed rapidly from the carcass. Transponders have become even smaller over the past years. Since the transponder being injected in the base of the ear appears to bring along difficulty in removing it, a new injection site has been experimented with. The smaller size of the transponder made it possible to inject the transponder in the ear. Because of disagreement on the proper spreading of the costs over the parties concerned, the implantable chip has only been used in experimental stages.

Vulnerability of the identification code plays an import role in choosing the proper identification method. A barcode, for example, can be easily damaged during the production process in the slaughterhouse. The barcode, on the other hand, has the advantage that its technical development has already reached maturity and is available for use against comparatively low costs. TNO has studied the possibilities of an introduction of an atomized production registration in a factory for meat processing using data carriers (Paardekooper, 1989 and Van Beek, 1991). In stead of filling in paper forms, a system combining screen forms and barcodes was introduced. In this system the barcode attached to carts with sausages or hams corresponds with an identification code referring to product specifications in the central computer. The barcode was used in a different way as an aid for filling in the screen form; product/production characteristics could be selected from a book with barcodes. The prime goal of the introduction of an atomized production registration was to create the possibility to analyze the conduct of production in more detail. In contrast with the paper forms the use of screen forms assures complete information which can be easily gathered, accessed and analyzed. The attitude of the workers towards the new registration approach appeared to be positive; the barcode and the screen forms reduced the number of redundant and boring procedures. With atomized registration an improved monitoring of the production process is realized.

The improved monitoring benefits as well efficiency of integral logistics as the control on product quality. The project, yielding an improved control on internal logistics against comparatively low costs, appeared to be successful.

EDI

Electronic Data Interchange, EDI, is something else than electronic mail. Electronic mail concerns the transfer of unstructured data (for instance memo's), as EDI relates to the interchange of structured data between two applications (Gelpke, 1993).

The fixed structure of the data enables the receiving computer application to process the data at once, without human intervention. Think for instance of trade data like invoices. Within every invoice a similar structure can be recognized; article number, price, amount delivered, sub-total, etc. Compared to sending data on paper or on diskette by post and sending data by fax EDI saves time, reduces necessary administrative actions and prevents mistakes in data-entry. Applied to the meat chain EDI creates the possibility to exchange more relevant data between the links in a more efficient way.The project EDI-pigs, supported by the Foundation Information Processing Pig Farmers (SIVA), aimed at automation of the exchange of data between pig farmers on the one hand and Artificial Insemination / pig breeder on the other (SIVA, 1993). The project consisted of a pilot and a broadening stage. The former concerned the procedural, technical agreements and the agreements in contents, which were tested in practice on small scale. The pilot stage was completed successfully in 1989. The objective of the broadening stage was to test and extend the automatized data interchange in such a way that after the project the pig farmers and the AI / pig breeder organizations would be able to keep on exchanging data independently. The broadening stage consisted of a design part, in which the experi-

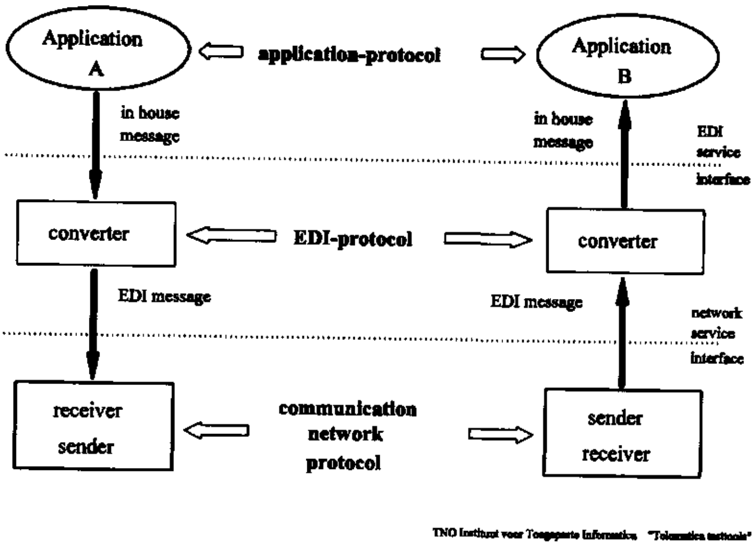

Figure 4. Efficient data transfer using EDI

ences of the pilot stage were processed, and an executional part with the purpose to test the realized design on large scale (170 pig farmers), before data interchange could be used in practice. This last part was completed in 1993. The project resulted among other things in an ISO standard for report syntax, a users group EDI-pigs and an improved attitude amongst participants towards cooperation.

Conclusion

For the pig industry the Integral Quality Control system (IKB) is introduced and implemented to assure product safety. This system can be used as a basis for implementing information systems combined with data carriers and information exchange. In pig/meat production automation of process control and data processing should be integrated for the whole chain. Throughout all stages of the production chain, i.e. breeding, fattening, slaughtering, cutting and finally selling the cuts to the retail trade, a diversity of information is needed. A distinction can be made between information concerning the product (carcass classification, PSE/DFD, weight, costs etc.) and data on production (feed systems, operation procedures, planning, etc.). All information is essential for controlling the costs, assuring the quality of the product and preserving the know-how of the process.

As production is more and more determined by consumers demand, the supply should be tuned to the demand throughout the whole chain. TNO researches tuning of supply and demand between links in the production chain and developed software systems for minimizing of costs within the different links, aiming ultimately at a data management system for effective and efficient chain control. In this system data from all production stages can be used for efficiency of the production and at the same time for product quality. Technological developments in data carriers create new and more efficient possibilities to fix and gather product and process data. For instance, data about conditions and veterinary treatment in the breeding and feeding stage can be collected by an interactive implantable chip. Transportation of the data relevant for the preceding or the successive link can be made more efficient by using Electronic Data Interchange (EDI).

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Integration of quality and logistics in distribution of fresh agricultural products. A concrete step towards a Total System Approach

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Introduction

In the Netherlands and other western economies, there's a strong connection between companies that take care of the processing and distribution of agricultural products, and the supplier of the raw material, agriculture itself. From the view point of agriculture it can be noticed that relations outside the agricultural branch have grown more frequent and larger, and their influence has increased. From the view point of distribution and industry it can be noticed that, due to increasing competition, the relations with suppliers of raw materials have become more intensified and important. Therefore, the character, the functioning and the development of agriculture, and the distribution and processing of its products can only be considered by regarding this branch as part of a larger whole, the agribusiness.

Fresh agricultural products, especially horticultural products, constitute an important product group in the agribusiness. The total Dutch export value of fresh fruits and vegetables amounted in 1988 to Dfl3240 million. Looking at this part of the agribusiness we can discern various logistic chains in which fresh agricultural products are produced, stored, distributed, and delivered to a customer. In this logistic chain different ownership constructions may be present, such as primary production, trade, distribution, and transport companies. The connection between these components is established by the product which is bought and sold. The task is to get the right product in the right place at the right time in the right quality at minimal costs. Many decisions have to be made to fulfil this task. Because of dependencies between components, decisions made in one part of the logistic chain strongly influence possible decisions that have to be made in other parts. Decisions that for example decrease product quality in an early part of the chain thus limit the possible product applications and markets for companies that are positioned later in the chain.

Total Systems Approach

In the possible control and management of such a complex, a Total Systems Approach is important. In this philosophy the focus is on the entire logistic chain. Total Systems Approach aims at controlling and directing all components that relate to the course and character of the physical flow of goods in an integrated fashion. This integration means both considering various stages from raw material to finished product as part of a larger whole, and the application of many different disciplines such as product physiology, biochemistry, cooling technology, logistics etc. One of the performance indicators for success of a logistic chain is product quality.

The success of a logistic chain as a whole is, in the long run, mainly determined by customer satisfaction. One of the key-factors of customer satisfaction is product quality. If the customer is not satisfied with the quality of the product he is likely to buy another product or to buy from another company. In the long run this influences the entire logistic chain. The quality of fresh fruits and vegetables is not only determined by the primary production but also by the way the products are kept during distribution. Quality is hence influenced by the entire logistic environment i.e. the logistic chain. So, to effectuate this approach we need to have insight in and control of the relation between quality and logistics. Moreover, we need to make both the concept of quality and the logistic chain manageable.

Logistics

There is a long history in logistics to deliver products at the right time at the right place. The emphasis in this process has mostly been on managing production and distribution optimally in terms of costs. Especially in the industrial world many concepts like MRP, MRPII, OPT and JIT are in common use. The managing of product quality is an implicit part of these concepts. The objective is to meet market demands in terms of time, place and predefined quality specifications. In these cases quality is often strictly defined and easily measured. In the agribusiness this is often not the case. Product quality is a result of environmental conditions and these in term are the result of logistic circumstances such as storage method, package type, transport etc. So, without any knowledge about quality behaviour, the implementation of logistic concepts and systems remains very difficult, if not impossible. Once we are able to grasp product quality the relation with logistics can be covered.

Quality

Multi-component

Quality is a major property of all vegetable and horticultural produce. Although everybody has a notion about quality, its behaviour and the implications, it remains very difficult to give a concrete form to quality behaviour and its relations with the logistic environment. Quality is a complex property of foods in general and fruits and vegetables in particular. It has been defined in various ways with different degrees of specifity. Three definitions are given below:

Kramer et al. (1973) formulated quality as follows: Quality of foods may be defined as the composite of those characteristics that differentiate individual units of a product, and have significance in determining the degree of acceptability of that unit by the buyer.

Juran (1974) defined it for a very general application as: Fitness for use. In the same line lies the definition of Anon (1988): Value for money.

All these definitions emphasize the importance of the user/buyer over the manufacturer/grower. In order to grasp the concept of quality, knowledge and understanding about quality behaviour and quality response to various and varying circumstances are necessary. Quality has many aspects, and for each product a specific subset is relevant. An additional complication is the variation in quality between different batches as they are offered at the start of the logistic chain. Another complication is the change in quality as a function of time and environment. This holds especially for distribution chains of fresh fruits and vegetables. Because it concerns biological products, the product quality deteriorates due to physiological processes. For example, a high temperature often increases and a low oxygen content generally decreases the rate of quality changing processes. Moreover, products may show an irreversible quality damage below certain temperatures or below certain oxygen contents. These quality changes can be limitedly controlled and directed by maintaining the appropriate environment conditions such as temperature, oxygen contents and humidity.

Single-component

Much of recent and past research has been devoted in search of objective processes and properties defining or influencing the subjective perception and evaluation of specific attributes. However, a detailed and comprehensive philosophy on quality behaviour in general is not yet available. For placing product behaviour in a logistical environment it is necessary to rely on such a philosophy. Until now keeping quality has frequently been used as a general, unspecific and easily applied approach to overall quality. Keeping quality is the time required to elapse at defined circumstances until the commodity is still just acceptable, based on any quality attribute at all (van Beek et al. 1985). Wether or not this limiting attribute is predefined (e.g. firmness) or depending on circumstances (e.g. firmness or bacterial decay whichever comes first), ought not to change the concept of keeping quality. Consequently, the keeping quality does not inform about the state of quality the product is in, but solely about the time the product can withstand the inevitable decay. The keeping quality evaluates if and how long product quality as a whole is satisfactory or not. By relating the behaviour of keeping quality at different temperatures and at different levels of initial and limiting quality, a generic model has been developed (Tijskens & Polderdijk 1994). This model predicts the keeping quality as a function of time under various environment conditions. In its dynamic form it makes it possible to predict quality behaviour and to optimize quality in distribution chains over a broad time and space region. Moreover, the effects of various combinations of an initial quality and a limiting quality level on the quality behaviour can be predicted.

Integration

Manageability of quality is the first step towards integration of logistics and quality. Manageability means the right detail level of information for the right decision. It is a compromise between search for focused indepth knowledge and creating overview and knowledge about relations between activities. An important question in this context is which quality aspects can be effectively controlled during distribution, which ones are manageable both for the customer and for the companies in the logistic chain, and which ones may serve as the right performance indicator. For example, firmness is regarded as one of the key-aspects of apple quality. Firmness is easy to measure and is commonly regarded as a good quality indicator. So, inevitably a simplification of the phenomena of general quality behaviour into an acceptable descriptive model of firmness is necessary. The concept of keeping quality provides us with this handle.

Besides manageability, the predictability of quality is important. Predictability of quality makes ex ante evaluation of the logistic system possible. This leads to improved understanding of the consequences of future changes in the logistic infrastructure for the product quality. For instance is it possible to deliver apples to England with a specific quality? Is it profitable to transport vegetables to Eastern Europe in a newly developed package? Moreover, predictability leads to better tracing and tracking of quality problems if occurred. The above described keeping quality model gives us the possibility of general prediction.

In order to integrate quality and logistics, we also need to make logistics manageable. For this we have to translate the entire logistic environment with all its interlinkages and related activities into a comprehensible structure which we can visualize and manipulate. In other words, manageability of the logistic circumstances is achieved by modelling the logistic chain. This is established by the development of a chain constructor. With this constructor logistic activities can be sequenced and the relevant environmental conditions in terms of throughput times, temperature, oxygen, carbodyoxide etc. can be defined. Important functionalities are graphical representation to increase the overview, file handling options to restore and compare various logistic chains, easy manipulation of the chain and its activities and report facilities both graphical and numerical.

The integration of quality and logistics is achieved by converting the data of the visualized logistic chain to a scenario. This scenario describes a sequence of throughput-times and environment data such as temperature, oxygen, carbodyhoxide etc. These data serve as input for the keeping quality model. As a result, the quality development of various products can be predicted throughout the entire logistic chain.

Applications

The application possibilities of this approach vary from chain simulation to design optimization. To illustrate the integration of quality and logistics, an example is given. In this example the quality change in an logistic chain for export of French Beans is evaluated for two different package types and two different routes. Each package type has a different rate of adapting the imposed environment in the various parts of the logistic chain. The chain starts at the auction. From there the products are transported to the export firm, where they are repacked and stored. After that, they are exported to a distribution centre in Germany and again they are stored for a short time. After transport to the supermarket and selling to the customer, they end up in the refrigerator of the consumer. The relevant question in this context is; what is, at any time, the keeping quality for the consumer? In other words, how long does the vegetable have an acceptable quality. *Tabel 1* shows the two logistic scenarios and figure 1 shows the change in keeping quality for the described scenarios.

Tabel 1: Logistic scenarios

Traject	Medium route		Long route	
	temp [°C]	time [hour]	temp [°C]	time [hour]
Auction to export firm				
Transport	8	1	8	1
Packing	16	1	16	1
Storage	8	4	8	4
Export firm to DC				
Transport	8	4	8	18
Storage	8	2	8	2
DC to supermarket				
Transport	19	2	19	2
Display	19	48	19	48
Refrigerator consumer	8	?	8	?
Total		62		76

In this figure, at any time in the logistic chain (X-axe), the remaining keeping quality under optimal conditions (Y-axe) is given. The difference between two package types is approximately 20% remaining keeping quality for the medium route, and 30% remaining

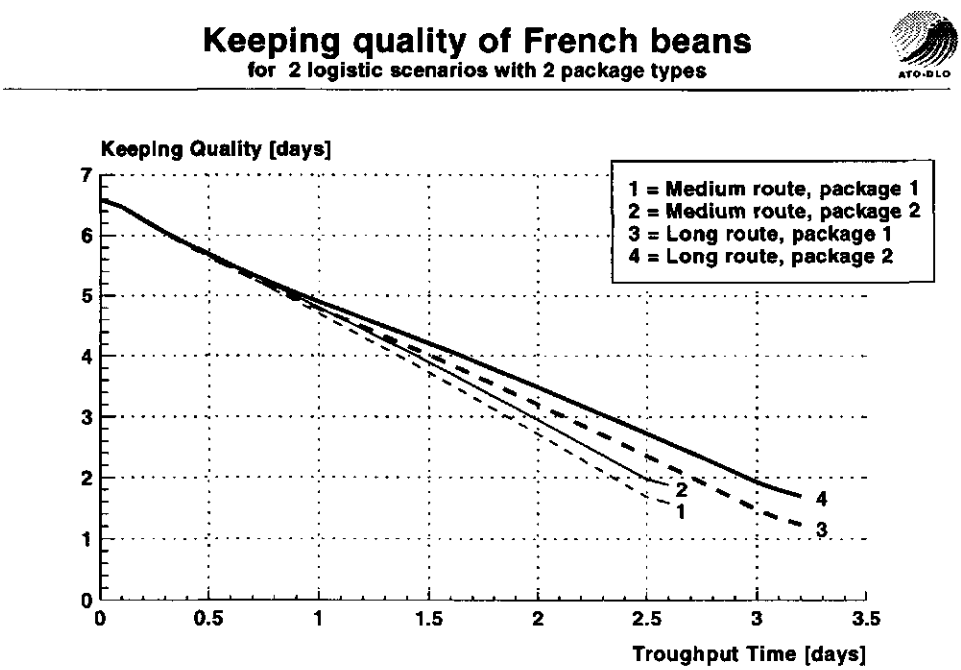

Figure 1. Keeping quality of french beans in a logistic chain

keeping quality for the long route. This way, the consequences of decisions that improve product quality may be quantified. Especially in complex distribution chains with long throughput times this is not a trivial problem.

Other application possibilities concern for example quality monitoring, exploration of new export markets, improvement of the logistic structure, and adjustment of supply and demand. Some of these have already been developed in the form of:

- A quality prediction system for apples; a visual interactive system that predicts the quality change of apples throughout the logistic chain.
- A quality prediction system for flowers; a visual interactive system that predicts the quality change of various flowers throughout the logistic chain.
- A Decision Support System for the layout and operation of distribution centres for fruit and vegetables; each product that is handled in a distribution centre has to be assigned to a location that minimizes the quality loss and the amount of handling.
- A chain control system for mushrooms. Based on the available logistic structures the flow of goods can be channelled in various ways. Based on supply and demand patterns and on predicted quality change, the optimal channel is assigned to different markets.

The basis of such systems is always a combination of quality change models and logistic models and can be regarded as a critical subsystem for an integral approach in this sector.

Conclusions

Quality plays an important role in the distribution of fresh agricultural products. Quality and logistics are strongly related and must be regarded on an integral base. One of the problems is to give this view a concrete form. This is mostly because the concept of quality and its behaviour in a logistic environment is difficult to grasp. The concept of keeping quality and the underlying processes that have been modelled make quality behaviour manageable and predictable. With these models, tools can be developed that both visualize the logistic chain and place quality behaviour in a logistic environment. This approach of the combination of logistics and quality makes it possible to analyze and quantify consequences of varying environmental circumstances. Thus it is a concrete step towards a Total Systems Approach.

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Strengthening agro-industrial chains: the barley - malt - beer case

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Introduction

There is a growing realisation that a market-oriented approach is an important key to the success of agro-industrial chains. Measurement and analysis of market requirements (including consumer needs), and subsequent translation into attractive product-market combinations, is vital to the survival of each link of the chain[1]. However, this orientation toward demand rather than supply calls for different forms of collaboration between the companies in a chain. This has meant the arrival of new kinds of agro-industrial chain in the agro-sector, each organised in accordance with its own specific market demands. A thorough understanding of how to optimise chain operations is vitally important in the development of such demand-oriented chains.

It is apparent from the 'chain projects' carried out at the request of the Dutch business community that there is a distinct lack of both theoretical and practical 'chain expertise'. This is why the NEHEM Consulting Group places such emphasis on stimulating the development of 'chain expertise' which is relevant to the requirements of the business community.

With this in mind, Nehem C.G. has been conducting a study entitled 'Strengthening Agro-industrial Chains' since 1991, initiated at the request of the Dutch Ministry of Economic Affairs and executed in close cooperation with the Ministry of Agriculture. The study's objective is to develop visions and organisational concepts for the optimal functioning of market-oriented agro-industrial chains, based on practical experience in the agro-sector. The business community has been involved as much as possible in this study. An example of such involvement is the Barley-Malt-Beer project which serves as a case-study for this paper.

A number of the concepts and potential bottlenecks related to chain-strengthening will be considered. The way these concepts can be applied in practice is illustrated in the Barley-Malt-Beer case study (see chapter 3).

[1] A chain is defined as follows: a sequence of business activities deliberately integrated by a number of companies, which ultimately result in the provision of a product or service.

Conditions for chain strengthening

Introduction
In the course of chain formation and strengthening, two separate processes can be distinguished:
- Development of expertise;
- Project development and execution.

The two processes will be dealt with separately, although there is a strong and continuous interaction between the two.

The Development of Expertise
There are four stages involved here:
1. Taking stock of the expertise required by the business community;
2. The development of such expertise in educational institutes;
3. The transfer of expertise to the business community;
4. Implementation by companies in an agro-industrial chain.

In the coming years the institutional infrastructure will devote more energy to the assessment of the kind of expertise required by the business community, and the development of such expert knowledge inside educational and research institutions.

During the execution of the chain projects it became apparent that while the transfer of expertise to the business community and its implementation in agro-industrial chains is of vital importance, it still receives inadequate attention.

Experience has revealed the following bottlenecks in the process of expertise development:
- Difficulties in the multiplication (scaling up) of demonstration projects to practical applications in the agro-sector;
- Inadequate functioning of the institutional infrastructure when it comes to the transfer of 'chain-expertise' to practical applications;
- The formation of chains through 'technology-push'; here marketing opportunities, market demands and the organisational aspects of chain formation are not taken sufficiently into account.

We will now look more closely at the transfer of expertise to the business community, and its implementation by companies in agro-industrial chains.

Project Development and Project Execution

Areas of Managerial Concern
In chain projects there are four distinct areas of managerial concern:
1. Chain formation (development of new chains) and/or chain strengthening (reorganisation of existing chains);
2. Chain organisation;
3. Chain design and establishment;
4. Chain management.

Each area calls for a different approach, and needs to be dealt with in more or less chronological order.

In *chain formation and strengthening* the following matters are raised: Which links need to be considered? what are the functions, positions and interests of individual links? what is the chain strategy, and chain objective? how much cooperation is there between links? Chain formation is a consequence of cooperation between organisations in an industrial column. (Zuurbier 1991). Through chain formation and strengthening the independence of cooperating parties is maintained.

Chain organisation concentrates on the way in which the links of the chain work together. Here a variety of organisational (chain) concepts are possible.

Chain design refers to the actual harmonisation of business activities between the links of the chain. This relates to areas such as marketing, the operation of quality control systems, and attuning the logistical and informations systems inside each of the individual links to the overall productive activity of the chain (Heyman and Maijers, 1992).

Chain management stands for the integral management and control of the flow of information and goods in an industrial column. Questions like: Integral management - who manages and who supervises? are handled here.

In the barley-malt-beer case study, we will consider chain formation and strengthening, and chain organisation in more detail (see chapter 3).

Chain Formation and Strengthening

In this section factors vital to the success of chain formation and strengthening are cited. These will re-occur in the Barley-Malt-Beer project, and are relevant to chain projects in general.

1. *Broad consensus.*
   Chain strengthening calls for a high degree of involvement and active participation from all the links in the chain.
2. *Acceptatance of leadership in the chain.*
   If a 'shift of power' takes place in the chain which is being formed or strengthened, the new chain leader must be accepted by all parties participating in the chain. There may be resistance from parties which are delegated a less central role in the new situation. The absence of a strong, innovative party in the chain ('chain leader') can form a serious bottleneck.
3. *Communication between links on the basis of mutual trust.*
   Cooperation forms the basis for participation in a chain. Mutual trust is the key concept. There is no point, for example, in checking the reliability of information which has been passed on if parties do not work on a basis of mutual trust.
   An integrated chain can only function if the various links make the right information available. Willingness to provide this information is an important condition for the successful functioning of such a chain organisation.
   The lack of relevant information and adequate information transfer in and between links of the chain, in relation to quality control and marketing information.
4. *From product orientation to market orientation*, (from more to better, from bulk to specialisation etc.)
   Bottlenecks can arise through the prevalence of a product-oriented rather than a market-oriented way of thinking and acting in one or more links.

5. *An integral approach rather than transaction-oriented thinking and acting.*
   The chain should function as a single organisation. This calls for a shared understanding of common interests (from competition to cooperation, from speculation to continuity, etc.) Bottlenecks can arise through:
   - The obstruction of cooperation through short-term thinking and transaction orientedness on the part of one or more links in the chain.
   - A conflict of interests between an individual company and the collective (chain).
   - The absence of a shared vision in the links of the chain.
   - Harmonisation problems between small-scale, for the most part unorganised, links in the chain (cultivation, collection) and large-scale, concentrated links (retail trade, industry).
6. *Appreciating the added value.*
   It goes without saying that a number of parties are involved in chain projects like the barley-malt-beer project. Demonstrating the added value of participation to individual companies has proven to be very important. Companies more or less want a 'guarantee' that their efforts will be appropriately rewarded, preferably, in the short term. This leads to delays in the development of chain projects, regardless of possible stimulating circumstances in the business environment. Making the *added value of chain formation and strengthening* and the way in which possible extra revenue is to be distributed among participants easily understandable is not a simple matter, and can easily lead to bottlenecks.
   In the first place, there seems to be confusion about the chain concept in relation to added value. Added value can be related to:
   1. The individual company;
   2. The internal production chain;
   3. The chain in relation to a competing chain.An awareness of these differing perceptions of added value is important in the development of chain projects. Differences of perception can lead to tensions, for example when a positive added value for the chain is achieved at the cost of a negative added value for an individual company.

   Besides this, added value needs to be related to the developmental stage at which the company/chain in question finds itself. When a company is asked to participate in a chain project, it is usually the potential short term and financial benefits which are discussed. As the project progresses however, there is a shift of emphasis from short term objectives to long term objectives. The most important added value factor in the medium and long term is the competitive advantage to be gained, which helps to ensure the continuity of company operations (NEHEM 1994).
7. *Willingness of the organisation to adapt.*
   Often the roles and functions of various organisations are subject to change in chain projects. For successful execution of chain projects, the organisations in the different links have to be prepared to adapt their company operations to the new situation. This also applies to the various sector organisations involved, when they are called upon to carry out new tasks and abandon old ones.

Chain Organisation

The organisation of a chain depends on the objectives set by participants, the conditions for chain formation or strengthening (with respect to the function, role and position of participants), and the anticipated forms of chain design and chain management. Experience shows that the final form of partnership between links in the chain is also strongly influenced by the market. The organisational concepts listed below are examples of how the relationships between links can be formalised.

1. Co-making.
   Building up a long term relationship with a limited number of suppliers, based upon mutual trust.
2. Upward and/or downward vertical integration.
   An existing organisation integrates upward or downward in the industrial column by means of fusion or takeover, so forming a chain with optimal adaptability to market demand.
3. Supportive operational bodies serving the entire chain.
   A supportive body is set up to serve an existing or planned chain. This body is responsible for optimal harmonisation, checking and initiating for example (marketing) research for the entire chain.
4. Adding a link to the chain.
   An extra link is added between two links whose modes of operation and interests continue to conflict.
5. Removing a link.
   A redundant link is eliminated.
6. Differentiation of activities in large organisations (business units). A link differentiates a certain activity within the existing organisation in order to improve the working relationship with other links.
7. Strategic Alliances.
   A link in the chain sets out to strengthen the marketing position in vital areas, co-operating with companies from the previous or the following link, while continuing to preserve its own identity.
8. Networks.
   A number of companies (in the same region) which are part of the same link, together form a network with its own central management or coordinating centre, so that they stand on an equal footing with other (concentrated) links in the chain.

The barley-malt-beer chain case

Introduction

In order to shed more light on the matters so far discussed, we will now consider a case study. In this project, strengthening of the chain on the basis of the chain organisation model plays a central role.

Background

The production of brewer's barley and its processing into malt and beer has a long and well-established tradition in the Netherlands (see *figure 1*). In 1991 NEHEM C.G. in co-operation with the Foundation Dutch Institute for Malting Barley, Malt and Beer (NIBEM

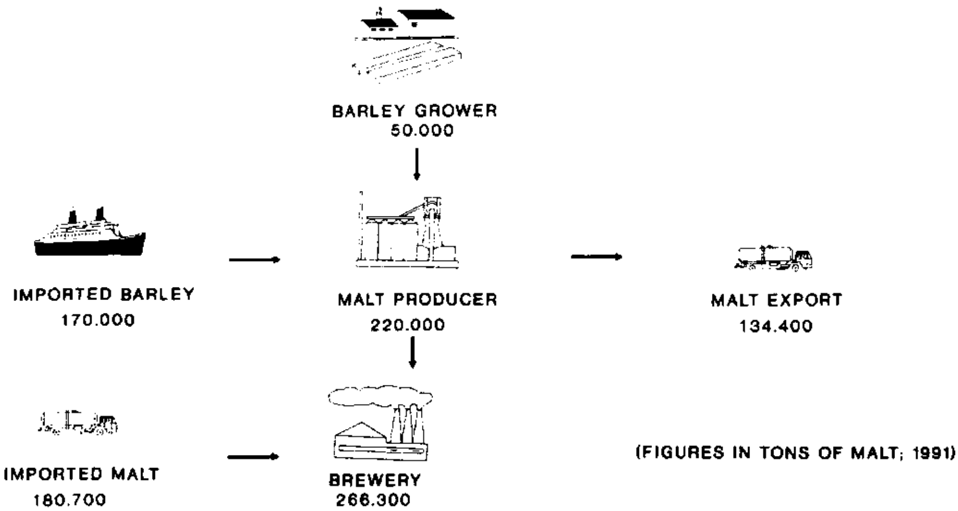

Figure 1. The Dutch barley-malt-beer chain (in tons of malt)

foundation) carried out a general survey investigating the strength of the Dutch barley-malt-beer chain. The investigation was called for because of changes in the business environment of the barley-malt-beer chain, which had seriously weakened it over the course of a number of years.

The study concluded that the relatively low (and falling) percentage of Dutch brewer's barley in the beer produced in the Netherlands was a cause for serious concern. Research and development activities were expected to come under pressure in the short term, and the position of the established Dutch processing industry in the longer term was seen to be endangered.

A possible answer to these developments, and to the special demands of the market, international competition and long term considerations, is improved collaboration between the links in the production chain.

One thing and another resulted in a project with the objective of 'strengthening the barley-malt-beer chain in the Netherlands' by developing an integral chain organisation model for the Dutch barley-malt-beer chain which would stimulate and strengthen the cultivation and processing of brewer's barley in the Netherlands (NEHEM Consultancy Group, TNO-foodstuffs Agro-NIBEM, 1993). This study was instigated in early 1993 by the NIBEM foundation and the Dutch commodity board for grain products.

Project description

The project is executed in the following stages.

Stage 1: Project development;
Stage 2: Development of an integral chain organisation model;
Stage 3: Practical application of the model on a small scale;
Stage 4: Scaling up to sector level.

The active participation of *all* links of the chain is required at every stage of the project. This means both companies connected horizontally in the chain (within a single link, for example different breweries) and those connected vertically (different links, for example cultivators, growers, traders, malt producers, breweries). Horizontally, competitor relationships are important; vertically, factors which affect the supplier-client relationship come into play. Outside the business community, branch organisations, government and the like fulfil an important function in the development and execution of chain projects. This is certainly true of this particular project.

To sum up: Where different organisations with different interests are involved in a chain project, and where the chain is confronted by a range of problems, this must be taken into account in the project development stage.

This case study deals with project development (stage 1), and the development of an integral chain organisation model (stage 2).

Project Organisation

The project organisation for the development of an integral chain organisation model is set up in such a way that the vital conditions for success (as cited in section 2.3.2) are adequately fulfilled. In this specific case the basic premise for the chosen project organisation is that an optimal contribution be made by all the participants. To this end, three task groups are set up along thematic lines, made up of carefully selected representatives from each link in the chain. This is important for the raising of awareness with regard to the interests of the chain as a whole. The areas of attention covered by the selected themes are matters of common concern to the participants in the task groups, so that a broad consensus upon which future cooperation can be based is obtained at an early stage.

A brief summary of the objectives of the three task groups follows:

Task group 1, 'Market oriented brewer's barley cultivation' has the objective of working out an organisational structure for market oriented barley production, and concentrates on the section of the integral barley-malt-beer chain where the relationship between cultivator and trader plays a central role.

