

# Agro-industrial supply chain management: concepts and applications

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by

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## Preface

This publication was conceived as an introduction to the discipline of Supply Chain Management (SCM), with particular reference to the agro-industrial domain. It introduces fundamental SCM concepts and illustrates them with selected agrifood related cases from different regions of the developing and developed world.

SCM concepts are already consolidated as an essential part of modern management thinking. Its tools and techniques have helped companies in traditional areas such as manufacturing and retailing to achieve unprecedented levels of operational performance and efficiency in transaction coordination with suppliers and customers. Yet, the discipline is still rather incipient in the agrifood domain. While managerial literature abounds with textbooks and publications about SCM in general, publications specific to agrifood enterprises are few and far between. The present publication represents a contribution to fill this gap.

The text has been planned to constitute a basic reference source for agrifood professionals seeking information on this relatively new area of work. It should address not only the needs of the traditional audience of FAO publications - field project managers, extension officers, Non-Governmental Organization (NGO) personnel, officers at Ministries of Agriculture etc, but also managers of agroprocessing plants, agribusiness development service providers and others with professional responsibilities in agro-industrial enterprises and support services. The publication may also be used as reference reading for agribusiness management training purposes and academic programmes.



## Acronyms

ATP	Available To Promise
CIAT	Centro Internacional de Agricultura Tropical
CODP	Customer Order Decoupling Point
DP	Decoupling Point
DPP	Demand Penetration Point
DRP	Distribution Resource Planning
EDI	Electronic Data Interchange
EU	European Union
EUREPGAP	European Retailer Produce Good Agricultural Practices
FSCN	Food Supply Chain Networks
GAP	Good Agricultural Practices
GMP	Good Manufacturing Practices
HACCP	Hazard Analysis and Critical Control Point
ICT	Information and Communication Technology
JIT	Just In Time
KPI	Key Performance Indicator
MRP	Manufacturing Resource Planning
NGO	Non-Governmental Organization
PO	Producer Organization
SCC	Supply Chain Council
SCM	Supply Chain Management
SCOR	Supply Chain Operations Reference
SOP	Standard Operation Procedure
UHT	Ultra High Temperature
USA	United States of America



# 1. Introduction

Fierce competition in today's global markets and the heightened expectations of consumers have forced business enterprises to invest in and focus attention on, the relationships with their customers and suppliers. While the need for increased efficiency in enterprise operations persists, modern management thinking advocates the collaboration among business partners and the responsiveness to client needs as additional thrusts towards a successful competitive strategy. It is within this context that Supply Chain Management (SCM) has become part of the senior management agenda in western countries since the 1990s, particularly in the manufacturing and retailing industries. More recently, interest in SCM has also been growing in the agrifood industry, both in developed and developing countries. Just as their counterparts in manufacturing and retailing, executives of agrifood enterprises are becoming aware that successful coordination, integration and management of key business processes across members of their supply chains will ultimately determine their competitive success. Moreover, agrifood businesses increasingly realize that they no longer compete as solely autonomous entities. Instead, competition occurs more and more among entire supply chains.

The increased interest in SCM has also been spurred by developments in Information and Communication Technology (ICT) that enable frequent exchange of huge amounts of information among chain participants, for purposes of coordination. Consequently, there is a need and an opportunity for a joint approach of business partners towards the establishment of more effective and efficient supply chains. This is especially true in agrifood supply chains, because of shelf-life constraints of food and agricultural products and increased consumer attention to safe and environment/animal-friendly production methods.

Agrifood chains and networks play an important role in providing access to markets for producers from developing countries, as well as for local, regional and export markets. Changes in agrifood systems impact the ability of agro-industrial enterprises to compete; small and large alike will have to innovate and reduce costs, while being more responsive to consumer needs. This is where SCM can help.

This paper introduces the concept of SCM and illustrates its applications in agro-industries, with a focus on developing countries. It presents an overview of the background and theory of SCM, drawing particularly from management thinking related to industrial supply chains that produce, trade and distribute merchandise. It also discusses current practices of SCM. The paper starts with an overview of SCM in the western world and then focuses on the specific characteristics of the developing world and on what can be learned. The paper will discuss a number of cases in order to make the lessons learned understandable and applicable to the reader's particular situation. The paper will also explore the concept of a 'supply chain', discuss its potential performance constraints and suggest improved approaches.



## 2. The global agrifood system

A number of recent trends that include globalization, urbanization and agro-industrialization, are placing increasing demands on the organization of agrifood chains and networks. Food and agribusiness supply chains and networks – which tended to be primarily characterized by autonomy and independence of actors – are now rapidly moving towards globally interconnected systems with a large variety of complex relationships. This is also affecting the ways in which food is produced, processed and delivered to the market. Perishable food products can nowadays be shipped from halfway around the world at fairly competitive prices. Demand and supply are no longer restricted to nations or regions, but have become international processes. The market exerts a dual pressure on agrifood chains, forcing improved coordination among buyers and sellers and continuous innovation. The latter encompasses the development and implementation of enhanced quality, logistics and information systems. Companies have to satisfy the increasing demands of consumers worldwide, Non-Governmental Organizations (NGOs) and other actors in the agrifood chains, and must react to changing government regulations. In the western world, companies nowadays have to obtain a ‘licence to produce and deliver’, that is, society has to accept the way they produce and deliver their goods. If this is done by using questionable methods, for example child labour, environmental pollution, etc, their products will not be accepted. In a global agrifood system, companies have to work continuously on innovations in products, processes and forms of cooperation. Further classical

### **Box 1. The importance of chain quality control**

The autonomy and independence of international food supply chains is shifting toward interconnected systems with a large variety of complex relationships. Changes in sourcing, producing and marketing as a result of the increased globalization of food trade, leads to exposure to new risks and greater potential consequences of food-borne illness outbreaks. During the last decade, concerns about food quality and food safety have risen among consumers. Several sector-wide crises, like the BSE crisis, dioxin crisis, classical swine fever and foot and mouth disease in Europe have fuelled these concerns. Consumers in industrialized countries have become more aware of potential food hazards through greater media coverage. National and international regulations and legislation in the area of quality and safety of food are set up by national and international regulatory agencies. For example in January 2005, the European Union introduced the General Food Law, demanding more stringent quality assurance and traceability of products. Food quality and food safety have also become an integral element of most wholesalers’ and retailers’ business strategies. These developments indicate that business strategies must now pay attention not only to traditional economical and technological aspects, but also to topics like the safety, healthfulness, taste, nutritional benefits and freshness of food products; at the same time, shifting from mainly bulk production towards production of special foods with high added value. Furthermore, new tight partnerships with other parties become important for all businesses to achieve safe and high quality food for consumers. Obviously, these developments will change the position and role of all parties and other stakeholders in international food supply chains.



issues such as price and quality are more important than ever, since consumers can now choose from an increasing number of products offered by competing chains.

The increasing integration of local and cross-border agrifood chains can be considered both a threat and a challenge for agricultural and rural development. Poor farmers in developing countries, who have limited resources and scarce access to markets and information, meet major constraints in the adoption of technological innovations and may therefore be excluded from trade. Economies of scale in processing, transport and distribution also lead to demands for growing volumes of production and for stable delivery capacities of homogeneous quality. These demands can be met better by commercially oriented, larger scale farm enterprises. On the other hand, smallholder production could offer cost advantages for farming enterprises based on labour-intensive products that require strong quality supervision. Wherever a competitive advantage as such can be identified, the involvement of family farmers into global agrifood chains can be pursued as a suitable strategy for ensuring a more equitable configuration of agrifood chains. Yet, bridging the gaps between local economic development and global chain integration calls for the emergence of new institutional and organizational networks that enable producers in developing countries to meet business requirements and trade standards. It also requires a fundamental reorganization of information streams and agency relationships, providing opportunities to smallholders to adjust their supply to consumers' demands and to become a recognizable part of global sourcing regimes. As we will later see, this reorganization is a task for which SCM principles have much to contribute.

The rapid growth of supermarkets (see Box 2) in both developed and developing countries deeply transforms the institutional landscape of agrifood production and exchange systems. Major challenges regarding how to guarantee the involvement of smallholder producers in these new and more demanding sourcing networks need to be addressed. Attention should also be given to the institutional requirements that enable smallholders to meet the more stringent food safety and quality regulations.

#### **Box 2. The rapid rise of supermarkets in developing countries**

Consumers in developing countries purchase an increasing share of their daily food through supermarket chains. Retail sales of fresh products, through supermarkets, already represent 2-3 times the size of agricultural exports. The supermarket share in food retail is estimated between 40 and 70 percent in Latin America and Asia and 10-25 percent in Africa, and increasingly involves middle- and working-class segments of the population in (peri-)urban and even rural regions. Supermarket procurement regimes for sourcing of fruits, vegetables, dairy and meat strongly influence the organization of the supply chains. The market requires product homogeneity, continuous deliveries, quality upgrading and stable shelf-life. Procurement reliance on wholesale markets is rapidly being replaced by specialized wholesalers, subcontracting with preferred suppliers and consolidated purchase in regional warehouses. These supply chains, which once were largely governed by less formal and often ad-hoc relations between buyers and sellers, are now closely coordinated and 'managed' by their lead players, the supermarkets. In other words, supermarkets thus increasingly control downstream segments of their chains through contracts, private standards and sourcing networks.

Source: Reardon and Timmer (2006)

Developing countries are becoming more and more integrated in the global food market due to the global sourcing of western retailers and food industries and to the increase of consumer demand in western countries for year round supply of exotic products. A consumer that visits a supermarket in Rome, Italy or Amsterdam in the Netherlands, can find papayas from Brazil, special coffees from Tanzania, beef from Argentina, mangoes from India or rice from Thailand, among many other imported foods from a diverse number of developing countries. This means, however, that developing countries must adapt to the stringent quality and safety standards and regulations in these markets. They must also gain better control over production, trade and distribution of their agricultural products in order to guarantee traceability and operate in a cost-effective way, so as to compete in the global market. One important barrier for developing country producers in this respect is the lack of an enabling environment (institutions, support services and infrastructure facilities). For example many countries lack adequately skilled people and laboratory facilities, which make good quality management difficult.

All these developments put dynamic requirements on the performance of the agrifood system, thus triggering a reorientation of companies with regard to their roles, activities and strategies, both in developed and developing countries. There is a need for SCM to cope with these changes and this cannot be done by one party itself. Cooperation is needed to fulfil market demands for responsive, low cost and high quality deliveries.



## 3. What is a supply chain?

### 3.1 Definition of a Supply Chain

In this chapter we take a process view; we look at a Supply Chain as a sequence of (decision-making and execution) processes and (material, information and money) flows that aim to meet final customer requirements, that take place within and between different stages along a continuum, from production to final consumption.<sup>1</sup> The Supply Chain not only includes the producer and its suppliers, but also, depending on the logistic flows, transporters, warehouses, retailers, and consumers themselves. In a broader sense, supply chains include also new product development, marketing, operations, distribution, finance and customer service.

**Figure 1. Schematic diagram of a Supply Chain (shaded) within the total Supply Chain network**

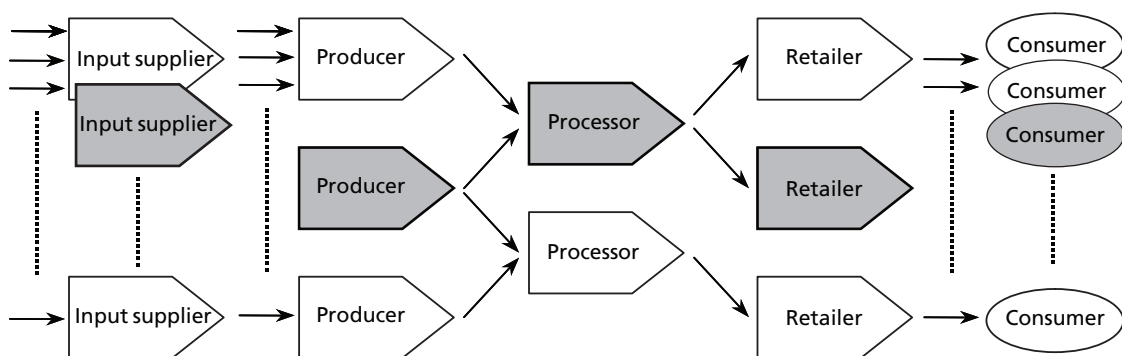


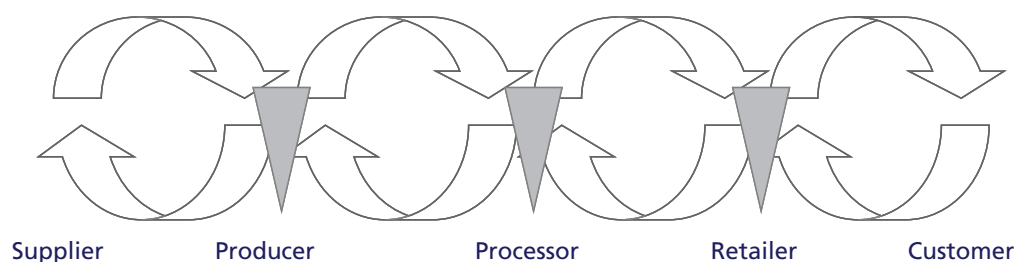
Figure 1 depicts a generic supply chain. It is shown within the context of what is usually referred to as a ‘total Supply Chain network’. In such a network, each firm belongs to at least one supply chain; i.e. it usually has multiple suppliers and customers. A milk producer, for instance, obtains inputs such as feeds and veterinary medicines from a number of different suppliers. He or she delivers milk to one or more processors, who in turn, distribute the processed products through one or more retail outlets.

One traditional view of a Supply Chain is the so-called ‘cycle view’. In this view, the processes in a Supply Chain are divided into a series of cycles, each performed at the interface between two successive stages (Figure 2). Each cycle is decoupled from other cycles via an inventory, so it can function independently, optimize its own processes and is not hindered by ‘problems’ in other cycles. As an example, we may think of a cycle where retailer

<sup>1</sup> Although some authors attempt to differentiate the concept of a ‘SC’ from that of a ‘value chain’ (e.g. Hobbs *et. al.*, 2000), the terms are more often considered interchangeable. While we do not differentiate the concepts in this text, we will use ‘SC’ throughout, as this is the most common terminology used in the SCM field.

inventories are replenished by delivering products from a processor's end-product inventory. Another cycle takes care of replenishing the processor's inventory, by the production of new end-products. A cycle view of the Supply Chain clearly defines the processes involved and the owners of each process and their roles and their responsibilities. Although this might seem a satisfactory situation, the next section will discuss some negative effects from a Supply Chain perspective.

**Figure 2. The traditional view of supply chain processes: cycles (the triangles represent inventories of products)**



### 3.2 Performance problems in the traditional supply chain: the 'bullwhip effect'

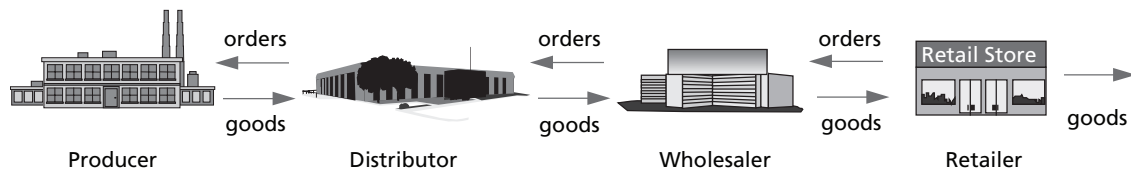
To illustrate the challenges and complexities of managing a supply chain, we will use the 'Beer Distribution Game' as an example. This is a classical management game developed at the prestigious Massachusetts Sloan School of Management in the USA. Managers and students are provided with an insight into the consequences of managerial actions taken independently by the actors of the successive stages of a supply chain. It provides an effective means of illustrating the impact of a Supply Chain view on overall systems performance and it is often referred to in SCM literature as the starting point of Supply Chain research.

The Beer Distribution Game is a role-playing game in which the participants are expected to minimize the costs of a supply chain by managing inventory levels in a number of production and distribution operations associated with different chain stages. The game consists of four supply chain stages: producer, distributor, wholesaler and retailer (Figure 3).

Players are assigned to each of the different stages. At the beginning of the game, each stage has its own small buffer stock of beer to protect it against random fluctuations in final consumption. A player needs to fill the orders received from his or her direct customer and then decide how much needs to be ordered from his or her supplier. The game is designed so that each stage has good local information (customer orders and inventory levels), but severely limited global (chain) information about inventory levels and orders of other actors in the chain. It represents the 'cycle view' just presented previously. This means that only the retailer knows real consumer demand. In the game, it takes two weeks for an order to reach the supplier and two weeks for the supplier to ship the requested amount of beer from one stage to the next. It is not possible to cancel orders. Stock-out costs (i.e. having no stock, which can lead to loss of customers) are considered twice as high as the weekly

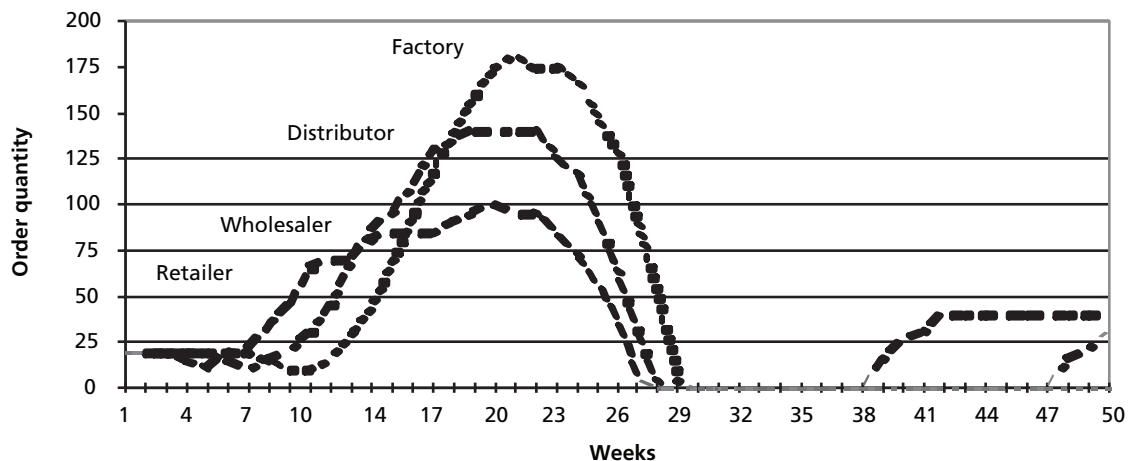
inventory carrying costs. The objective of the game is to minimize the total sum of costs of all players in the beer supply chain. Yet, the players make their decisions independently, guided only by their perception of retail demand, as indicated by the orders they receive from their customers.

**Figure 3. The beer supply chain**



The results of this game, after a simulated 50 weeks of play, are always remarkable. Although the game concept establishes that consumer demand remains stable for a number of weeks, then grows and continues stable for the rest of the simulation period, huge order fluctuations and oscillations take place in the supply chain. One period a player receives orders for high volumes, the next period low volumes of beer are ordered. Usually when playing the game, the producer receives demand patterns with 900 percent amplification compared to end consumer demand fluctuations (Figure 4). Furthermore, during the game huge stock-outs occur at the retail level.

**Figure 4. Ordering patterns showing the Forrester or 'bullwhip effect'**



Even when this game is played by different people (students or managers) following the same structure, similar results are produced. Although the participants act very differently as individuals when ordering inventory, the overall (qualitative) patterns of behaviour are still the same; oscillation and amplification of order patterns and a phase lag in reaction time, resulting in bad delivery performances and high costs. The further upstream an action is in the supply chain, the larger the variation in its demand.

This phenomena, in which orders to the supplier tend to have larger variance than orders from the buyer, is called the 'Forrester effect' named after the researcher who discovered it. It is also called the 'Bullwhip effect', named for the variations in reaction down the length of a whip, after it has been cracked. The distortion propagating upstream in an amplified form (i.e. variance amplification). The effect has serious cost implications and illustrates the importance of coordination among actors in a supply chain. The increased variability in the order process; (i) requires each facility to increase its safety stock in order to maintain a given service level; (ii) leads to increased costs due to overstocking throughout the system; (iii) can lead to an inefficient use of resources, such as labour and transportation, due to the fact that it is not clear whether resources should be planned, based on the average order received by the facility or based on the maximum order. Furthermore, material shortages can occur due to poor product forecasting.

### **Box 3. Mindset behind the 'bullwhip effect'**

The game is deceptively simple compared to real life. All you have to do is meet customer demand and order enough from your own supplier to keep your inventory low while avoiding costly backlogs. There are no machine breakdowns or other random events, no labour problems, no capacity limits or financial constraints. Yet the results are shocking. So what is causing these results that can be found in real life practice in every supply chain?

When customer orders increase unexpectedly, retail inventories fall, since the shipment delays mean deliveries continue for several weeks at the old, lower rate. Faced with a growing backlog, people must order more than demand, often trying to fix the problem quickly by placing huge orders. If there were no time delays, this strategy would work well. But in the game and in practice, these large orders stock-out the wholesaler. Retailers don't receive the beer they ordered and grow increasingly anxious as their backlog worsens, leading them to order still more, even though the supply pipeline contains more than enough. Thus the small increase in demand at the retailer is amplified and distorted as it is passed to the wholesaler, who reacting in kind, further amplifies the signal as it goes up the chain to the factory. Eventually, of course, the beer is brewed. The players cut orders as inventory builds up, but too late - the beer in the supply line continues to arrive. Inventories always overshoot, peaking at an average of about forty cases.

This pattern can be found anywhere in practice; small changes in demand from customers, result in bigger changes in demand to suppliers. One of the main causes as we will see is 'reducing decision-making uncertainties'.

### **3.3 Causes of the 'bullwhip effect' and potential solutions**

The problem that emerges in the beer distribution game is also frequently observed in real life and it is not caused by external factors, e.g. consumer demand, but created by the independent actors of the supply chains themselves. The main causes are the perceived demand, the quality of information and the inherent delays that may be found within the supply chain. In sum, the lack of adequate coordination among chain actors is directly associated with poor chain performance. In the game, as in many cases in real life, there is no timely information on changes in demand and one has to deal with a long lead time between placing an order and receiving the products.

Because of this long lead time, the reaction time is too long; in the game it takes over four weeks to respond to sudden changes in demand. This also leads to ‘misperceptions of feedback’, i.e. people tend to disregard the inventory in the pipeline they ordered earlier and keep on ordering more.

Several redesign strategies are proposed to reduce the problem of demand amplification and improve supply chain performance. In one way or another, they all show the importance of better coordination:

- Eliminate all ‘time delays’ in goods and information flows from the supply chain; this can be achieved by better planning and better use of ICT and improved logistics
- Exchange ‘information’ concerning true market demand with parties upstream in the supply chain; again, ICT and collaboration among chain partners are key issues
- Remove one or more intermediate ‘echelons’ in the supply chain by business take-over; the so-called ‘vertical integration’, where activities in one stage (e.g. production) are absorbed by another (e.g. processing) is an example of this strategy
- Improve the ‘decision rules’ at each stage of the supply chain: modify the order quantity procedures or their parameters using information from the supply chain. Chain partners can develop contracts and/or establish parameters, standards or procedures to facilitate and streamline their transactions.

Current research shows that the ‘bullwhip effect’ is still present in all kinds of supply chains in the western world (food, health, insurance, and so on), which gives some indication that also in the developing world there is much to improve. Current designs of supply chains are still causing inefficiencies and inflexibility. To improve supply chain performance, a new way of managing the supply chain is required that focuses on the alignment of supply chain processes, i.e. SCM.



**Box 4. Chain collaboration in horticulture in the Netherlands**

Nowadays, consumers and retailers demand a varied assortment of floricultural products and a year-round supply of top quality produce, all at a reasonable price. To meet growing consumer demands, the horticultural chains will have to be reversed from product-oriented (push) to market-oriented (pull). A consumer-driven chain can only be successful if the chain is organized in a flexible, efficient and responsive way. In order to speed up the flow of goods throughout the chain, from the grower to the retailer or florist, new logistical chain concepts have been developed in the project 'Shortened Fresh Collection'. These new concepts were inspired by the need to deliver more frequently, in smaller batches\* and within a lead time shorter than the current 27 hours.