Task group 2, 'Integral processing' has as its objective the optimisation of productivity throughout the entire barley-malt-beer chain, and the harmonisation of the various links of the chain in such a way that the entire operation from barley to beer can function as an integrated whole, and be managed as such.

Task group 3, 'Integral chain organisation' has the objective of formulating the necessary conditions for integral chain organisation. This is done on the basis of so-called connector discussions (discussions between the representatives of two links from the barley-malt-beer chain at a time), the analysis of barley-malt-beer chains abroad, and the opinions of individual companies with regard to problem areas in the sector. A managerial group is also set up. This consists of important representatives from the chain-links, branch and public organisations, and the financing parties (i.e. the NIBEM and the Ministry of Agriculture). The management group has an independent chairman to ensure that it can function effectively.

Barley-malt-beer Chains Abroad

In order to gain a better insight into feasible organisational concepts, a group of four chains abroad were analysed at the start of the project. Visits were made to (delegated)

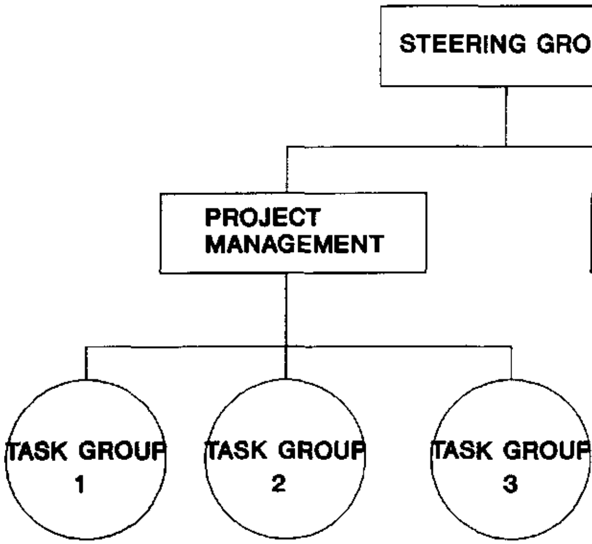

Figure 2. Project Organisation

chain leaders in Denmark, Germany, France and England.The general conclusion can be drawn that in neighbouring countries greater progress has been made in the development of integrated barley-malt-beer chains. This can be seen in *figure 3* where three different chains and the relationship between the various links is illustrated.

In Denmark the brewery has taken on the role of chain leader. The barley is cultivated under contract to the brewery, and then processed in accordance with brewery specifications. The system works; the brewery has its native barley delivered as malt, having first

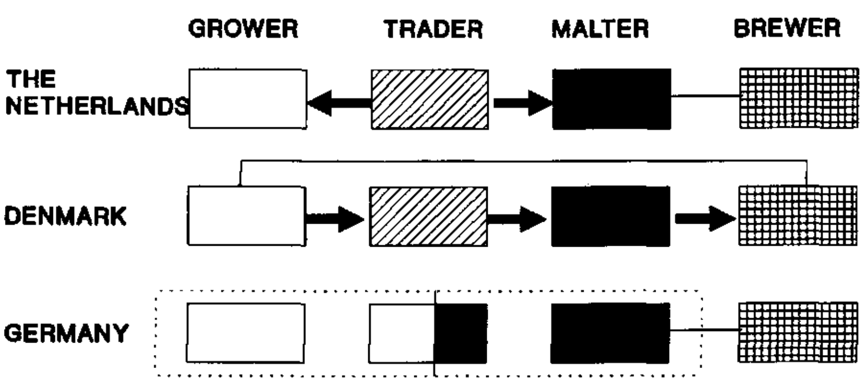

Figure 3. Organisation of barley-malt-beer chains abroad

gone through a fully supervised process. Because of the strict requirements of German breweries with regard to malt quality, malt producers in that country have a direct relationship with growers. The collector is not made redundant however. Attitudes and ways of doing things are based on long term considerations, and cooperation between links in the chain is based upon mutual trust. This means that the link between grower and malt producer is one of partnership.

In France we see that the malt producer has acquired a natural leadership role. The growers have worked in partnership with malt producers for years, so that there now exists a well developed integral chain. There is a high degree of openness and clarity in the chain.

The malt producer in England is strongly market oriented and has, besides a good relationship with the breweries, direct contact with growers. The collecting companies sign contracts with growers at the instigation of the malt producers, and are responsible for both logistics and commercial administration.

The development of an integral chain organisation model

The most important organisational aspects of the chain and the bottlenecks which hinder its proper functioning have been illustrated, in order to help us see the possible ways in which the Dutch barley-malt-beer chain might be strengthened. The analysis is largely done by the chain participants themselves, with the assistance of a neutral third party. The situation desired in the future is also indicated by representatives of the sector. The present and the desired future organisation of the barley-malt-beer chain is sketched here primarily at management level; more operational matters are not considered. The following aspects related to chain strengthening and chain organisation per link are set out in schematic form:

- The function a link performs in the chain;
- The role a link plays in the chain;
- The way consecutive links cooperate;
- The business interests of each link in the chain;
- Market orientation (with an eye on the following links in the chain).

At present in the Netherlands the four parties involved - grower, collecting trader, malt producer and brewery operate more or less independently of one another. The Dutch production column shows no traces of an integral approach. The transaction-oriented collecting trade is in practice the dominant link when it comes to Dutch brewer's barley. This is partly a result of the fact that none of the other parties wishes to take on a leading role. At the same time, there is scarcely any flow of information between the separate links of the chain. This creates considerable tensions from time to time. The relationship between malt producer and brewery is an exception here however, and can fairly be called partnership-oriented. The only objective which is shared by practically all the participants in the chain is: 'To maintain the chain by stimulating the cultivation of brewer's barley through collective hybrid and cultivation research.'

The participants in the chain are not happy with this situation; the weakness of the chain is acknowledged. The concept of an integrated chain in which quality is particularly emphasised, costs are cut, and the cultivation of Dutch barley is assured of a secure place, has considerable appeal. It is fair to conclude that there is a broad consensus for a strengthening of the chain organisation which maintains the same number of links, but which

	GROWER	TRADER	MALTER	BREWER
CHAIN FUNCTION	- CULTIVATION OF BREWERS BARLEY	- TRADE, COLLECTION STORAGE ← SCALING UP	- PROCESSING BARLEY INTO MALT CONSTANT QUALITY →	- MARKETING AND PROCESSING BEER - INSTRUCT MALTER
CHAIN ROLE	- EXECUTOR	- LOGISTICS BARLEY	- EXECUTOR	- QUALITY/PRICE LEADER
COOPERATION	- TRANSACTION ORIENTED	- TRANSACTION ORIENTED	- TRANSACTION ORIENTED - PARTNERSHIP	- PARTNERSHIP
INTEREST	- PROFITABLE BALANCE CROP - SHORT TERM	- HIGH MARGINS - SHORT TERM	- CONTINUITY - LONG TERM	- OPTIMAL QUALITY/ PRICE - SUPPLY ASSURANCE - LONG TERM
MARKETDRIVEN	- NO	- YES/NO	- YES	- YES

Figure 4. Present organisation Barley-Malt-Beer chain

gives a different content to the aspects of chain organisation cited above. In *figure 5*, a new content per link is given to aspects of the chain. Knowledge and experience gained abroad has also been incorporated.

The organisational structure sketched here illustrates the open lines of communication between links of the chain. For individual companies, the present operations and organi-

	GROWER	COLLECTOR	MALTER	BREWER
CHAIN FUNCTION	- CONTROLLED CULTIVATION OF BREWERS BARLEY	- COLLECTION AND STORAGE - QUALITY MANAGER GROWING AND STORAGE	- PROCESSING BARLEY INTO MALT ← SCALING UP	- MARKETING AND PROCESSING BEER - INSTRUCT MALTER CONSTANT QUALITY →
CHAIN ROLE	- SPECIALIST - EXECUTOR	- EXECUTOR	- LEADER LOGISTICS - DELEGATED CHAIN LEADER Q/P	- QUALITY/PRICE LEADER
COOPERATION	- PARTNERSHIP	- PARTNERSHIP	- PARTNERSHIP	- PARTNERSHIP
INTEREST	- PROFITABLE BALANCE CROP - LONG TERM	- CONTINUITY - LONG TERM	- CONTINUITY - LONG TERM	- OPTIMAL QUALITY/ PRICE - SUPPLY ASSURANCE - LONG TERM
MARKETDRIVEN	- YES	- YES	- YES	- YES

Figure 5. Desired organisation Barley-Malt-Beer chain

sation are adapted and new ones formulated. The picture which emerges constitutes the basis for an integrated barley-malt-beer chain.

In practice the integral chain organisation model is implemented in the third stage of the project. Preparations for this stage are at present under way. A number of practical activities have been planned now. In total there are five initiatives, each involving a group of growers, a collector, a malt producer and a brewery. The execution of this stage will take about five years. The timing of scaling up to the entire sector depends on the outcome of this stage of the project.

The most important outcome to be seen from the second stage is that the various links of the chain are prepared to cooperate with one another to find new answers in a rapidly changing social and economic climate.

From this and other projects, NEHEM C.G. have gained a knowledge and experience, which will be briefly summarised in the following chapter.

Conditions for the development and execution of chain projects

Besides making the added value of chain projects clearly understandable, and illustrating the fact that chain projects should aim at medium and long term benefits, the case we have considered demonstrates that there are other important conditions which have to be met for successful development and execution of chain projects.

Here are some of them:

1. *Genuine cooperation by participants in the chain.*
   The participants must be prepared to commit themselves to the chain objectives which will be collectively drawn up at a later stage. Future activities should be in tune with these objectives.
2. *Working in a framework of several years.*
   A proper assessment of the chain to be strengthened or formed cannot be made after a single year. An objective assessment is only possible after the chain organisation has actually been functioning for a number of years. During these years, the organisation can adapt in a natural way to the business environment in which it operates.
3. *Expert back-up and careful guidance.*
   The development and execution of chain projects requires the guidance of experts to avoid frustration of the initiatives being taken through conflicts of interest and/or lack of clarity about who should do be doing what, and when. An understanding of development processes is therefore a prerequisite for the project leader. In this way the various companies involved are assured of expert advice at every stage on the path to their altered function in the new chain organisation. Guidance and counselling is primarily aimed at:
   - Initiation of the project (understanding of chains at all management levels, knowledge of the sector, knowing how to work together);
   - Gaining acceptance for the project;
   - Developing a plan of action together with all those involved;
   - Guidance and support during execution.
4. *Education and training in the field of chain integration.*
   Functioning in a chain based upon an integral chain organisation model requires companies to engage in new activities. For certain functions, new staff will need to be taken on. This new personnel must be provided with training.

5. *Being prepared to make an investment.*
   Forming and strengthening a chain requires an investment on the part of the companies involved. Investment in knowledge, personnel and equipment. Participating companies must be prepared to make this investment.

In conclusion

The final outcome of chain projects should be a greater degree of cooperation between the links of the chain. By adapting to the general state of development in the branch/chain it is possible to achieve an accelerated strengthening of the chain. Taking steps that are too large results in a great deal of discussion and few practical results.

A 'bottom-up' philosophy lies at the heart of the approach. A high degree of motivation is required from participants, to achieve a maximum acceptance and input of knowledge. The approach is characterised by a high degree of sector commitment throughout the execution stage, (the participation of all links in the production chain and all sector organisations and institutes which have a role to play in the framework of the project). For technical know-how from the sector, the companies involved often work in close cooperation with research institutes.

The conflicting interests and opinions which are often present are taken into account in the description/formulation of potential bottlenecks and necessary conditions for the execution of a chain project. However, the project consultant must ensure that these are presented objectively and not coupled to individual company interests. This makes the potential bottlenecks and conditions which need to be fulfilled clearly recognisable, so that the chances of acceptance of the formulation reached are greater. This approach considerably increases the willingness to participate in the following stage.

To summarise: Chain strengthening projects are complex and require expert counselling and supervision. Experience has shown that laying out the path to be followed, guiding participants and the external elements along the collectively chosen route toward (thinking in terms of) chain formation and strengthening, and removing obstacles which result from differences of opinion, are matters of vital importance.

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IV. Quality management in agriculture

Quality management in the meatchain. A management approach

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Abstract
Due to several developments Dutch meatindustry is facing an increasing competition. To meet new demands the meat chain has to be restructured. This means a new approach of the concept of quality. This problem is considered as a managerial problem therefore a managementmodel is introduced to manage this process. The essence of this model is to adjust the organization to the product and its processingstages. Also is argued that a chain of organizations is to some extent similar to an individual organization, therefore the same managementtools can be used. The adjustment of the porkmeatchain in order to meet the new demands is described by using this model. Special attention is paid to Integrated Quality Control. Finally the model is used to analyze quality management in the porkmeatchain. Both the model and IQC are discussed.

Introduction

A lot of pressure is put on Dutch meat industry, due to several developments. They have a considerable impact on the organization and structure of meat-production in the Netherlands. Some examples of these developments are:

- An increasing self-supply within the EC,
- International treaties to cut down trade barriers like Gatt and MacSherry,
- More environmental and animal-welfare legislation puts restrictions to an increase of production on scale,
- Consumers are more critical and are demanding for a product of high quality, safe and easy to prepare.

The Dutch meat industry has always emphasized on bulk goods. Characterized by a few processingstages and minimization of costs. Less attention was paid to value adding, contrary to a country like Denmark. The Dutch meatindustry is now costleader. This was made possible due to other favourable productioncircumstances, like the availability of cheap compoundfeed, highly skilled farmers, a well developed extensionservice, specialized research institutes, etc.. The earlier mentioned developments however have brought Dutch meat-production into a position of reconsideration. Competition has increased. Costs and production advantages are diminishing compared to other countries. In order to stay competitive it is necessary to restructure the meat chain. More emphasis has to be put on quality in a broad sense. A chain approach might contribute to obtain this objective. This has also been recognized by the product board for livestock and meat (PLM). They introduced the concept of Integrated Quality Control (IQC).

The restructuring of the meatchain is considered as a managerial problem, as quality is too. For this purpose a general managementmodel will be introduced. Next the concept of a chain is introduced and it will be argued that to some extent a chain of organizations is similar to an individual organization, followed by the introduction of the chainmanagementmodel (CM). The porkmeatchain will be described according to this model. Special attention is paid to the concept of IQC. Finally the IQC concept and the use of the CM will be discussed using the porkmeat chain as an example.

Quality management

The concept quality

The concept 'quality' has several meanings. Often it is translated as 'meeting the needs of specification' or as stated by Juran (1988) 'Quality is fitness for use'. A more proper definition of quality and more suitable for human foodstuffs is: 'quality is meeting the expectations of the consumer' (Van den Berg 1993, p22), because the consumer of human foodstuffs is taking more aspects into account then only those which are part of fitness for use. Cramwinckel cited by Van den Berg (1993, p23) distinguishes analytical and emotional quality. Analytical quality consists of production traits which contribute to the quality of the product. The appreciation of a product by its consumer is the so called emotional quality. Both are not completely the same. There are productdifferences which can not be noticed by consumers, on the other hand consumers recognize productdifferences which can not be analyzed.

Often consumers are prepared to pay more for products which are perceived as qualitative. In this sense quality means value. The foundation of the price of a product are its costs. Minimizing costs is very often an objective of producers. This means avoiding costs of products which can not meet the qualitystandards, but also producing efficient and effective. Actually quality has two meanings. First, quality related to the product with the main objective to add value. Second, quality related to the production with the main objective to produce efficient and effective and to avoid 'no-quality' products. A policy which emphasizes on productquality is successful. This can be illustrated by a research of Clifford and Cavanagh (1985) among 525 midsize businesses. They concluded that almost all of the winning businesses compete on the base of value, not price. They are superior in quality to the average. Also a policy which puts the emphasis on effective and efficient production is successful. This can be illustrated by a research of Ziggers (1993) among 39 potplant nurseries. An improvement of the level of management (which means a more structured planning and productioncontrol) by 1% leads to an improvement of annual turnover by 0.26%.

Quality, a management approach

The quality of human foodstuffs is actually a reflection of the producing organization. Decision-making processes precede the production of products and determine the quality to a large extent. Not only at the operational level but throughout the whole organization. Now, managing the organization is conceived as initiating, directing and controlling goal-setted activities (Kampfraath and Marcelis, 1981:p20). It involves decision-making. In general: management is considered to be equal to decision-making.

Decision-issues can be divided into three special areas of attention. Decisions related to the production-process (A-level), decisions related to the production-resources (B-level) and decisions related to the management infrastructure (C-level). These three levels will be briefly explained.

A-level decisions
These decisions are related to purchasing, processing and selling. Decision-items are for example the acceptance of raw materials (Do raw materials meet quality standardlevel ?), the composition of a production programme (When and how should which activities take place?), the audit of work in progress (How much time is spent on activity ?, Does the product meet quality level ?), the provision of buyers with ordered products (Is the order meeting the demands of buyer ?), etc. The production of products, with a certain quality performance, against certain costs and a certain supplying reliability, reflects the operation of these decisions. A good productquality is a balance between quality, quantity and costs. This balance depends on the objective of the organization (Van der Berg, 1993:p202).

B-level decisions
These decisions are about productionresources. Resources include people, capital, raw materials, processing equipment, etc. given form into terms of numbers of vacancies, investmentbudgets, marketingbudgets, purchase deals etc.. Decision-items are for example the weigh up of objectives and resources (What resources are necessary to realize the objectives?; Which objectives can be realized regarding the given resources?), the evaluation of available resources (Do existing resources still meet the required quality levels regarding the objectives?), the evaluation and acceptance of suppliers (How reliable are my suppliers?; What quality can they deliver?), etc.. These decision-items can only be answered properly if objectives are described in terms of marketshare, productionlevels, qualitylevels, research and development activities, etc.. Actually this means that decision-items about objectives should be solved first, however they interact with decision-items about productionresources. Analyzing markets, evaluating products, recruiting and educating labour, contracting suppliers, installing, maintaining and innovating processing equipment, etc.. reflects the operation of these decisions.

C-level decisions
These decisions affect the performance of the organization. An organization can be described in terms of people, information, organizational arrangements and management means. So called management conditions. Together they form a 'management infrastructure', which determines the solvation and operation of A- and B-level decisionitems. In other words it determines the performance of the organization. C-level decision-items are actually about organizing the organization. Decision-items are for example the provision with management-conditions (What management conditions are necessary to solve A- and B-level decision-items properly?), the consideration of how decision-items should be

solved (Should the production-programme problem be solved in a different way?), etc.. Operating these decisions means a provision with managementconditions and a creation of a certain managementinfrastructure. In general: these decisions will affect the performance of the organization. In other words: 'organizing the organization'.

Four types of management conditions have been distinguished:
1. people; the competency of people who are involved with decision-making, like education, age, experience, skills, etc.,
2. availability of information and knowledge,
3. organizational arrangements; tasks, responsibilities, authorities, procedures, etc.,
4. management means; decision support systems, information systems, databanks, etc..

A-level decisions are considered as operational decisions, while B-level decisions as strategic decisions. Decision-making itself is a process of reducing the number of alternatives. At the board level there are often a lot of alternatives. Their decisions will reduce the number of alternatives. The next layer of the organization, f.e. the manager, has to make decisions within the scope of the left alternatives. This is an ongoing process until the final decision is made. If there is a discrepancy there should be feedback as far as necessary. In reality several decision-problems have to be solved at the same time. These are often related to and/or affecting each other. This is illustrated with *figure 1*.
The decisionmaking process itself can be evaluated by testing the decisionmaking process on:
- *systematics*, are similar decisionmaking problems solved in a similar way?,
- *foresight*, are effects of a decision taken into account during the time period covered by that decision?,
- *feedback*, are previous related decisions evaluated?,
- *integration*, has the decision problem been placed in a broader context?

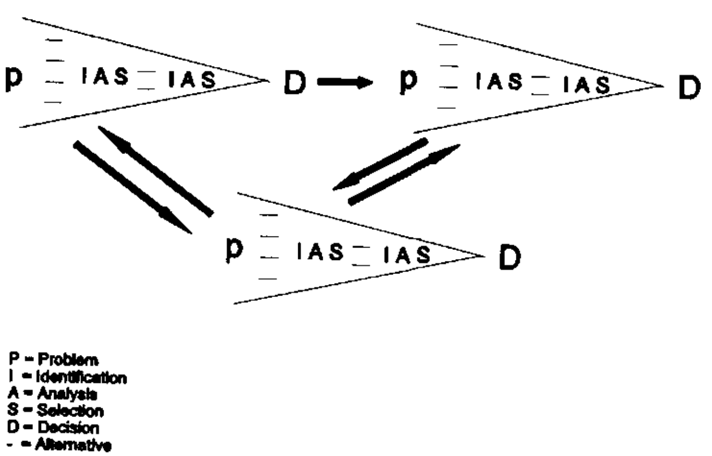


Figure 1. The decisionmaking proces

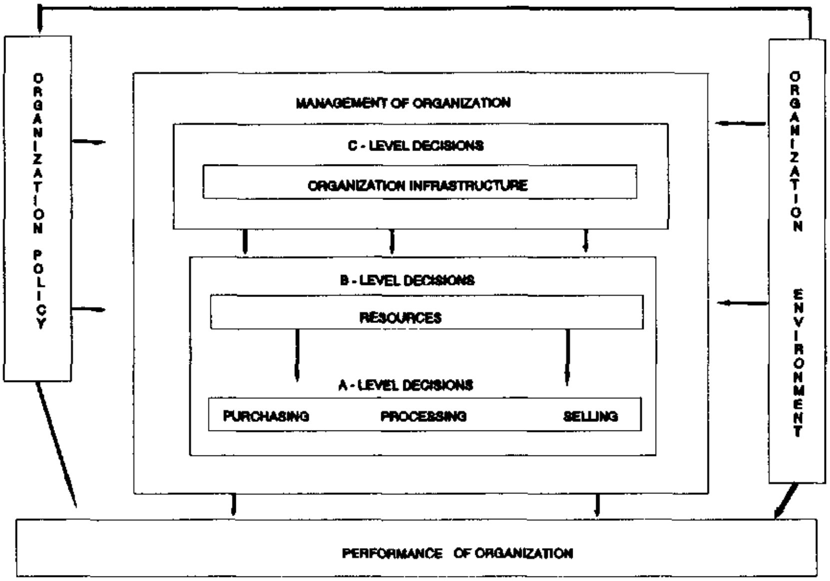


Figure 2. The managementmodel

The effectiveness of a organization is the outcome of a certain organizational environment, its policy and its management. It can only be affected by either changing the policy or the management or both. This is illustrated with *figure 2*. Apart from this one should be aware that the performance of a organization is not only the organization as described in terms of people, information, organizational arrangements and management means, but this performance is also affected by the behaviour of people and their interrelations. These relations depend on power, values, attitudes, etc., of an individual or groups of people and might have a considerable effect. This is the so called informal organization.

Often several special areas of attention are distinguished, like quality, processing, environment, financing, marketing, logistics, research and development, etc.. These areas have in common that they are all related to a product one way or another, but they are also related to each other. All these special areas of attention are part of the management of an organization and should be considered together. Quality as a special area of attention is just a part of the total management. Therefore quality will be conceived as 'the performance of the organization', which takes the total management into account.

The essence of this model is to adjust the organization to production not to adjust production to the organization. Therefore the starting point of the analysis should be the product and its processingstages, not the organization.

The chain managementmodel

The chain

Nowadays agribusiness is confronted with all kinds of developments. They have a considerable impact on the structure and organization of agribusiness. It is a challenge for agribusiness to meet these new demands. In general it means to adapt the product and processingstages, which is considered as a managerial problem. Nevertheless the solution of this problem is more complex. Often a solution goes beyond an individual firm. Therefore firms are forced to adjust their production to each other. Even worse, often an optimal solution goes beyond at least two firms. A web of cooperating firms arises. Adjusting their production to each other either forced to be able to meet the demands of the market or to create new markets or both.

Several organizational forms can evolute. Zuurbier (1993:p97-98), citing several authors, distinguishes three main organizational forms, free market, network and vertical integration. Vertical integration is characterized by single ownership. Its main advantages are reduction of transaction costs, technological economies, enhanced ability to innovate and differentiate products, stable relationships, economics of information and creation of entry and exit barriers. Disadvantages are high exit barriers, reduced flexibility, less incentives and more bureaucracy. Also horizontal integration has to be mentioned. Its main advantages are the exclusion of competitors and economics of scale. Its counterpart is the free market. Markets promote high-powered incentives and restrict bureaucratic costs. Networks can be considered as an intermediate form. The involved firms are autonomous, but have committed to cooperate together to gain mutual benefits. Using the advantages and avoiding the disadvantages of a vertical integration.

In general the problem dealing with is a processing problem within the chain which can not be solved by two successively autonomous firms (or firmunits) within that chain. There is a high interdependency among firms (or firmunits) in meeting the demands of the market or creating new markets.

The chain managementmodel

As earlier mentioned the effectiveness of an organization is a result of the interrelations between its business environment, its policy and how its management. This principle can also be used to describe the effectiveness of a chain. Again A-, B- and C-level decisions can be distinguished. This idea is supported by Godfroij (1981, p105-115) by saying that organizations and networks show only gradual differences along dimensions that measure the degree of organization and therefore can be analyzed with the same concepts and theories as organizations. Instead of optimizing the production process within one single organization it has to be optimized throughout the chain.

A model to describe the effectiveness of a chain is therefore deduced from the managementmodel to manage organizations. The effectiveness of a chain can now be defined as the outcome of a certain chain environment, its policy and its management. It can only be affected by either changing the policy or the management or both. As a result of this the effect can be a non-optimal situation for a certain individual partner within the chain but optimal to the chain. The CM-model is illustrated with *figure 3.*

Theoretically it might be quite obvious to establish an effective functioning production chain, but practically there are a lot of obstacles. These obstacles refer to the production chain environment. This can be elucidated by using the network approach. A production chain often consists of many firms. They are considered to be interdependent and are engaged in bargaining, transactions and/or cooperative action and develop structural forms to coordinate and/or regulate these actions (Godfroij, 1993:p80-81). The participation of firms in a network depends on the differences and similarities between their individual

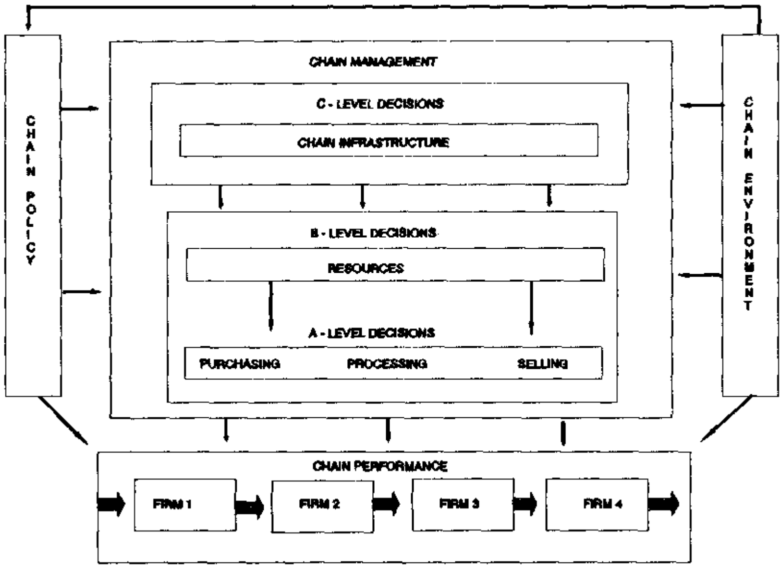


Figure 3. The chain managentmodel

goals and strategies and those of the network. It also depends on the nature of their interdependency. Especially where interdependency has competitive elements, the gains of one actor can be to some extent the losses of others (Godfroij, 1993;p81). This means that a production-chain can not only be considered as a collective, but also the position of an individual actor within the production chain should be considered. The actual performance of a production-chain is similar to the performance of an organization and will depend on the variety of interests individual firms will have. The actual structure and performance of a production chain might depend more on power and mutual interdependency of firms then on production chain efficiency (see also Godfreij,1993;p82), which can be considered as similar to the informal organization mentioned earlier.

The dutch porkmeatchain

The porkmeatchain environment

In 1992 the porkchain produced 1.5 million tons of porkmeat. Of this meat 0.6 million ton was disposed at the internal market (24%) and 0.9 millions ton was exported (76%). The EC is the main export market with a volume of 85%. Dutch porkmeat export products are characterized by less addition of value. The exportvalue stands for 6.3 billion dutch guilder (DFL). This is 9% of the total Dutch agricultural exportvalue. This was accomplished by a high degree of specialization of dutch pigfarming, low compoundfeed prices accomplished by import of raw materials against world market prices and a favourable geographical situation, a well established knowledge-infrastructure and a technical equipped and highly skilled processing industry.

However due to several developments the porkmeat chain has to reconsider its position, like:

- An oversupply of porkmeat of approximately 3% within the EC
- Treaties to liberate international trade, like MacSherry and GATT, reduces the advantage of cheap compoundfeed,
- European legislation on cattle transports,
- The development of a high competitive skilled porkmeat production in other competing countries, especially Denmark,
- A market demanding for a meatproduct which is easy to prepare and which has a high quality standard, especially in the Northern European countries,
- Less favourable production circumstances, due to high wages, animal welfare - and environmental legislation, oppose a further increase of production and therefore oppose a decrease of costs per productunit,
- The bad reputation of porkmeat, consumers do relate porkmeat to abuse of hormones and mistreatment of pigs.

The Dutch porkmeat industry is also a vulnerable one. It is depending heavily on exports and it is very concentrated, which makes it susceptible to contagious pig diseases with a large impact on exports. In addition the processing industry faces an overcapacity which causes mutual competition. As a result this chain is dominated by retailers and pigdealers. Besides this, processing has always focused on minimization of costs and less on maximization of value. Emphasis is put on 'how' to produce instead of 'what' to produce, neglecting the market. This holds as long as there is a shortage and one can compete on price. This chain structure and environment does not contribute to a powerful chain in financial terms

On the short term only meatprocessors seem to be affected, but on the long term also pigproducers, pigdealers (a reduction of exports of living pigs and piglets), etc., will be affected. Therefore all actors within the porkmeat-chain need and will benefit of a strong competitive chain, because sales can only be assured by exports. As a result the porkmeat chain has to adapt to the earlier mentioned developments.

The meatchain policy
The PLM has recognised that the porkmeat chain can only survive if it remains competitive. They together with actors of the porkmeat chain developed and introduced a framework to guarantee quality. This is known as Integrated Quality Control (IQC)(PLM, 1992). The aim of this framework is to guarantee origin, hygiene, use of compoundfeed, use of animal medicines and the absence of residuals in the meat throughout the porkmeat chain.

Management of IQC
IQC is an assurance system to guarantee and to control meatproduction throughout the chain. The system includes the processing stages reproduction, fattening and slaughtering. Within these stages guarantee is given (not in a juridical sense) to origin, treatment, hygiene, use of animal compoundfeed, use of medicines and absence of residuals within the meat.

The system depends on the exchange of information related to the individual registration and identification number of an animal. Exchange of information towards two directions. The slaughterhouse receives information of the pigfarmer (reproduction and fattening) about origin and healthstatus of the animals. In return the pigfarmer receives information about the slaughtering- and inspection results.

The slaughterhouse is responsible for the operation of the system. They have to control the firms that take part of the system at least two times a year. On the other hand the slaughterhouse is controlled by an independent board, nominated by the PLM. Also veterinarians and animal compoundfeed suppliers do have obligations, concerning the use of medicines and the composition of animal food, if they deal with an IQC-farmer. If a pigdealer is involved then he has to be juridically owner of the pigs and has to make an agreement with both the pigfarmer and the slaughterhouse. To get the IQC-certificate the slaughterhouse has to make a contract with the PLM and will be tested on:

- the manual concerning IQC,
- the use of IQC in practice.

To take part in IQC is free, but with commitment to the obligations of the PLM. IQC is illustrated with *figure 4*.