The project aimed at optimizing the logistical processes of the ornamental plant cultivation network in Bleiswijk, the Netherlands. The objective was to clarify and significantly reduce the lead time of the product range for a supply chain, from the moment the exporter places an order to the time of actual delivery to the exporter's premises. Participants in the project were FloraHolland Flower Auction, growers, a large wholesaler and carriers. Via chain analysis, simulation of logistical flows and a pilot study, new logistical chain concepts were tested in practice and evaluated on environmental burden, feasibility, total costs and lead time. The results showed that lead times could be significantly decreased at lower costs. It requires: (1) the use of electronic ordering systems; (2) reduction of waiting times in the supply chain, especially a change in the working methods of growers; (3) collaboration in the transport of plants from specific regions.

The project showed that 'people make the difference' in vertical chain partnerships. Time is needed to build trust and to create commitment between the successive links in the chain. It requires the use of tools; for example workshops with partners, chain performance measurements, agreements on responsibilities and the division of costs and revenues. In the project, trust between partners in the chain has grown significantly. Especially the understanding of each other's role, added value and gains for chain cooperation lead to a common competence to act as a whole. The chain as a whole has changed their way of working, from a daily trade operation being concerned with daily prices and orders, into a long term partnership in which joint consumer concern is leading and supply performance is under control. This should be followed by scaling up and developing a universally applicable solution with which to reduce the lead times of an ornamental plant cultivation cluster.

\* A batch is a quantity produced together showing the same identifying characteristics such as production date and process parameters

## 4. What is supply chain management and why is it important?

The term ‘Supply Chain Management’ is relatively new. It first appeared in logistics literature in the 1980s, as an inventory management approach with emphasis on the supply of raw materials. Logistics managers in retail, grocery, and other high inventory industries began to realize that a significant competitive advantage could be derived through the management of materials that flow in their ‘inbound’ and ‘outbound’ channels. The managerial literature in the area of purchasing states that “SCM evolved from an upgrade of the purchasing function to an integral part of the corporate planning process”. Since its introduction in the retailing and manufacturing industries, the supply chain concept has spread to other industries, including the agrifood sector.

### 4.1 Definition of supply chain management

In the early 1990s, academics first described SCM from a theoretical standpoint to clarify how it differed from more traditional approaches to managing the flow of materials and the associated flow of information (Christopher, 1998). We define SCM as follows:

*SCM is the integrated planning, implementation, coordination and control of all business processes and activities necessary to produce and deliver, as efficiently as possible, products that satisfy market requirements.*

In section 3.1 we defined a ‘supply chain’ as a series of physical and decision-making activities connected by material and information flows and associated flows of money and property rights that cross organizational boundaries. Under this view, the supply chain does not include only the producer and its suppliers; depending on the logistical flows it also considers processors, transporters, warehouses, retailers, service organizations and consumers.

In the definition of SCM, a ‘business process’ can be seen as a structured, measured set of activities designed to produce a specified output for a particular customer or market. Next to the logistical processes in the supply chain, which include activities such as operations, inventory management and distribution, we distinguish business processes such as those associated with new product development, marketing, finance, and customer relationship management.

Finally, ‘value’ is here understood as the amount consumers are willing to pay for what a company provides. It can be measured by the total revenue of a company. The concept of ‘value-added activity’ typically characterizes the value created by an activity in relation to the cost of executing it.

More recently, the value concept has been expanded. We now can also refer to values associated with the so called ‘Triple P’: People, Planet and Profit (or Prosperity). So, in addition

to the financial performance, also the social and environmental dimensions are incorporated in performance evaluation. These latter two lead to attributes that are generally associated with the product itself, the companies producing it and the raw materials and the resources used. For example a food processing company may develop a reputation for its concern with environmental sustainability, either because it uses agricultural inputs that are produced without pesticides or because its packaging is made of recyclable materials, among other reasons. It may also be perceived as socially responsible, because it combats child labour and/or supports community development. These properties are then inherited and associated by all products produced and delivered by the food processing company.

SCM distinguishes itself from classical managerial approaches in many aspects, as illustrated in Table 1 below.

**Table 1. Contrasting supply chain management with traditional management**

<b>Element</b>	<b>Traditional Management</b>	<b>supply chain Management</b>
Inventory management approach	Independent efforts	Joint reduction in channel inventories
Total cost approach	Minimize firm costs	Channel-wide cost efficiencies
Time horizon	Short-term	Long-term
Amount of information sharing and monitoring	Limited to needs of own current transactions	As required for planning and monitoring purposes
Amount of coordination of multiple levels in the channel	Single contact for the transaction between channel pairs	Multiple contacts between levels in firms and levels of channel
Joint planning	Transaction-based	On-going
Compatibility of corporate philosophies	Not relevant	Compatible at least for key relationships
Breadth of supplier base	Large to increase competition and spread risk	Small to increase coordination
Channel leadership	Not needed	Needed for coordination focus
Amount of sharing of risks & rewards	Each on its own	Risks and rewards shared over longer term
Speed of operations, information and inventory flows	'Warehouse' orientation (storage, safety stock). Interrupted by barriers to flows. Localized to channel pairs	'Distribution Centre' orientation (focus on turnover speed). Interconnecting flows; JIT, Quick Response across the channel

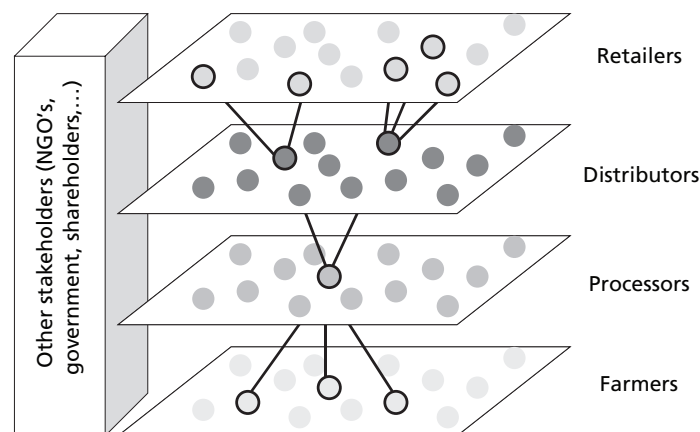
Source: Cooper and Ellram (1993)

## 4.2 Food supply chain networks

As we mentioned earlier, supply chains seldom exist without being part of more complex networks. Figure 5 depicts a generic supply chain at the organizational level within the context of a complete supply chain network. Each firm is positioned in a network layer and belongs to at least one supply chain, i.e. it usually has multiple (varying) suppliers and customers at the same time and over time. Other actors in the network influence the performance of the chain,

so that what happens in transactions between two companies does not solely depend on the two business partners involved, but also on the outcomes of other relationships within the chains and networks. Therefore, the analysis of a supply chain should ideally take place or be evaluated within the context of the complex network of food chains, in other words within the context of a Food supply chain Network (FSCN). This is often a fairly complex task.

**Figure 5. Schematic diagram of a supply chain from the perspective of the processor (bold flows) within the total Food Supply Chain Network (based on Lazzarini *et al.*, 2001)**



In a FSCN different companies collaborate strategically in one or more areas while preserving their own identity and autonomy. As stated, in a FSCN more than one supply chain and more than one business process can be identified, both parallel and sequential in time. As a result, organizations may play different roles in different chain settings and therefore collaborate with differing chain partners, who may be their competitors in other chain settings. In brief, chain actors may be involved in different supply chains in different FSCNs and participate in a variety of business processes that change over time and in which dynamically changing vertical and horizontal partnerships are required.

### 4.3 Specific characteristics of food supply chain networks

An agrifood system comprises organizations that are responsible for the production and distribution of vegetable or animal-based products. In general, we distinguish two main types:

1. 'Agrifood chains for fresh agricultural products' (such as fresh vegetables, flowers, fruit). In general, these chains may comprise growers, auctions, wholesalers, importers and exporters, retailers and speciality shops and their input and service suppliers. Basically, all of these stages leave the intrinsic characteristics of the product grown or produced untouched. The main processes are the handling, conditioned storing, packing, transportation and especially trading of these goods.

2. 'Agrifood chains for processed food products' (such as portioned meats, snacks, juices, desserts, canned food products). In these chains, agricultural products are used as raw materials for producing consumer products with higher added value. In most cases, conservation and conditioning processes extend the shelf-life of the products.

Participants in both types of chains, e.g. farmers, traders, processors, retailers, etc, understand that original good quality products can be subject to quality decay because of an inadequate action of another participant. For example, when a farm leaves a can of milk for pick-up on a roadside, under the sun, without any cover, there will be a loss of quality that may even render the raw material unfit for processing. If processors, on the other hand, use packaging items and/or technologies that do not maintain freshness and nutritional characteristics of their products as much as possible, retailers will be likely to face customer complaints. A list of specific process and product characteristics of FSCNs is summarized in Table 2 and categorized by their potential stage in the supply chain. It is clear that each characteristic has an impact on the way the logistical processes are organized.

Due to specific characteristics of food products, the partnership principles in SCM have already received a lot of attention over the past years in FSCNs. It is vital for industrial producers to contract suppliers to guarantee the supply of raw materials with the right volume, right quantity, right quality, at the right place and at the right time. Furthermore, they coordinate the timing of the supply of goods with suppliers to match capacity availability.

**Table 2. Overview of the main characteristics of Food Supply Chain Networks and their impact on Logistics and Information and Communication Technology**

supply chain stage	Product and process characteristics	Impact on Logistics and ICT
Overall	<ul style="list-style-type: none"> <li>• Shelf-life constraints for raw materials, intermediates and finished products and changes in product quality level while progressing the supply chain (decay)</li> <li>• Recycling of materials required</li> </ul>	<ul style="list-style-type: none"> <li>• Timing constraints</li> <li>• Information requirements</li> <li>• Return flows</li> </ul>
Growers / Producers	<ul style="list-style-type: none"> <li>• Long production times (producing new or additional products takes a lot of time)</li> <li>• Seasonality in production</li> <li>• Variability of quality and quantity of supply</li> </ul>	<ul style="list-style-type: none"> <li>• Responsiveness</li> <li>• Flexibility in process and planning</li> </ul>
Food processing industry	<ul style="list-style-type: none"> <li>• High volume, low variety (although the variety is increasing) production systems</li> <li>• Highly sophisticated capital-intensive machinery leading to the need to maintain capacity utilization</li> <li>• Variable process yield in quantity and quality due to biological variations, seasonality, random factors connected with weather, pests, other biological hazards</li> <li>• A possible necessity to wait for the results of quality tests</li> <li>• Alternative installations, alternative recipes, product-dependent cleaning and processing times, carry over of raw materials between successive product lots, etc.</li> <li>• Storage buffer capacity is restricted, when material, intermediates or finished products can only be kept in special tanks or containers</li> <li>• Necessity to value all parts because of the complementary nature of agricultural inputs (for example, beef cannot be produced without the co-product hides)</li> <li>• Necessity for lot* traceability of work in process due to quality and environmental requirements and product responsibility</li> </ul>	<ul style="list-style-type: none"> <li>• Importance of production planning and scheduling focusing on high capacity utilization</li> <li>• Flexibility of recipes</li> <li>• Timing constraints, ICT-possibility to confine products</li> <li>• Flexible production planning that can handle this complexity</li> <li>• Need for configurations that facilitate tracking and tracing</li> </ul>
Auctions / Wholesalers/ Retailers	<ul style="list-style-type: none"> <li>• Variability of quality and quantity of supply of farm-based inputs</li> <li>• Seasonal supply of products requires global (year-round) sourcing</li> <li>• Requirements for conditioned transportation and storage means</li> </ul>	<ul style="list-style-type: none"> <li>• Pricing issues</li> <li>• Timing constraints</li> <li>• Need for conditioning</li> <li>• Pre-information on quality status of products</li> </ul>

Source: Van der Vorst *et al.*, 2005

\* A lot or a batch is a quantity produced together sharing the same identifying characteristics such as production date and process parameters.



## 5. Supply chain management and logistics

In this section we discuss in more detail logistics. This in order to be able to understand the content and context when designing and innovating logistical systems. We first give a definition of logistics, then discuss logistical activities and the trade-off between efficiency and responsiveness and then discuss performance management.

### 5.1 What is logistics?

We start with a definition of logistics that is based on the one proposed by the Council of Logistics Management, demonstrating that logistics is a part of SCM;

*Logistics is that part of the supply chain process that plans, implements and controls the efficient, effective flow and storage of goods, services and related information from the point-of-origin to the point-of-consumption in order to meet customer requirements and satisfies the requirements imposed by other stakeholders such as the government (new rules and regulations such as the General Food Law) and the retail community (e.g. Global Food Safety Initiative)*  
(Cooper *et al.*, 1997)

Included within this definition are aspects such as customer service, transportation, storage, plant site selection, inventory control, order processing, distribution, procurement, materials handling, return goods handling and demand forecasting. In addition, aspects of product development, such as package design variations and associated product labels are also important.

Historically, logistics has been considered an issue deserving modest priority in organizations; it was merely regarded as a cost component. Nowadays logistics is seen as a value-adding process that directly supports the primary goal of the organization; being competitive in terms of high levels of customer service. It also enables competitive price, quality and compliance with rules and regulations, in order to satisfy extensive qualitative service and information requirements imposed by consumers and other stakeholders of the supply chain. Finally logistics allows for flexibility in responding to market demands.

In the agrifood sector in particular, efficient logistics is a crucial element for achieving enterprise and industry competitiveness. An example can be drawn from the modern poultry industry, where the demands from the consumer have to be translated into planning activities related to production at the farm level, including the definition of feed mixes, bird production scheduling, bird collection at the farms, transportation to slaughterhouses, poultry product mix decisions, inventory levels and distribution systems. The coordination of these logistical processes into a seamless flow of closely integrated activities allows considerable cost efficiencies and is presently a prerequisite for a competitive poultry business. Other industries



that increasingly rely on optimized logistical systems as a competitive edge include sugar and ethanol from sugar cane, orange juice and cut flowers, just to name a few.

Until 30 years ago logistical activities, such as order administration, transport, ordering and inventory control, were often separate functions or activities involving individual managers with their own tasks and objectives. This was often called a 'functional island approach'. Consequently, each function sought to maximize its own objectives. As seen when discussing the beer game, this type of individualistic behaviour invariably leads to sub-optimal performance. During the early 1970s, the notion of trade-off analysis was proposed. Problems of sub-optimal performance on the level of an entire chain business process could be overcome if sub-optimal performance in one, or even two, of the activities of that process were accepted and traded-off against economies obtained from other activities in the process, thus lowering the overall costs. For example, inventory holding costs and warehouse costs (storing inventory), were reduced considerably when faster, but more expensive transportation modes replaced slower traditional modes, for example, the substitution of sea freight by air freight. The path to modern SCM thinking has been evolutionary and not as abrupt as in other managerial areas (Box 5)

### **Box 5 – The evolutionary path of supply chain management**

Stevens (1989) describes an often-cited four-stage evolutionary path from functional control to SCM which reflects an increasing level of integration of chain business processes:

- **Stage 1. *Baseline*:** Functional islands. Responsibility for different activities in the organization is vested in different, almost independent, departments such as purchasing, production, distribution and marketing. Characteristics of this phase are staged inventory caused by failure to integrate and synchronise activities, independent and often-incompatible control systems and procedures, and organizational boundaries and functional islands.
- **Stage 2. *Functional integration*:** Materials Management and Physical Distribution. This level of integration is characterized by an emphasis on cost reduction rather than performance improvement; by the existence of discrete business units, each of which is buffered by inventory of inputs, parts, goods in process and products; by reactive customer service (whoever shouts the loudest, gets the goods); and by poor visibility of final consumer demand (using only managerial techniques known as 'Manufacturing Resource Planning' or MRP-II\*).
- **Stage 3. *Internal integration*:** Logistics Management. This stage involves the integration of those aspects of the chain directly under the control of the company. It embraces outward goods management, integrating supply and demand along the company's own chain. Characteristics are a comprehensive integrated planning and control system (MRP-II combined with Distribution Resource Planning, or DRP\*), full systems visibility, an emphasis on efficiency rather than on effectiveness, extensive use of EDI (Electronic Data Interchange), and reacting to customer demand rather than managing the customer.
- **Stage 4. *External integration*:** SCM. Finally, full chain integration is achieved. This stage embodies a change of focus from being product-oriented to being customer-oriented, i.e. penetrating deeply into the customer organization to understand its products, culture, market and organization. Integration upstream in the chain to include suppliers also represents more than just a change of scope – it represents a change in attitude, away from the adversarial attitude of conflict to one of mutual support and cooperation while preserving the autonomy of participants.

\* For an elaboration on MRP, DRP, JIT and EDI, refer to Slack et al. (2006) or Silver et al. (1998).

Going from baseline to SCM up the integration ladder presented in Box 5 has a significant impact on all elements of the FSCN. It requires innovations in the network structure (which partner is going to perform what role?), in the business processes (who does what activity?), in the management structure (what new planning and control structure is used?) and in the resources used (what new technological systems are required?).

At the moment more and more integrated supply chains are created in FSCNs, especially when high-quality, reliable and sustainable products are demanded at consumer markets. However, we must recognize that many well-performing firms are still in stage 3 and sometimes even stage 2 of the integration ladder. External integration, or SCM, is especially beneficial for those firms that gain profits (in terms of speed, quality, reliability, flexibility or cost) by collaborating in their activities. The latest trend is to develop flexible networks of actors where each can fulfil one or more specific required tasks dependent on the customer's wishes. This reduces the dependency of the company on a specific supplier and increases capacity-flexibility.

## **5.2 Case 1: Climbing the integration ladder as a fruit and vegetable exporter** (case based on Van der Vorst. 2000)

EXPO is an exporting company of vegetables and fruits in the Netherlands that strengthened its position in the supply chain network and its performance by climbing the integration ladder.

EXPO exports more than 300 product groups (distinguishable by product type, size and quality class) to over 400 customers in the world. The strategic goal of EXPO is to play a leading role in the marketing and distribution of vegetables and fruits and to obtain sustainable profits in order to guarantee continuity. Customers of EXPO are either large retail organizations or wholesalers at wholesale markets. The most important customers are the large retail organizations that have strict logistical demands for EXPO deliveries. They want a variety of products with the requested quality delivered within 24 hours at a low price. An average customer order comprises about 50 different products.

EXPO buys its products at several auctions, from importers and/or directly from growers. For each transaction the transfer price, product quality and delivery lead time can and usually will be different. In general, all bought products are transported to a central place, a distribution centre, where they are regrouped and sometimes repacked depending on the customer order specifications. It is also possible for EXPO to buy products for speculation, i.e. the products are stored until they can be sold at a higher price. The storage of products can either take place at EXPO or at the auction.

There are several ways to obtain products from the auction. The traditional way is to buy products at the 'auction clock'; products are presented to multiple buyers and prices are determined by auction. These products are delivered to the auction in the previous afternoon. After quality inspection, products with matching characteristics are grouped (in a so-called 'block') and positioned in the auction hall. During the auctioning, uniform blocks are offered; buyers can take a number of products out of the blocks for the price set by the clock. After the auctioning, products that have been bought are grouped at the dockside of each buyer. If the packaging does not satisfy the buyer, products can be repacked at the auction or at their warehouse.

The other way of obtaining products is by 'auction mediation'. In this case, a buyer shortcuts the auction by dealing directly with the grower for direct delivery of products, according to specifications. Then, transfer prices are pre-arranged, which are slightly higher due to the extra services provided. However, this method eliminates regrouping and repacking activities in the chain. The products can be delivered either directly to the buyer or to the auction, where the buyer can collect them. This is currently the most dominant form of marketing.

Growers are responsible for the growing, harvesting, sorting and packing of vegetables and/or fruits. If the grower is a member of an auction cooperative, the grower is obliged to market all products via that auction. If the grower is not, the grower will sell products directly to exporters or national wholesalers. The sorting takes place according to quality criteria, e.g. size or colour, and results in quality classes. Packing can be done in different packages, depending on the destination. The supply of vegetables and fruits is seasonal and market prices are unknown beforehand. Some products, for example apples, can be stored at the farm and sold when prices are higher.

The coordination of business processes at EXPO is relatively low. Because of the different time windows, supply and process/distribution control are unavoidably partly decoupled. The distribution plan to customers is based on; 1) actual customer orders, 2) customer delivery requirements (delivery time windows) 3) allowed product combinations for transportation (which influences product quality), 4) available trucks, and 5) roughly fixed transportation schedules. Note that the distribution plan is not based on the supply times of purchased goods. The distribution planner assumes that time tables are met. On the other hand, the supply transportation planner is not aware of the delivery time restrictions of customer orders! Hence, supply lead times are not coordinated with distribution departing times. EXPO tries to coordinate these activities by using several hand-made 'rules'. These are:

- ultimate departure times for distributing trucks;
- fixed purchasing locations for certain products and quantities;
- stocking products, which are often ordered very late by customers or usually bought at supply locations far away;
- priority rules for supply transportation (although the planner is not aware of the time, he or she can be informed of the urgency by flashing icons on his or her screen).

Hence, the internal coordination is not optimal. The lack of coordination between departments is mainly caused by different objectives and reward systems. The purchasing department is evaluated on purchasing costs, the sales department on customer satisfaction and revenues and the distribution department on logistic costs. Hence, the sales department accepts all customer orders at all times and leaves the logistics departments with the task of delivering the requested products on time. But the purchasing department will buy its products at the lowest prices, sometimes at auctions far away, resulting in high transport costs and long supply lead times. Furthermore, goods often arrive at the distribution centre too late because the supply transport planner was unaware of changed time restrictions set by the distribution planner due to (late accepted) rush orders. The combination of all customer orders and their corresponding delivery times determines the distribution route and the latest departure time for the truck.

Based on Stevens' (1989) evolution path of functional control to SCM (see Box 5), four supply chain scenarios with different levels of integration are given for the supply chain of EXPO (see table 3):

**Table 3. supply chain scenarios for EXPO**

Level 0: Current situation: separate managing systems in the chain stages.	Internal improvements are obtained by, e.g. the provision of real-time stock information together with a new order acceptance procedure, the integration of supply, production and distribution planning and the standardization of purchasing locations.
Level 1: Information exchange in advance between supply chain stages.	Advanced information is exchanged concerning, e.g. expected orders, current stock-levels, ATP (available to promise) in time and quantity. For example, the retailer gives retail outlets point-of-sale and stock information to EXPO.
Level 2: Coordination of the managing systems in the supply chain.	At this level it is possible to influence the management system of suppliers or customers in order to obtain a better logistical performance. For example, EXPO influences the capacity plan of growers or takes over the inventory management at retailers.
Level 3: Changing the structure of the supply chain.	At this level the roles and processes in the chain are changed. For example, the auction is eliminated from the supply chain and new suppliers are contracted.

From the viewpoint of the export firm, the levels were evaluated based on their implications for logistic performance. The results of the analyses gave the managers insight into the firm's logistic control structure in chain perspective. In the short term, EXPO has chosen to standardize the reward systems and purchasing locations for certain products. Furthermore, some retailers now place their orders the evening before the day of auctioning, which gives EXPO additional time to coordinate the purchasing locations, i.e. supply lead times, with distribution schedules. In the long-term, EXPO is investigating possibilities to redesign the chain structure by contracting suppliers for direct deliveries of high-quality products. EXPO is also investigating the possibility of increasing information transparency in the supply chain by exchanging inventory and demand (forecast) information. Finally, it hopes to implement a real-time inventory information system in the near future.

### 5.3 Logistics activities and the customer order decoupling point

The design of a logistics system depends on the performance objectives of that system related to the markets it wants to deliver to. It is a well known principle in management that the nature of demand for a product should be carefully considered before a supply chain strategy is designed. When product cost is the major issue, the supply chain should be efficient; when quality and speed are more important for customers, the supply chain should be responsive and assured. Nowadays, supply chains are expected to be extremely flexible, responsive and at a low cost, in order to satisfy constantly changing consumer demand. Some SCM authors<sup>2</sup> argue that the organization's or supply chains's performance is influenced by four drivers:

<sup>2</sup> See, for instance, Chopra and Meindl (2001) or Simchi-Levi et al. (2003)

- ‘Inventory’ is all raw materials, work in process and finished goods within an organization. The level of inventories influences product quality, the delivery lead time and the costs associated with that delivery.
- ‘Transportation’ entails moving inventory from point to point in the supply chain. Transportation can involve the use of many combinations of modes (e.g. truck, train, plane, boat) and routes, each with its own performance characteristics.
- ‘Facilities’ are places in the FSCN where inventory is stored, conditioned, assembled or fabricated. The two major types of facilities are production / processing sites and storage sites (distribution centres). Whatever the function of the facility, decisions regarding location, capacity and flexibility of facilities have a significant impact on the supply chains’ performance.
- ‘Information’ consists of data and analysis regarding inventory, transportation, facilities and customers throughout the supply chain. Information is potentially the biggest driver of performance as it directly affects each of the other drivers.