IQC: The financial aspects

The costs for a sloughterhouse to receive the IQC-certificate can be as high as DFL 40.000,-. Additional and permanent costs are the annual controls and some extra labour. There is no direct benefit, but an indirect preventive benefit can be gained by an improve-

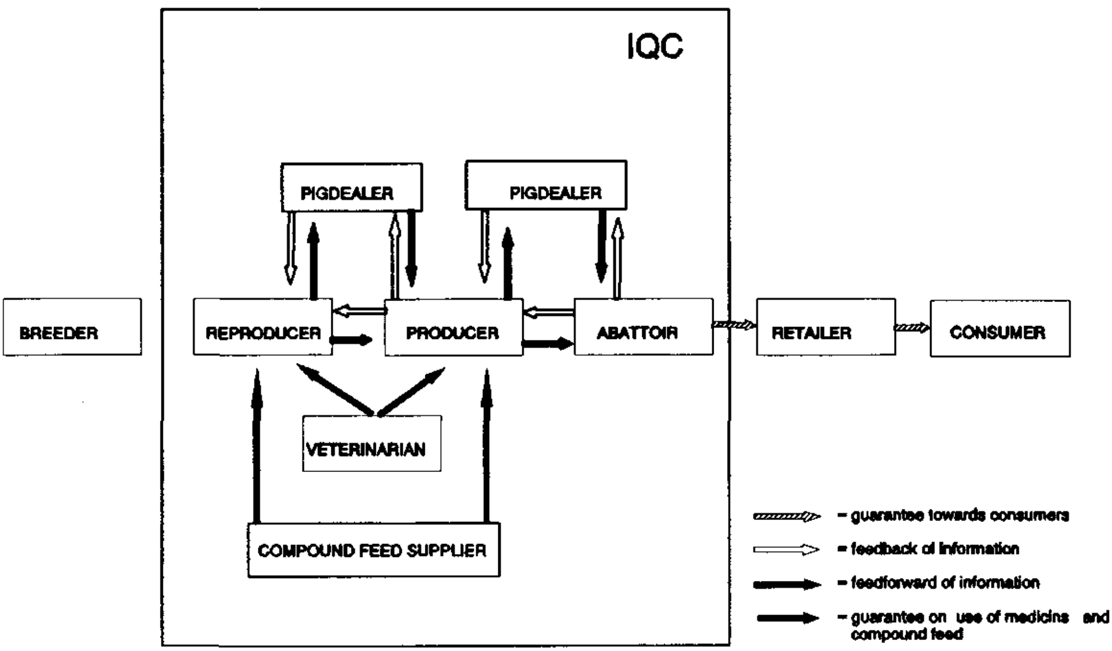


Figure 4. IQC in Dutch pork production

ment of management, less use of medicines and less slaughterlosses. A PLM experiment indicated that the Dutch meatchain could earn about 100 millions DFL by improving healthstatus. So far about 12.4% of all Dutch pigs come into IQC. Pigfarmers are stimulated to take part in IQC and can receive a bonus of DFL 3,- per pig and DFL 1,- per piglet. On the other hand slaughterhouses are confronted with retailers demanding for IQC-meatproducts. Due to oversupply retailers are not very willing to pay extra. Another problem is the fact that IQC-pork can only be sold partly as a IQC-pig to the fresh-meat segment. Other segments so far do not recognise the presumed extra value of IQC-meat.

Other quality-assurance systems
According to some meat processors IQC is not enough. They developed special quality programmes based on IQC. These programmes are not only focusing on processes but also on the product. Special demands are requested for food composition, housing, breed and slaughter classifications in order to produce a special kind of meat. This meat is sold under special brandnames like farmers-best, top, etc..

Nowadays special attention is paid to ISO-9000 standards. Many organizations consider ISO-certification as an assurance of the relation between supplier and customer, but also as a competitive advantage. ISO-certification has become for many businesses an objective on itself. Besides this ISO is an organization approach rather then a chain approach.

Discussion

A managementmodel has been introduced and used to describe quality management in the porkmeat chain. Next this model will be used to analyze quality management in this chain. As already said the effectiveness of an organization or chain is conceived as the interrelation between environment, policy and management. Analyzing the Dutch porkmeat environment the conclusion can be drawn that to much emphasis is put on bulk production against low costs and little addition of value. This concept worked for many years but due to the mentioned developments it is obvious that a new market concept is necessary.

The PLM concept of IQC is still a policy of the traditional production-model, although it contributes to the idea of 'quality' thinking. It mainly focuses on the production processes to ensure safety and origin. This is just a small part of the total product quality itself. So called programme meat suits better with the concept of product quality. Analyzing the environment further the policy should be at least one which is taking into account the production structure of the Dutch porkmeat-chain: less addition of value, increasing costs and a poor image. The production-model has to be translated into a market-model. The policy should enclose ideas and concepts which meet the environment. This policy has to be translated into product and processing specifications. Next the organization or chain should be adjusted to meet the product and processing specifications. This is also the essence of our model. To put it in another way: emphasis has to be put on 'what' instead of 'how' to produce.

According to our managementmodel IQC is pointing at C-level decisions and is merely going beyond A and B level decisions. From the existing chain procedures and responsibilities have been introduced to assure safety and origin of porkmeat. The exchange of information between actors is crucial in this assurance system. Besides the same counts for the implementation of ISO-standards, especially when ISO has become an objective on itself. The possibility exists to create a bureaucratic system which does not take into account the effects on the organization. One should first analyze the product and its processes in order to determine necessary changes, then adapt and/or provide with production resources to meet the new situation and finally assurances should be implemented (is equal to C-level decision-problems).

An example. To meet the demands and developments of the market it might be necessary to refine the product. Nowadays much emphasis is put on sustainable production, environmental and animal welfare issues. This might affect the complete chain. The meat processor might have to increase his number of manufacturing processes and products (diversification), the pigproducer might have to change his housing system, the pigreproducer might have to change his breed and housing system, the animal-foodstuff supplier might have to produce special animal foodstuffs, etc. Next the critical points in this chain have to be determined, then an assurance system can be developed meeting these critical points. This should also be the base of certification. Only then certification makes sense. This also counts for brandmeat. It has only a chance if it represents what it pretends to be. This can only be achieved by a market approach, because quality is: 'meeting the expectations of the consumer' and is propagated by the organization or chain.

This example includes an enlargement of the chain. All actors within the chain have to communicate and do depend on each other. Contrary to nowadays situation retailers have to be involved more. To communicate and explicate their demands. Especially in an oversupplied market retailers do possess a powerful position. In this situation it is questionable if pigfarmers should receive a bonus by taking part of IQC. One could argue that prices should be cut down if they can not meet the market-demands.

Theoretically it seems quite obvious what should happen, but practically there are many barriers. One of the main problems are individual interests. What might be optimal for the chain might be not optimal for an individual. Another problem by introducing chain production is the question of the division of costs and benefits. Also can existing structures impede new ideas and concepts, because parties fear the lost of gained positions. To get over these kind of barriers might be the hardest task after all.

The main challenges the Dutch porkmeat chain is facing next decade, are:

1. the restructuring of the chain into a market-orientated chain where quality and sustainable production are key words,
2. the development of a production chain focusing on profit maximization, by means of maximization of value and minimization of costs.

In general three strategies are possible, 1) to be marketleader, 2) to be costleader and 3) to be niche-marketeer. The second strategy seems to be the most reasonable one, because:

- The first strategy demands a high marketshare, which is not the case at this moment. The marketshare of Dutch pork within the EC is approximately 12%. To increse marketshare (international) mergers, take-overs, etc. are necessary, which is capital demanding. Capital which is not available.
- The third strategy is focusing on special segments. It is not realistic to start to the assumption that the total production of Dutch pork can be disposed at this kind of mar-

For example pigmeat industry leaders in Denmark pointed to quality considerations as a growing part of the reason for their share of the UK market. Also the fact that controlling pigmeat quality not only ensures that products meet defined and constant standards but also provides an effective way of meeting consumer demand and obtaining a price premium for doing so successfully, has been recognised. In an effort to achieve this position the Irish Meat Board have devised a Pigmeat Quality Assurance scheme.

Therefore since the function of markets cannot be assessed validly without taking account of quality it is necessary to know what product attributes consumers regard as desirable, and how they relate them to the complete product seems basic to successful marketing. This paper attempts to examine some of these issues in relation to the pigmeat market.

Defining Quality in general terms

In the vernacular quality often seems to express general approval (Holbrook and Corfman 1985). It appears that in everyday marketing language 'quality' or 'high in quality' means 'good'. However these promotional uses convey approval in an extremely imprecise way. Definitions of quality in general, and more precisely meat quality vary widely so a framework for analysing quality will be briefly discussed.

One dimension of quality is whether it is *implicit* or *explicit*. A further dimension is whether quality is characterised as *mechanistic* (viewing quality as an objective aspect of a thing or an event) or *humanistic* which sees quality as a subjective response of people to objects and therefore a highly relativistic phenomenon that differs between judges.

Using the above dimensions one can make four categories of definitions but most marketers advocate a definition of quality assessment which typically regards quality as a *subjective response* to variously explicitly recognised properties of an object (Holbrook and Corfman 1985). Conversely production led or engineering based definitions tend to approach quality from a mechanistic viewpoint, and look mainly at implicit (tangible) attributes of a product.

Some definitions of quality

Examples of definitions used by marketers include, 'the relation between the real and desired properties of a product, or as a measure of satisfaction to the customer', (Lavenka 1989) 'Consumers judgments about a products overall excellence and superiority', and Van Schothorst (1989) argues 'quality means that the customer gets what the customer wants'.

Researchers suggest that the focus be set on the consumers subjective judgement of an attribute (Callingham 1988) since unbiased objective quality does not exist at all (Maynes 1976). Lavenka (1989) points out that it appears objective measures are restricted to intrinsic palpable attributes. But Honikel (1989) suggests that subjective preference of attributes cannot be the basis of scientific discussion.

It seems that because it is subjective and personal 'product quality is at a higher level of abstraction than the composite of specific attributes' (Zeithaml 1988).

Prost (1986) mentions that 'the importance of particular quality traits as seen by individual consumers and also their ability to perceive them, result in highly differentiated and even quite different ideas about quality itself'. Juran (1962) found as many as 13 definitions, depending on the point of view of the person evaluating quality. Hence it was necessary for the ISO (International Standards Organization) and the EOQC (European Organization for Quality Control) to agree on a precise definition of quality from a technical viewpoint as 'A composite of characteristics, which affect the ability of foods to satisfy certain requirements and determine fitness for consumption'.

Williams (1985) points out that 'A producer should know his potential customers likes and dislikes and attitudes to his products, and understand various economic and social factors that may influence purchase'. And 'It is desirable that such information is expressed not in vague terms, as is often the case, but **where possible** is related to the chemical or physical properties of the food in a way that the food technologist can understand. It is only by doing this that he can build quality into his product and give it the same weight as he does the availability of raw material, processing capability and energy requirements at present'. However Williams (1985) goes on to admit 'overall acceptability (by the consumer) results from an integration of many factors, some of which like sensory properties, are primarily intrinsic to the food, whereas others depend on the needs or attitudes of the customers[1].

Folkers (1985) argues that to establish the potential effect of information one must ensure that information refers to the quality indicators that consumers find relevant, although it may be argued Folkers would have been more precise if he had said 'a segment of consumers' instead of merely 'consumers'.

Meat Quality

Consumer perceptions of quality are therefore all important but one must consider that there are many aspects involved in the quality of pigmeat. These aspects are summarized under the headings, Animal Quality, Carcase Quality, Hygienic Quality, Utilization Quality, and Meat Quality in *Figure 1*.

Figure 2 outlines the make-up of pigmeat quality according to Ingr (1989). A number of quality features go to make up a single quality characteristic. The features comprising the characteristic 'sensory properties' are also illustrated in *Figure 2*. Ten quality characteristics then go to make up overall quality.

These 'quality characteristics' in pigmeat quality include, morphological structure, chemical composition, physical properties, biochemical condition, and microbiological contamination as fundamental properties. They also embrace sensory properties, technological properties, hygienic condition, nutritional value and culinary properties as necessary properties to satisfy markets, inspectors etc. Different weights are given by different parties along the marketing chain to the quality characteristics in relation to their ideal overall quality. Therefore pigmeat quality is hard to define although the components involved are not.

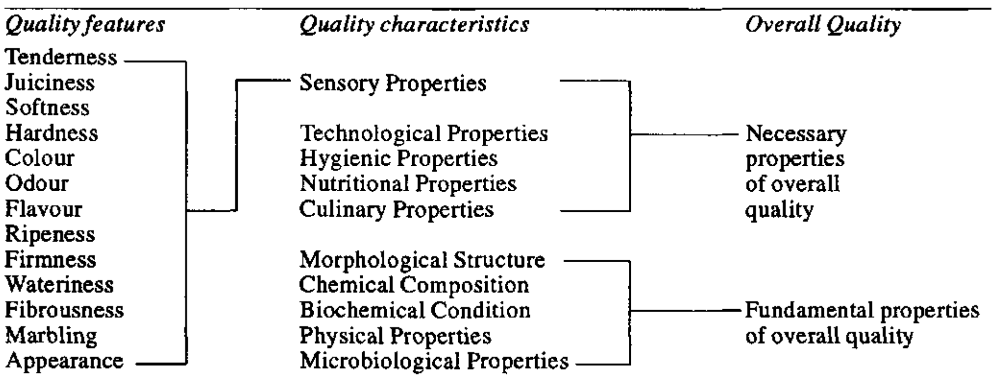
Some of the important quality considerations in the context of the pigmeat chain will be discussed in the following sections.

[1] From a later discussion we will find that definitions of meat quality must also include economic aspects and any other factors relating to health, nutritional, sensory, functional, and culinary properties, that players in the marketing chain for that product find important.

Quality Type:	Components:
Animal Quality:	Health, Genetic make-up, Stress susceptibility, Conformation, # Quality of life. ##
Carcase Quality:	Composition, Mass distribution, Geometry of carcase, # Yield of saleable meat. ###
Hygienic Aspects:	Safety aspects, Shelf-life, Residues, Pathogenic organisms and/or their toxins. ####
Utilization Quality:	Traits determining usefulness, Products ability to satisfy definite needs or wants. ####
Meat Quality:	Organoleptic (sensory), Technological (functional), Nutritional, # Hygienic aspects. #####

Sources # Soerensen et al (1989)
Barton-gade (1989)
Ingr (1989)
Prost (1986)
Honikel (1989)

Figure 1. Aspects of meat quality



Source: Ingr (1989)

Figure 2. Make-up of pigmeat quality

Quality in relation to the pigmeat marketing chain

Romans and Norton (1989) state that much of the research work done on the quality of pork was accomplished in the 70's but that in the late 80's the subject surfaced again. This study will attempt to complement work from both periods in so far as is possible.

Sebranek (1982), and Boccard (1986) state that everybody has his conception of quality, but the detailed description of this general concept, offers different aspects owing to the position or function of the speaker along the meat marketing chain.

Quality is seen differently by the consumer, the producer, the retailer and the food inspector, each concentrating on different aspects of the product (see Appendix 1).

At the **production** level of the pigmeat chain the quality traits of most concern would include live weights, dressing percentage, degree of muscling, absence of fat, general appearance (Sebranek 1982), and more recently parameters such as intramuscular fat level, stress susceptibility, animal welfare factors, and incidence of boar taint in whole male pigs.

The **processing** segment will generally concur with these but also add additional concerns such as muscle firmness, meat colour and yields or weights of cuts produced (Sebranek 1982).

The **retailer** further imposes requirements for leanness, appearance, storage stability, and drip losses in packages. Wood (1990) pointed out that retailers in the UK have recognized the demand for easy to prepare low fat cuts, and have increasingly purchased primal cuts, which are boneless, well trimmed and vac-packed to specification.

Consumers the final link in the chain conventionally evaluate pork quality in two separate instances, the first being selection from the retail display (Sebranek 1982). This is where extrinsic quality cues are important in that 'consumers first eat with their eyes'. The retail selection criteria involve colour, freshness, firmness, leanness, amount of bone, and amount of surface wateriness. Final satisfaction attributes at the consumption stage include such intrinsic attributes as tenderness, juiciness, flavour, ease of preparation and shrinkage.

However there is also an additional feature of quality at the consumer level ie. the perceived relationship to good health (Sebranek 1982).

Consumer preferences in relation to pork.

Preference and acceptability studies in the literature have indicated that consumers in the **United States and Canada**

- prefer pork with little or no fat (Davis et al 1978; Birmingham et al 1954; Gaarder and Kline 1956).
- are uncertain about quality when purchasing pork cuts and seek assurance of the government grade mark like they find in beef (Maybee 1955).
- indiscriminately select among pork cuts irrespective of size, quality or price (Gaarder et al 1960; Trotter and Engelman 1959).
- criticize some pork for unsatisfactory flavour, juiciness, and tenderness (Hendrix et al 1963).
- consider leanness and size of cut the most important factors when purchasing pork (Emerson et al 1963).

More recently Florkowski et al (1989) from a consumer study in Atlanta, US, revealed that consumers would increase purchases of pork if it were lean and would pay a premium price. The study predicted that the initial impact of a shift in preference towards pork would be an upward trend in price and eventually an increase in production and consumption. Romans and Norton (1989) concluded that leanness was the most important reason with US consumers for purchasing pork, with price of secondary concern, and colour mentioned but of lesser importance. Thus more recent US studies would suggest that leanness is the most important factor influencing consumer purchasing decisions.

It may be concluded that quality is looked on differently by the many players in the marketing chain. Ultimately consumers select pork on the basis of extrinsic cues, intrinsic cues, and its perceived relationship with good health also plays an important role. However views of different consumer samples tend to vary quite a bit depending on the country and the date at which the survey was carried out. Nonetheless although opinions differ, extrinsic cues such as colour, leanness, firmness, and amount of waste are obviously important. Intrinsic cues that were mentioned include flavour, juiciness, tenderness, aroma, and overall digestibility, of which, flavour tenderness and juiciness are most important. Safety, versatility and value for money are other perceived factors in the consumers decision making process.

Relating pigmeat quality from a technical point of view to how consumers perceive it
Hughes (1976) classifies meat quality into eating quality, wastefulness, problems serving cuts, hygienic quality, and nutritional quality (as shown in *Figure 3*). These are good consumer descriptives of the necessary quality characteristics depicted in Figure 2 above.

Moreover the consumer selection process closely resembles the quality control process for individual parameters of quality (*Figure 4*). Therefore if one determines the parameters of quality used in the consumer selection processes one can organise the quality control subsystems into an overall integrated quality control system (eg Appendix 1) finely tuned to the consumer needs.

But Ungern-Sternberg (1981) points out that consumers, 'instead of applying the real indicators of quality which matter to them, will, when purchasing a product, search for observable shopping criteria (indicators of quality) which they think are related to desirable aspects in the consumption experience'. These 'shopping criteria' may then be applied in the context of a model for consumer demand based on subjective characteristics

Meat Quality —
- Eating quality
- Wastefulness
- Problems serving cuts
- Hygienic quality
- Nutritional quality

Source: Hughes (1976)

Figure 3. Consumer classifications of pigmeat qualities

A Stages in the buying process (Kotler 1976).

Need arousal-> Information search-> Evaluation (behaviour)-> Purchase decision-> Post-purchase feelings (feedback)

Basic quality control flowchart (Steiner 1968).

Inputs-> Process[2] -> Comparison to desired -> Acceptance/Rejection decision -> Review Process (feedback).

Figure 4. Consumer selection process and quality control process

[2] The process must be defined by an interdisciplinary quality team. Quality characteristics to study must be selected and prioritized in order of their contribution to competitiveness or cost and the ability to measure a particular quality attribute must be assessed (O' Connor 1990).

such as was forwarded by Thompson and Mc Ewan (1985). This is referred to in Appendix 2. Whether these 'shopping criteria' are objective or subjective, they are subjectively evaluated by each individual consumer.

Jul (1985) notes that whether one is an agronomist or a food scientist, it is obvious that the final decision with regard to food quality, whether the scientists like it or not, will rest with the ultimate consumer. There is no way of getting away from having the final decision made by the consumer. That is not to suggest that objective or sensory tests are useless. What is important is that these are guide-posts, hopefully intelligently placed, but that they are not the final goal.

Prost (1986) describes three important types of criteria in assessing the necessary properties of meat, these being; sensory criteria such as colour, appearance, packaging, tenderness, juiciness, taste, odour, texture etc., easily perceptible by consumers in their judgments; nutritive criteria such as, content of essential nutrients, energy, dietary value, and digestibility making up the true nutritive value preferred by dietitians and consumers conscious of these properties; and technological criteria that characterise the distribution and functionalism of the food product ie. efficiency, durability, ease of storage and transport, dimensions, functionalism and attractiveness of the package.

Although many of the qualities mentioned are general to all meat it is essential to have an understanding of them, and how they relate to quality along the pigmeat marketing chain. In the first three headings in Figure 1 (Animal Quality, Carcass Quality and Hygienic Quality) quality can for the most part be determined objectively. However subjective methods of determining quality become more important for utilisation quality and meat quality.

If consumers are to be given priority in relation to the criteria important in the necessary properties of meat which were outlined by Prost (1986), then it is imperative that the *focus of quality control* is to *match* those *areas* that *consumers* are shown to lay *emphasis* on in market research studies.

The following section discusses consumer aspects of pigmeat quality in relation to the Irish market and considers areas in the pigmeat chain where these may be controlled to consumer specifications.

Application to the Irish market

Background

A potential customer takes an immense number of factors into account when deciding whether or not to buy pigmeat, but it is thought that eating satisfaction is a major consideration for the customer when deciding *how often* to buy pigmeat. There is evidence to suggest that shopping criteria and eating quality attributes may be related directly or even inversely to quality decisions taken at different stages in the marketing chain. For example much of the recent work in the UK has been on intrinsic factors, and tenderness and flavour are shown to be the most important factors to consumers. The reason for this work was that there was a fear in the trade and particularly among butchers that pigs that are too lean would have inferior eating qualities as much of the literature shows positive correlations between fat content of pork products and their eating qualities.

Work was also carried out in Ireland and due consideration was given to fat factors and intrinsic qualities. These are discussed in the context of this paper below.

Results, discussion and conclusion

The previously mentioned study consisted of a survey on consumers attitudes to pork, their actual purchase behaviour and a product test where selected respondents compared two pork products with different levels of marbling.

It was found that leanness was considered by far the most important quality factor for Irish consumers when purchasing pork (see *Figure 5*). This is consistent with the emphasis on leanness found in the literature (Birmingham et al 1954; Gaarder and Kline 1956; Davis et al 1978; Florkowski et al 1989; Romans and Norton 1989; and CBF 1990).

Leanness is a factor which can be controlled to meet consumer requirements. Advances in methods of *production* together with the low slaughter weight of the Irish pigs have reduced the fatness levels in pigs for slaughter. Similarly the *processor* can trim the pork products to the specifications of the retailer, and the *retailer* has a further opportunity to trim some fat before displaying the product. We can conclude from the marketing research that there is every justification of a payment system based on lean meat to Irish pig producers.

The question that the industry must address from integrated chain management point of view is what weight of pig gives lowest processing costs. If processing costs would be lower per unit of output when heavier pigs are slaughtered, and these generally have more fat which may be trimmed at a cost, would the chain as a whole be more efficient.

Findings also showed that consumers wanted pork chops that are well cut and prepared, and these factors can also be controlled to meet consumer requirements. But the features may be controlled at a number of stages of the pigmeat chain, the most obvious being the processing and retailing sectors. Other findings suggest poor presentational features such as fat splitting on pigmeat products from pigs too lean at slaughter.

Consumers indicated that although pork had a relatively good quality image compared with other meats, they thought it could still be improved (*Figure 6*). Most were of the view that pork chops were tender but considered them dry.

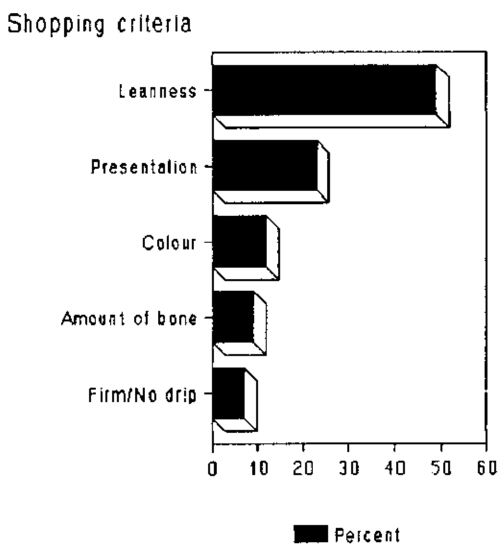


Figure 5. Influence of different factors when buying pork chops

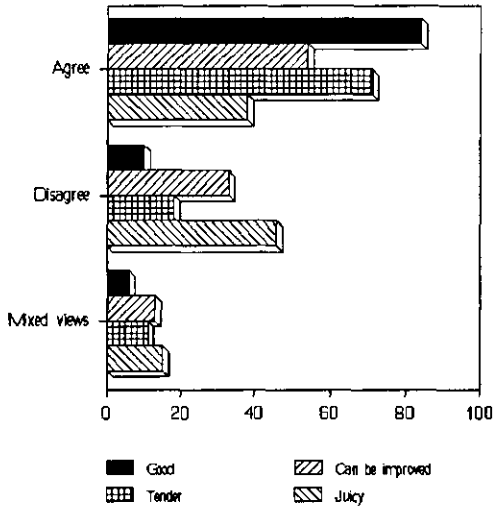


Figure 6. Attitudes of consumers to the quality of pork chops available

Those involved in the chain must evaluate their options on how to address the issue of juiciness and how important it is to consumers. It may be the case that consumers trade of eating quality attributes such as juiciness for the purpose of a leaner product for example. It must also be noted that juiciness may influenced by the cooking practices of consumers in which case promotional information at the point of purchase can be used to affect such cooking practices.

For eating quality (*Figure 7*), tenderness and flavour were identified as the most important attributes by consumers with juiciness being the third most important.

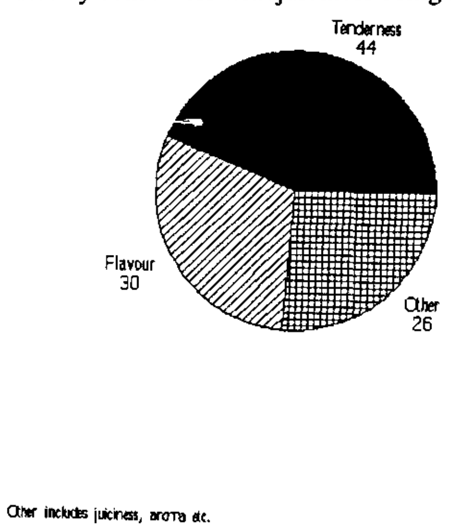


Figure 7. Attribute ranked most important in terms of eating quality

There is conflicting evidence in the literature as to whether fatness level or marbling will influence eating quality attributes such as tenderness and flavour. For example Danish work (Begerholm 1984) found definite positive relationships between marbling and these eating quality attributes while in the UK (Wood et al 1986) concluded that there was neither evidence to suggest that leanness lead to inferior eating quality or that marbling affected eating quality.

Consumers generally found marbling undesirable in pork chops and choose pork chops with least marbling (*Figure 8*).

Results from a product test (O'Mahony et al 1993) showed that differences in marbling (fat which cannot be removed by physical trimming) did not lead to differences in consumer perceptions of eating quality attributes. The results are shown in tables 1 and 2 below. Marbling is a quality feature that can be influenced at the production stage of the marketing chain.

Table 1. How the flavour(n=114) and tenderness (n=112) of the chops sampled were rated by consumers.

	Flavour Chop type		Tenderness Chop type	
Score for flavour\tenderness	Low	High	Low	High
			Percentages	
Very good	17	13	27	26
Good	24	22	20	25
Slightly good	25	21	23	19
Neither good nor poor	16	21	12	13
Slightly poor	9	13	12	10
Poor	6	4	5	7
Very Poor	3	5	2	1
Mean rank	35.5	33.8	36.4	34.5

NS for both flavour and tenderness.

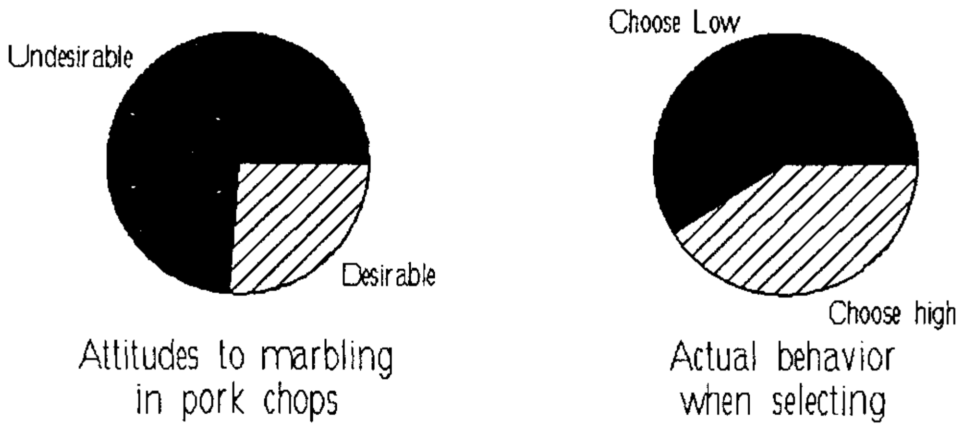


Figure 8. Comparison of attitudes to and behavior of consumers to marbling

Table 2. How the juiciness(n=113) and overall acceptability (n=118) of the chops sampled were rated by consumers.

Score for juiciness\overall	Juiciness Chop type Low	Juiciness Chop type High	Overall Chop type Low	Overall Chop type High
	Percentages			
Very	14	16	18	20
Good	18	12	31	23
Slightly good	24	25	23	18
Neither good nor poor	20	20	13	16
Slightly poor	16	12	11	13
Poor	5	9	3	7
Very Poor	3	5	2	4
Mean rank	34.0	36.7	32.2	39.0

NS for both juiciness and overall eating quality.

However this study concluded since no benefits would accrue to consumers if levels of marbling were increased to the upper limits available on the Irish market, no price premium could be exacted from consumers, therefore there is no justification for payment to producers on the basis of this attribute.

Factors such as leanness and intramuscular fat are examples of quality attribute that are measurable by consumers and other players in the pigmeat chain. And while marbling is technically believed to affect eating quality attributes (Smith and Carpenter 1976) Irish consumers do not detect these.

In this case marbling is a quality parameter that need not be built into the pigmeat chain in so far as it extends to the Irish market. Quality parameters such as leanness should be built into the chain in the most efficient way, at least cost to consumers and with the appropriate signals/incentives for their implementation. Pricing systems sensitive to consumer demand provide a communication link that ultimately determines the nature and consistency of the quality management regimes to be used at various stages of the pigmeat chain.