The choices made concerning these drivers and related operational processes determine the responsiveness and efficiency of the supply chain. So let us look at the operational processes that make use of inventory, transportation, facilities and information. As we saw before, the traditional view on logistics management in a supply chain is the ‘cycle view’. In this view, chain processes in a supply chain are divided into a series of cycles, each performed at the interface between two successive stages of a supply chain (see Figure 2). A cycle view of the supply chain clearly defines the business processes and activities involved and the owners of each process and relative roles and responsibilities. Furthermore, because of inventory being held between the cycles, the main processes are decoupled to a certain extent. This implies that each process can function independently and is not hindered by ‘problems’ in other processes. In other words, each actor in the supply chain manages its own processes without coordination with chain partners. This opposes the ‘Just-In-Time’ (JIT) philosophy of inventory management, which states among other things that the decoupling of activities by inventories should be eliminated, since it hinders supply chain visibility and supports the sub-optimization of the supply chain.

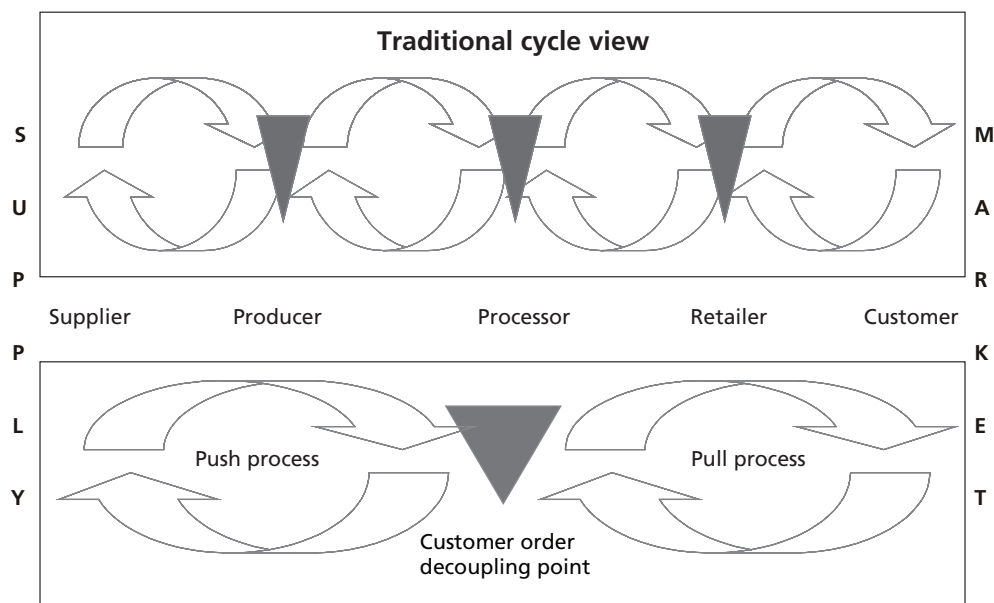
Reducing inventories is beneficial from the point of view of visibility and reducing costs. Considering the nature of products in agrifood businesses, it is also beneficial for quality reasons. These businesses have to deal with specific characteristics of the product and processes (see also Table 2), such as perishability, with resulting timing and conditioning constraints for storage, long delivery lead times, sometimes products are supplied from far away or one has to wait until products are harvested, uncertainty and variability in product quantity and quality, bulkiness of goods flows, and so on. Traditional inventory management principles, mostly developed for the manufacturing industries, do not necessarily apply. The main challenge for agrifood businesses is to match (often uncertain) supply and (often uncertain) demand, taking care of specific requirements regarding product quality and safety. Furthermore, one has to keep in mind that excessive inventories in supply chains tie up capital that could otherwise be used in productive investments. This is an area of special concern for developing countries.

Due to increasing consumer demand variability and uncertainty resulting in an increased demand for capacity-flexibility and thus reduction of inventories, the ‘push/pull’ view of



supply chains is gaining more interest (Figure 6). This view aims at eliminating as much stock as possible in the supply chain and focuses on the extent to which customer orders penetrate or may penetrate the logistics system. By eliminating stock at the retailer and wholesaler, they are risking less by having the wrong products in stock. So when a customer arrives and demands a product, the retailer will order the product at the processor, resulting in a delivery lead time. For example, think of buying a car that is manufactured according to the customer's expectations (with or without sunroof, radio and so on). This type of customization is now also used in food supply chains; where is inventory kept, what stages in the supply chain are so flexible that they can first order and then deliver the product; the starting point is not at the individual consumer, but at the retailer. Due to product proliferation, shelf space has decreased enormously in retail outlets. This results in a request for frequent deliveries and short lead times. Some products are packed in customer specific packaging materials; this packing process can be done at the wholesaler, processor or producer. The less handling in the supply chain, the lower the costs and quality losses. The idea is to minimize inventory levels in the supply chain. If the producer keeps stock, the processor keeps stock and the retailer keeps stock, this results in a long product throughput time, high costs and possible quality decay. By eliminating as much inventory as possible in the supply chain, costs are minimized, quality is optimized and service can be maximized since the right product is delivered in the right quality and quantity, at the right time, at the right place.

**Figure 6. Views on supply chain processes.** (based on Chopra and Meindl, 2001; note that an upside down triangle stands for an inventory)



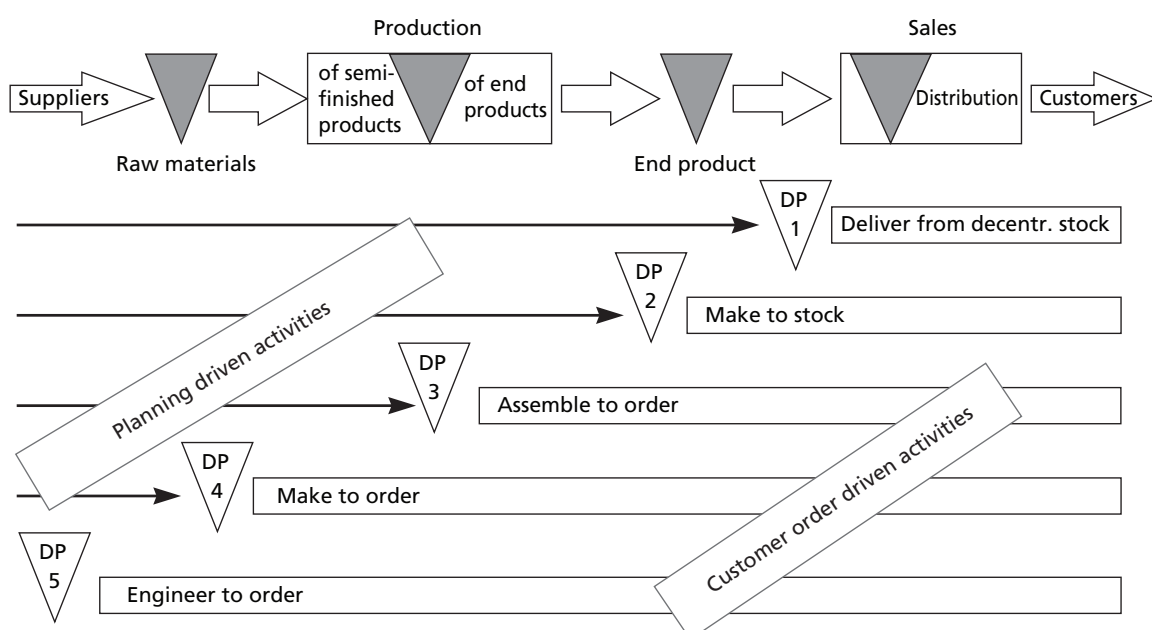
One of the concepts that goes into the ‘push/pull’ view is the Customer Order Decoupling Point (CODP) – also referred to as the Demand Penetration Point (DPP); this point separates the part of the supply chain whose management decisions are governed by customer orders (pull process) from the part of the supply chain where production plans are made based on forecasted demand of consumers and/or forecasted orders from partners downstream in the

chain (push process). Downstream of the CODP- that is towards the customer - the material flow is directly controlled by customer orders and the focus is on customer responsiveness (lead time and flexibility). Upstream towards suppliers, the material flow is controlled by forecasting and planning and the focus is on efficiency (usually employing large lot sizes) and taking into account inherent properties of material flows and production capacities and resources. It must be determined where the decoupling point should be for each product-market combination or product group in the company.

Hoekstra and Romme (1992) distinguish five possible positions of a decoupling point (DP) as depicted in Figure 7. These range from having inventory in all stages of the supply chain and delivering customer orders from stock (DP 1), to having practically no inventory in the supply chain and starting to assemble (make) a product when the order comes in (DP 5). Hoekstra and Romme regard the CODP as important for several reasons:

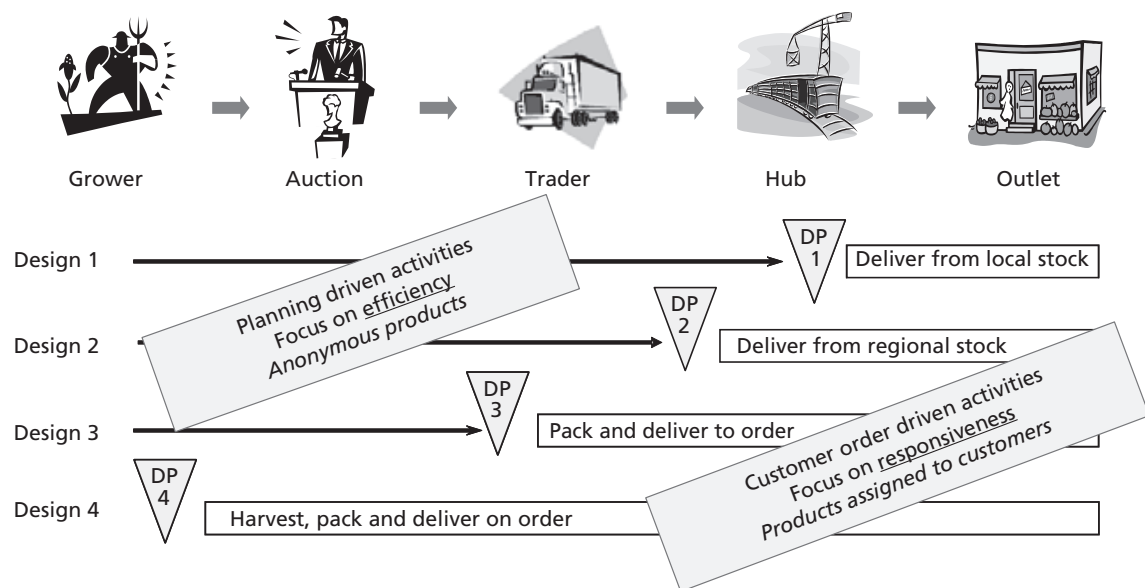
- It separates order-driven activities from forecast-driven activities.
- It is the place where ‘independent demand’ is converted into ‘dependent demand’.
- It generally coincides with the last major stock point in the goods flow.
- It creates the opportunity for upstream activities to optimize independently from irregularities in market demand (in contrast to the JIT concept in which inventories are seen as ‘blocking the view on problems’).
- It separates two areas in which the nature of decision-making is very different: upstream from the CODP the focus is on planning and efficiency, downstream the focus is on the acceptance of orders and lead time management.