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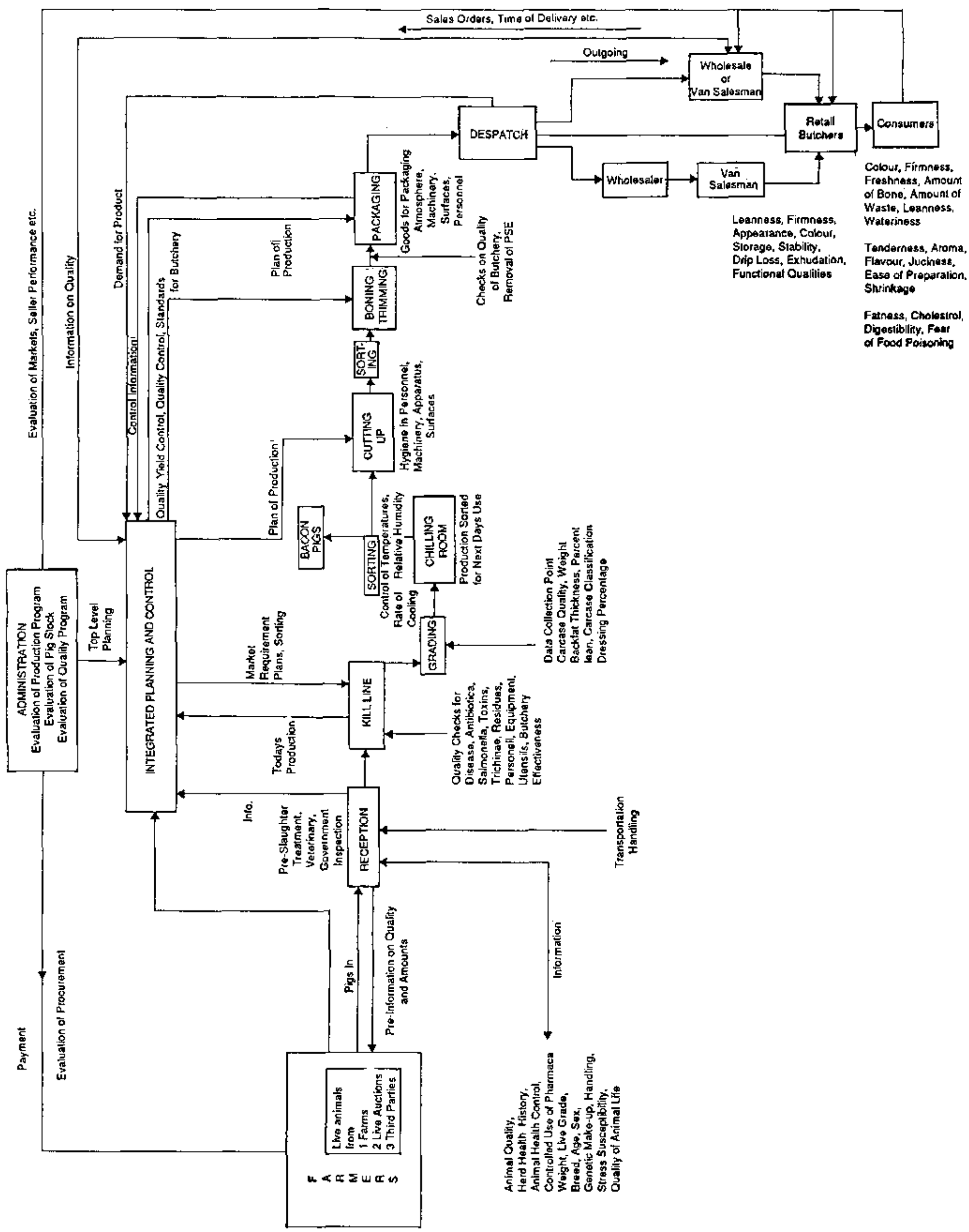
Appendix 1


Sales Orders, Time of Delivery etc.
Outgoing
Wholesale or Van Salesman
DESPATCH
Retail Butchers
Consumers
Wholesaler
Van Salesman
Colour, Firmness, Freshness, Amount of Bone, Amount of Waste, Leanness, Wateriness
Tenderness, Aroma, Flavour, Juciness, Ease of Preparation, Shrinkage
Fatness, Cholestrol, Digestibility, Fear of Food Poisoning
Leanness, Firmness, Appearance, Colour, Storage, Stability, Drip Loss, Exhudation, Functional Qualities
Evaluation of Markets, Seller Performance etc.
Information on Quality
Demand for Product
Control Information
Quality Yield Control, Quality Control, Standards for Butchery
PACKAGING
Goods for Packaging Atmosphere, Machinery, Surfaces, Personnel
Plan of Production
BONING TRIMMING
Checks on Quality of Butchery, Removal of PSE
SORT-ING
CUTTING UP
Hygiene in Personnel, Machinery, Apparatus, Surfaces
Plan of Production
BACON PIGS
SORTING
Control of Temperatures, Rate of Cooling, Relative Humidity
CHILLING ROOM
Production Sorted for Next Days Use
ADMINISTRATION
Evaluation of Production Program
Evaluation of Pig Stock
Evaluation of Quality Program
Top Level Planning
INTEGRATED PLANNING AND CONTROL
Market Requirement Plans, Sorting
GRADING
Data Collection Point
Carcase Quality, Weight
Backfat Thickness, Percent lean, Carcase Classification
Dressing Percentage
KILL LINE
Todays Production
Quality Checks for Disease, Antibiotics, Salmonella, Toxins, Trichinae, Residues, Personell, Equipment, Utensils, Butchery Effectiveness
Info.
Pre-Slaughter Treatment, Veterinary, Government Inspection
RECEPTION
Transportation Handling
Payment
Evaluation of Procurement
Pigs In
Pre-Information on Quality and Amounts
Information
F A R M E R S
Live animals from
1 Farms
2 Live Auctions
3 Third Parties
Animal Quality, Herd Health History, Animal Health Control, Controlled Use of Pharmaca
Weight, Live Grade, Breed, Age, Sex, Genetic Make-up, Handling, Stress Susceptibility, Quality of Animal Life

Appendix 2

Thompson and McEwan (1985) illustrate the following model to detail demand based factors that may influence an individual consumers subjective evaluation of a food/food situation.

1 Anticipated or actual appreciation of the sensory characteristics of the food and packaging.

2 Anticipated or actual appreciation of the food purchase or consumption situation.

3 Anticipation of the nutritional properties and health beliefs.

4 Anticipation of hygienic and toxicological status

5 Evaluation of the functionality of the food (anticipated or actual).

6 Evaluation of the cost of acquisition (monetary or actual).

7 Appeal of the presentation, either at the point of purchase or consumption.

8 Familiarity

9 Food/Product/Brand image

Source: Thompson and Mc Ewan (1985), in Predictive Modelling and Evaluation of Food Acceptability. University of Reading. U.K.

V. Movements in marketing

Chain marketing of agricultural products

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Introduction

In the classic textbook on marketing of agricultural products by Kohls and Uhl (1990, p. 5/6) food marketing is defined as: 'the performance of all business activities involved in the flow of food products and services from the point of initial agricultural production until they are in the hands of consumers.' Traditionally activities of different companies and institutions in the marketing channel are co-ordinated through market prices. At present in many channels, these activities have to be co-ordinated in a more precise way than the 'invisible hand' of market prices can bring about, e.g. contract farming is familiar in raising pigs and poultry, account management creates relationships, contracts between food industry and food retail chains are a co-ordination device in private label operations. Vertical integration is familiar to agricultural marketing and has often international dimensions, e.g. 'Multinational corporations are beginning to assemble cattle the way they assemble cars, bringing together inputs - seeds, grain, pharmaceuticals, cattle embryos, cattle, automated slaughtering processes, wholesale marketing, and retail distribution- from various countries into a single coordinated operation.' (Rifkin 1992, p. 148), or 'In the United States, Cargill, Continental, and Bunge have all moved aggressively into domestic grain 'refining' with their investments in flour-milling, soybean-crushing plants, and ultra-modern facilities for manufacturing feed ingredients or corn sweeteners.' (Morgan 1980, p. 305).

While a host of co-ordination mechanisms are applied in agricultural marketing channels, there is no theoretical framework on marketing co-ordination in agricultural marketing channels. In marketing and economic theory and in organization sociology, many concepts and theories on co-ordination of business activities in general and marketing activities in particular have been developed. Our paper intends to develop a theoretical framework for marketing co-ordination in agricultural marketing channels, making use of a number of concepts and theories on co-ordination as developed in other disciplines.

Our analysis of marketing co-ordination in agricultural marketing channels is focused on the concept 'chain marketing'. Chain marketing is defined as *a joint marketing operation by two or more successive companies in a marketing channel vis-à-vis a third party, the customer/ consumer.* We use the concept 'chain marketing' in analogy of the 'value chain' concept of Porter (1985). The agricultural marketing channel as a whole can be viewed as a value chain. With respect to chain marketing, a set of successive companies are working closely together to manage the flow of agricultural goods along the entire value-added chain, i.e. the agricultural marketing channel.

Our concept of chain marketing is also closely related to the well known concept of 'vertical marketing system' (Bucklin 1970; Stern and El-Ansary 1992). While the introduced concept of 'chain marketing' is concerned with the marketing process in the channel, the concept of 'vertical marketing system' refers to the marketing structure/phenomenon. Actually, in one of the first authoritative publications on that topic a 'vertical marketing system' is defined as '...the set of *forces, conditions, and institutions* (italics are ours) associated with the sequential passage of a product or a service through two or more markets.' (Bucklin 1970, p. 2).

Since chain marketing is concerned with vertical planning of marketing policies through the marketing channel, we first will pay attention to the concept of the marketing channel. In section 3, chain marketing is analyzed by discussing successively the objectives, the objects, the functions, the institutions and co-ordination mechanisms/relationships of a chain marketing operation. After having analyzed these structural elements of chain marketing, environmental developments, which may stimulate chain marketing in agriculture, will be discussed. Finally, some hypotheses about the development of chain marketing are proposed and related to the environmental developments.

Marketing channels

Often a sequence of companies from producer to final consumer perform marketing functions in order to fit market supply to the needs and wants of prospects. This sequence of companies is called the marketing channel. Marketing functions can be classified as exchange functions, physical functions and facilitating functions. While producers perform marketing functions in addition to the production function, other companies in the marketing channel (like wholesalers and retailers) have specialized on marketing functions only (in particular distribution functions). Although many companies in the marketing channel take title to the good, some other companies, like brokers or agents, facilitate exchange processes without taking title to the product. Other companies, like transport companies, perform facilitating marketing functions without taking part in marketing decision making at all. Typical of some agricultural marketing channels are specific market institutions, like auctions and futures markets, which enhance marketing efficiency and marketing effectiveness.

A marketing channel can be characterized by :

1. *The marketing functions being fulfilled*

   According to the Structure-Conduct-Performance paradigm, market structure in the various stages of the marketing channel has a strong impact on the fulfillment of marketing functions in the channel. In case of pure competition price formation, transport and storage are basic functions, while in imperfect markets many other functions like product differentiation, information/promotion and service are indispensable too. In the latter case, marketing strategies of channel participants determine the performance of marketing functions.

2. *The number of participating companies*
   The number of participating companies is related to the type of product, marketed through the channel. Convenience goods as described by Copeland (1923) and the so-called Red Goods, defined by high replacement rate, low gross margin, low adjustment, low time of consumption and low searching time (Aspinwall 1958), are more suited for indirect marketing channels than the opposite type of products. More service with the product, like in the case of specialty goods, complex goods and Yellow Goods as defined by Aspinwall (1958), and an acceptance of a longer delivery time (Bucklin 1965) by the client stimulate direct marketing channels. Also it is suggested that a need for more information with the product will enhance direct marketing channels. More information is probably correlated with product complexity, and product specialty.
   The number of successive companies in the marketing channel also depends on the market structure at the various stages of the channel. For instance, Alderson (1954) argued that a middleman will emerge between producers and consumers/customers, if it results into a smaller number of transactions.

3. *The relationships between companies*
   The relationship between successive companies in the channel is influenced by the market structure too. In case of a pure competition market, prices are an effective co-ordination mechanism. Commodity markets, like the wheat market, have much in common with that market structure. However, in the case of imperfect competition, additional co-ordination mechanisms should be used to lower transaction costs and/or to bring actual market propositions in line with marketing strategy.

4. *The downstream flow of goods, services, information, and property rights*
   The flows of goods, services, information, and property rights are the outcome of marketing decision making and of the fulfillment of marketing functions in the channel. Important is in this respect to what extent these flows are interrelated.
   Chain marketing, as defined in the introduction, is in principle concerned with planning and implementing joint marketing policies of successive companies in the marketing channel. It may differ on various aspects, like the number of successive companies involved in the chain marketing operation (at least two companies), the number of marketing functions included in the marketing operation, and the extent of horizontal integration going along with vertical co-ordination of marketing operations.

Basic dimensions of chain marketing of agricultural products

Introduction
Chain marketing has been practiced in agriculture during a long time already, but at present it has become more relevant for various reasons to be discussed in section four.In view of its increasing importance, there is a need for a systematic approach to this type of agricultural marketing. We will analyze chain marketing on the basis of its objective, object, marketing functions, institutions performing marketing functions, and co-ordination

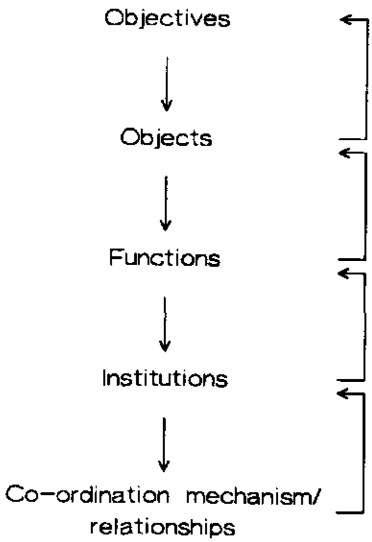

Figure 1. Structural elements of chain marketing

mechanisms/relationships (*see figure 1*). We suggest a hierarchy in these basic dimensions of a 'chain marketing' program.

The objective of chain marketing
Co-ordination of marketing in the channel is, generally speaking, concerned with the effectiveness, efficiency and/or equity of the marketing operation of the participating channel members. Ultimately, the objective of a chain marketing operation is a larger turnover/profit for the participating companies. It may be more specific, like a specific market share or a more positive product image. Finally, such partial objectives have to be instrumental to the general objective of turnover/profit.

The object of chain marketing
Marketing is concerned with exchange processes between organizations. Exchange processes in chain marketing are concerned with flows of products/services, information and property-rights through a marketing channel (Bucklin 1970; Mallen 1977). A money flow opposite to the flow of values allows for a smooth exchange process. The first distinction between different types of chain marketing is whether it is concerned only with a product/service flow, an information flow, a property flow, or with a combination of these flows.

It is hard to imagine that a chain marketing operation, i.e. a joint agricultural marketing operation of two or more successive companies in a marketing channel, is *only* related to a *flow of property rights*. Even marketing decision making by a food broker, who typically is taking no title to a good, is in the *strategic* sense related to a *product flow*. A flow of property rights in a chain marketing operation is by definition linked to a product flow.

From a marketing point of view, chain marketing focusing on *information flows only* has a limited scope. For instance, successive companies in the channel might together set up a marketing information system in order to improve marketing performance vis-à-vis a third party. Companies may link their marketing information systems to improve marketing decision in the channel at the operational level. In fact the development of EDI systems and the availability of scanning data increase opportunities in this respect.

The scope of chain marketing, related to the *product flow* in the channel, is ranging from a limited number of product benefits/attributes to the total product. In this respect a distinction should be made (Kotler 1991, p. 431) between: (i) the generic product or core benefit, comprising the basic, instrumental, benefits of the product, and (ii) the augmented product, comprising all additional product features like package, as well as expressive features. Co-ordination in chain marketing is more basic when chain marketing is concerned with instrumental product features than when it is focused on augmented product features, like package or expressive product values only. For instance, chain marketing focusing on health attributes of agricultural products requires the co-ordination of functions performed in various stages of the marketing channel, while size, form and package of the final product can be controlled by the last company in the channel supplying the final product to the retailer/consumer. Since 'Product augmentation leads the marketer to look at the buyer's total consumption system' (Kotler 1991, p. 430), a refined marketing program and consequently a refined system of co-ordination is needed in chain marketing.

Information and property flows are linked to the product flow. *Information flows* can be operational or strategic. The former type of information is often attached to the product flow. The importance of the latter type is related to power sharing by companies involved in chain marketing. In case of a channel leader, there is less reason for sharing strategic information between the participating companies, than in the case of equal partners. A channel leader has more opportunities to impose his strategy without communicating information about the pro's and con's of his strategy, than a company doing business with another company being equal in market power. A physical product flow in the marketing channel without any *property flow* puts the burden of risk on the owners of the product. It has consequences for profit distribution between companies participating in chain marketing, because the owners want to have compensation for their risks.

Marketing functions

Agricultural marketing is shifting to the *marketing management approach*, characterized by consumer orientation, co-ordinated planning and implementation of marketing instruments. Essential in this approach is the role of product policy and its impact on the programming of other marketing instruments, like promotion and price. From the marketing management point of view, chain marketing functions are basically performed to realize a specific marketing mix. Collection and dissemination of marketing information is important in this respect. It has already been pointed out that the intensity of chain marketing, and consequently of function performance, will differ depending on whether chain marketing is focusing on the generic product or on the augmented product.

Chain marketing, which does not include product policies, may be concerned with other marketing functions in different ways. *Exchange* functions - like price formation and selling - are included in chain marketing programs amongst others by producers and retailers in an agreement on minimum retail prices to prevent ruinous price competition, or by producers and traders, who have established selling organizations for specific markets. Chain marketing is focusing on *physical* functions - like transport and storage - amongst others in programs set up by producers and traders in order to provide smooth and efficient transport to specific markets, like distant export markets. Chain marketing is concerned with *facilitating* functions - like grading/sorting, market information and credit facilities - in the development of marketing information systems, which collect and disseminate market information, or in the establishment of grading systems and quality control systems to maintain and improve product quality through the channel.

Marketing institutions.
Traditionally agricultural marketing channels exist of the following institutions: supplier - farmer - wholesaler - processing industry - wholesaler - retailer. In addition there are a number of specific marketing institutions, like auctions, co-operatives, marketing boards and futures markets. Some institutional characteristics are relevant to chain marketing operations:

- The relative size of the successive institutions participating in chain marketing influences the channel leader structure in chain marketing operations (*see figure 2*). For instance, in purchasing raw agricultural material, a large food industry has more bargaining power vis-à-vis a small farmer than vis-à-vis a large wholesale cooperative.
- The degree of specialization by institutions of the marketing channel stimulates chain marketing operations. Specialization by farmers, processing industry, or wholesaler enlarges the interdependence between institutions in the marketing channel. Chain marketing is a way to adapt the activities of successive companies to the specified marketing outcome and to spread marketing risks over the companies of the marketing channel.
- In line with the former point, chain marketing will become more urgent when the number of successive companies in a market orientated marketing channel increases. Except for 'make or buy' decisions, chain marketing cannot exist when one company has integrated all successive companies involved in a chain marketing operation.

INSTITUTION B \ INSTITUTION A	Large	Small
Large	No Leader power sharing	One Leader B
Small	One Leader A	No Leader co-ordination institution

Figure 2. Channel leader structure in chain marketing operations

- Marketing institutions taking no title to the product in marketing operations, like auctions or food brokers, complicate co-ordination of decision making in chain marketing operations.

Co-ordination mechanisms and relationships.
Chain marketing of agricultural products is triggered by the limited capacity of market prices to adjust agricultural supply, in particular product quality, to the needs and opportunities of the market. According to the Transaction Costs Theory, transactions will be determined by transactions costs, which depend on the co-ordination mechanism used (price or other co-ordination mechanisms). Relevant factors in this respect are bounded rationality and opportunism of decision makers, and respectively asset specificity, uncertainty, and frequency of transactions (Williamson 1985; Williamson 1989). These factors seem to have relevance to chain marketing in agriculture too: agricultural and food marketing based on consumer orientation cannot be co-ordinated appropriately, or at a high cost only, by means of market prices only. Additional co-ordination mechanisms have to be applied.

Mintzberg's typology (Mintzberg 1989) of co-ordination mechanisms - 'Mutual adjustment, direct supervision, standardization of work processes, respectively standardization of outputs, of skills and/or of norms' - is also relevant to chain marketing in agriculture. *Mutual adjustment*, co-ordination by informal communication, is applied in chain marketing, when there is a large common interest and a very good understanding between successive companies in the marketing channel. The relationship between farmers and their co-operative is a case in point. This co-ordination mechanism lacks formal power to enforce specific behavior upon the parties involved. *Direct supervision* can be used by a channel leader or a co-ordinating authority in chain marketing in order to achieve the formulated marketing objectives. *Standardization of work processes*, respectively *standardization of outputs* of participating companies, are helpful to achieve a chain marketing outcome, like a specific product quality. Systems of certification and Integral Quality Control in fresh meat marketing operations are a case in point. *Standardization of skills and/or standardization of norms* do not seem effective co-ordinating mechanisms for agricultural chain marketing. They do not provide sufficient uniformity in marketing output, like uniformity of product attributes, when a large number of companies have to be co-ordinated.

Traditionally *vertical marketing systems* are classified in administered, contractual and corporate systems, which differ in the formal co-ordination of marketing operations, namely by deliberation/persuasion, by contract or by integration. All three procedures may occur in chain marketing operations. The procedure used depends in particular on the required precision in the co-ordination of marketing operations. For instance, a franchise operation requires a very precise co-ordination of operations which has to be secured by contractual relationships. Specific characteristics of a company may prevent the application of specific co-ordination mechanisms in chain marketing. For instance, some farmers' co-operatives do not allow the co-operative company to contract specific product supplies from members.

Also contributions from economic *agency theory* can contribute to our understanding of co-ordination in chain marketing like aspects of risk sharing and reward structure (Holmstrom and Tirole 1989).

Table 1 Summary of basic elements of chain marketing

Objectives	Turnover/profit
Object	Product (basic/augmented) Information Property-right
Functions	Functions to realize a specific marketing mix Exchange functions Physical functions Facilitating functions
Institutions	Relative size of successive institutions Degree of specialization Number of successive companies Taking title to the product?
Co-ordination mechanism/relationships	Transaction Cost Theory Mintzberg's typology of co-ordinated mechanisms Vertical Marketing Systems Agency Theory

The basic elements, discussed in this section, are summarized in table 1.

The impact of the environment of agricultural marketing channels on chain marketing

The environment of agricultural marketing channels
Environmental changes influence agricultural marketing processes. The emergence of chain marketing in the food marketing channel is a response to these changes in the environment. The marketing environment consists of the actors and forces that affect the ability to develop and maintain successful transactions and relationships with target customers (Kotler 1991, p. 129). The environment of a chain marketing program is a relative concept in so far it depends upon the number of successive companies in the channel which participate in a specific chain marketing program.

Four sectors can be distinguished in the environment of a chain marketing program (Achrol, Reve and Stern 1983, p. 58):

- The *input sector,* which consists of all direct and indirect suppliers to the chain marketing operators.
- The *output sector,* which consists of all direct and indirect customers of the chain marketing operators.
- The *competitive sector,* which consists of the actual and potential competitors of the chain marketing operators.
- The *regulatory sector,*which consists of regulatory groups, including governmental agencies, trade associations, interest organizations, and ad hoc groups.

Major changes in the environment of agricultural marketing channels relevant to chain marketing
Changes in the input sector. Technological progress has been important in the input sector. Output per farm has increased dramatically due to a continuous 'technical push', the development of new breeds, machinery and production methods. Machinery is substitut-

ing labour and the use of various inputs (e.g. chemicals, mixed feed, fertilizer) is intensified. Recently technological progress, relatively speaking, has become more focused on the improvement of product quality.

Technological progress and the development of new breeds and varieties have increased agricultural production potential. In this way they have created the threat of overproduction, but they offer also opportunities for developing markets for new products. Chain marketing can be useful to manage adequate marketing programs for that purpose.

Changes in the output sector. During the last decades, the demand for food products has changed dramatically. These changes run parallel to the need hierarchy by Maslow (1954), which suggests that needs will be satisfied in a hierarchical order starting with physiological needs and ending up with satisfying the needs for self actualization. In the affluent Western societies, food supply is abundant and consumers are in a position to satisfy high order needs, related to human interaction and self actualization. The rise of per capita disposable income creates a consumer having a substantial discretionary income and being able to choose from a great number of alternatives. Quality, variety, convenience, service, consciousness with respect to environment and animal welfare have become relevant choice criteria to consumers. This is all the more important since food demand, in terms of volume, is increasing slowly.

The other important development in food markets is the concentration in retailing. In various western countries, four or less retail chains command more than 50 % of the food retail market. These retail chains have their own marketing policies, require a high service, in particular logistical service, from suppliers and have a strong bargaining position vis-à-vis food suppliers. This bargaining position is strengthened yet by the development of international alliances of retail chains which centralize purchasing of various products. Clearly, these developments have a strong impact on agricultural and food marketing and for that reason on the need for chain marketing.

Changes in the competitive sector. Companies in agricultural and food marketing are confronted with an open EC market. The latest developments in CAP and in GATT negotiations, suggest that agriculture will have to live in a more competitive world with less price protection. Also internationalization of agribusiness will increase. The stagnating food demand is enforcing competition. Also product substitutes, like milk products on the basis of soybean and artificial sweeteners as a substitute for sugar, stimulate competition in Western food markets. These developments together stimulate concerted action of farmers and agribusiness to face competition. Chain marketing is an important issue in this respect.

Changes in the regulatory sector. The CAP is an important factor in the markets of various agricultural products. The reforms of the CAP have on the one hand freed markets from some price protection, but have on the other hand introduced additional regulatory measures, like milk quota and set aside programs. In addition to CAP regulations, agriculture and agribusiness are confronted with an increasing number of environmental regulations, which put preconditions to production and marketing of agricultural and food products. But on the other hand these regulations stimulate the development of new market segments, focusing on environmentally friendly products. In particular, the latter marketing propositions require a good co-ordination of production and marketing through the marketing channel of the respective products.

Implications for chain marketing of agricultural products

As a consequence of the changes in the environment mentioned above, agricultural marketing channels are offering their products in very competitive markets. The success of these channels will be determined by the competitive advantage over its rivals. In such a situation, a co-ordinated marketing operation is needed in order to gain competitive advantage. Therefore, chain marketing probably is becoming more relevant to the marketing of food and agricultural products. In order to derive more support for this thesis, we will develop a number of general hypotheses about agricultural chain marketing - partly based on elements of section three -, and use these hypotheses to evaluate the future of chain marketing.

H_1 *A market driven type of agriculture will be more inclined to chain marketing than a production driven type of agriculture.*

Market orientation of agriculture implies that the agricultural marketing mix, in particular the product benefits, fit to the needs and wants of the market. It requires a co-ordination of marketing functions, performed by companies in different stages of the marketing channel.

A production driven channel is trying to find the best outlet for a given production and as such does not start with specifying product attributes to the needs and wants of the market.

In fact, it has been argued in the foregoing part of this section that consumer demand is stagnating and that food consumers are becoming more quality-conscious and environmentally conscious. Also food retail chains have specific requirements with respect to product and service. These developments towards the need for market orientation in combination with H_1 suggest that chain marketing is becoming more relevant to agricultural marketing in Western countries.

H_2 *Chain marketing will become more important in agricultural marketing when marketing strategies of 'focus' and 'differentiation' become more important.*

When *focusing* on specific needs and *differentiation* vis-à-vis competitive supply are becoming more important in agricultural marketing, product characteristics, both of the core product and of the augmented product, will have to be better specified and standardized. It requires close co-ordination of marketing activities through the marketing channel.

In fact environmental changes, in particular with respect to consumer behavior and food retail policies, require strategic policies of focus and differentiation by agriculture and agribusiness. Amongst others this happens to be the case with fresh produce, fresh meat and dairy products. Combining these market developments with H_2 it seems probable that chain marketing will become of increasing importance in western agricultural marketing channels.

H_3 *Specialization by companies in the marketing channel advances chain marketing in order to fit the activities of successive companies to the specified marketing outcome (marketing mix) and in order to spread marketing risks over the companies of the marketing channel.*
When specialization is profitable both to lower costs and to improve product quality, co-ordination of marketing in the channel will be necessary to avoid the costs and risks which result from a lack of marketing co-ordination.

In fact, farmers have specialized to a large extent in western agriculture and have become more dependent on the market of a specific product. This may have made them more inclined to participate in chain marketing according to H_3. However food industries and food retail chains have diversified their product assortment and marketing operations. So not all companies in the marketing channel are stimulated to engage in a chain marketing operation because of the 'specialization' argument.

H_4 *Companies in the marketing channel are more inclined to chain marketing when marketing decisions of channel members are more interrelated*
When channel members themselves are able to correct weak features of their input from preceding companies, they might prefer to stay free and profit from opportunities in the market, e.g. the marketing channel of commodities, like wheat. However when input from preceding channel members should fit precisely, the reverse is true, e.g. brand operations for fresh meat or for fresh horticultural products.

Actual marketing policies of more added value and product differentiation in agricultural markets increase the interrelationship between activities and decisions by companies in different stages of the marketing channel.

H_5 *There is a 'Life Cycle' pattern in the co-ordination mechanisms of chain marketing. Coercive co-ordination mechanisms will gradually be substituted by non-coercive mechanisms.*
Gradually participants in chain marketing get used to standardize marketing and production operations in agreement with the co-ordinating specifications. Consequently, the need for co-ordination by strict procedures, like contracts and vertical integration, will gradually diminish.

At present, heterogeneity of products and marketing services seems so large yet in many sectors of agriculture, that weak co-ordination mechanisms are insufficient for a smooth and effective chain marketing operation. In some sectors, like egg production in the Netherlands, the latest stages of the life cycle in chain marketing may have arrived already.

H_6 *Concentration in food retailing and food processing diminishes the need for using contracts as a co-ordination procedure and favours co-ordination by adjustment in chain marketing.*
Large companies do business by joint planning and deliberation, which will lead to a well prepared action program. In view of the interest at stake, both parties will com-

ply to the joint action program (high asset specifity). As a result there is no strong need to secure business relationships by contracts or by integration.
In fact, it seems that the relationship between large food industries and large food retail companies is more often based on mutual trust than on formal contracts.

Final comments

In the foregoing sections, a theoretical framework for the analysis of marketing co-ordination in agricultural marketing channels has been developed. For that purpose the "chain marketing" concept has been introduced and elaborated. The developed theoretical framework allows for the classification and analysis of a great many different types of chain marketing. In addition, some hypotheses are proposed for a better understanding of chain marketing. The latter is warranted in view of the increasing importance of marketing problems and the need for market orientation in agriculture and agribusiness.

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Vendor loyalty as a strategy to purchase materials by farmers

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Introduction

Farmers are often viewed as starting point of the food marketing channel. However, more than 65% of the farm output is spent on buying inputs. Thus, purchasing is an important task for farmers and consequently also for the following companies in the food marketing channel. Furthermore, in some agri-chains like the pork chain in the Netherlands, the input side (producers of compound feed and breeding products) and output side (slaughteries) of the farm are becoming vertically integrated. In order to manage these chains, understanding of the buying and selling behavior of farmers is essential.

Often, farmers buy the same product successively from the same supplier, and they use the same vendor for different inputs. Farmers tend to exhibit this repeat buying behavior with respect to vendors for at least three reasons: (i) because of the scarce discretionary time which can be spent on purchasing, (ii) in order to utilize the contacts with their vendors as advice and expertise, and (iii) because of the comfort of not being forced to make a new choice (convenience). Farmers' high repeat buying behavior may lead to the seller's (erroneous) belief that it is indicative of customer satisfaction and commitment. However, this conclusion might be wrong, since other reasons than commitment, such as habit, a lack of decision making, a perceived absence of choice or a lack of time to evaluate other alternatives, might motivate repeat buying behavior. For this reason, it is essential to distinguish true from spurious vendor loyalty.

True vendor loyalty only exists when repeat buying behavior is accompanied by commitment to the vendor. Repeat buying behavior without commitment is characterized as *spurious vendor loyalty*. Thus, spurious vendor loyalty is repeat buying behavior which is not based on commitment. Although the resultant behavior appears to be the same regardless of the underlying cause, the distinction between true and spurious vendor loyalty is important from a marketing point of view. Farmer's reactions to marketing efforts of competing vendors differ depending on the factors underlying repeat buying behavior. More specifically, a truly loyal group of farmers is less likely to switch vendors as a result of competitive marketing efforts. On the other hand, farmers who merely exhibit repeat buying behavior without commitment would, over time, be more sensitive to competitive marketing activities. Due to their lack of commitment to a vendor, these farmers could well change vendors in response to very small differences in, for example, price (Jarvis and Wilcox 1977; Assael 1987; Wernerfeldt 1991).