**Figure 7. Five positions of the decoupling point** (Hoekstra & Romme, 1992)



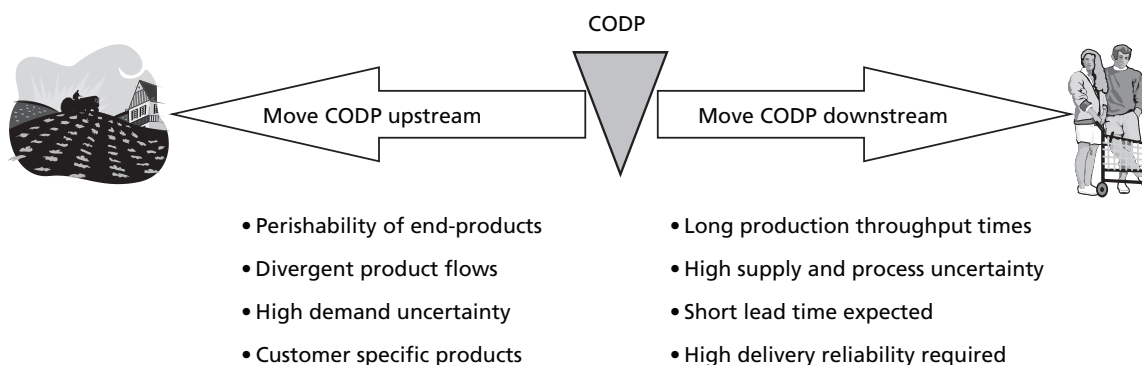
It is clear that in food supply chains, less DPs are possible due to long production throughput times. Figure 8 presents an overview of DPs that are possible in the supply chain of perishable products; in this case flowers and potted plants. In the first two designs (DP1 and DP2) all products are delivered to the customers from local or regional stock – no customization activities are performed. In design 3, potted plants are customized (that is value-adding activities performed to make the plants customer specific) at the auction, trader or hub and successively delivered to the market outlets. Finally, in design 4 the grower has a direct relationship with the final customer and harvest, packs and delivers its products (via traders or transporters) to customer outlets; the auction can be bypassed in this network design. The concept is useful to determine if processors should produce a large volume of end-products and put them on stock or try to minimize inventory levels by assembling/packing products to order.

**Figure 8. Four network designs with different decoupling points for perishables**



There are several elements exerting an upstream or downstream influence on the position of the CODP (Figure 9); in other words where to keep product inventory. It is a balancing process between the delivery time requested by the customer, the throughput time in purchasing, production and distribution and the expected customer service of an organization. If the requested delivery lead time is very short, stock should be kept close to the market. On the other hand, if the delivery lead time is relatively long, stock could be kept upstream in the supply chain (towards the processors) taking advantage of centralized inventory management. Other factors, such as whether the products are universal or specific, also play a role in this trade-off process.



**Figure 9. Elements that influence the position of the decoupling point**

Currently the general trend is to shift the CODP upstream in the supply chain (shift inventories towards processors/suppliers) in order to increase the responsiveness to variable market demand and limit the amount of non-value adding activities (such as keeping the wrong products or the products in wrong packaging material on stock). Each time, the major challenge is to find scenarios that allow fast deliveries whilst keeping costs at a low level.

#### 5.4 Case 2: The customer order decoupling point at a poultry processor (This case is based on Van der Vorst *et al.* 2001)

At Wings & Legs, a large poultry processor, the working day starts very early in the morning. Before a single cock-a-doodle has sounded, live chickens are delivered to the processing plant where they are cleaned, processed, packed and stored. The next day, packages of fresh poultry meat are distributed to several large retail distribution centres and a large number of smaller retail stores; the same evening many people will enjoy their chicken Tandoori or fried chicken legs. The product is simple and the whole operation seems efficiently executed. However, the sales manager complained that the delivery performance had decreased in the last couple of months. Moreover, he complained that retailers are less satisfied with the quality of products they receive. Several times in that month, product freshness and product weight were not according to specifications. The operations and purchase managers responded that the sales department made sales agreements with retailers that could not be met in such a short time. They needed to have prior information on promotional activity so they could respond more effectively. They needed to have better forecasts of future sales so they could match the supply of chicken with the demand for poultry products.

The food and retail market that Wings and Legs serves is very dynamic. During recent years, the assortment of most retailers has increased by a factor of 4 to 5 times. A single retail outlet used to store 4 000 to 5 000 different products; now they have 20 000 to 30 000 different products. Obviously, this has had an effect on the assortment of Wings & Legs itself. They introduced a large number of new fresh poultry products to remain competitive. Poultry meat was packed in more variations and combinations and processed in many more different ways. They introduced new seasonings and microwaveable ready-meals based on poultry products. Their own assortment grew from 100 different products to 450 different products and product-variations.

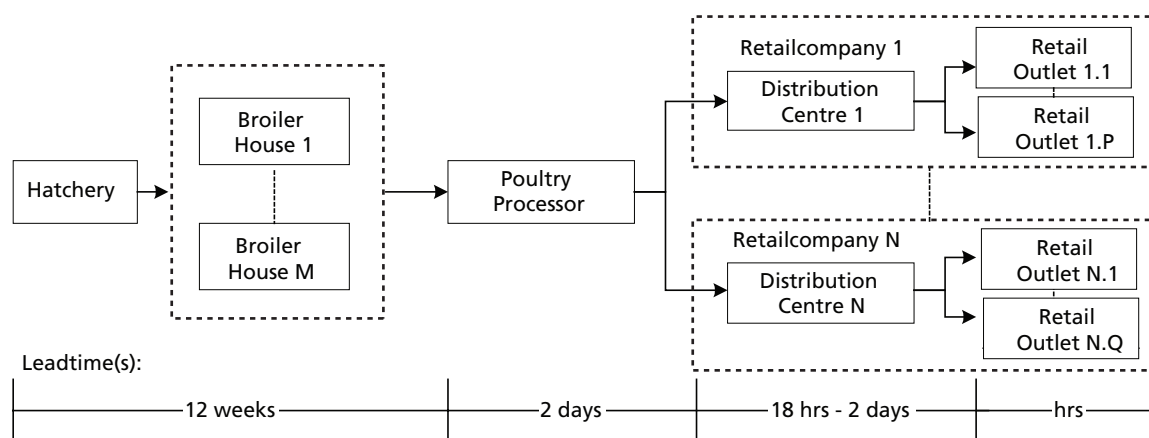
The demand for poultry products by end-consumers shows a very variable pattern, and seems unpredictable. This may look strange at first sight, but is explained by the heavy use of promotional activities at the retail stage in the supply chain; promotional activities are not always communicated in detail to Wings & Legs. The size of consumer reaction to a promotion is not easy to predict. If there were no promotional activities, consumer demand actually shows a more or less seasonal pattern, which is relatively predictable. The promotional activities initiated by the larger retail companies place heavy strains on Wings & Legs and the upstream supply chain. An opportunity to level demand is to eliminate all promotional activities. However, this encounters much resistance from the retail companies involved; promotions of poultry products are a favourite instrument for competitors to bring in new customers. Meat products are the most expensive components of evening meals and a reduction of sales price is therefore very interesting for consumers.

In addition, the poultry processor itself initiates promotional activities. This is usually motivated by the need to sell excess capacity. Over-production of specific poultry products will always be the case, because the demand for the different component poultry products is not equal or 'balance'. Wings, chicken breast and legs are all part of the same chicken, but demand for each product is not the same most of the time.

An important characteristic of fresh poultry products is product perishability. Processed poultry stays fresh for a limited number of days, after which the quality deteriorates and the products are not allowed for human consumption. Product freshness is an important performance indicator in the poultry supply chain. Retail companies demand the highest product freshness possible. One can see that there exists a strong relationship between product freshness, lead-times and inventory turnaround. If turnaround is low and leadtimes are long the chance of product obsolescence increases. All products where the best-before-date has been exceeded are written-off and sold to downstream food-processing industries for a lower price.

Furthermore, the end of the supply chain is characterized by very tight lead times; retail companies demand a delivery time of 18 to 48 hours. Retail companies place their orders every day and products are delivered at a high frequency rate, many times per week, thus stock is held at the poultry processor, this clearly requiring higher levels of service for poultry products. The poultry processor has to comply with a minimum delivery reliability of 99 percent, even in the case of promotions.

The supply chain of Wings & Legs can be characterized as a chain of strongly interconnected processes with minimal possibilities for buffering of products and materials. This is caused by the nature of the product exchanges in the supply chain. At the hatchery, eggs are hatched during three weeks and the newborn chicks are immediately transported to the broiler houses. At the broiler houses chickens are fattened over nine weeks and when the agreed delivery-date or specified weight is reached, they are delivered to the poultry processor. Because the 'goods flow' in this supply chain concern live birds, processes cannot be buffered very easily and short-term coordination is of utmost importance. In Figure 10 the average lead times of each phase in the production of chickens and poultry products are shown.

**Figure 10. supply chain overview**

The chickens supplied by the broiler houses have to comply with specific quality characteristics. Chickens have to be from certain breeds, of a specific weight, fattened with high quality certified feed and fattened according to several quality systems (e.g. HACCP and the Dutch Integral Chain Control Policy for Poultry). Only broiler houses and hatcheries that comply with these quality specifications are allowed to supply Wings & Legs. These high quality specifications are necessary to guarantee food safety of the consumer product. The number of certified broiler houses and hatcheries that are able to supply Wings & Legs is therefore limited.

Because of the longer lead times upstream in the poultry supply chain, the planned volume of supply is not easily changed. If estimated demand exceeds the planned supply it is possible to purchase chickens from other broiler houses, but only if they are able to comply with the mentioned quality specifications. Another option is that Wings & Legs purchases finished poultry products from other poultry processors. Most of the time, these products have to be repacked and have different quality characteristics with regard to weight and processing procedures. These different quality characteristics sometimes give rise to complaints from the retail companies. However, the purchase of finished poultry product from other processors does not have the disadvantage of over-production of divergent poultry products at Wings & Legs itself.

In short, demand uncertainty is relatively high. As a result, the need for production capacity, and thus the need for raw materials (live chickens), fluctuates. The production capacity itself is planned for maximum utilization (to keep production costs per kg product as low as possible) resulting in low production flexibility. Finally, the supply of (certified) chickens from suppliers has to be planned twelve weeks ahead because of the duration of hatching and fattening stages. The potential for buffering and inventory storage is limited in the supply chain since the quality of the supply (chickens) and of the consumer products will deteriorate.

At Wings & Legs, the general manager and the other managers realize that responsiveness is needed in their supply chain, but that physical costs and quality are still of utmost importance due to low profit margins. What other possible positions of the CODP could help them?

One of the scenarios is related to delaying product differentiation. One delays as much as possible the moment when different product versions assume their unique identity, thereby gaining the greatest possible (mix) flexibility in responding to changing consumer demands. This resembles the production control situation assemble-to-order. That is, transformation is done according to standardization and the assembly and distribution process is customized. Another scenario deals with postponement which is based on the principle of seeking to design products using common platforms, components or modules, but where the final assembly or customization does not take place until the final market destination and/or customer requirement is known.

The processed semi-finished poultry products are perishable. This means that products can only be held in stock for a limited time before they become non-consumable, or obsolete. The (vacuum-) packaging of semi-finished components in very small batches extends the lifetime of these components. When these components are stored together in large batches (non-vacuum), quality deteriorates much faster and the risks of cross-contamination increase, e.g. the spread of salmonella-bacteria. At this moment, the costs associated with advanced forms of meat-storage, which do not have the above mentioned drawbacks, are too high compared to the costs associated with reduced mix-flexibility of strategic inventory. This (quality and cost constraints) also applies for the postponement of the packaging or labelling process further downstream, to the distribution centre for instance. Moreover, packaging of fresh poultry products at the distribution centre requires an advanced production line in a low-temperature environment. This is only feasible if more fresh meat products are packaged at the distribution centre for reasons of economies of scale.

Finding a good position of the DP is, according to the general manager, of central importance to the solution of the problems at Wings & Legs. Delaying the point of product differentiation could solve a part of their matching problem, because in several cases the amount of raw material supplied seemed sufficient, but the wrong amount of product variants had been produced and demand could not be met. Because of the divergent product structure of poultry products, opportunities for postponement seem obvious; the divergent structure offers 'modular and common component' as by nature. Moreover, taking a closer look at the current information DP and information exchange in their supply chain could generate several improvement opportunities they would not have identified before.

As a large part of total demand is generated by promotional activities, longer-term information about future promotions, but also category management decisions at the retail-outlets concerning the product-assortment, need to be communicated in an earlier stage and on a more structured basis to Wings & Legs. Cooperation between retail companies and Wings & Legs on promotional activities should be extended.