This paper deals with the empirical results concerning the vendor loyalty of farmers with respect to buying materials. A number of hypotheses describing the relationships between the type of vendor loyalty and the product characteristics, the farm enterprise characteristics, the individual characteristics and other buying characteristics are proposed in section 2. In the third section, the data set, the measures, and the data analysis procedures are discussed. The results of the analyses, including a classification of farmers based on the two vendor loyalty dimensions and the test of the proposed hypotheses by means of a discriminant analysis, are discussed in section 4. Finally, the most important conclusions are reported in the last section.

Hypotheses

Since farmers' buying decisions are influenced by the characteristics of the buying task and the buyer (Kool 1994), the vendor loyalty of farmers may also be associated with these contextual factors. These relationships are useful to predict the type of vendor loyalty which will occur in a particular situation. Our attention is focused on the influence of the following variables on the vendor loyalty of farmers: (1) *product-related characteristics*, i.e. purchase complexity and product importance; (2) *farm enterprise characteristics*, i.e. farm size and participation of family members and employees in the farm enterprise; (3) *farmer characteristics*, i.e. quality-consciousness and age; (4) *other buying variables*, i.e. evaluation of alternative vendors and type of relationship with the vendor. The motivation for a certain type of vendor loyalty from the farmers' point of view serves as a guideline for the discussion of the hypotheses.

Time and/or energy costs

Spurious vendor loyalty is explained in the buying behavior literature by inertia (Jarvis and Wilcox 1977; Asseal 1987). Inertia means that a farmer is selecting the same vendor, because it is not worth the time and energy to search for another vendor. The farmer is not selecting the vendor out of strong preferences. In contrast, true vendor loyalty means that the current vendor is chosen after comparing other competing vendors and because of strong preferences. Favourable experiences with the vendor lead to commitment which strengthens the relationship and which can compensate for less positive points of the vendor. This reasoning leads to the following hypothesis:

H_{1a}: *True vendor loyalty is associated with more vendor evaluation than spurious vendor loyalty.*

The choice of a well known supplier is a valuable and efficient strategy for farmers in stead of searching additional information to reduce uncertainty in high-risk situations (Cardozo and Cagley 1971; Newall 1977; Puto et al. 1985). Farmers can spend only a very limited amount of time on buying decisions. Vendors are experts for certain inputs and farmers can use this expertise by means of loyal behavior. Purchase complexity and product importance determine the risk perception in a particular buying situation (Cunningham 1967; Newall 1977). Purchase complexity is the buying task uncertainty due to the perceived lack of information relevant to a buying situation (McQuiston 1989; Bunn 1993). Product importance is the perceived significance of the buying decision in terms of the size of the purchase and/or the potential impact of the purchase on the functioning of the farm (Möller and Laaksonen 1986; McQuiston 1989; Bunn 1993). Since high-risk situation leads to true vendor loyalty, the following hypotheses are proposed:

H_{1b}: *Purchase complexity is positively associated with true vendor loyalty.*

H_{1c}: *Product importance is positively associated with true vendor loyalty.*

Switching costs

Switching costs are the costs incurred in changing vendors. These costs are caused by specific investments which each party has made in a buyer-seller relationship. Switching costs may result from human as well as physical investments. An interactive relationship between the farmer and the vendor may range from a formal or business relationship to a close personal relationship (McCall 1970). A formal relationship can develop into a personal relationship, when both parties invest into the relationship by means of money and time. These investments are worthless outside the relationship (idiosyncratic) and serve to intensify and personalize the relationship, and to gain trust from the other party. Along with investment and trust, commitment is developed and links the parties together (Wilson and Mummalaneni 1986).

H_2: *A personal relationship between the farmer and his vendor is positively associated with true vendor loyalty and negatively associated with spurious vendor loyalty.*

Switching risks

Switching risk is the uncertainty that farmers face when they can not foresee the consequences of a vendor change. These risks refer to the *potential* costs incurred in changing vendors which the farmer can not totally assess in advance. The higher the perceived switching risks, the lower the chance of a vendor change. A shift to another vendor exposes a farmer to the risk that the new vendor does not meet his quality requirements. Since more quality-conscious farmers have higher quality requirements, these farmers perceive higher switching risks than farmers who are less quality conscious. Based on this reasoning, we propose the following hypothesis:

H_3: *The quality-consciousness of the farmer with respect to a particular product is positively associated with true vendor loyalty and negatively associated with spurious vendor loyalty.*

A summary of the hypothesized associations is presented in *table 1.*

Table 1 Summary of the hypothesized relationships

	Types of vendor loyalty	
	True vendor loyalty	Spurious vendor loyalty
Product-related characteristics		
purchase complexity (H_{1b})	+	
product importance (H_{1c})	+	
Individual characteristics		
quality-consciousness (H_3)	+	-
Buying variables		
evaluation alternative vendors (H_{1a})	+	-
type of relationship: personal (H_2)	+	-

Segmentation
Farm input market are frequently segmented by means of variables which are relatively easy to measure and available in agricultural statistics. These variables may refer to farm enterprise characteristics (e.g., size, sole proprietorship/partnership, participation of family members in the farm enterprise), farmer characteristics (e.g., age), and type of farm input supplier (cooperative versus private supplier). Because of their importance in segmenting the farm input market, it is interesting to evaluate their relationships with the various types of vendor loyalty.

Research methods

The sample
This study is part of a research project on the buying behavior of farmers. For this research project, 879 farmers were interviewed (personal interviews) in February/March 1990. The questionnaire consisted of three parts: a general part, a part about buying equipment or contracting a loan of more than Dfl. 50,000 and a part about buying materials. This study is focused on the results in relation to buying materials.

The sampled population consisted of four types of farmers: arable farmers, dairy farmers, pig farmers, and greenhouse market gardeners. In cooperation with the Ministry of Agriculture and Agricultural Economics Research Institute, a random sample was taken from a database consisting of all Dutch farmers. The original sample consisted of 2,241 farmers; 38% refused to participate, 19% did not belong to the target group, and 7% of the interviews on materials were incomplete or worthless. Finally, 36% of the 2,241 subjects were successfully interviewed on materials. No significant differences were found between the interviewed farmers and the defined population on farm size and age of the farmer. Table 2 presents an overview of the number of interviewed farmers selected by means of the types of farming and the different types of materials being the subjects of the questionnaire. For more details concerning the total data-set see Kool (1994).

In this study, the farmer was the key-informant. In case of partnerships, only one of the farmers was selected. Another research had shown high agreement between informants, if two informants per farm (i.e. the farmer and another informant) were interviewed independently (Kool 1990). Apparently, one informant per farm (i.e. the farmer) provides reliable and valid information about how inputs are bought on a farm. In this study, the

Table 2 An overview of the number of interviewed farmers for the types of farming and for the different types of materials.

	Type of farming				
Types of materials	Arable farming	Dairy farming	Pig farming	Greenhouse market gardening	Total
Compound feed		170	182		352
Fertilizer	83	147		71	301
Crop protection products	96		58		154
					807

interviewed farmer was always one of the most important decision makers or the only decision maker.

Measures

The contextual factors of farmers' buying behavior were measured in this study by both multi- and single-item measures. Multi-item measures were used only for the following constructs: type of relationship with the vendor, purchase complexity, and quality-consciousness. To judge the internal consistency and uni-dimensionality of the multi-item measures, Cronbach's was calculated and the measures were subjected to a principle component analysis (PCA). Nunnally (1978) suggested that in the early stages of research on hypothesized measures of a construct, reliabilities of .70 or higher suffice.

Vendor loyalty dimensions

As argued in section 1, a distinction should be made between true and spurious vendor loyalty. For this reason, two variables, i.e. *repeat buying behavior* and *commitment to a vendor*, are required to measure the vendor loyalty of farmers. These two vendor loyalty dimensions are operationalized in the empirical study as follows.

Repeat buying behaviour (RBB)

Repeat buying behaviour is operationalized as a combination of the number of years that an on-going relationship has lasted (*duration*) and the number of products that a particular dealer has delivered (*intensity*):

RBB = (NUMYEAR/5) * NUMPROD, where

NUMYEAR = duration of the relationships in years (minimum = 0, maximum = 35 for relationships of 35 years or longer);

NUMPROD = number of delivered products, four categories:

1 = the dealer had delivered only the product of the questionnaire;

2 = the dealer had delivered 1-2 other products;

3 = the dealer had delivered 3-4 other products;

4 = the dealer had delivered 5 or more other products.

Degree of commitment (COMMIT)

This variable is measured similarly to the 'dollar-metric' measure of brand loyalty, initially proposed by Pessemier (1959). Jacoby and Chestnut (1978) recommended the dollar-metric measure for operationalizing commitment, because of the high test-retest reliability (r = .82, Olson and Jacoby 1971) and because of identical results whether one estimates brand loyalty by either reducing or increasing the price of the target brand relative to alternatives (Jacoby and Kyner 1973).

This study questioned the respondent to indicate the switching price from the present dealer to an unknown dealer both offering the same products and conditions. An unknown dealer had been taken as a reference instead of the second best alternative, because an unknown supplier is an identical point of reference for every farmer.

Product-related characteristics

Purchase complexity (COMP)
Based on a review of the literature by Möller and Laaksonen (1986), purchase complexity was measured by a three-item measure consisting of: (1) necessity of gathering much information in order to make a buying decision, (2) number of new technical developments, and (3) the necessity of supplier support in order to use the product. The verification of the measure was based on 2,344 cases because every interviewed farmer had to rate at least three products.

Scale verification: Cronbach's = .69; PCA: one factor with eigenvalue higher than one explaining 61.4% of the variance.

Product importance (IMPOR)
Based on a review of the literature by Möller and Laaksonen (1986), three items were used to measure product importance: (1) small versus great part of the total costs (financial importance), (2) influence of price fluctuations on total revenues (financial importance), and (3) necessity of the input for the production (end-product importance). According to the verification of *COMP*, the verification of the measure was also based on 1,570 cases. The first two items are part of one construct (correlation coefficient .72), and the third item is part of a separate construct (correlation coefficients with item 1 and 2: .16 and .13 respectively). Thus, two aspects of perceived product importance of materials were measured: *IMPOR1* = financial importance (item 1 and 2), *IMPOR2* = end-product importance (item 3).

Farm enterprise characteristics

Size of the farm (SIZE)
An indication of the size of the farm was provided together with the address information. Based on the economic size expressed in NGE (Dutch Size Unit, a gross margin concept), the size of each selected farm was classified into one of the following categories: (1) 40-70 NGE, (2) 70-100 NGE, (3) 100 NGE.
Participation of family members in the farm enterprise:

#FARMER =	Number of farmers
#SPOUSE =	Number of wives working in the farm enterprise
#FAMMEM =	Number of other family members working in the farm enterprise
#EMP =	Number of employees working in the farm enterprise.

Farmer characteristics

Quality-consciousness of the farmer with respect to a particular product (QUALCON)
On the basis of a measure proposed by Steenkamp (1989), a four-item scale was used to assess the quality-consciousness of a farmer: (1) willingness to pay more for better quality, (2) intention to work only with high quality specimen, (3) the decisiveness of quality in buying decisions, (4) endeavour to purchase only the best quality. The measure was verified on the based of 1,686 cases because every interviewed farmer had to express his quality-consciousness with respect to equipment or financial loan and materials.

Scale verification: Cronbach's = .76; PCA: one factor with eigenvalue higher than one explaining 58.6% of the total variance.

Other buying variables

Evaluation of alternative vendors (EVALV)
Since farmers evaluate other vendors occasionally, for example once a year, this variable was measured by the frequency of evaluating alternative vendors.

Type of relationship with the vendor (RELVEN)
The existence of a personal relationship was measured by a five-item scale consisting of: (1) qualification of the relationship (reasonable versus very good), (2) the importance of the relationship, (3) the knowledge of the vendor about the specific farm situation as perceived by the farmer, (4) the attachment to the vendor, and (5) the confidence in the vendor. The verification of the measure was based on 1,662 cases because every interviewed farmer had to rate two suppliers.

Scale verification: Cronbach's = .71; PCA: one factor with eigenvalue higher than one explaining 46.2% of the variance.

Type of supplier (COOP)
Type of supplier is expressed in a dichotomous variable: (1) if the supplier is a farm purchasing cooperative and (0) in case of a private supplier.

Data analysis procedure

Classification of farmers on the basis of the vendor loyalty dimensions
In order to find homogeneous groups of farmers with different types of vendor loyalty, farmers had to be classified on the basis of the two vendor loyalty dimensions, i.e. repeat buying behavior and commitment. The two-stage clustering procedure of Punj and Steward (1983) was used. First, a *hierarchical method* (Ward's minimum variance method) was used in order to obtain a preliminary solution and to determine a candidate number of clusters. Second, an *iterative partitioning method* (K-means method) was used in order to refine the clusters.

The reliability of the cluster solution was demonstrated by a cross-validation procedure recommended by Punj and Steward (1983) and Aldenderfer and Blashfield (1984). The sample was divided randomly into two non-overlapping subsets and the two-stage clustering procedure was carried out separately on each subsample. After that, the cluster solutions of each subset were used to assign the cases of the other subset. Finally, for each subset, the degree of agreement between the solution of the subset itself and the assignment based on the solution of the other subset was determined. The coefficient of agreement, kappa (Cohen 1960), was used as an objective measure of stability. The external validity of the cluster solution was demonstrated by relating the clusters to variables other than those used to generate the solution.

Analysis of the associations between (observed) types of vendor loyalty and contextual variables. After the classification of farmers into groups with different types of vendor loyalty, differences on the contextual variables were analyzed. First, the mean differences were analyzed with univariate F-tests (ANOVA). After that, the variables with significant differences between groups of farmers with different types of vendor loyalty were subjected to a *multiple discriminant analysis* (MDA) with the clusters as the dependent subgroups and the other related variables as the predictor variables. The purpose of MDA in this study was to determine which of the contextual variables account most for the differences in the average score profiles of the three clusters.

Validation of the results of the MDA is very important issue, since the analysis may be capitalizing on relationships that exist as an artefact of the sample. For this reason, a 'jackknife approach' was applied in order to reduce bias in estimating the coefficients. This approach partitioned out the effect of a particular subset of the data on an estimate derived from the total sample. The steps involved in performing a jackknife procedure are as follows:

1. Using the full set of data, calculate the statistics of interest: y_{all}.
2. Divide the total sample in k sets of observations; in this study k=10.
3. Leave out each of the sets in turn and for each reduced new subsample calculate the statistics of interest: y_{-j} , j = 1 to k. These statistics are the result of leaving out the j^{th} subset.
4. Define pseudo-values y^*_j by the formula: $y^*_j = ky_{all} - (k - 1)y_{-j}$.
5. Calculate the mean and standard error of the k pseudo-values using the usual formulas.
6. Assuming the pseudo-values to be independent and t (or normally) distributed, then t-test (or z-test) can be performed on the jackknife estimates.

In order to get an indication of the classification errors, the objects of the hold-out set which were left out to calculate y_{-j}, were used to get classification results. This procedure was repeated k times and an estimate of misclassifications (or good classifications) could be obtained by calculating the mean percentage of misclassifications of the k hold-out subsets (Lachenbruch and Mickey 1968; Crask and Perreault 1977).

Results

Classification of farmers based on the vendor loyalty dimensions

The results of the classification of the interviewed farmers on the basis of the two dimensions of vendor loyalty, i.e. repeat buying behavior (*RBB*) and degree of commitment (*COMMIT*) are shown in table 3. This table presents the results of the cluster analysis of the two subsets and the results of the cross-validation procedure.

A three-cluster solution was chosen for each subset based on the Ward's minimum variance method. Stable cluster solutions were determined after 2-3 iterations using an iterative partitioning method (K-means). The cluster solutions of the two groups were compared with each other. The cluster solutions of both subset are almost identical, because 99% of the cases of both subsets were assigned to the same cluster based on the solution of the other subset. The coefficients are both statistically significant ($p < .001$). A discriminant analysis of the clusters by the cluster variables, i.e. *RBB* and *COMMIT*, gave a hit ratio (percentage correctly classified cases) of 98.6% and confirmed that the cluster membership was not spurious.

Table 3 Results of the cluster analysis of the two subsets

Subset 1 (n=402)	Subset 2 (n=403)
Number of clusters: Coefficient of the Ward's minimum variance method (first stage): 5 clusters 168.06 4 clusters 226.88 3 clusters 298.75 2 clusters 526.71 1 cluster 821.58 K-means (second stage): Three-cluster solution is stable.	*Number of clusters*: Coefficient of the Ward's minimum variance method (first stage): 5 clusters 166.89 4 clusters 204.37 3 clusters 289.38 2 clusters 481.77 1 cluster 786.06 K-means (second stage): Three-cluster solution is stable.
Cross-validation: Agreement between the replication of group 2 into group 1 and the cluster solution of group 1: assignment of 99% to the same cluster; kappa coefficient: $K = 0.99$ test statistic of the K coefficient: $Z = 24.86 \quad p < .001$	*Cross-validation*: Agreement between the replication of group 1 into group 2 and the cluster solution of group 2: assignment of 99% to the same cluster; kappa coefficient: $K = 0.99$ test statistic of the K coefficient: $Z = 26.46 \quad p < .001$

Cluster interpretation

To interpret the clusters, table 4 provides the means and the standard deviations of the cluster variables for the whole sample and the different clusters. The assumption is confirmed that farmers tend to exhibit repeat buying behavior. The average duration of the relationship with one vendor is 16 years and 74% of the interviewed farmers had bought at least one other product from the same vendor besides the product being the subject of the questionnaire.

Three distinct groups of farmers with different types of vendor loyalty were determined:

- Cluster 1:*Spurious vendor loyalty*

  The relationship of the farmers with their vendor has lasted on average about 11 years and 69% have bought at least one other product. Despite of the repeat buying behavior, their commitment to the vendor is low.

Table 4 Means (and standard deviations) for the different groups on the cluster variables

Cluster variables	Cluster 1 (n=394)	Cluster 2 (n=214)	Cluster 3 (n=197)	Total (n=805)
Repeat Buying Behavior (RBB,min.=0, max.=28)	4.59 (3.45)	4.96 (3.89)	18.12 (4.53)	8.00 (6.94)
Duration of the relationship (years)	11.17 (8.12)	13.21 (11.01)	28.86 (9.99)	16.04 (11.95)
Number of delivered products	2.17 (1.02)	1.96 (.99)	3.43 (.71)	2.42 (1.11)
Degree of commitment (min.=1, max.=41)	13.24 (6.58)	37.94 (4.68)	23.55 (10.34)	22.33 (12.60)

- Cluster 2: *True vendor loyalty*
  In a behavioral sense, these farmers are comparable to the farmers of group 1: the average duration of the relationship is about 13 years and 58% has bought at least one other product from the same vendor. However, their commitment to the vendor is very high.
- Cluster 3: *Behavioral vendor loyalty*
  The farmers of this cluster are, in a behavioral sense, extremely loyal to their vendor. The average duration of the relationship with the vendor is almost 29 years and 100% has bought at least one other product (56% five or more other products). These farmers are less committed than the farmers of cluster two, although this cluster is quite heterogeneous with respect to this aspect (relatively high standard deviation). The farmers of cluster three distinguish from the other clusters primarily on the basis of their very high repeat buying behavior, although some commitment always exists because of conditioning.

Description and analysis of farmers' vendor loyalty

Univariate F-tests (ANOVA)
First, the mean differences of the contextual variables with respect to the different clusters will be analyzed with univariate F-tests (ANOVA). Table 5 presents the means and the univariate F-tests on the buying variables for the whole sample and for the separate clusters.

Most of the univariate tests are statistically significant (p .05) with the exception of farm size (*SIZE*), quality-consciousness (*QUALCON*), and three variables related to the participation of family members in the farm enterprise (i.e. *#SPOUSE*, *#FAMMEM*, *#EMP*). Thus, hypothesis H_3 is not supported by these findings.

Table 5 Means and univariate (ANOVA) F-tests on the explanatory variables for the different clusters

	Clusters				
	Total (n=805)	Cluster 1 (n=394)	Cluster 2 (n=214)	Cluster 3 (n=197)	F-test (df: 2,802)
Product-related characteristics					
purchase complexity (*COMP*)	42.34	41.26	44.45	42.20	F= 3.53 **
product importance:					
financial (*IMPOR1*)	26.40	26.16	28.91	24.14	F= 9.30 **
end-product (*IMPOR2*)	16.50	16.79	16.82	15.59	F= 3.45 **
Farm enterprise characteristics					
farm size (*SIZE*)	1.73	1.76	1.67	1.72	F= 1.06
participation family members					
#FARMER	1.32	1.31	1.26	1.41	F= 4.24 **
#SPOUSE	.77	.76	.73	.83	F= 2.00
#FAMMEM	.34	.35	.26	.39	F= 2.24
#EMP	.35	.39	.31	.31	F= 1.48

		Clusters			
	Total (n=805)	Cluster 1 (n=394)	Cluster 2 (n=214)	Cluster 3 (n=197)	F-test (df: 2,802)
Individual characteristics					
quality-consciousn. (*QUALCON*)	15.09	15.01	15.17	15.14	F=.69
age (*AGE*)	42.77	41.56	42.36	45.62	F=10.34 **
Buying variables					
evaluation vendors (*EVALV*)	1.00	1.21	.86	.75	F=11.44 **
pers. relationship (*RELVEN*)	19.01	18.38	19.86	19.35	F=23.87 **
type of farm input supplier: cooperative (*COOP*)	.53	.45	.44	.77	F=32.98 **

** significant at $p < .05$
* significant at $p < .10$

The farmers in cluster 1 are young and have a relatively extended buying process and a less personal relationship with their vendor. Moreover, these farmers have bought products with low purchase complexity. The relatively extended buying process is opposite to the expectation in hypothesis H_{1a}. In agreement with buying equipment, farmers with repeat buying behavior and no commitment, i.e. spurious vendor loyalty, often compare their current vendor with alternatives.

The farmers in cluster 2 have a personal relationship with their vendor. They have purchased products which can be characterized as: high purchase complexity, high financial importance, and high end-product importance. Furthermore, these farmers are quite young and, contrary to the expectation in hypothesis H_{1a} but in agreement with the results for buying equipment, they do not evaluate other vendors frequently.

The farmers in cluster 3 also have a personal relationship with their supplier. They have purchased products which can be characterized as: low financial importance and low end-product importance. The farms in cluster three have the highest number of farmers per farm indicating a relative high number of partnerships. The farmers in cluster 3 are relatively old and most of them buy from farm purchasing cooperatives.

Multiple Discriminant Analysis

Multiple Discriminant Analysis (MDA) has been used for clarifying the overall relationships between the clusters and the significant variables (see table 5). The jackknife estimators of the MDA for the different clusters are presented in table 6.

The results in table 6 indicate that there are two significant discriminant functions (p .01). The mean hit ratio (percentage correctly classified cases) of the ten hold-out samples is *53%*. Based on the maximum change criterion (49%) and the proportional change criterion (37%), this finding of the MDA is acceptable (Hair et al. 1987). The nature of the differences among the various types of vendor loyalty is clarified by the evaluation of the discriminant function loadings (i.e., correlations between the predictor variables and the multivariate function) and the centroids (i.e., the mean score on each discriminant function for each cluster).

Table 6 The jackknife estimators of the Multiple Discriminant Analysis for the different clusters

	Discriminant functions	
	I	II
Canonical relationships		
(based on the total sample):		
Canonical correlation	.360	.269
Wilks' lambda	.808	1.927
Chi-square	166.45	58.63
Degrees of freedom	16	7
Probability	.000	.000
Discriminant loadings:		
type of farm input supplier: cooperative (*COOP*)	.751**	-.338
age (*AGE*)	.421**	-.039
evaluation vendors (*EVALV*)	-.399**	-.314**
number of farmers (*#FARMER*)	.234**	-.191
end-product importance (*IMPOR2*)	-.206*	.081
personal relationship with vendor (*RELVEN*)	.375	.867**
financial importance (*IMPOR1*)	-.198*	.466**
purchase complexity (*COMP*)	-.054	.329**
Standardized coefficients:		
type of farm input supplier: cooperative (*COOP*)	.763**	-.440
age (*AGE*)	.368**	-.113
evaluation vendors (*EVALV*)	-.205*	-.353**
number of farmers (*#FARMER*)	.256**	-.151
end-product importance (*IMPOR2*)	.202*	.066
personal relationship with vendor (*RELVEN*)	.339	.774**
financial importance (*IMPOR1*)	-.240**	.476**
purchase complexity (*COMP*)	.259**	-.025
Group (cluster) centroids:		
Cluster 1	-.290	-.193
Cluster 2	-.079	.468
Cluster 3	.647	-.109

** significant at $p < .05$ (two tailed), * significant at $p < .10$ (two-tailed)

The first discriminant function discriminates between cluster 3 and the clusters 1 and 2, i.e. between farmers with behavioral vendor loyalty (cluster 3), and farmers with spurious and true vendor loyalty (cluster 1 and 2 respectively). This discriminant function demonstrates that farmers who buy from farm purchasing cooperatives (*COOP*) are behaviorally vendor loyal. These farmers are relatively old (*AGE*) and they do not evaluate other vendors frequently (*EVALV*). It seems that these farmers have delegated their purchasing task to the cooperatives. In principle, they buy what their farm purchasing cooperative offers. Moreover, there are many partnerships in cluster three (*#FARMER*), because the number of farmers (and wives) can be more than one only if the farm has the legal structure of a partnership. In agreement with the findings regarding buying equipment, when a father-son partnership exists for the succession of the farm, the status quo of the business is apparently continued until the father withdraws in favour of his successor. After that, the successor possibly searches the market for new opportunities (see cluster 1).

The second discriminant function discriminates between cluster 2 and the clusters 1 and 3, i.e. between farmers with true vendor loyalty (cluster 2), and farmers with spurious and behavioral vendor loyalty (cluster 1 and 3 respectively). This discriminant function demonstrates that true vendor loyalty is strongly related to a personal relationship with the vendor. This finding confirms hypothesis H_2.

Furthermore, in agreement with hypothesis H_{1b} and H_{1c}, true vendor loyalty is positively related to financial importance (*IMPORI*) and purchase complexity (*COMP*). Apparently, farmers tend to buy from a well-known vendor in high-risk situations when they buy materials. Finally, contrary to hypothesis H_{1a} but in agreement with the findings of equipment, farmers with spurious vendor loyalty evaluate other vendors frequently (*EVALV*), while farmers with true vendor loyalty refrain from this. Apparently, the farmers of cluster one prefer to have the flexibility to change vendors if another vendor has a better offer. In fact, they are regularly looking for better opportunities. Farmers with spurious vendor loyalty regularly compare their current vendor with other vendors. These farmers behave differently as would be expected on the basis of the buying behavior literature. The motivation for their behavior is not inertia, but in contrast an active behavior towards the market. Consequently, in spite of the stable relationship, the current vendor continually competes with other vendors. The farmer with true vendor loyalty (cluster 2) obviously does not want to risk the good relationship with his vendor by evaluating other vendors, i.e. a cooperative purchasing strategy.

Major findings and conclusions

Repeat buying behavior

In general, farmers buy the same product successively from the same supplier, and they use the same vendor for different inputs (high repeat buying behavior). With respect to suppliers of materials, the average duration of the relationship with one vendor is 16 years and 74% of the interviewed farmers had bought at least one other product from the same vendor besides the product being the subject of the questionnaire. Although all farmers have high repurchase rates, there are very different types of vendor loyalty.

Types of vendor loyalty

Based on the two vendor loyalty dimensions, i.e. repeat buying behavior and degree of commitment, three types of vendor loyalty were observed regarding suppliers of both equipment and materials. One group of farmers is characterized as *spuriously vendor loyal*, because a commitment to the vendor was absent. Another group consisted of farmers with *true vendor loyalty*, because their commitment to the vendor was very high. Finally, the third group of farmers were extremely loyal in a behavioral sense and were therefore typified as *behaviorally vendor loyal*. The similarities between the classifications regarding vendors of equipment and materials were remarkable.

Analysis of farmers' vendor loyalty

The findings of the analysis of farmers' vendor loyalty are summarized in table 7. The major findings and conclusions are discussed per type of vendor loyalty.

Table 7 Summary of the findings

	Types of vendor loyality		
	True vendor loyalty	*Spurious vendor loyalty*	*Behavioral vendor loyalty*
Product-related characteristics			
purchase complexity	+	-	-
product importance:			
financial importance	+	n.s.	-
end-product importance	+	+	-
Farm enterprise characteristics			
farm size	n.s.	n.s.	n.s.
number of farmers/partnerships	n.s.	n.s.	+
Individual characteristics			
age	-	—	++
quality-consciousness	n.s.	n.s.	n.s.
Buying variables			
evaluation alternative vendors	-	+	—
personal relationship vendor	++	—	+
buying from cooperative	-	-	+

++ = strong positive influence, + = positive influence, n.s. = not significant, - = negative influence, — = strong negative influence

True vendor loyalty Switching costs are an important determinant of true vendor loyalty. if farmers have a personal relationship with the vendor, they are truly loyal towards their vendors. For this reason, deliberate relationship management is important regarding marketing of farm inputs. In addition, investing into a personal relationship with the farmer is a suitable strategy for a supplier of farm inputs to make the farmer less sensitive for competitors' marketing activities. Switching risk are not an important influence of the true vendor loyalty of farmers for buying materials. Finally, farmers with true vendor loyalty do not often evaluate alternative vendors.

Spurious vendor loyalty In contrast with the common view in the buying behavior literature, spurious vendor loyalty of farmers is not associated with a lack of information seeking and evaluation of other vendors. Farmers with repeat buying behavior and no commitment toward the vendor, i.e. spurious vendor loyalty, spend relatively much efforts in comparing their current vendor with other vendors. The motivation for their behavior is not inertia, but an active behavior towards the market. Farmers with spurious vendor loyalty do not want to commit themselves to one vendor and wanted to have the flexibility to change to another vendor. These farmers are relatively young and prefer to have the flexibility of searching the market for the best alternative.

Moreover, this study indicates that in case of father-son partnerships the current situation regarding the vendor is continued until the father withdraws in favour of his successor. After the withdrawal of the father, the successor possibly searches the market for new opportunities.

Behavioral vendor loyalty Farmers with behavioral vendor loyalty are relatively old and they put less efforts in buying inputs. Inertia characterizes the buying behavior of these farmers: the farmer routinely selects the same vendor without evaluating alternatives. An explanation for this behavior is that these farmers prefer the comfort of not being forced to make a new choice (convenience). Furthermore, farmers with behavioral vendor loyalty mainly buy their materials from farm purchasing cooperatives. It seems that these farmers have delegated their purchasing task to the cooperatives. In principle, they buy what their farm purchasing cooperative offers.

Some final remarks Although the choice of a well known supplier is described in the buying behavior literature as a valuable strategy to reduce uncertainty in high-risk situations, this strategy is hardly used by farmers. The purchase complexity and product importance hardly influence the vendor loyalty of farmers. Only the financial importance of a product and purchase complexity positively influenced true vendor loyalty. Finally, although theoretically commitment to one supplier is less risky for large farms than small farms, farm size does not influence farmers' vendor loyalty.

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Changing preferences on the market for fresh pork and effects on upstream industries

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The market for meat and meat products in the EC is increasingly dominated by firms that act on an international level. Cross border trade is increasing at a fast pace and leads to competition of meat suppliers on an EC wide level. Hence, the preferences of customers in the member countries are not solely relevant to domestic suppliers but to all larger meat suppliers in the EC. An excellent knowledge of customers wants and needs is important in the competition process because it will help to design and distribute a product according to those preferences. Early information about the emergence of changing preferences might give a firm a competitive edge towards ist competitors.

In order to better understand those preferences a survey was carried out among 26 major food chains and meat processors. The results presented are based on personal interviews and on a questionnaire that was mailed out in the second half of 1993. In a second step the implications will be discussed with a focus on the slaughtering industry and the possibilities to implement those changing preferences into the strategie of slaughtering firms.

The German Market for Pork

Germany is the largest market for pork in the EC. A population of 80 mio and a per capita consumption of 41 kg make it an attractive market for both domestic and international suppliers. For many years the import of live pigs, pork and processed meat products has been a major feature of the German market. This is becoming more and more important because the domestic production of slaughter pigs decreases permanently while imports take a larger share of the market. All stages of the production and marketing chain show a significant amount of international activity. Hence, the developments on the market for pork are not only of interest to domestic firms.

The Marketing Channels

On the German market, a coexistence of a traditionell and a modern channel can be observed (See Christodoulou, Burns, 1991). Butchers still have a large share on the market and their portion is comparably stable. However, butchers cut down on their vertical activity by giving up the purchase of live animals and slaughtering on their own premises or at municipal slaughterhouses. They expand horizontally by widening the range of products they are selling or by the opening of new outlets. They become more and more integrated in the modern channel.

The modern channel shows less vertical integration. Slaughtering, processing and the sale to the final consumer is separated. Individual firms at each stage of the production chain perform those activities. About 50% of all pork is processed into meat products and the processing industry is an important customer to domestic and foreign suppliers. In the last years they started to cut down on vertical activities and expand their product lines into ready to eat dishes. Supermarkets sell about 50% of all fresh pork to the final consumer and pork has been a major source of turnover for them. The interviews indicate that around 25% of their retail turnover is based on the sales of their meat department. Most of the chains place value on reasonable meat prices, because they observe that consumers show strong response to a change of those prices. The meat department is also used to create a particular store image. Both arguments indicate that supermarkets put a lot of emphasis on their meat department.

26 representatives of food chains and meat processors were asked to define their product needs for the years to come. They were asked to highlight major buying criteria that they apply to select among different suppliers of fresh pork. The results indicate some major trends that the interviewees expect to be important in the future.

Buying Behaviour of Food Chains and Meat Processors

In general, the interviewees were satisfied with the pork that is available on the market. They observe an improvement of meat quality during the last ten years. Supermarkets see that the final consumer is more demanding and is more concerned about meat quality but they also observe that the willingness of the consumer to pay a higher price is limited because it is difficult to signal a higher meat quality to the customer. This is not the same for all types of supermarkets. Some supermarkets put emphasize on lower meat prices to signal a discount image to the consumer. The price level of their meat department is strongly influenced by the price level of competing chains in the same area. Others observe that the consumer is willing to pay a higher price for meat because their meat department offers a good customer service and products with a good appearance. Meat processors indicate that so far the purchase of pork has not been a serious problem. The quality they need is available on the market.

For both groups the experience with a particular supplier is an important issue and suppliers have the ability to build up a reputation over time. Both groups indicate that there is limited time available for an extensive quality control at the time of delivery and the experience with a supplier over time helps to minimize the risk of a delivery that does not fulfill the requirements of the firm. Nevertheless, once the level of quality and the terms of delivery are defined, price is the major tool in the competition process among the suppliers.

Competition will be more complicated in the years to come. Most of the representatives interviewed indicate that more and more criteria will be included to select among different suppliers.

Changing Preferences

Product Attributes and Collaboration

Product Variation will be one of the most important criteria in the competition process. Processors and food chains expect that the product attributes will have a major impact on the future trade relationships with their suppliers. Both groups will focus on buying pork with overtime homogenous characteristics that fits their needs precisely. Variation in valuable product characteristics is costly. Supermarkets will focus on more homogenous pork because the consumer is only able to identify the quality of meat in their outlets when the product is homogenous over time. This is especially the case for those product attributes that can be identified visually (meat and fat colour, size of the cuts, fat cover etc.).

Meat processors are in a comparable situation. They focus on criteria that are important in the production of meat products (water retaining ability, fat quality, pH level) and where low variation of these product attributes will help to have better control over production process.

While currently the production process has to be adjusted to the minimum quality of the pork, the delivery of pork with permanent and homogenous product characteristics would help to lower the costs of meat processors.

In the last years meat processors and food chain focused more and more on meat suppliers that accomplish with the EC regulation concerning international trade to fulfill a minimum product *hygiene*. Due to changes in the legislation this will be mandatory for all meat suppliers in the next year. Other minimum standards that have been developed are not based or above legal requirements. These are dealing with the meat temperature at the time of delivery, hygiene in the slaughterhouses etc. The abolishment of border controls is not welcomed by all meat buyers. Some feel the need for more control to avoid any kind of negative publicity in the media.

The *delivery system* of their suppliers will be more important in the near future. Supermarkets assume that they will have fewer local meat suppliers to their outlets. Some will decrease their activity at own cutting plants and own meat distribution systems. Slaughtering firms with access to an excellent logistical system will have an advantage. The high price elasticity of demand for cuts on the consumer level and the increasing number of outlets of a food chain add to the necessity of having a supplier with an good distribution system that has the flexibility to deliver on a short term basis to a comparably large number of outlets. Meat processors focus on installing just in time delivery systems to cut down on storage costs. Again, a reliable and flexible supplier is needed to fulfill these needs.

The two points mention show that suppliers that have access to a sophisticated logistical system and are in a position to deliver pork with homogenous product attributes will have a competitive advantage. These two criteria do also indicate that the *volume* is becoming more and more important. Only suppliers that have access to a sufficient amount of pork will be able to fulfill this demand. The interviewees mention two other advantages associated with the collaboration with suppliers that have access to large volumes. It will help to lower administrative costs because it will reduce the number of trading partners and it will offer possibilities in the area of quality control.

Quality control is another major issue in the coordination process between food chains, the processing industry, and their pork suppliers. Discussions on product safety and the increasing efforts of firms to accomplish with the ISO 9000-9004 requirements indicate the importance. Quality control at the time of delivery is costly and due to the perishability of the product sometimes impossible. Most respondents see that quality control will shift more and more to the slaughtering industry or will at least be organized jointly between buyer and supplier.

The *price* will be as significant as it was in the past. Most food chains assume that low meat prices on the consumer level will prevail as a strategic tool of the competition among food chains. Especially the current economic situation will contribute to a situation where consumers have less money available and will look for possibilities to cut down their spendings. In addition, the consumer price for meat has been comparably stable throughout the last ten years and limits the ability of food chains to raise the consumer price. Meat processor will increasingly be involved in the production of food with a lower meat content like ready to eat dishes. Meat will be less important as an input for the production, but the requirement will be much more specific.

Both groups state that the room for a price increase is limited to circumstances where the supplier is able to lower costs of the food chain or the meat processor. This cost saving might be shared between suppliers and buyers.

Changing Preferences and the Price

Most interviewees explained that price and the product quality cannot be evaluated separately. Some product attributes are a minimum requirement to start business with a supplier. Some others will be appreciated if available but do not lead to a higher price for the supplier. In order to show the importance of the criteria mentioned the interviewees were asked to rank these criteria by the possibility to compensate them by price. A five indicates that even a favourable price cannot compensate for a lack of a product attribute. A two indicates that there is room for a compensation by lowering the price.

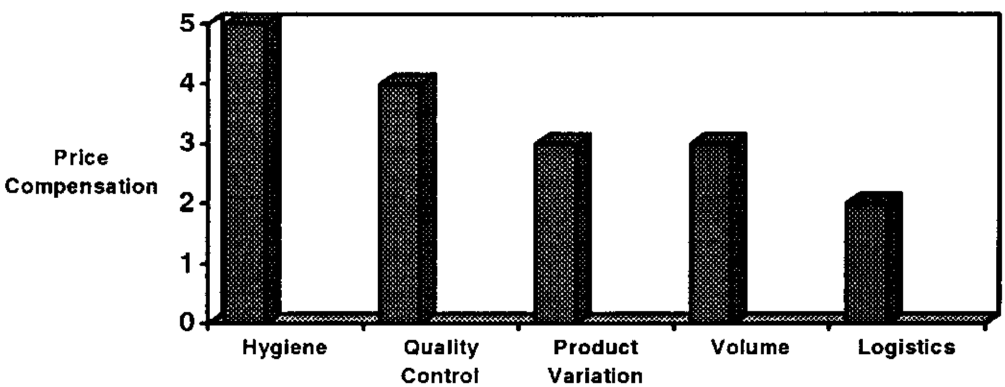

Figure 1. Price and other Buying Criteria

The graph shows that some of the buying criteria are a prerequisite for a trade relationships some others are not absolutely necessary. However they can be considered as a competitive advantage in the competition. Product hygiene and the quality control are very important and can hardly be compensated by a lower price in the near future. The procurement of the product, access to a sufficient amount of products with the required product attributes and the distribution network will become more important. However, those buying criteria are better to compensate by a lower price.

The graph should be seen as an example of how one buyer considers the relevance of major buying criteria. It should be kept in mind that the importance of those criteria is not the same for all buyers.

Without a discussion of the implication on the value chain, the buying criteria mentioned hint at the crucial position of the slaughtering firm in the value chain. The criteria mentioned are mainly under their control. However, implications for the slaughtering industry are not as straightforward as it seems to be at this point, because:

(a) the results presented here show the average trend. The interviews show that the representatives of the food chains and meat processors vary widely in their statements concerning future business relationships with their suppliers.

(b) the focus here is primarily on the customer. An adjustment of a firms strategy has to consider the reaction of competitors. A balanced consideration of customer-focus and competitor centered perspectives is necessary to develop implications for a strategy (Day, Wensley, 1988:17).

The survey indicates that the market for pork will be much more precise in the product attributes they require. Suppliers of pork to these customers will have to find a way to integrate this into their production system to fulfill those needs. Any supplier of fresh pork will face the decision of serving a particular market and focus on particular customers and/or being a supplier to a more anonymous market where the price of the product is much more important. A comparison of costs and benefits will lead to a decision whether there is an incentive to serve particular customer needs.

Implications for the Slaughtering Industry

As an example, the importance of some product attributes for particular customers will be used to identify the potential benefits of a closer collaboration between a slaughtering firm and ist customers. In order to identify the major issues of the decision process three simplified cases will be presented to discuss some of the implications.

Changing Preferences and Sorting Strategies

Let us assume that a slaughtering firm has access to a market for live hogs (Q) with a given distribution of quality ((Qh + Ql)Q = Q) for one product attribute and given slaughtering costs C(Q). The firm sells the pork that is produced on the commodity market and receives the price Pm. The market is defined by minimum standards. However product characteristics vary because the level is not defined in absolute terms and heterogenous lots are sold on the market.

A firm might have the option to supply fresh pork to a market segment with particular product requirements where the buyer of the pork is willing to pay a higher price Ph if it is delivered in homogenous lots. Serving this market segment will cause additional costs of selection Cs(Q) in the slaughtering firm because it has to identify the pork with the required product characteristics (Qh).The remaining pork (Q -Qh = Ql) can only be sold to a lower price Pl.

Assuming all other costs being equal the decision whether to sort or not no sort will be determined by the profit the firm will achieve under both options. The two options are:

Option 1: not sorting: $\pi ns = Q\,Pm - C\,(Q)$ (1)

Option 2: sorting: $\pi s = (QlPl + QhPh)Q - C(Q) - Cs(Q)$ (2)

where:

$Ph>Pm>Pl$

$Q = (Qh + Ql)\,Q$

By substracting those two equations it will be clear what the determinants are for choosing one or the other option.

$\pi s - \pi ns = QhQ\,(Ph - Pl) - Cs(Q) - Q\,(Pm - Pl)$ (3)

The firm will have an incentive to sort the:

- higher the difference betweenn Ph and Pl
- the lower the selection costs
- the smaller the difference between Pm and Pl

The equations show that selection costs and the price differentials are important variables in the decision process of a firm to choose one option (See Roseman, Wilson, 1991). The product attributes used to select has a major impact on those variables. While some are easy to identify either by the firm or its customers others require complicated devices or intensive personel training to separate the product required. In addition, not all customers place value on the same attributes, because they use the product for different purposes.

Product Attributes Food product quality can be defined as a set of product attributes that distinguish individual units of production and that have significance in determining the degree of acceptability to the consumer. (Starbird, 1991: 464). If a firm starts to sort it will try to identify products with those attributes that are relevant to the buyer. Based on these definitions, product quality cannot be defined in absolute terms. Buyers place different values on particular attributes and hence, what is considered as product of higher or lower quality will differ. It is therefore important to identify those product attributes that have major impact issues concerning product attributes, three cases will be used.

Case 1

Let us consider that a customer is willing to pay a higher price Ph if the firm supplies products with a particular product attribute. The product attribute is valuable to all customers and can easily be identified. If a firm starts to sort it will be able to receive the price Ph for a share of its production. The remaining share of output has to be sold at a price Pl, because other customers recognize that the rest of the output is of lower quality.

Case 2
In a second case let us assume that the product characteristic that is used to sort into Ql and Qh is valuable only to one customer, while other customers are, eventhough they realize the difference, are indifferent.

This will have an impact on the price differentials between the prices on the market, because the price discount for Ql will be very small or not even existing, so that the difference between Pm and Pl is small or equal to zero. The equation shows that this will increase the incentive to chose option 2 and start to sort according to the needs of a customer.

Case 3
Some product characteristics cannot or only very costly be identified by the customer on the market. If a firm will sort according to one of those product characteristics the customer buying Qh will pay the price Ph. However, Ql, the pork that does not have the relevant product characteristics will bei sold to other customers, which are not able to identify this product attribute. The firm is able to sell Ql on the commodity market with the price Pm so that the price difference between Pm and Pl is small or equal ot zero. Again, there is a strong incentive for a firm to sort.

The three cases show that the type of product attribute that is applied to distinguish Ql from Qh is an important issue. The latter two cases seem to be more beneficial to a firm than the first case because the discount that is payed for Ql is comparably low or does not exist at all. Case three represents a problem of information assymetrie. While the firm has the information on product characteristics, the buyer has only the minimum market standards that defines the product attributes on the commodity market. The buyer does not realize that the products delivered by sorting firms to the commodity market have on average a lower quality. This example shows that there is the potential for a lemons problem on the market (See Akerloff, 1970). The products on this market are heterogenous and are defined by an average quality. The potential exists that under these circumstances the sales of Ql on the commodity market with the price Pm will increase and the average quality on this market deteriorates.

The Selection Costs There might be different mechanism available to sort in a slaughtering firm that will differ according to product characteristic, the volume per unit and the reliability of the mechnism. All three have to be considered in the process of implementing the appropriate technology. The product attributes that are relevant cannot always be quantified. Some can be measured easily like weight, lean meat percentage, others require complicated and expensive devices, while others cannot be measured and require well trained personel that will do the sorting. The example shows a potential for large differences in sorting costs. Volume is also crucial to the decision of the appropriate mechanism the amount needed to serve a customer is marginal. The reliability of the sorting mechanism is important. One sorting mechanism might be more precise than another. Sorting the product into the wrong category will have two effects. Sorting a product of lower quality in the group of high quality bears a risk. The buyer might realize this by random samples and will end the business relationship with ist supplier if the error margin is not acceptable. Sorting a product of higher qulity into the wrong category does not damage the business relationship but leads to a loss because the firm does not receive Ph.

Impact on Firm Strategies

The interviews with representatives for food chains and meat processors indicate their willingness to be more specific about the product attributes.Slaughtering firms will have the opportunity to react to this changing preferences by adjustment in the slaughtering process in order to identify products with the required attributes. The previous sections indicate that the selection attribute used to sort has a major impact on the profitability of the sorting strategy. Sorting costs and the price differences can be used to identify the most promising sorting strategy. The discussion of the sorting and none sorting option show some points that have to be considered in the process of identifying the appropriate selection criterion. However, the decision wether to sort or not to sort has to be seen in a more broader perspective.The interviews indicate that the willingness to pay a higher price for fresh pork is limited to those product attributes that help to lower costs in the processing industry or the food chain. This will open up the possibility to share the cost saving that might be achieved between slaughtering firm and their customers. It might also be the starting point for a more long term business relationship. Both options are important because they give a firm the ability to gain a competitive advantage towards its competitors (Porter, 1992: 178)

Changing preferences on the market will not be restricted to particular product attributes that might be identified during the slaughtering process. All points mentioned show that the market for pork will be more segmented and business relationships will be more specific. It opens up new ways of collaboration between slaughtering firms and their customers because beside the price of a product other tools will become more important in the competition process and offer new areas of competition among the slaughtering firms.

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Internationalization activities of german brewers

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Within the European brewing industry an increasing number of international activities can be observed. These activities are induced by changes in consumer behavior and lifestyle, the removal of barriers to entry, an increasing number of collaborative arrangements and concentration processes within the industry as well as by firms intent to follow a growth strategy, namely through internationalization.

The following paper is dealing with entry decisions, the perception of difficulties in serving specific markets and strategies of German breweries which are already active in different EC-countries, as well as overseas. The analysis tries to identify key factors, which are of importance for the success in the internationalization process of a sample of German breweries.

Characteristics of Foreign Market Servicing Strategies

The selection of the most effective international market entry and development strategy is seen as one of the most complex decisions facing an international firm (Young et al. 1989). Although a wide variety of classifying international business arrangements exists, all of them are assuming some implicit spectrum of involvement from exporting through to wholly owned subsidiaries. In principal, there are three generic strategies which firms can use to enter foreign markets:

- exporting, involving production in one country and the transfer and selling of goods and services across national boundaries via direct or indirect methods;
- licensing, involving the assignment of know-how, technology, production and selling rights or trade marks to foreign producers in return for financial compensation;
- foreign direct investment (FDI), involving the establishment of production and selling facilities in foreign markets.

According to the literature on internationalization (Buckley 1991, Porter 1990, Young et al. 1989), the three generic strategies can be distinguished by a location and an internalization effect. The location effect separates exporting from the other two methods, because most of the value adding activities take place in the home country, whereas, licensing and FDI transfer substantial proportions of these to foreign country markets. On the other side, exporting and FDI are separated from licensing by the internalization effect. With licensing, rights and the use of assets (know-how, production methods, brand names) are sold to a foreign firm, whereas, in exporting and FDI such activities are internalized. Each of the alternatives has its own inherent pros and cons and is interrelated with the maintenance and enhancement of a firms' competitive advantage. As each strategy involves trade-offs between the control available, flexibility, costs and risk, the choice of strategy is affected by a range of often conflicting forces (Maurer 1991:280).

Some examples may be used to illustrate these trade-offs. In resource and competitive terms, exporting is generally recognized as a low-risk and relatively inexpensive method of internationalization. Centralized production allows firms to exploit economies of scale and thus lower unit costs. But a firm can find itself at a competitive disadvantage if local producers have lower cost structures, i.e. because of preferential access to raw materials, or control of distribution channels. Likewise, licensing provides a firm with the advantage of rapid access to the international market, even if the firm is constrained in its internationalization efforts by a shortage of management or capital resources. On the other hand, the financial compensation for the transfer of assets may represent a poor return on an innovative process or product and it also implies the danger that technologies or products are captured by competing firms, leading to the loss of a firm's initial competitive advantage.

As the most comprehensive method of entry, foreign direct investment comprises the transfer of capital, management and know-how and is therefore seen as a relative expensive and risky approach. But, in competitive terms, the presence of a firm in a foreign market may increase its familiarity and knowledge about local market conditions, an essential prerequisite to build up a profitable market share on the long term (Maurer 1992:8). Furthermore, FDI may enable the firm to avoid the transaction costs of using the market, i.e. costs of contracting and monitoring agents and distributors, and to increase its effectiveness through better control of distribution and marketing functions.

Apart from the entry method chosen, firms internationalizing also have to achieve the necessary "strategic fit" to be able to cope with opportunities and threats on an international level. Managers of these firms will have to review and adjust their business strategies (Kuehl 1991:11, Jahn 1991:58) to achieve, sustain or improve a competitive position. If competitiveness is defined as

"the ability of a firm to meet and beat its rivals in supplying a product on a sustainable (long-term) and viable (profitable) basis" (Buckley 1991:34),

two main strategic options are open to firms to create a sustainable competitive advantage: cost leadership and product differentiation. According to Porter (1985) firms can use these two forms of advantage to compete across the broad scope of an industry or focus on competing in niches. Sources of cost effectiveness include the exploitation of economies of scale to lower unit costs, investments in state-of-the-art technology and preferential access to raw materials and/or distribution channels. The general aim of this strategy is to become a major player or market leader within a specific market. To maintain cost advantages, investments in plant renewal and process innovations are essential over time.

In the case of product differentiation, however, a firm seeks to be unique in its market along a dimension which is valued by its customers. Possibilities to differentiate vary from market to market but are associated with the potential for distinguishing products by variations in their properties and attributes. Product innovation and the ability to upgrade existing products are essential to maintain a competitive advantage with this strategy.

The realization of one of these basic strategies in an international context adds a number of other dimensions to competitiveness (Porter 1990). For example, the advantage of low production costs in a centralized large plant might be offset by the extra costs of physical distribution. Or, in the case of product differentiation, cultural differences might require firms to customize their products and marketing efforts in order to meet regional or national preferences and tastes.

In conclusion, the selection of an appropriate foreign market entry strategy, designed to enhance and protect the competitiveness of a firm is dependent on an amalgam of (Root 1987, Young et al. 1989, Buckley 1991):

- firm-specific factors, e.g. the nature and uniqueness of a firms' competitive advantage like the product design, a superior process technology, a well recognized brand name, an opportune organizational structure, and the ability of resources.
- industry-specific factors in the target market, e.g. the competitive structure, the initial market size and growth prospects, the quality and costs of inputs, the marketing infrastructure and entry and exit barriers.
- and location-/country- specific factors, e.g. political, economical and socio-cultural characteristics as governmental policies, legal regulations, norms, standards and inspection policies, local tastes and preferences, and the geographical and cultural distance.

Structural Features of the Beer Market in the EC

Europe, having a share of 40% of world-wide beer output, is the major center of beer production and beer consumption in the world. Total production accounts for approximately 400 million hectoliters, being more than 50 percent higher than in the USA, the largest single beer-producing country in the world. Within the sector of alcoholic beverages beer production is the dominating industry. Overall consumption is, apart from some shifts, relatively stagnant, whereas exports to third country markets show an increase of about 5% during the last years (CBMC 1993). Also imports from non-European countries have been doubled during the last 10 years, but are still amounting for 10% of the export volume only.

On a global scale, the beer brewing industry has been undergoing a steady process of internationalization (Karrenbrock, 1990:3). With respect to EC-countries, imports of beer from non-EC countries have doubled between 1987 and 1991, whereas intra-EC trade was mainly concerned with the export of premium beer and beer specialties (CBMC, 1993). Since 1990 intra-EC trade in beer is more important than extra-EC trade, however, both segments account for a relatively small amount of EC-production. Main importers are Italy, Spain, Portugal and the UK. Main exporters are Germany, Denmark and the Netherlands. EC-wide, the industry comprises a number of different enterprises, ranging from large multi-national corporations to medium and small sized firms. Nevertheless, all three types of firms can be found in international markets.

Beer is traditionally consumed all over Europe, but demand shows a typical seasonal pattern in some Southern European countries. Northern Europeans prefer stronger beer types and also per capita consumption is substantially higher than in the more southern regions (CBMC, 1993). Main distribution channels are the gastronomic sector (bars, taverns hotels), retail outlets and supermarkets which are becoming more and more important according to changes in the distribution system and a growing at home consumption. Main consumer groups are younger people. With an increasing differentiation of the product additional segments have been targeted during the last years.

But, the European beer market is by far not homogenous and has to be viewed as a multi-local market. Steele (1992:26) summarized the situation:

"In many respects, the European brewing industry epitomizes the paradox of European business. A principal component of this paradox is the degree of diversity which exists across the major European brewing countries".

Apart from the fact, that this paradox applies to most of the segments of the European food-industry, examples highlighting the diversity in the brewing sector between European countries are the different levels of industry concentration, different consumption patterns and attitudes, distribution channels and product varieties.

The industry

Overall, European brewing companies can be classified into five groups (CBMC, 1993, Steele, 1992:27). First, global players with significant brewing and selling operations across Europe and worldwide as Heineken of Holland and Carlsberg of Denmark. Second, Euro-international firms with European-wide activities and ownership of breweries in different European countries as Stella Interbrew of Belgium and Groupe BSN of France. Third, national competitors with operations mainly in their country of origin as the British brewers Bass and Allied Lions. Fourth, regional brewers with activities in a particular region of their national market as Cruz del Campo and Mahou of Spain and many of the medium-sized German brewers. Fifth, local brewers with operations restricted to markets in close proximity to the production plant.

Table 1 provides an overview on production volumes, sales and market shares of the top 15 European brewers. The European market is not very concentrated, the top five brewers having a combined market share of 32 percent. Furthermore, the brewers are very insular, most of them selling their produce in the country of origin. Only five of the fifteen companies listed have sales of beer outside Europe of more than 1 million hectoliters per annum and just three of them are among the top fifteen breweries world-wide (Heineken, BSN, Carlsberg).

Table 1: Top 15 brewers in Europe (1992)

Company	Sales world-wide (mill. hl)	Non-European sales (mill. hl)	European sales (mill hl)	European market share (%)	Output home-country breweries (mill. hl)
Heineken (NL)	43.0	17.8	25.2	10.0	11.0
Groupe BSN (F)	19.8	2.9	16.9	6.7	11.2
Carlsberg (DK)	16.0	2.3	13.7	5.5	8.6
Bass (UK)	13.8	0.3	13.5	5.4	13.5
Stella-Interbrew (B)	13.0	3.2	9.8	3.9	8.0
Guiness (IRL)	11.4	4.4	7.0	2.8	5.0
Allied-Lyons (UK)	9.0	0.5	8.5	3.4	8.5
Whitbread (UK)	8.0	0.1	7.9	3.1	6.5
Kulmbacher (D)	8.0	1.0	8.0	3.2	8.0
Metropolitan (UK)	7.5	n.s.	7.5	3.0	7.5
Oetker (D)	6.9	0.1	6.8	2.7	6.8
S & N (UK)	6.7	n.s.	6.7	2.7	6.7
Dortmunder (D)	6.0	n.s.	6.0	2.4	6.0

Table 1: Top 15 brewers in Europe (1992) (continued)

Company	Sales world-wide (mill. hl)	Non-European sales (mill. hl)	European sales (mill hl)	European market share (%)	Output home-country breweries (mill. hl)
Paulaner (D)	6.0	n.s.	6.0	2.4	6.0
Courage (UK)	6.0	n.s.	6.0	2.4	6.0

Source: CBMC 1993, BVE annual reports, Steele (1992:29)

During the last ten years, significant cross-border activities (acquisitions, cooperations and integrations) can be observed for the four principal European brewers Heineken, BSN, Stella-Interbrew and Carlsberg. But this investments have been mainly targeted to two countries, Italy and Spain, where a significant shares of the beer brewing industries are owned by foreign brewers. There is still a high degree of diversity in ownership patterns across Europe. Germany, Denmark and the United Kingdom show no significant ownership of breweries by other European companies. Likewise, there is also little ownership of European breweries by non-European brewers. Exceptions are Courage (UK) which is owned by an Australian based brewer, Moretti and Prinz (Italy) which are owned by Labatts of Canada and Cruz del Campo, where Stroh of USA holds a minority stake (Steele, 1992:30-44). Even after the repeal of the purity-law by the European Court of Justice, only a few activities of foreign brewers can be observed in Germany till 1992 (Robock 1992:52). The only substantial foreign investment in production facilities has been made by Grolsch (NL) in 1990. Up to 1992, all other investments by foreign brewers were principally aimed at gaining access to already existing beer distribution systems within Germany (i.e. Tuborg 1988 and Fosters 1991).

The particular industry situation within European countries is very different from the overall situation (Table 2). The brewing industry is highly concentrated in Belgium, Denmark, France, Italy and the Netherlands, where one or two major competitors hold more than 70 percent of the national market. Cost leadership in production and distribution plays a major role in competition.

Table 2: Industry situation in major beer producing countries of the EC

Country	Industry situation	Number of major competitors	Combined market share (%)
Belgium	highly concentrated	2	85
Denmark	highly concentrated	1	80
France	highly concentrated	2	80
Germany	fragmented	5	12
Italy	highly concentrated	2	70
Netherlands	highly concentrated	1	70
Spain	concentrated	6	88
United Kingdom	concentrated	6	80

Source: Steele, 1992:37

The British and the Spanish industry can be described as concentrated with no dominant firm on the national level, but with regional production and distribution monopolies. In comparison to this, the German brewing industry exhibits a very fragmented structure. Mainly regional and local brewers supply German markets, with a relatively low number of firms marketing their brands into other regions or countries. Focus on specific regions and/or customer segments as well as cost focus in some cases are the competitive strategies mainly used.

Production, trade and distribution

Production volumes differ substantially between European countries (Table 3). The main producer of beer is Germany, accounting for more than one third of the European industry output. The overall production volume is stagnating, especially in the northern European states.

Since 1990 intra-EC trade is more important than exports of beer from the EC to third countries. But, exports of beer account only for a small proportion of total beer production (2-5 percent) in most of the states (Table 4). Exceptions are Ireland with 41 percent, the Netherlands with 35 percent, Denmark with 27 percent and Belgium 23 percent of their production. Countries with a negative import/export ratio are Greece, France, Italy, Portugal, Spain and the United Kingdom, whereas Belgium, Denmark, Germany, Ireland and the Netherlands are mainly exporting quality beers. The most important third country market are the USA, with 37 percent of all European exports in 1990. Remarkable is the fact that Mexico is the main third country beer supplier of the EC. Since 1991, about 25 percent of all EC beer imports are shipped from Mexico.

Distribution channels also differ substantially between countries and are determined by consumption characteristics. Whereas in some countries drinking of beer is a common social activity it is only an occasional drink in other countries. Therefore, according to the different consumption characteristics in each market, places of purchase and channels of distribution vary considerably.

Table 3: Beer production in European countries

Country	1980	1985	1988	1991
Belgium	14.2	13.9	13.8	13.8
Denmark	8.2	7.9	8.7	9.7
France	21.6	20.3	20.1	21.0
Germany	115.9	117.6	117.0	118.0
Greece	2.5	3.0	4.1	3.7
Ireland	6.1	5.5	5.0	6.4
Italy	8.5	10.3	11.3	10.7
Netherlands	15.7	17.5	17.5	19.9
Portugal	3.6	3.7	5.5	6.9
Spain	20.0	23.4	26.6	26.7
United Kingdom	64.8	59.7	60.2	57.4
Austria	7.5	8.7	9.0	10.0
Czechoslovakia	23.4	22.3	22.7	24.0
Hungary	7.9	8.7	9.5	10.0
Total	319.9	322.5	331.0	337.3

Source: CBMC 1993, BVE annual reports

Table 4: Exports and imports of beer in European countries (1991)

Country	Exports		Imports	
	1000 hl	% of domestic production	1000 hl	% of domestic production
Belgium	3145	22.8	459	3.0
Denmark	2560	26.6	16	1.6
France	1017	4.8	2906	13.8
Germany	6174	5.2	2809	2.4
Greece	58	1.6	175	4.7
Ireland	2615	40.9	651	10.2
Italy	165	1.5	2476	23.1
Netherlands	7025	35.3	771	3.9
Portugal	376	5.4	n.a.	n.a.
Spain	249	0.9	1389	5.2
United Kingdom	1842	3.2	5329	9.3

Source: CBMC 1993, BVE annual reports

In most European countries (France, Netherlands, Spain, Italy, Belgium, Denmark) brewers do not own retail outlets. Beer is distributed through two typical channels: (a) wholesalers which supply liquor stores, bars, cafes and restaurants, and (b) super- and hypermarket chains. The latter is becoming increasingly attractive to brewers throughout Europe by offering substantial cost savings through high order volumes and central delivery points. What is varying between these countries is the proportion of beer sold through each channel (Steele, 1992:36).

Because brewers own a significant proportion of retail outlets, the channels of distribution exhibit a very different structure in the UK and Germany. Approximately 60 percent of pubs and bars in the UK and 25 percent of them in Germany are supplied directly by the brewers.

Beer consumption and market trends

As indicated in Table 5, some clear consumption trends can be observed for different national markets. On average, sales of beer are decreasing or stagnating in countries like Germany, Denmark, Belgium, the United Kingdom, Ireland and the Netherlands, which exhibit an already high per capita beer consumption. In the Southern European countries the trend is in the opposite direction and, with the exception of France, substantial increases are observable. But it has to be considered that demand follows a characteristic seasonal pattern in this markets.