The general and senior managers found the first explorations of designing an effective supply chain strategy and supply chain improvements very promising. They decided that Wings & Legs should continue to find solutions from a supply chain perspective. Postponing the labelling process in their operations is an important option they will work out in more detail. The operations and logistics managers will form a project team that will address these details. The improvement of information exchange in their supply chain with sales and operations managers throughout the organization will be pursued.

## 5.5 The trade-off between efficiency and responsiveness in supply chains

A simple but powerful way to characterize a product when seeking to devise the right supply chain strategy is the ‘uncertainty framework.’ This framework specifies the two key uncertainties faced by the product—demand and supply. Marshall Fisher (1997) introduced the matching of supply chain strategies to the right level of demand uncertainties of the product. Lee (2002) expanded Fisher’s framework to include supply uncertainties.

Fisher suggests that the nature of the demand for a product should be carefully considered before a supply chain strategy is (re)devised. Fisher divides products into two categories:

- primarily ‘functional products’ satisfying basic needs which have stable, predictable demand and long life cycles typically with high levels of competition resulting in low profit margins. Examples are energy/oil, furniture and basic food products.
- primarily ‘innovative products’ with higher profit margins, have unpredictable demand and short life cycles and usually higher levels of product variety. Examples are computers, fashion clothes and to a certain extent, innovative food products.

**Table 4. Physically efficient versus market-responsive supply chains**  
(Fisher, 1997)

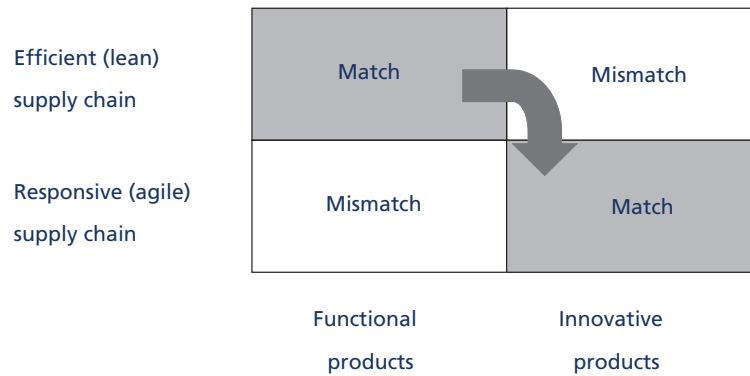
Characteristic	Physically efficient (lean) process	Market-responsive (agile) process
Primary purpose	<ul style="list-style-type: none"> <li>• Supply predictable demand efficiently at the lowest possible cost</li> </ul>	<ul style="list-style-type: none"> <li>• Respond quickly to unpredictable demand in order to minimize stock outs, forced markdowns, and obsolete inventory</li> </ul>
Manufacturing focus	<ul style="list-style-type: none"> <li>• Maintain high average utilization rate</li> </ul>	<ul style="list-style-type: none"> <li>• Deploy excess buffer capacity</li> </ul>
Inventory strategy	<ul style="list-style-type: none"> <li>• Generate high returns and minimize inventory throughout the chain</li> </ul>	<ul style="list-style-type: none"> <li>• Deploy buffer stocks of parts or finished goods</li> </ul>
Lead time focus	<ul style="list-style-type: none"> <li>• Shorten lead time as long as it does not increase cost</li> </ul>	<ul style="list-style-type: none"> <li>• Invest aggressively in ways to reduce lead time</li> </ul>
Approach to choosing suppliers	<ul style="list-style-type: none"> <li>• Select primarily for cost and quality</li> </ul>	<ul style="list-style-type: none"> <li>• Select primarily for speed, flexibility and quality</li> </ul>
Product-design strategy	<ul style="list-style-type: none"> <li>• Maximize performance and minimize cost</li> </ul>	<ul style="list-style-type: none"> <li>• Use modular design in order to postpone product differentiation for as long as possible</li> </ul>

Fisher states that the root cause of the product availability problem in present-day supply chains is a mismatch between the type of product and the type of supply chain. Supply chains that deal with functional products should focus on ‘efficiency / leanness’ to minimize the physical costs related to production, transportation and inventory storage. On the other hand, supply chains that deal with innovative products should be designed focussing on ‘responsiveness / agility’ to minimize market mediation costs, i.e. the cost that arise when the variety of products

reaching the marketplace does not match what consumers want to buy resulting in lost sales opportunities and dissatisfied customers. Table 4 compares both types of supply chains.

What we have seen in the last 20 years in the western world, and more recently in developing countries, is that consumers and retailers have become far more demanding and product-life cycles have shortened significantly in all kind of sectors (e.g. computers, food, automotive). In today's marketplace the keys to long-term competitive advantage are flexibility and customer response. This has resulted in functional products becoming innovative products with high demand uncertainty. The problem is that the supply chains that produce those innovative products are still mainly focussed on efficiency. According to Fisher they should change towards responsive customer-driven supply chains in order to be competitive again (Figure 1).

**Figure 11. supply chain design in relationship with the nature of product demand**



On a more detailed level we see a number of innovative sub-concepts that facilitate an efficient and responsive supply, such as ‘postponement’ or ‘delayed configuration’ (Van Hoek, 1998) or ‘value added logistics’. By postponing product differentiation, one delays for as long as possible the moment when different product versions assume their unique identity, thereby gaining the greatest possible (mix) flexibility in responding to changing consumer demands. According to Van Hoek postponed manufacturing equates to ‘assemble to order’ where fabrication of parts is standardized, but the assembly and distribution process is customized. Postponement is based on the principle of seeking to design products using common platforms, components or modules, but where the final assembly or customization does not take place until the final market destination and/or customer requirement is known.

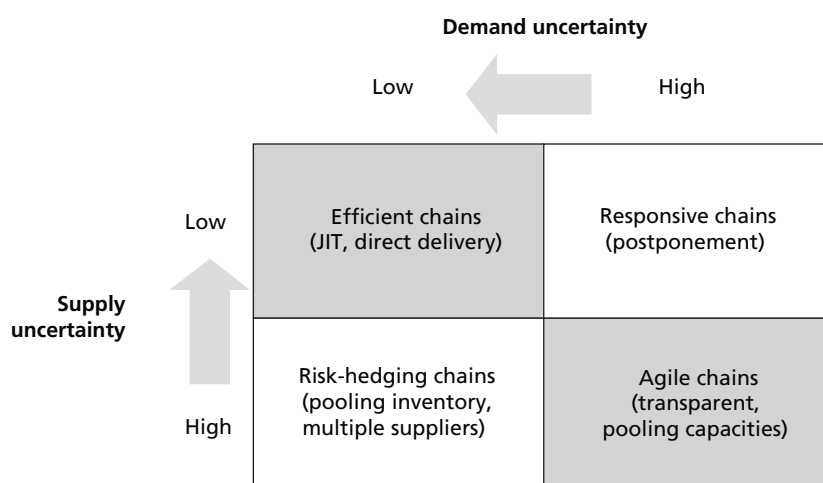
The CODP and postponement concepts result in logistic structures in which a consolidation point is used to perform product differentiation to customer demands; the supply part towards the consolidation point is efficiency-oriented and the distribution part aims for responsiveness.

As stated, Lee (2002) extended the thoughts of Fisher by incorporating the aspect of ‘supply uncertainty’. He noticed that it is not always the case that functional products require an



efficient supply chain and innovative products a responsive supply chain. Lee uses a stable (low uncertainty) and evolving process (high uncertainty) to indicate the level of supply uncertainty. A stable process is characterized by stable and high yields, more supply sources, reliable sources, less process changes and it is easy to change over. The evolving process is characterized by variable yields, limited supply sources, unreliable suppliers, and more and difficult process changeovers, etc. This is very typical in agrifood supply chains. Lee describes four strategies which correspond with the four cells in Figure 12. In general, information systems play an important role in the different strategies to exchanging and enabling information to deal with uncertainty. Let us discuss the four supply chain strategies:

**Figure 12. Different supply chain strategies to cope with (un)certainty (Lee 2002)**



**Efficient supply chains;** low demand and supply uncertainty requires an efficient supply chain strategy to optimize profitability. Profitability can be reached by cost and information coordination. Low costs are realized by eliminating non-value-added activities, striving to scale economies and optimizing of techniques and production. Examples of these supply chains are commoditized non-perishable products.

**Risk-hedging supply chains;** supply chains with low demand uncertainty but high supply uncertainty should follow the risk-hedging strategy to reduce costs. This strategy implies that companies with high supply chain uncertainty try to cope with this vulnerability by being responsive with the lowest safety stock as possible. To realize this, they share their safety stock with comparable companies with the same key components. This strategy, called inventory pooling, is commonly used by retail organizations. One could think of fruit and vegetable supply chains.

**Responsive supply chains;** the responsive supply chain strategy focuses on being responsive and flexible to meet the changing needs of customers with an efficient supply chain. To realize this, companies possess mass customization processes. Besides, the aim is to postpone the final assembly as far as possible downstream in the supply chain to be more responsive. Examples of these supply chains are meat supply chains.

**Agile supply chains;** the agile supply chain strategy is a combination between the risk-hedging and responsive supply chain. These supply chains try to cope with demand and supply chain uncertainty to be responsive to unpredictable demand. They have the capability to minimize supply disruptions by using pooling inventories that form a DP, e.g. a wholesale market. Besides, they could be responsive by postponing the DP, where the final assembly takes place, as far as possible downstream in the supply chain. The profitability in this kind of supply chains is to be obtained by the extra margin they get because of the responsiveness and the capability to minimize supply costs (Lee, 2002). Examples are ready-to-eat products in supermarkets.

It is clear that the easiest supply chain to manage in Figure 12 is that one in the left upper cell (efficient chains). That means that supply chains which are currently in one of the other cells should try to make the move, as far as possible, to the left (low demand certainty) and/or to above (low supply certainty). It is important to recognise that for perishable products there is uncertainty regarding supply volume and product quality. Specific to perishable products is the dependence of weather and seasonality, which is of great importance. Seasonality means that certain products cannot be grown in certain periods (winter/summer) and due to this there is lower availability of products at certain times. To assure year round supply, a range of products has to be imported from overseas, usually at higher prices. Demand uncertainty could best be managed by collaboration and sharing information as much and frequently as possible between partners in the supply chain, as indicated by the theory on SCM.

We can conclude that supply chain networks are subject to different levels of uncertainty in time for different product-market combinations. The major challenge for businesses is to design robust supply chain networks that can deal with these variations.

## 5.6 Performance improvement

Current challenges for an optimal supply chain performance include; the increasing variety of products, globalization, shorter product-life cycles and increased regulatory complexity. They all make it increasingly difficult for supply chains to achieve a strategic fit between what they do particularly well and the desired, variable customer needs. In general, the profitability of the supply chain could be improved drastically via better delivery performance (improved responsiveness and reliability of deliveries, fewer stock-outs, higher product quality, more receiver-friendly loads) and increased information availability (better demand insight, more predictable order cycles, accurate, real-time). The potential for improvement when applying SCM-concepts is based on the reduction of inventory-carrying (reduced overstocks, faster inventory turns) and transportation costs (pooling of transport), the reduction of indirect and direct labour costs and the increase of sales and sales margins (also due to a reduction of stock-outs). Many companies are re-engineering and rationalizing their supply chain network to obtain these benefits (see for example Box 4).