Table 5: Per capita consumption of beer in European countries

Country	1980	1985	1988	1991
Germany	146	146	144	143
Denmark	122	121	120	126
Belgium	131	121	119	112
United Kingdom	117	108	111	107
Ireland	122	105	97	103
Netherlands	86	85	87	90
Spain	53	61	69	71
Portugal	38	38	53	63
Greece	26	34	40	45
France	44	40	39	41
Italy	17	22	24	27
Czechoslovakia	138	133	130	130
Austria	102	119	118	124
Hungary	86	99	101	101

Source: CBMC 1993, BVE annual reports

Because quantitative growth cannot be achieved in highly saturated markets, a shift to more high priced premium beers and beer specialties can be observed. This shift is induced by changes in consumer attitudes and life-style spirits. Well established premium brands, light, low-alcohol and 'life-style' brands are more and more accepted as semi-luxury items (Wangen, 1993:182). They are increasingly gaining market share from those beers, which are still perceived to be a blue-collar workers' drink, with high caloric and alcohol content. Furthermore, the increased health and fitness consciousness of consumers is also positively influencing this trend.

Empirical evidence

To obtain information about the foreign market servicing strategies of German brewers, standardized interviews among experts have been conducted. Because the aim of the study has been mainly explorative, the sample includes 15 firms, with 5 small firms (yearly turnover between 20 and 60 million DM) and 10 large corporations (turnover 200 - 1000 mill. DM). According to the generic strategies presented above, all of them are engaged in exporting, but 5 firms are additionally co-operating with host country firms with one having a foreign subsidiary. Small firms in the sample are using exports as the only means of foreign market supply.

Major driving forces of the internationalization process of German breweries are changes with regard to consumption patterns, attitudes and preferences of customers at home and abroad (demand forces), as well as developments in the competitive environment (industry forces). With respect to consumers, tourism seems to have a major impact on internationalization decisions of German brewers. More than 50 percent of the interviewed brewers try to utilize this demand drain created by tourists. Even if this demand shows a characteristic seasonal pattern, it is creating an advantage even for small breweries by easing up market entry and development in a foreign country. Other strategic factors, more or less decisive for large brewers, are the increasing beer consumption in Southern and Eastern European countries, the trend to premium beers and the positive impact of foreign sales on domestic sales. Considerations about opportunities in

Eastern Europe, one of the few growing markets worldwide, are becoming increasingly important for internationalization decisions. At the time, the Eastern European countries account for approximately 28 percent of the total European market volume of 400 million hectoliters of beer. According to a study of an international consultant (Berger 1991), this share is expected to grow up to 50 percent on the long run.

Generally, the competitive pressure on German firms in foreign markets is perceived to be not as high as in Germany itself. This is due to the fact, that breweries serve domestic markets with a much broader variety of beer types and brands than international markets. Furthermore, the industry is starting to become more concentrated and the larger firms are beginning to gain market shares at the cost of small regional brewers. According to Porter's generic strategies of cost-leadership, differentiation and focus, specific strengths in international business are the ability to differentiate German beer from other beers.

A cost-leader strategy is not feasible for German breweries in international markets. Reasons are the highly fragmented industry structure, the relatively low output volumes and the higher costs for brewing inputs caused by the regulations of the purity law. As a fact, all German breweries are still committed to this regulation and are using it as a key characteristic for differentiation strategies, which play a major role in domestic and international marketing of German beer. Eighty percent of large and small breweries of the sample see the product itself as being effective enough to differentiate it from competing beers. Innovations play a minor role to achieve an international advantage. Restricted by purity regulations real product innovations cannot take place. Newly introduced beers are more or less re-launches of traditional local or regional recipes, providing newly introduced brands with some novelty character.

Apart from differentiation by inherent product characteristics, specific marketing know how is used as a differentiation aspect in international markets. Vertical marketing instruments are used to support business partners abroad. But this activities are particularly aimed at differentiating the own product from competing German brands. Niche strategies are mainly employed by small export brewers. They are serving a very narrow market segment with one or two specialty beers, targeted at the more profitable gastronomic sector, and utilizing already existing distribution channels of foreign partners.

Entry and development strategies used by the interviewed brewers are direct export, cooperative arrangements and direct investment. Direct export is the dominating strategy for internationalization. The most important export markets, ranked by priority and frequency of nomination, are shown in Table 7. The seven top ranked markets are supplied with German beer since the early 60s. These countries are, with the exception of Britain and the USA, also the classical German tourist destinations. But it is worth mentioning,

Table 6: Competitive strengths of German brewers in international markets (n=15, multiple answers)

Competitive strengths	perceptions of brewers interviewed		
	total	large	small
Differentiation by product features	12	8	4
Differentiation by marketing know-how	6	4	2
Cost-leadership	-	-	-

Table 7: Most important export markets (n=15, multiple answers)

Country	Designations	Country	Designations
Italy	10	USA	6
Austria	7	Switzerland	5
Spain	7	Greece	3
United Kingdom	7	Poland	3
France	6	Sweden	2

that supply of 2/3 of the export markets, quoted to be important for brewers in this survey, started in the late 80s.

Preferred partners in the host country are large wholesalers and local brewers, providing access to already established distribution channels. Exclusive distributorship for specific brands or a product program are most common arrangements used.

The marketing policies used and activities performed on the functional level to achieve entry and development in foreign markets are shown in Table 8. For ten of the breweries the active search for distributors in export markets is part of their international distribution policy. Selection criteria for cooperation with a specific foreign partner are the product range and groups already distributed, an existing distribution system, the financial liquidity, professional experience and price conditions. As a matter of fact, the large breweries check and choose their distributors much more actively than the smaller ones. Small firms tend to react on the initiative of foreign wholesalers, indicating a more short-termed international orientation.

As mentioned, all brewers are producing in accordance to purity law regulations, enabling them to achieve and utilize a differentiation advantage. Large firms mainly export premium beers, whereas small breweries concentrate on beer specialties. Both groups use domestic brand names in foreign markets, too. Product innovations play a minor role in the export strategies of German breweries, even if one of the firm's exports a new dry beer created exclusively for the British market.

Regarding the product assortment exported, 13 of the respondents concentrate their efforts on two to three beer brands. Only two large breweries serve international markets with a wide range of different beer types and brands. Both brewers are supplying international partners with a particular line of their product mix, enabling them to have more than one distributor in the same geographic market.

Promotional efforts of the interviewed brewers include point-of-sale activities and media advertising, whereas three large and one of the small brewers use a combination of both. Contracts with importers in the target country include lump-sum payments for promotional efforts. On average, these expenses are between DM 10.- and 15.- per hectoliter sold. Even if the promotional tools used are similar, the strategic intent of the brewers is very different. Whereas the smaller brewers and one alcohol-free beer producer promote to achieve market development, the large ones mainly try to gain market expansion.

Table 8: Marketing policies and activities in international markets

Policies/activities	number of brewers		
	total	large	small
Initial export activity:			
active search for importers	10	9	1
selection of importers contacting the brewer	5	5	-
no selection, delivering orders by chance	5	1	4
Product policy:			
premium beers	8	7	1
specialty beers	6	2	4
innovations	1	1	-
Assortment:			
concentration on one to three brands	13	8	5
broad product range	2	2	-
Promotion:			
activities of brewer at point of sale	11	6	5
media advertising by brewer	4	3	1
no advertising activities by brewer	5	1	4
Distribution:			
exclusive distribution	15	10	5
Price policy:			
high-price strategy	9	9	-
low-price strategy	1	1	-
no active price strategy	5	-	5

All brewers cooperate with their foreign partners on the basis of exclusive distributorship, mainly based on geographic regions. Firms marketing more than one product line in one country or region often use different distributors for each brand. Contracts with foreign distributors usually include restraints on marketing beer of other German brewers. Distributorship contracts are therefore an important strategic tool to erect most effective entry barriers against possible new entrants that might basically have the same differentiation advantage.

With the exception of one firm, all large export brewers are using a high price strategy in their foreign markets. This is due to the fact, that these firms try to cover substantially higher transport costs and additional distribution margins. From a strategic point of view this is consistent with the strategy of differentiation followed by the brewers interviewed. Small brewers do not pursue an active price policy in their foreign markets. Tending to respond more or less to initiatives of prospective foreign business partners, they have no influence on the final selling price of their beer.

Possible entry strategies and marketing policies are highly determined and affected by entry barriers, reactions of competitors, trade barriers and weaknesses internal to the internationalizing firm. To a more or less extent, all these categories create problems in the internationalization process of the German brewers under investigation (Table 9). Interviewed brewers were asked to rank main problem areas on a scale from 1 (unimportant) to 6 (very important).

Table 9: Major problem areas in exporting

	1	2	3	4	5	6
Information deficiencies			X			
Access to qualified partners					X	
Lack of time				X		
Financial risks				X		
Problems with transport/logistics			X			
Trade barriers				X		
Language problems		X				

Aggregated results indicate, that access to qualified business partners is perceived to be the dominant problem. Internationally, there is a strong competition between breweries to cooperate with foreign wholesalers, importing domestic and international brewers. Importers are mainly interested in well-known products with a high sales potential, new markets are usually developed with resources of the exporting brewery. Especially small German breweries have problems to fulfill these requirements. Also financial risks, caused by different legal and economic systems, fluctuating exchange rates and restricted convertibility of currencies are seen to impose substantial problems on exporting brewers.

Foreign language and communication skills seem not to pose a major problem on the exporting activities. Information deficiencies, lack of time, transport/logistic problems and trade barriers are ranked between 3 (not very important) and 4 (of some importance). The aggregated results in Table 9 do not provide a clear picture and have to be discussed for small and large breweries as well as for particular export markets separately.

Trade barriers are hampering the free exchange of goods and services between countries. Among the interviewed brewers different perceptions about the importance of tariff and and non-tariff barriers exist. In some cases, duties and taxes are of major importance to the exporting firms. Whereas duties within the EC do not play any role, they are major entry barriers to particular markets. In Poland, additionally to a duty of 30 percent, a tax rate of 150 percent is charged on imported beer. Prohibitions on alcohol and environmental regulations play a more important role for exporters to Scandinavian countries than duties, taxes and border controls. Another recently introduced export barrier excluding many German beer exporters from some Eastern European markets are requirements with regard to the minimum capital stock needed by beer importers. In 1992, Poland introduced a regulation that beer importers have to have capital resources of approx. 1.5 million US dollars, resulting in a decrease of the number of beer importers from 350 to 6 within months and excluding many of the German export brewers from the Polish market.

Lack of time is more a decisive factor in the internationalization process of smaller than larger brewers. On average, small brewers rating of this factor is at 4.5 (important), whereas large firms rating is at 3.3 (not very important), indicating that there are shortages of resources and a lower committment to the export activity in smaller firms. Perceptions of transport and logistic problems are relatively similar between large and small brewers, but differing between the markets served.

Additionally to their exports, five of the large brewers interviewed are co-operating with host country firms through licensing. Results on the strategic intents of these firms in

Table 10: Motives for international cooperation

	1	2	3	4	5	6
Circumventing import restrictions				X		
Development of new markets				X		
Production cost advantages					X	
Transport cost advantages						X
Access to technical know-how	X					
Access to distribution systems					X	
Counteracting activities of competitors			X			

international markets are not representative in a statistical sense, but the information gathered provides some insights into motives and the strategic directions followed by German brewers. Table 10 gives an overview on major motives for international cooperation of the responding firms, ranked by their importance (1= absolutely unimportant, 6= absolutely important).

The most important characteristic of international cooperation is the intent to combine specific strengths of two or more firms to achieve a competitive advantage. With regard to firm specific advantages, it enables a firm to utilize the know-how, competencies and capacities of a local partner which normally impose costs and disadvantages on the foreign firm. That cost advantages and preferred access to distribution systems are the major motives to cooperate is clearly indicated by the responses of the brewers interviewed. The local partners market knowledge and the experience with the country specific distribution system are seen to substantially lower information and setup costs. Overall, the intentions to cooperate are clearly market-driven and are aimed at the improvement of the competitive position within foreign markets. Cooperation as a defensive adjustment strategy to match or circumvent host-country government regulations plays a minor role for the firms.

Of the German brewers interviewed, only one stated to operate foreign subsidiaries, particularly in Southern European markets. From a corporate viewpoint, the preference of wholly owned subsidiaries is generally associated with strategies that require tight controls, either for manufacturing or marketing reasons or to protect proprietary technology. Better control enables the firm to implement and revise its strategies as well as to coordinate actions independently. But, this comes along with a higher risk, a substantial committment of resources (capital, technology, management) and a lower flexibility than with any other entry strategy. Foreign direct investments are either market- (export substitution), cost- or resource-oriented. In the particular case, the investments are clearly market-oriented and are aimed to replace exports to a number of local markets.

Concluding remarks

To conclude, the major findings on strategic factors which are of importance to internationalization activities of German brewers can be summarized as:

- In comparison with the large European brewers, German brewers cannot achieve the necessary economies of scale to compete with a cost-leader strategy in international markets.

- The business strategies employed are differentiation and niche strategies, whereas the German 'purity law' regulations still provide an excellent point of differentiation against other European and international competitors.
- An increasing health consciousness and changing consumer preferences are opening market niches for innovative products like premium, dry and alcohol-free beer.
- Whereas one group of German brewers very actively tries to enter and develop foreign markets by implementing programs and plans for specific brands or segments, other firms are just reacting on occasional orders.
- Export development is commonly achieved through contracts with large national wholesalers in the host country. Indirect exports, i.e. through internationally operating German based supermarket chains are not carried out yet, but this may be a promising.
- Major entry barriers identified by interviewed managers are the contact to business partners, a lack of market information, and the oligopolistic structure of the industry in some markets.
- Trade restrictions are not seen as a major barrier, even by firms exporting to non EC countries.
- Tourism plays the most important role for international activities of German brewers. The demand drain caused by tourists eases up entry and allows firms to gain experience and an initial foothold in a new market. This is providing brewers with the stepping stone needed to extend their marketing efforts to local customer groups on the long run.
- Cooperations and direct investments are mainly aimed at the realization of cost advantages and the preferred access to distribution systems. Because of the substantial transfer and commitment of resources this option is not feasible for the majority of the German brewers.
- Product features, access to distribution channels and promotional strategies seem to be the most important factors to utilize a product focused preference strategy in the high price segment of specialty beers, whereas product innovation plays a minor role.

With regard to Eastern European markets, brewers are very reluctant to provide much of information about their activities in these countries. It can be argued, that the relatively high per capita consumption of beer in this regions, which best can be described as 'adjacent markets', will offer a number of opportunities for German brewers. This is even more important in a situation when other European brewers do not pay very high attention to these markets and are still concentrating their efforts on Western and Southern European countries.

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Production chain of hemp, a 'new' crop for natural fibre

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Introduction

Farmers in the Netherlands, especially those in arable production, suffer from low prices of food crops, due to overproduction, while the environmental load of agriculture has to decrease. Implementation of set aside programs, a search for new industrial crops and introduction of sustainable agriculture are some of the actions to find contributions to a solution. In an effort to support finding such solutions the Ministry of Agriculture of the Dutch Government started a research program to investigate the chances and possibilities of the production of hemp for paper pulp. For this research project, which was set up for 4 years (1989-1993), Dfl. 15.10^6 were spend (Bakker 1993, Berlo 1993).

Hemp is a well known cash crop in the illegal circuit but a relatively 'new' crop, as raw material for paper pulp production. Since timber has become more and more a favourite raw material for paper production there is no market pull to be expected from that side. Therefore new concepts have to be put in the approach to make the use of hemp interesting: new markets, new production techniques, less pollution, logistic chain approach, and system approach.

The crop is very old, maybe even the eldest agricultural product, primarily used for textile, rope but also for paper pulp. The fibre hemp plant (cannabis sativa) has a long stem consisting of bast and woody core. The yield of stem dry matter can reach 12 ton/ha in dutch conditions. The ancient production techniques cannot be used for nowadays conditions. To make production legal, breeders have developed varieties which have a low content of hallucinating material (THC). A level below 0.3% is considered to have no narcotic interesting content. For our purposes the yield of bast fibre is more important since this is the valuable component for paper production. The interesting breeding varieties available, have a THC content between 0.1 and 1.8%, while the bast content varies between 12 and 28% of the stem mass (Meijer 1993). The varieties with highest bast content generally have lowest THC content. The seeds can be used for oil, birdseed and feed. Varieties with highest stem yields flower in The Netherlands in august and can be harvested in september. At that time the seeds are not dry enough for harvest, so only fibre is harvested.

The objective of the 4 year research was: The feasibility of production of hemp fibres for paper pulp in The Netherlands, resulting in a 'go'/'no go' decision on building a pilot plant.

A special problem that was expected from the beginning was that due to the limited research period and the fact that all researchers started at the same time, not all necessary information of the various chain elements about the production from seed to paper would become available at the moment other researchers needed them. This makes selection of the optimal chain, needed to calculate costs and benefits properly, difficult so the process of project management became very important. Tuning and timing of the research along the production chain was given much attention in the project. A scientific leader worked together with a manager with a business approach.

Method

Define goal.

- 'Go'/'no go' for pilot plant

Define criteria.

- Economics (costs and benefits)
- Technology: available on short term.
- Environment: pollution, energy
- Certainty: delivery, purchase, workability, quality
- Flexibility on market

Define premises:

- Application of hemp for paper pulp
- Harvest with maximum physical yield
- Harvest and processing of both bast and core.
- Require constant quality
- Year round delivery for processing
- Chain optimisation

Define chain components:

- PRIMARY PRODUCTION
  - Seed production / plant breedin g(max. production of fibre, low content THC)
  - Agronomy .(max. yield, min. input, production advise)
  - Plant diseases .(sanity, pollution)
  - Harvest .(low labour input, machines, workability)
  - Storag e(central, decentral)
  - Conservatio n(seasonal production, constant quality)
- PULP-PROCESSING
  - Transport (high density, distance)
  - Pulping .(new concepts, product cost)
- PAPER-PRODUCTION
  - Paper market .(markets for pulp blends, goals, price development)
- Define team
  - Related to the chain components, 30 researchers of 12 different institutions/specialisms

- Develope new ideas.
  - Ancient technology is to much labour demanding, energy consuming or environment polluting.
- Select from all possible logistic chains.
  - Support the selection of the various possible production chains by management: team levels, meetings, reports. Make models and databases for calculations and sensitivity analyses.
- Develop Business concept.
  - Continue until a few interesting chains remain, describe the concept of the business strategy: Production region and area, organisation of primary production and processing, industrial cooperation, market development, financial aspects, start of production.

Results

In this chapter we will concentrate on harvest mechanisation, storage and conservation in the production of hemp. The choices between alternatives depend much on the results of the research of the other chain elements.

Existing methods:

The techniques used in the past and nowadays in Eastern Europe for the production of hemp for textile, paper and ropes consist of mowing, bundling and drying in bundles standing against each other (Hennink, 1991:10,11). After drying, the product can be stored until it is retted in cold, warm or hot water or in chemical solutions. After retting, a process in which the connection between the bast fibres and the core disintegrates, the stems are dried, and decorticated, a process in which the bast and core are separated. Retting also can be done in the field right after cutting and laying on the ground. This is called dew retting. After dew retting the material is picked up from the field by balers. The crop is defoliated mechanical or chemical. In France drying is performed in a swath on the field (Werf, 1992). After drying the hemp is baled by round balers and stored at the farm. In the processing plant it is shredded and sieved to separate bast and core fibres. Only the bast fibre is used for cigarette and document paper.

Possible chains.

The above mentioned methods cannot be used in nowadays dutch conditions and given the premises mentioned in chapter 2. So new concepts have to be developed, using the chain concept in system approach. The following chain has to be optimised (Huisman, 1993a):

Topping —> Mowing —> Handling —> Field Transport —> Conservation —> Storage —> Road transport —> Temporary storage —> Preprocessing.

Optimisation is also defined by the requirements of the processing techniques and hence the quality requirements related to the application of pulp. Also the plant production aspects at the beginning of the chain influences the options and selection.

Topping:

Objective: Removal of leaves, flowers and seeds as far as possible, to keep paper clean, improve conservation and leave pollution as green manure on the land or gather the removed material.
Options: New designed machines are needed but the design can be based on existing principles:

a) Cutting by cutterbar, with support by a reel and transport of cut material sidewards by a belt.
b) Flail mower, throwing the shredded material on the ground between the crop.
c) Rotating brush, dropping the removed material between the crop on the ground.

Selection: The cutterbar is a heavy and complex machine, but offers the possibility to collect the leaves if wanted. As far as known no legal valuable stuff can be extracted from the leaves. The height of cutting depends on the length of the crop, the machine type and the loss of stem material that is acceptable.

Table 1 gives the loss of stem material in case the cutting height is chosen such that the harvested stem material is polluted by 4 % and 6% leaf material. Originally (before topping) the content of leaf material of the total plant mass was 20%.

Although the final design of these machines is not ready it can be expected that the costs are roughly the same. The brush seems to be the best choice, however the technology of the flail is more perceived. The optimum topping height has to be defined through chain optimisation when the disadvantages of leaves in the harvested product are quantified. Since these are dependent on the pulping technology and the application of the pulp, there is no answer yet.

Mowing:

Objective: Separation of the hemp stems from the roots, with a minimum of loss of stem material and pollution of sand.
Options: Depending on the method of handling after cutting. Existing farm machines can be used. When the hemp is lodged, an additional vertical cutting mechanism is needed to divide the cut material from the remaining standing crop.
Selection: Related to the handling method.

Table 1. Loss of stem mass at topping.

Machine	Stem loss at a perc. of leaves in the stem material	
Type	of 4%	of 6%
Rotating brush	4%	2%
Flail mower	7%	4%
Cutterbar	14 %	7%

Handling

Objective: To bring the harvested material in such condition that transport, storage or preprocessing is simplified. Quantity and quality should remain maximal.

Options: Ancient harvesting systems cannot be used, since they demand to much labour. The nowadays used technology in agriculture show the following solutions:

a) Chopping, to create material with a flow behaviour, and to obtain a higher density at transport and storage.

b) Compacting to increase the density by
   b1 baling,
   b2 bundling
   b3 automatic loading on a wagon.

c) Preprocessing by separation of stem and core in a field machine. The technology, called decortication, is known for flax but only in stationary machines. A mobile machine was developed based upon a prototype available in France (Huisman, 1993c).

Selection: A separating machine only can work in the harvest period of 1,5 month, so a large capacity or much machines are needed. After some preliminary test it showed to become a large, complicated machine, so an expensive operation. Only in case the value of the product is increased much by such operation it is a real option. The usefulness of the chopping and compacting options depend on the conservation technique to be chosen. These machines are normally available in agricultural practice.

Field Transport

Objective: Transport of the harvested material from the field to the storage place with a capacity, about equal to the harvest capacity, without loss of quantity and quality.

Options:

a) Farm wagons suitable for the appearance of the material related to the handling: With or without sideboards for chopped material and baled material respectively.

b) Commercial trucks in case of immediately transport to the plant.

Selection: Directly related to the handling and storage techniques used.

Conservation.

Objective: The combination of seasonal production of hemp and year round processing of pulp requires conservation during storage. This demands minimal decrease of quantity and quality as required for processing (Huisman, 1993b).

Options:

a) Drying.
   A low moisture content nearly stops biological production of the plant and the microbes in and on it. For hemp about 10% moisture content (wet base) is needed for long storage.

b) Anaerobic conditions:

b1) Additives:
   Adding acid or caustic to such a concentration that biological activity stops. Additives with antibiotics or with some antibiotical effect are also effective.

b2) Natural fermentation:
A well known and also in this application useful method is lactic acid fermentation as is used in feed and food production. In agriculture this is widespread for conservation of grass and maize. The availability of enough sugars is required for the fermentation. When not present they can be added in the form of molasses, a byproduct of sugar production. Fermentation is in fact a kind of controlled deterioration. The amount of the decay and the produced byproducts will define the usefulness.

Selection: Artificial drying is too expensive. It costs more than the value of the crop. Field drying only, is interesting if the drying certainty in the given period for the given climate conditions is such that quality of the product is guaranteed. In dutch weather conditions in the harvest period september, there is not such guarantee, since the drying conditions are too low and too variable. Combination of field and artificial drying is also too expensive. Additives are also rather expensive so natural fermentation is very interesting, as we will see further on the losses are small and the logistic aspects are attractive.

Road Transport

Objective: Transport of the product from the farm to the pulp processing plant.
Options: Combination of truck and loading equipment or tractor and farm wagons.
Selection: The distance to the plant is expected to be 50km average, so trucks will be the only solution.

Storage

Objective: Keep the material stored on a certain place, while keeping quantity and quality conserved until it can be processed. Year round storage is necessary to make year round processing possible.
Options: Central storage near the plant or local (decentral) storage at the farm.
Selection: Local storage has many advantages: The organisation of transport after harvest to storage is easy since it can be managed by the farmer and assures quick silage making. Since silage is an anaerobe process, it is very important to cover the heap of hemp by plastic as soon as possible so the silage process can start immediately. Central storage asks for a large transport capacity in september, roughly 10 times as large as with local storage.

Preprocessing

Objective: Separation of bast and core because the value of the bast is much higher due to the length and the strength of the elementary fibres as well as the higher content of cellulose. Bast fibres are about 2.5 mm long whereas core fibres are about 0.5 mm (Huisman, 1993c).
Options:
a) Separation in a field machine in which the whole stem is decorticated directly after mowing, so in a fresh condition. In that case the core pieces become available in particles of about 1 cm in length, while the bast remains at the original length of the string as it was in the stem, about 2 m long. (See also 3.2.3)

b) An other possible separation technique is based on the fact that during chopping in a field chopper the bast and core are loosened from each other largely which is sustained during storage in the silo. Separation is possible by putting the product in water in which the bast sinks and the core floats.

Selection: The decorticating field machine will be large and expensive. Since it will only work in harvest time, many machines are needed, so costs will be very high compared to the value for pulp. In addition the transport and storage of two products is required which makes harvest complicated. Maybe in case the bast can be used for high value products as textile, the system will be attractive. Separation by flotation could be performed before or after storage (local or central). Most interesting due to logistics and costs is central separation as a first step in the pulp processing where cleaning in water is always included.

Discussion.

Theoretically there are in total 366 possible chains, when the number of options of all components of the chain are multiplied. Practically some are excluding others and some are so costly that they can be neglected. In the remaining 75 different chains it is hard to detect an optimal result because of the interactions of the various criteria. (see section 2). Therefore a database with relevant information about each option of the elements of the chain was made. A calculation routine was added to make easy calculation of total costs for remaining product (loss of product incorporated) for each chain possible. In this way it became clear that the following chain is a good one: topping, harvesting by forage chopper, local storage at the farm, conservation by natural fermentation supported by adding of molasses, transport by truck to the pulp plant, and temporary storage at the plant before separation of bast and core by flotation. Addition of NaOH can be interesting if the recently developed Alkaline Peroxide Mechanical Pulping process will be used. However many details about costs and process variables are not yet available so no definite decision about that can be taken. This decision also depends on the demand from the paper market. Only when the detailed requirements of the market are known, the requirements for pulping and hence for conservation and harvest techniques can be defined. Then also the detailed cost and quality parameters can be assessed and the chains can be optimised.

An other aspect of the production chain of pulp from hemp is the organisation structure. There are three products: hemp, pulp and paper, produced in separate production units for which an open market exists. Between them there are two intermediate places where material and money have to be transferred. At those places there is a tension between making on one hand production possible and on the other interesting.

1. *Economical*: The farmer needs a price high enough so hemp can compete with other crops and the industries can pay for the raw material only such price that they can make a sufficient return on investment.
2. *Logistical*: Farmers need a guarantee of sale while the industries need a guarantee of delivery of products in the right rate.
3. *Technological*: Connection of requirements and possibilities for a technological and environmental acceptable processing technique.
4. *Acceptation*: All parties need to see advantages.

To make the whole chain possible there must be some kind of organisation that binds partners for production, specifications and prices.

The processing industry can be:

a) An investor owned firm. In this situation farmers cannot control the buyer market and are not assured to sale their hemp.

b) A cooperative farmers organisation of production and purchase of hemp.

In the last case farmers own a share which gives them a duty for a minimum production and a right for a maximum production. This enables them to make long term adjustments on the farm practice to produce hemp. At the same time the pulp processing plant is assured of product. Amount, quality and production technique of the delivered hemp can be managed by the organisation. Also production advise to the farmers, deliverance of seed and other production means can be centralised.

Since all details were not available after the 4 years of research, but the decision about go/no go had to be taken, a sensitivity analysis was performed. The effect of variations from -20% to +20% of investments costs, production costs, cost of hemp, cost of pulp, dollar exchange rate, process efficiency and production capacity on Pay Back Time and Return on Investment was calculated for different paper markets.

The project management has put the whole chain together in a business concept that has to be worked out by the industrial partners and farmers cooperative in a business plan. This plan contains cost and investment estimations, market possibilities, financing and the organisation. The final conclusion of the research is that with help of the nowadays available EU subsidy of Dfl. 1700,- per ha on the production of hemp it must be possible to introduce hemp as a new crop in agriculture in The Netherlands and to make paper of it in a profitable way.

Conclusion

Chain management has been a very helpful instrument in managing the research about the feasibility of producing hemp for fibre for paper pulp in The Netherlands, resulting in a 'go'/'no go' decision about on building a pilot plant. Two chains could be distinguished: The chain of the many research fields from seed production to the paper market and the chain of the three production processes of paper from hem: at the farmer, at the pulp processing plant and at the paper processing plant. The chain approach made interactions clear and made calculations and sensitivity analyses possible although all details were not available. The final conclusion of the research was that it would be possible to make paper from hemp in a profitable way. The following step now has to be the establishment of a business plan with which the industry really can start.

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The behaviour of firms in the Parmesan Cheese filière

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Introduction[1]

The aim of this paper is to analyze the behaviour of firms in the Parmesan Cheese (the correct brand name is 'Parmigiano Reggiano') filière. Parmesan Cheese (from now on indicated as PC) is a famous cheese (1) product in a typical territory of northern Italy, the 'typical zone', including the provinces of Parma, Modena, Reggio Emilia, Bologna and Mantova. The area extends over a million hectares, 90% of which is in Emilia Romagna region and includes mountain, hill and plain, each with particular climatic conditions and a specific typology of farms. Rigorous standards, established by law, determine the method used in the production of cheese (2).

The PC has been the subject of many studies in Italy because of a number of interesting economic and social factors: these studies began with a theoretical analysis of the determinants of demand, supply, market behaviour and have now developed in an analysis of filière. This sector has been one of the first in Italy that has been studied from a filère point of view, with a particular attention being paid to the different factors and agents that contribute to the production and improvement of the product.

The analysis of 'filière' moved from the requirement to overtake the traditional noclassical theory based on firm and sector. The innovation is that the subject of the analysis, the different agents, are considered as part the whole economic and social system.

The filière approach is connected to the idea of 'vertical integration' that comprehends all the stages from raw materials production to the final product. The filiere approach study the whole system of relationships between the agents (farm, firm, institutional subject, etc.) in their global environment.

Among the different theoretical meanings (studied by French authors: Arena, Rainelli and Torre, 1985) our case-study can be included in the interpretation 'Filière - Product'.

[1] The introduction and the conclusion has been discussed jointly by the authors. C. Giacomini is author of par. 3 and 4; P. Bertolini is author of par. 5., 6. and 7; C. Mora is author of 1 and 2.

Tab. 1: DOC and typical cheese (tons)

	1985	1990
Doc		
Parmesan Cheese	90972	109427
Grana Padano	83058	95132
Gorgonzola	38064	38541
Pecorino Romano	20000	27796
Asiago	12619	16603
Typical		
Provolone, Caciocavallo	41000	45000

Source: ISMEA (Institute for the study of agricultural markets)

The Parmesan Cheese

Today the production of PC represents 15% of Italian cheese market and more than 30% of the DOC and labels cheeses (Tab. 1), that represent about 75% of all cheese manufacturing in Italy; 75% of the milk used in the production of PC originats in Emilia Romagna (from now indicated as ER), the second most important region in milk production after Lombardy (respectively producing 20% and 35% of the national milk production).

PC is now protected by national and E.C. brand name that guarantees its origin and quality. As early as 1954 the 'Consorzio del Parmigiano Reggiano' (from now indicated as Parmesan Cheese Consortium, PCC), originated as a national body protecting the PC brand. Parmesan Cheese has the strongest market image in Italy and the largest consumption base, it is widely consumed across all regions of Italy, beeing integrated into the most traditional Italian dishes, such as 'pasta'.

In the market of hard cheeses, the granas are the most important. Besides PC, we must also mention Grana Padano, that is protected by a Consortium and by a DOC brand, too. Grana Padano is the most important competitor of PC because it is a direct substitute. The GP production zone is larger and includes almost all the northern regions of Italy.

Localisation and principal aspects on raw material sector

As noted before, the origin zone of milk for the production of PC is defined by low: provinces of Parma, Reggio Emilia, Modena and parts of Bologna and Mantova; the first four provinces are in Emilia Romagna, while Mantova is in Lombardy. Thus, the link between the production zone of PC and the source of raw material is very strong in Emilia Romagna area; about 75% of the milk produced in Emilia Romagna is processed into PC (Tab.2); in the mentioned four provinces (representing 80% of the farms and the cows of the region) almost the whole dairy production is directed to the PC, netherless in this area we have the most important processing milk factories.

Tab.2: Weight of milk produced for PC and total production in Emilia Romagna (ER)

	Milk produced in ER (000 q.li)	Milk produced in ER direct to PC production (%)
1985	17166.2	61%
1991	18228.0	75%

Source: calculation on ISMEA and Consorzio PC data

Tab. 3: Milk cows distribution in ER

	1982			1990		
	Farm	Milk Cows	(%)	Farm	Milk Cows	(%)
Mountain	8823	58698	(16)	5124	57883	(15)
Hill	8693	100872	(27)	5368	105158	(28)
Plain	13143	218464	(57)	7490	211395	(57)
Total	30659	378034	(100)	17982	374436	(100)

Source: calculation on ISTAT (Central Statistic Office) data.

In 1991 milk produced for PC in the 'typical zone' was about 16 million quintals, 14 million quintals of which were produced uniquely in the region ER. The milk produced in ER comes from many small (less than 20 hectares) family farms; many of them found in the disadvantages hill and mountain areas: 43% of total amount of cows is in these areas.

Recent studies pointed out a remarkable processes of reorganization, with a progressive concentration of cows in the largest farms especially in plain areas. In this respect, the data from the Third and Fourth Census of Agriculture underlined an acceleration of this process: in this short period, the number of farms in ER were reduced by 40%, passing from 30659 to 17982, and the average herd size passed from 12.3 cows in 1982 to 20.8 in 1991.

This reduction took place in different ways according to altitudinal zones: was particularly marked in the mountain and plain areas (-43%), while it was much smaller in the hill areas (-38%). Today 28% of the farms and only 15% of the milk cows are concentrated in the mountain areas, while in the hill areas we have 30% of the farm and 28% cows, and in the plain zones we have 42% of the farms and 57% of the cows (*Tab.3*).

As far as it concerns the distribution of cows in the various types of farms (Tab. 4), the small farms (with less than 20 cows) represent 66% of the total; the medium sized farms and large farms (20-49 and more than 50 cows) represent together the remaining 34% of the farms, but concentrate 75% of the cows. This phenomenon is becoming more intense in the last ten years: in 1982, infact, only 55% of the cows was concentraed in this second group of farms bred.

The number of small farms is particularly reducing in the plain areas, also they remain in the mountain areas where dairy farming constitues an important link between man and territory, an essential element in the protection of the natural environment and also an indispensable condition for the continuation of other economic activities.

Tab. 4: Distribution of dairy farm in ER region

	1982			1990		
	Farm	Cows	Average	Farm	Cows	Average
Dimension						
1-5	12764	37052	2.9	4336	12497	2.9
6-9	6514	46902	7.2	3016	22134	7.3
10-19	6523	85550	13.1	4582	62069	13.5
20-49	3714	105527	28.4	4378	128800	29.4

Tab. 4: Distribution of dairy farm in ER region (continued)

	1982			1990		
	Farm	Cows	Average	Farm	Cows	Average
50-99	846	54111	64.0	1243	80312	64.6
>100	298	48892	164.1	427	68624	160.7
Total	30659	378034	12.3	17982	374436	20.8

Source: calculation on ISTAT data

Tab. 5: Results of the programme of definitive abandoning of dairy production in ER (1984-1991)

Milk cows slaughtered	Disposable Milk
62032	q.1 2977536

Source: Assessorato Regionale Agricoltura

In the period between the two last Census of Agricolture, the drop in the number of cows has been slight, especially if we consider the six programme of definitive abandoning have been stenghtened (Regg. EEC 857/84 and 1546/88 recently modificated by Regg. EEC 1183/90 and 2138/90, national D.M. 8.11.84, D.M. 20.3.86, D.M. 21.12.87, D.M. 29.10.91) (Tab.5). The effects of these restriction of EEC policy in the production zone of PC are partially offset by a favourable milk price trend (3).

The positive trend in milk price and the increased productivity has mantained Emilian milk farmers' incomes at level superior to the average in agricolture. In the last 5 years the net income per hectare has been stable and family income per work unit increased.

The farms specialised in the production of milk (2/3 of their total output comes from milk) are 9435 (6% of the total farm) and they have a Standard Gross Income of 236000 ECU (8% of the regional one). The average economic dimension of these farms is about 20.9 UDE (25055 ECU), bigger than the regional average (16.6) (Tab. 6).

Tab. 6: Economic Indicators for ER dairy farm, 000 £ (1 DG = 880 £. in 1994)

	1986*		1990**	
	Average dairy farm	Average total farm	Av. dairy farm	Av. total farm
AUAA				
Average UAA	20.5	19.1	24,8	18.9
Utilised Agricultural Area				
Cows/UAA	2.6	2.1	2.5	2.4
Total Otput/UAA	6416	5070	7496	6618
Net Farm Income/UAA	3305	2517	3331	2971
Net Farm Income per Family Work Unit				
NFI/FWU	29362	22092	33521	27192

* Sample of 386 farm

** Sample of 206 farm

Source: calculation on FADN (RICA) accountancy data

Tab.7: Average size (in hectares) of dairy farm in ER

	Average size					
	Mountain		Hill		Plain	
	1982	1990	1982	1990	1982	1990
1-5	2.9	3.0	2.9	2.9	2.8	2.7
6-9	7.1	7.2	7.2	7.3	7.2	7.5
10-19	12.6	13.1	13.1	13.6	13.3	13.8
20-49	26.2	28.2	28.2	29.5	28.8	29.7
50-99	65.5	62.3	63.8	64.1	63.8	65.1
>100	151.3	131.1	145.8	147.5	169.6	167.1
Totale	6.7	11.3	11.6	19.6	16.6	28.2

Source: calculation on ISTAT data

In the last ten years a comparative enlargement of the farms has reduced the difference between ER region and Europe, while it remains a significant difference between ER and the rest of Italy, where the average dimension of the farms is smaller.

If we look at the ratio of milk cow to hectares, we find out that is bigger in the plain than in the mountain areas. The reduction of intensity in the disadvantaged areas brings attention to the natural environment and to the quality of the product, which depends on the cows' feed rations originated in the same area. A recent italian law allows the introduction of a quality brand for the disadvantaged areas of production. Unfortunately up to now there is not application on PC cheese.

Cheesemaking dairies

As we observed before, the farms that produce milk are closely linked to the cheesemaking dairies. This is evident from the large amount of milk producers' cooperatives (85% of the total). This link between cattle breeding farm and cheese dairy is one of the most particular aspects of the productive filière and has both advantages and disadvantages.

In the private cheese dairy the farmer buys the milk and processes it, with all the risks this entails. The cooperative cheese dairy, which is the most common in the area, processes milk of its members (breeders); the cheesemaking dairy has an average of 35 member-breeders supplying milk.

Tab. 8: Livestock intensity

	1982	1986	1990
Mountain	1.3	1.5	1.6
Hill	1.7	2.4	2.1
Plain	2.5	3.4	3.4

Source: calculation on FADN (RICA) data

Tab. 9: Distribution of cheesemaking dairies

	Private	Cooperative	Total
1955	729	1627	2356
(%)	31	69	100
1992	134	653	787
(%)	17	83	100

Source: calculation on 'Consorzio PC' data

Tab. 10: PC Cheesemaking dairies

	Emilia Romagna (%)		Total 'Typical zone'
1980	1.069	(90.7)	1.178
1985	898	(90.4)	993
1991	763	(91.2)	837

Source: calculation on PCC data

In the same way as milk, the cheese dairies are numerous in ER: 91% of the total is concentrated in this region. These 763 cheesemakins dairies are the highest number of productive units for the dairy sector, which is a very important sector of the whole regional economic system.

There are great differences between the structures of PC and the structures of milk for industrial processing, which have industrial production, while PC still retains traditional/artisan characteristics. This is evident if we compare the quantities of milk processed in the farms: 18000 quintals in the cheese dairies against an average of almost a million quintals in fresh milk.

Regarding the distribution of the cheese dairies, 2/3 of PC is now produced in the plains, and the rest is equally distributed among the hills and the mountains; the greatest number (278) is concentrated in Parma, followed by Reggio Emilia (212).

A great decrease in the number of cheese dairies has taken place since 1955, when PC was given the DOC brand; the 2300 units in the fifties have fallen to the current 800, with a strong restructuring process (Tab.11).

The farms that processed up to 12000 quintals of milk in 1985 represented about 50% of the total, while only 15 years before they represented more than 80%. The reduction has

Tab. 11: General data on restructuring process

	Cheesemaking farm	Production (q.li)	Average (q.li)
1955	2356	570000	242
1970	1652	762650	462
1980	1178	794832	675
1985	994	910000	915
1991	837	1062640	1270
1993	737	900000	1221

Source: calculation on PCC data

Tab.12: Milk processed (q.li) per cheesemaker dairies, 1993

	Plain	Hill - Mountain
Parma	19815	15009
Reggio Emilia	22861	14768
Modena	17478	11473
Mantova	25242	-
Bologna	20322	13751

Source: calculation on PCC data

been greatest in the plains than in mountains where there are many more limitations to the concentration, related to the distances between farm and cheese dairies. Currently, the Consortium rules state that the cheese dairy must be situated in a place central for the milk producers.

As we said before, the production capacity of each cheese dairy increased even if many big differences remain, especially between hill and mountain areas.

Moreover, these different typologies of firms and the provinces have evolved differently in the process of restructuration and concentration: so there is a bigger reduction in private structures, and between different provinces; Parma has the bigger drop in firms (-50%), followed by Reggio Emilia (35%), Modena (27%), Mantova (22%) and Bologna (18%). The current situation shows the prevalence of Parma and Reggio Emilia (65% of cheese dairies).

A strong variability in productivity is illustreted in an analysis of all the cheese dairies of Parma province, where the data show better performance by cooperatives.

Tab.13: Distribution of cheesemaking dairies by province

	1955	1992	Var.
Parma	560	266	- 294
Reggio Emilia	669	236	- 433
Modena	723	199	- 524
Mantova	301	67	- 234
Bologna	32	19	- 13

Source: calculation on PCC data

Tab. 14: Productivity per work unit in Parma province, 1991

Dimension	Mould yearly product per work unit				
	Cooperatives	Private	Mount.	Hill	Plain
< 8000 q.li	1626	748	1817	1691	933
8000 - 16000 q.li	1435	946	1160	1655	1533
16000 - 24000 q.li	1586	1356	1607	1868	1542
24000 - 36000 q.li	1585	1520	1479	1621	1612
> 36000 q.li	1448	1252	1500	1682	1402

Source: calculation on PCC data (one mould= 0.35 q.li)

The relationship between cooperatives and milk producers establishes fixed links between then and introduces some rigidities into the whole system, with much inefficiency especially in the use of equipment. We must consider that the system has already other rigidity problems because of difficulty in adapting equipment to the seasonal variability in the production.

If we consider the strategies of the cheese dairies up to now, their principal efforts have been the reorganization to a bigger scale; the most common dimension is still small, especially if compared to the producers of Grana Padano. This is the strongest competitor of PC and cheesemaking dairies equipment processes more than double the quantity of milk.

Another element becoming more and more important in the PC zone is attention to the quality, with the gradual introduction of the payement milk according to quality: the number of cheese dairies that adopted this strategy goes from 32% in 1984, to 41% in 1985, to 50% in 1990.

From this it is evident that the cheese dairies face many problems; we must also remember the undercapitalization (typical in cooperatives), low rotation in storehouses (that causes a lenghthening of the financial cycle and worses the liquidity of the invested capital).

From the analysis of the data of a sample of cheese dairies (all situated in Parma province and representing 33% of the total) we also notice that the current processing structure and the relationship between the agents of the filiere are more complicated than they appear. This is due to the fact that approximately 90% of the cooperative cheese dairies let out dairy collection and processing on contract to artisans ('casaro'). These artisans are paied according to the quantity of processed milk. The strategy of the contract is used less in small (< 8000 quintals of processed milk) or very large (>36000 quintals) cheese dairies.

Ripening and distribution

After the stages of milk processing and the connected operations, the cheese needs a long process of maturing, afterwards continued in adjoining store rooms.

This aspect of the production process has particular importance for product quality and needs heavy financial investment for the equipment of the storehouses, where the product must remain for the ripening period (18-20 months). It also needs a large amounts of capital because of the time lapse between production and selling.

So, from a technological point of view the maturing is a very important stage of the production process, while, from an economic point of view, it is the farthest stage from breeding and processing and differs from them both in dimensions and operative strategies. 70% of the cheese dairies have installation that are not large enough to contain their own output for maturing.

The most part (85%) of PC is distributed through a 'long channel'; with the intermediation of the wholesaler-seasoner between cheese dairy and consumer. The remaining PC is sold in farm shops annexed to the cheese dairies (direct channel) or conveyed to cooperatives and retail traders ('short channel'). In this way, the ripening stage of a great part of the production is mostly entrusted to farms external to the processing and of quite different types. They range from wholesalers who ripen the product directly before selling it to the complex structures of consortia, that collected cooperatives. These represent an important aspect (even if it is not big) because they connect production to ripening and

Tab. 15: Prices from cheese maker to seasoner (1), and prices fron seasoner to consumer (2), index 1982 = 100

	(1)	(2)
1984	144	150
1986	118	153
1988	143	161
1990	138	175
1992	127	173

avoid the speculations, that cause the cyclical crises typical of PC. Today 80% of the production of PC is seasoned in private structures, where the production of the cooperatives is also taken, while the consortia control only about 15% of the ripening. Private farms, as said before, is spread among many different subjects: there are more than 250 wholesalers, but 90% of the market is controlled by 1/5 of them.

The wholesalers-seasoners often turn to the store rooms of banking companies, from which they obtain a loan with 'pledge on product' with a slightly reduced rate interest. The seasoners' role is important because they have a strong market power that could frustrate the attempts of the producers to control the market fluctuations: for instance, because it could nullify the supply autoregulation policies that have been realized, with many difficulties, in order to stabilize market and prices (Tab.15).

On the other hand, the wholesaler-seasoners are the ones who take the risk of the ripening (in terms of final quality of the product) and the problems of tied up capital.

One of the biggest problems in the management of the wholesale-ripening farm is the fraction of the ageing and marketing costs, that vary considerably according to the dimension of the farm.

As it can be seen in the table, when the ripening firm is bigger, there is a variation in the ratios cost of cheese purchased / administrative costs, and in the costs of amortization.

Tab.16: % share of seasoning costs on the total costs

	Small 400-1000 mould	Medium 10000-35000	Big 35000-135000
Cost of cheese purchased	80	52	40
Amortization, storage costs	10	25	30
Labour cost	2	8	12
Administrative costs	8	15	18
Total	100	100	100

Source: calculation on balance sheet, 1991

Tab. 17: Distribution of PC (%),

	Cheesemaking dairies capacity		
	Total	Up to 12000 q.li	Over than 12000 q.li
2° degree Consortium	12.6	6.5	15.3
Modern distribution	1.7	1.6	1.8
Wholesaler	79.7	85.4	77.0
Retailers	1.1	1.3	1.1
Direct to the consumer	3.8	4.8	3.3
Others	0.9	0.4	1.5

Source: calculation on 'PC distribution' - Parma University, 1992- data.

Marketing mix

The majority of the cheese dairies sell their entire annual output production to the wholesaler-seasoners (Tab.16). So today PC distribution is mostly operated by the wholesaler-seasoner, who has at his disposal a distribution system of agents and small wholesalers.

As already said, the fact that most PC passes through the 'long channel' is due to the low concentration of production, and to the high number of selling outlets.

PC, like other hard cheeses, is a 'mature product', and its sales can increase only if it is diversified into different marketing typologies: grated, packed, etc. At present 77% of PC is distributed in moulds, 22% packed and 1% grated.

The positions of both traditional and modern retail traders towards 'grana' cheese are different. For the first it is a product with a fair margin, for the second it is strategic because of its healthy and genuine image. Both are interested in this product. Modern distribution wants to encourage self-service and offers consumers wide ranges of the product (vacuum-packed, grated, in pieces, and so on); it also sells cheese on delicatessen counter and aims to sell a product of constant quality. Traditional retail, on the other hand, aims essentially at price and is less interested in new formats of the product.

There are also different opinions on advertising. The cheese makers and seasoners don't use very much advertising, because the brand policies are almost absent, while the Consorzio of the PC organizes a large advertising action and is interested in the modern marketing strategies.

As far as merchandising is concerned, there are also different positions: the wide distribution is interested in advertising promotions and in control of the lay-out in the points of sale/retail outlets.

Tab. 18: Marketing typologies

	Retail store	Supermarkets	Large scale retail
1985	58	21	21
1990	48	24	28
1992	45	25	30

Source: calculation on 'PC distribution'-Parma University, 1992- data

Tab. 19: Cost structure of PC, % quotas on final prices, 1991

Milk		58.5
Processing costs	7.0	
Seasoning costs	13.9	
		20.9
Distribution costs		20.6
Price to consumers		100.0

Source: calculation on surveys data

At the moment PC doesn't organize particular merchandising promotions, while Grana Padano does.

The build-up of the final price through the filière is noticeable. The adoption of the 'short channel' would allow the producer to obtain a highier mark-up and would lower the price to consumer.

The strategic factors for the filierè

The demand

Demand for PC is linked to the demand for 'pasta'. PC in fact is consumed during the principal meal (as a condiment or ingredient or in pieces) and has no alternative ways of consuming, while other soft cheeses and dairy products can be also consumed as dessert or snacks, outside the principal meal (4). Consumption is seasonal: the highest is place in December-January, the lowest in August-September.

At present, the consumption of PC per capita is about 1.5 Kg, which is about 9% of the total consumption of cheeses.

Tab. 20: Way of consuming for PC (% of total consumers)

Ingredients or condiment	88%
Alternative uses:	
to finish lunch	19%
to finish supper	15%
supper main course	12%
lunch main course	9%
snack	4%
Total alternative uses	58%
Alternative uses of GP	75%

Source: calculation on Nielsen data

Tab. 21: Pro-capita consumption of cheese in 1993 (kg)

Parmesan Cheese	1.5	Grana Padano	1.4
Others grana	0.1	Asiago Montasio	0.5
Tot. hard cheese	4.2		

Source: Largo Consumo

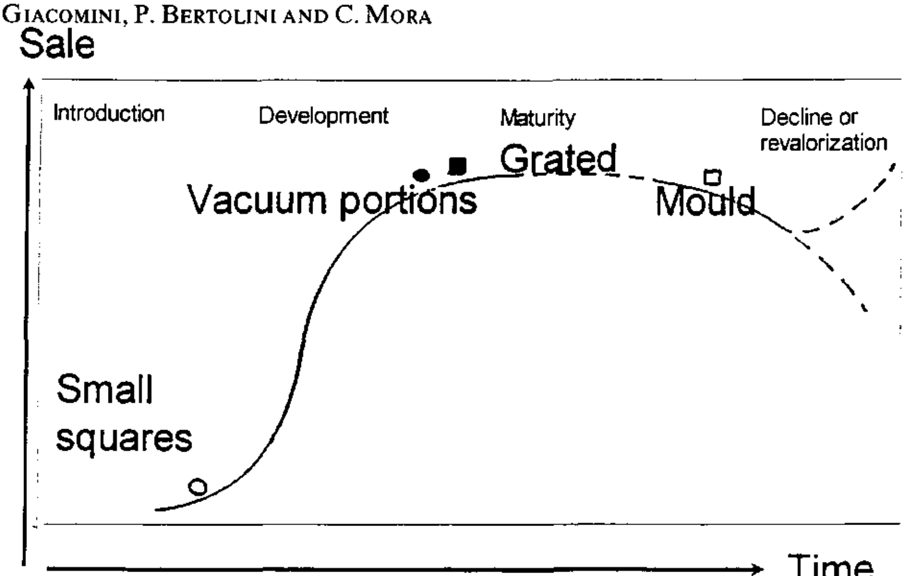

Figure 1. Life cycle of Parmigiano Reggiano

Household consumption represent about 60% of the total, while the remaining 40% is absorbed by catering (5). 95% of output is directed to home consumption, 5% to exportation, which is growing. In the past overseas demand was mainly constituted by emigrant' consumptions, nowadays the consumption of PC is spreading also in special occasions and festivities. The expansion of demand abroad is often prevented by the fact that PC is directed to very specific uses and in many countries there are no dishes that need grana as condiment or ingredient (pasta). It is not easy to diffuse the name 'Parmesan Cheese', which is difficult to remember abroad and is often confused with other granas, because of the same translation of their names into 'parmesan cheese'. Thanks to Reg.Cee 2081/92 that concerns the introduction of the denomination DOP 'denomination of protected origin', there is hope for better diffusion and protection of the name of PC.

Many recent studies show that the price elasticity of demand for PC is negative and inferior to the unity (it is lower than the GP elasticity); the income elasticity of demand for PC (greater than unity), as do other hard cheeses that must be grated, while the artisan and soft cheeses had less rigidity.

The sign of the cross elasticity of demand for PC with respect to changes in the price of GP is positive (the goods are direct substitutes).

The 'cyclical crisis' of PC

The 'PC cyclical crisis' (every 5-6 years) has been the subject of many studies.
The most important reasons for these cycles seem to be:

- small dimension of dairy farming (milk producers) and cheese dairy;
- fragmentation of social agents (farmers, cheesemakers, seasoners and retailers) who are responsable for the production and valorisation of PC.

Regarding the first reason, the deep division between farmers-cheesemakers and wholesaler-seasoners was indicated as the most dangerous causes of instability of the filiere. These facts demonstrate that a conflict still exists in the filière and it is not resolved by social solidarity.

This behaviour leads to a lack of transparency on the market, and increases the fluctuations due to the demand. The length of the response process makes it difficult to forecast the sales and prices and leads to speculative behaviour (the 'gap' between market and production decisions can be calculated from an annual analysis of retailer prices and consumer prices during the last ten years).

Some mechanisms have been introduced to manage these crises and to stabilize the market:

a) the attempt made to restructure the dairy farm and the cheesemaking dairies sector, to favour the adoption of scale economies;
b) supply limitation (fixing of a certain productive level, inferior to the equilibrium level) applied by all the cheese dairies together to keep up prices. Recently the Consorzio of the PC and the Consorzio of the Grana Padano agreed on a common action of supply limitation. This is very important because the two products are substitutes and the fluctuations of one affect the other.
   Up to now the self regulation hasn't been very successful because of the lack of unanimity in the decisions taken by some filière agents.
   Moreover, with the adoption of the milk quotas decided by the EEC, the productive self regulation would become useless.
c) to increase the intervention of the 'agricultural parties' in the seasoning and distribution of PC: this will mean more responsibility for the cheese makers' cooperative than now.
d) the 'quality payment' of milk has been introduced more recently. The opportunities for the future, considering also the bond of the milk quotas that (after a non-fulfilment by our country over many-years) will became effective, depend on a qualitative improvement of production and a better remuneration for milk, especially that produced in unfavourable areas.
e) Up to now, diversification of output in the cheesemaking dairies (for example soft-cheese) is not widespread. Diversification will be able to mantain producers and farmers' incomes during the crisis.
   The local solutions are supported by the ones decided at EEC level: public intervention have been realized by AIMA.

Briefly, new strategies are necessary to make the filière successful, to complete the integration and social 'agreements' between the agents who work, not only for the production but also for the improvement and image of PC cheese.

Institutional aspects:the 'Consorzio del Parmigiano Reggiano'

The 'Consorzio del Parmigiano Reggiano' (PC Consortium), which was founded in 1954, is the Association of the producers of the cheese. Its aims are to protect and promote the production and sale of PC cheese, as well as the use of the brandname; to further all initiatives meant to safeguard the established character and essential qualities of the product, to stimulate the demand for it, assist its sale and guarantee quality. Its activities range from the control of breeding farms and milk, to the marketing of the final product.

Since the Decree of June 17, 1957, the Consortium has been entrusted, in addition, with approval and branding of the cheese to certify its origin, and with the supervision of production and distribution. For the latter purpose the Consortium employs vigilance officers holding Public Safety qualifications.

The brand name PC applies exclusively to cheese which meets the requirements laid down and has the characteristics of the appropriate standard (Law n.125 passed on April 10, 1954 and Decree n.1269 of the President of the Republic, dated October 30, 1955), having been produced within the confines of the 'typical zone' (Decree n.667 of the President of the Republic, dated Agust 5, 1955). The milk of the 'typical zone' is a regional speciality to the genesis of which soil, climate, fodder vegetation, cattle-rearing traditions, and other environmental factors less easy to categorize, have contributed with especially happy results.

Since 1981 (DPR 22.81) the brand name PC has applied to packaged PC cheese portions and since 1992 to package grated PC cheese (DPR 8.4.92). (6)

A special stamp known as 'Export mark' is reserved to PC to be exported, its function is to certify the qualty of the product, and to facilitate the customer control. The purpose of this mark is to normalize and increase the process for certification of the quality of PC in international markets.

Conclusion

From our analysis we can deduce three type of considerations. The first concerns the convenience of using an analitic method based on the 'filiere approach'. Using the 'filière', we can pass over a merely sectorial and business point of view to pick out the strong and weak elements of the economic system taken as a whole. This global vision made it possible for us to notice that one of the weakest elements of the system is the typology of relationships between the different social agents of the filiere. For instance, the integration between the agents is very little during the last fase of the production (seasoning) and this fact weakens the whole system. We saw also that the conflict of interests between seasoners and producers, and the possibility for the first to speculate can enlarge market fluctuations. Moreover, the action of institutional agents (see Consortium) seems to be limited and unable to coordinate the various economic subjects. We should reflect upon these elements in order to introduce useful correctives and reinforce the coordinative action in the filière. But the analysis of filière presents the limits of an essentially descriptive kind of analysis, still without any theoretical base, alternative to the traditional one. Criticism against standard economics has developed the new idea of filière, but little progress has been made on a propositive level. Nothing new has been said about the theory of firm behaviour, while this problem should be considered attentively to introduce new analytic categories, different from the standards of neoclassical paradigm. So, for example, the strategy of reorganisation suggested by many local adiministrations and hypothesized on a theoretic level, is still giving priority to the strategies of enlargement of the firm dimension, and this is a clear structural typology of neoclassical models. Only very recently a very innovative approach has been introduced: it is based on the analysis of 'Funds and Flows'. This kind of analysis demonstrates that many rules of the agroindustrial production are very different from the rules of the manufacturing production centred on the large scale firm.

With our analysis, we see that in the production of PC the enlargement of the structures is accompained by a systematic under-utilisation of them and this causes diseconomies of scale. The analysis underlines that a vision centred only on the activity dimension is not sufficient; it is necessary to pay attention to the organisational and institutional aspects, that can play a very important role in finding successful and unsuccessful paths for the activity, both on microeconomics and macroeconomics levels. Similar considerations have been formulated also by the neoinstitutionalism, which is now subject on discussion in our country.

Other considerations concerned some operative indications that can originate from our filière approach. Our study has pointed out the problems of every relevant stage of the production. For example, we notice the existence of structural problems for farms and cheese dairies, that are in the process of reorganisations, especially in the last ten years. However, our study revealed the importance of the relationships between the various sections of the production chain: once more it become clear how important the organizational problems are, togheter with the institutional ones. The lasts are connected to the creation of synergies between the agents, in order to evidentiate the positive aspects of their complementarity and not the conflicts. From this point of view, an approach, even if substantially descriptive, comes more or less to the same conclusions as the more rigorous method of analysis 'Funds and Flows' and it is not very far from the neoinstitutionalism.

The last consideration concerns the intervention policies: at this level there are many difficult problems which need specific reflections, but are not the object of our present study. Now we have to notice, once again, how little attention is paid to the coordinative problems among the different agents, but also among the different instruments of agricultural policies, operating directly or indirectly in the sector and in the territory. In our country, very little attention has always been paid to the creation of sinergies among the different policies carried out. On the contrary, at the present moment, starting the riduction and reorganisation of public intervention, this aspects will be crucial; it is also due to the fact that the E.C. policy is giving new rigour and selection to the public intervention. Besides this, as we said before, the activity of the local administration is largerly directed to the enlargement of farms and cheese dairies, while few efforts have been done to strenghten the integration and collaboration between the agents of the filière. These actions began too late and are still limitated, because they consist almost only in the creation of the Consortia. This depends essentially from the private agents'cultural backwardness, that limits public intervention in this field; however, it may be also due to the public agents'inability of finding new ways (financial or other type) to promote a coordinative action. Finally. this kind of action is not easy, because of the sector specific characteristics, but these difficulties must not prevent us from trying to solve them.

Notes:

(1) The history of this cheese originates in the period of the Roman colonization in the Cisalpine region. According to the tradition,the place of origin of PC was between the actual provinces of Reggio and Parma. Nowadays the production zone includes not only this territory, but also the province of Modena and some parts of the provin-

ces of Bologna and Mantova. The word Parmigiano appears in 1300. Today the production technique of PC is still that used as in the past because of the use of traditional and artisanal methods and equipments (this production technique has been improved at the end of the XIX century).

(2) PC is a cheese made of cows milk, whose basic feeding is forage from field and alfalfa meadow-grass; the processing of the milk is established by Law (DPR 30.10.1955, DPR 15.7.1983 e DPR 9.2.1990).

(3) The milk price trend in Italy has been very favourable: in the period from 1984 to 1990 prices rose, instead of diminishing as happened in all the other countries of the EEC: the Italian dairy farmers received a high price than the indicative one fixed by the EEC (+28%).These values are unlikely to be the same in next years; however, in 1990 an opposite trend has already taken place: between 1990 and 1991 milk price fell by about 10% in ER. The price in ER was above the national average.

(4) The most recent data on cheese consumption in Italy showed an increase in the consumption of cottage, white and soft cheese with neutral taste; on the contrary, the consumption of savoury products and ripened hard cheeses shows a decrease.

(5) A recent study revealed that PC consumption has become habit in the families of North and Central Italy, with a greater diffusion in medium-large towns (>30000 inhabitants) and among families with high incomes. The penetration of PC into the consumptions of the families in Italy is about 80%. Almost 50% of the consumers use only PC.

(6) The PC is marked (the first mark) from top to bottom all the way around, during the 24 hours while the fresch curd is settling down in its wooden mould to assume the final shape of a cheese, a special matrix imprints the identifyng marks over its rind-forming surface. This mark registers the date of cheese production for the cheese making dairy. At a much later stage (after the complete ageing, after a full year) an oval mark (the second mark) engraved with heat is added on a patch left vacant for the purpose. This final stamp confirms the success of a year's work, faithfully carried out by the tradtional methods, and certifies the year of production.

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