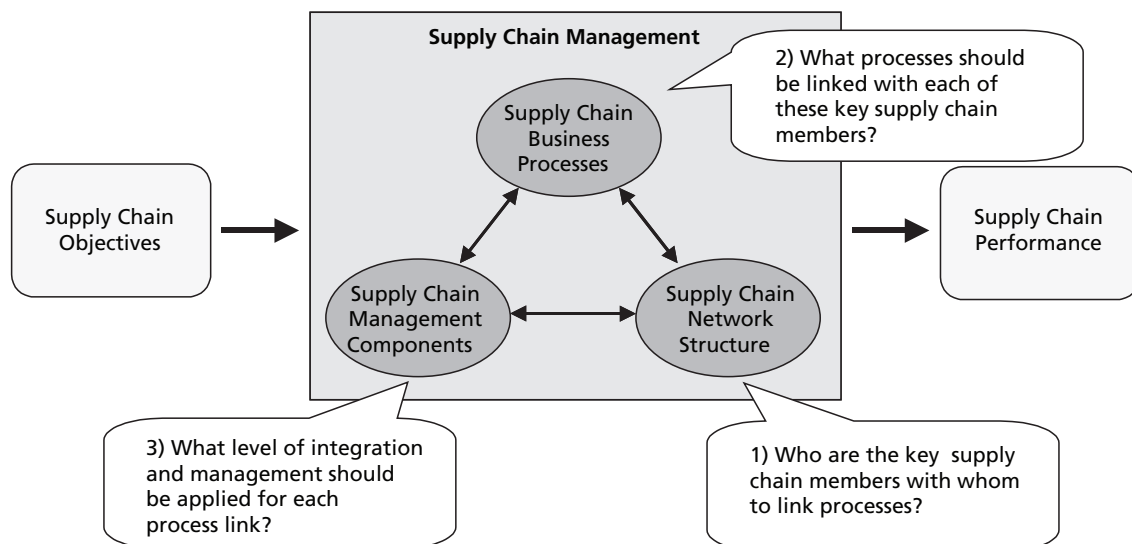




## 6. Key decisions for supply chain redesign

Lambert and Cooper (2000) distinguish three key decisions in SCM, summarized in Figure 13. The conceptual framework emphasizes the interrelated nature of SCM and the need to proceed through several steps to design and successfully manage a supply chain. Each step is directly related to the ‘supply chain objectives’, i.e. the degree to which a supply chain fulfils end-user requirements concerning the key performance indicators at any point in time and at what total cost. Key Performance Indicators (KPIs) refer to a relatively small number of critical dimensions which contribute more than proportionally to the success or failure in the marketplace (Christopher, 1998). KPIs compare the efficiency and/or effectiveness of a system with a norm or target value. A well-defined set of supply chain performance indicators will help establish benchmarks and assess changes over time. A good example is the supply chain Operations Reference-model (SCOR) developed by the Supply-Chain Council (SCC) as the cross-industry standard for SCM (see [www.supply-chain.org](http://www.supply-chain.org)). SCOR provides an integrated, heuristic approach for supply chain improvement via (i) the modelling of business processes, (ii) the definition of SCM metrics for evaluating the supply chain and rapidly identifying high value opportunities and (iii) the identification of best practices to provide a candidate list of improvement options.

**Figure 13. Key decisions in supply chain management** (adapted from Lambert and Cooper, 2000)



Supply chains can be managed as a single entity through the dominant member or, alternatively, through a system of partnerships requiring well-developed cooperation and coordination. Formulating supply chain objectives is therefore not an easy task since all partners have to agree on the selection of indicators, the definition of the indicators and the target values.

The present performance measures used in most companies have several problems that prevent them from effectively measuring total supply chain performance. supply chain participants should start with jointly identifying order winners and satisfiers for the supply chain, because these provide the intended direction of control actions to improve supply chain performance. By analysing the goals of each individual organization and by identifying market requirements, integrated KPIs can be defined and norms established. We will now discuss the three key decisions in more detail.

### ***1. Who are the key supply chain members with whom to link processes?***

The first step in analysing and redesigning a supply chain is to determine the organizations that are part of the supply chain under investigation. For most manufacturers, the supply chain looks less like a pipeline or chain than an uprooted tree, where the branches and roots are the extensive network of customers and suppliers. The question is how many of and how intensive these branches and roots need to be managed. Management will need to choose the level of partnership appropriate for each particular supply chain member knowing that firm capabilities in time and effort are limited (Lambert & Cooper, 2000). With some suppliers, partnerships are required, since the raw materials they deliver are crucial; others are less important and only have to be monitored. The key is to sort out which members are critical to the success of the company and the supply chain – in line with the supply chain objectives and thus, should be allocated managerial attention and resources.

### ***2. What processes should be linked with each key member?***

Successful SCM requires a change from managing individual business processes within one organization to integrating activities over organizations into key supply chain processes. Lambert and Cooper (2000) have identified eight key business processes that could be integrated with the key members in the supply chain (Table 5). It is usually not necessary to integrate all processes; e.g. if the order winning performance indicator is responsiveness, focus should be on order fulfilment, whereas if the order winner is product innovation, focus should be on joint product development.

The SCM literature suggests several redesign strategies to improve the effectiveness and efficiency of these business processes in the supply chain. Van der Vorst and Beulens (2002) have identified a generic list of SCM redesign strategies to facilitate the redesign process and accomplish joint supply chain objectives. These are the following:

- Redesign the roles and processes performed in the supply chain, e.g. change or reduce the number of parties involved, re-allocate roles and eliminate non-value-adding activities;
- Reduce customer order lead times (e.g. change the position of the decoupling point, implement ICT systems for information exchange and decision support, reduce waiting times, increase manufacturing flexibility);
- Create information transparency (e.g. establish an information exchange infrastructure in the supply chain and exchange demand/supply/inventory or work-in-process information, standardize product coding);

- Synchronise logistical processes to consumer demand (e.g. increase execution frequencies of production and delivery processes, decrease the lot sizes); and
- Coordinate and simplify logistical decisions in the supply chain (e.g. coordinate lot sizes, eliminate human interventions, differentiate to and simplify products, systems and processes).

In order to identify the most effective strategies in a specific supply chain one should focus on the identification and management of the sources of uncertainties in the supply chain's decision-making processes.

**Table 5. Business processes that could be integrated in the supply chain**

<b>Business process</b>	<b>General description</b>
Customer relationship management	Specifying service level agreements with key customers
Customer service management	Providing the customer with real-time information on promised shipping dates and product availability through interfaces with the organizations' production and distribution operations
Demand management	Balancing the customer's requirements with the firm's supply capabilities
Order fulfilment	Delivering products and meeting customer need dates
Manufacturing flow management	Pulling product through the plant based on customer needs
Procurement	Developing strategic plans with suppliers to support the manufacturing flow management process and development of new products
Product development and commercialization	Customers and suppliers must be integrated into the product development process in order to reduce time to market
Returns process	Aligning processes to realize an efficient return of re-usable items

**3. What level of integration and management should be applied to each process link?**

The literature on business process re-engineering and SCM suggests numerous possible components that must receive managerial attention when managing supply relationships. Lambert and Cooper (2000) distinguish two groups of management components. (see Table 6). The first is the physical and technical group, which includes the most visible, tangible, measurable and easy-to-change components. The second group, the managerial and behavioural components, defines the organizational behaviour and influences how the physical and technical management components can be implemented. If the managerial and behavioural components are not aligned to drive and reinforce an organizational behaviour supportive to the supply chain objectives and operations, then the supply chain will likely be less competitive and profitable. If one or more components in the physical and technical group are changed, then management components in the managerial and behavioural group likewise may have to be re-adjusted. Especially the managerial and behavioural components are well-known obstacles to SCM.

**Table 6. Two groups of management components**

<b>Physical and technical components</b>	<b>Managerial and behavioural components</b>
<ul style="list-style-type: none"><li>• planning and control methods (e.g. push or pull control);</li><li>• work flow/activity structure (indicates how the firm performs its tasks and activities);</li><li>• organization structure (indicates who performs the tasks and activities, e.g. cross-functional teams);</li><li>• communication and information flow facility structure (e.g. information transparency);</li><li>• product flow facility structure (e.g. location of inventories, decoupling points).</li></ul>	<ul style="list-style-type: none"><li>• management methods (i.e. the corporate philosophy and management techniques);</li><li>• power and leadership structure;</li><li>• risk and reward structure;</li><li>• culture and attitude.</li></ul>

The groundwork for successful SCM is established by an explicit definition of the supply chain objectives and related KPIs and successively by taking the three key SCM decisions. The optimal supply chain design will differ for each supply chain depending on the competitive strategy and the market, product and production characteristics.

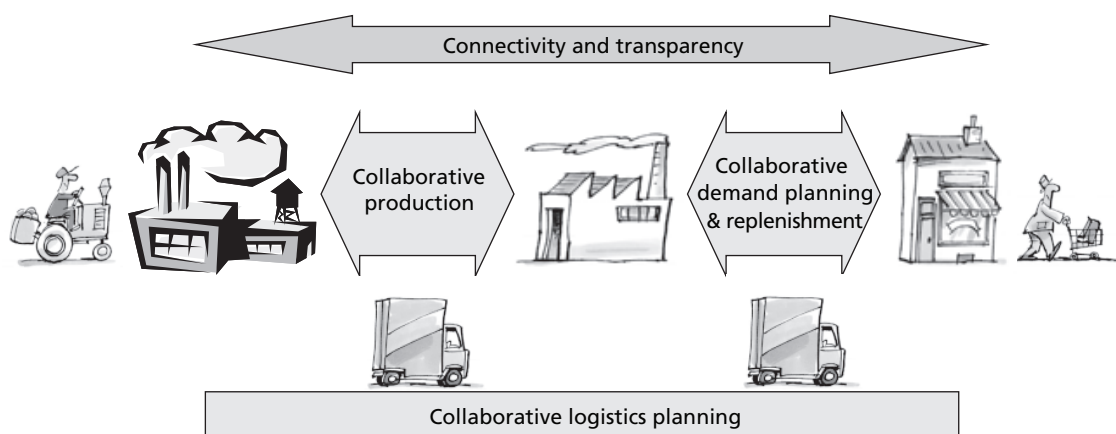
## 7. More practices of supply chain management in the agrifood sector

In the last years numerous projects on supply chain collaboration were done to analyse how firms could use their suppliers' and customers' processes, information, technology and capability to enhance competitive advantage. Most projects were done in the front-end of supply chains, that is, in the interface between retailer and manufacturer. But also in the interface between manufacturers and suppliers and/or third parties numerous enhancements were made. In the past years manufacturers have been instigated to focus on core business, resulting in the outsourcing of non-core activities such as transportation and the centralization of manufacturing activities. The practical experiences can be categorized into the following areas (Figure 14):

- Collaborative demand planning and replenishment: retailers and manufacturers work together to assess consumer demand and to determine the most appropriate supply management and replenishment approach to meet this consumer demand;
- Collaborative production: manufacturers and suppliers work together to harmonize the supply of raw materials and the production of end products in such a way as to minimize the stocks within the supply chain and maximize the responsiveness;
- Collaborative logistics planning: coordinating transport and warehousing between the various parties involved, including shippers, logistics service providers, carriers and recipients.

A precondition for supply chain coordination is the establishment of connectivity and transparency, i.e. interconnecting the information systems of the successive partners in the supply chain and exchange information via this infrastructure.

**Figure 14. Areas for collaboration in the supply chain** (after Barratt and Oliveira, 2001)



Although considerable research and practical experience with SCM issues has been obtained, we have to acknowledge that few companies have actually established a management environment that supports the integration required for effective SCM. Instead, many chains are still functionally oriented and are characterized by a lack of trust and credibility among the supply chain organizations. In the remainder of this section we will discuss cases extracted from Trienekens *et al.* (2005) and Ruben *et al.* (2006) that present an overview of supply chain issues in different product-market combinations.

### **7.1 Case 3: Pork chain in China**

Pork is the most important meat consumption item in China. Per capita consumption of pork amounted to 20.4 kg in urban areas and 13.8 kg in rural areas in 2003, amounting to 62 percent and 76 percent of all meat consumption, respectively. Consumption of pork increased throughout the 1980s and 1990s and is still increasing, despite the increasing share of beef and broilers in meat consumption. In part, pork demand has been driven by rapidly increasing incomes, but on average, the income effect is not strong. This suggests that part of the increasing demand for pork is caused by the rapid increase in food consumption 'away-from-home' in restaurants and other food service outlets. The growing health consciousness among certain groups of urban consumers in particular is causing a shift towards lower-fat poultry and seafood. At the same time there is also evidence of an increasing demand for lower fat pork products.

Total pork production in China amounted to 45.2 million tonnes in 2003. It is projected to increase to 57 million tonnes in 2030. Currently, around 89 percent of demand is met by small backyard production and specialized household production. But large-scale commercial production is gaining ground. The share of pork produced on large commercial farms (with more than 500 hogs) has increased from 2.5 percent in 1985 to 10.7 percent in 2003. This growth has partly been stimulated by the rapid rise of supermarkets which requires volume, quality and safety assurances that only the commercial sector can guarantee.

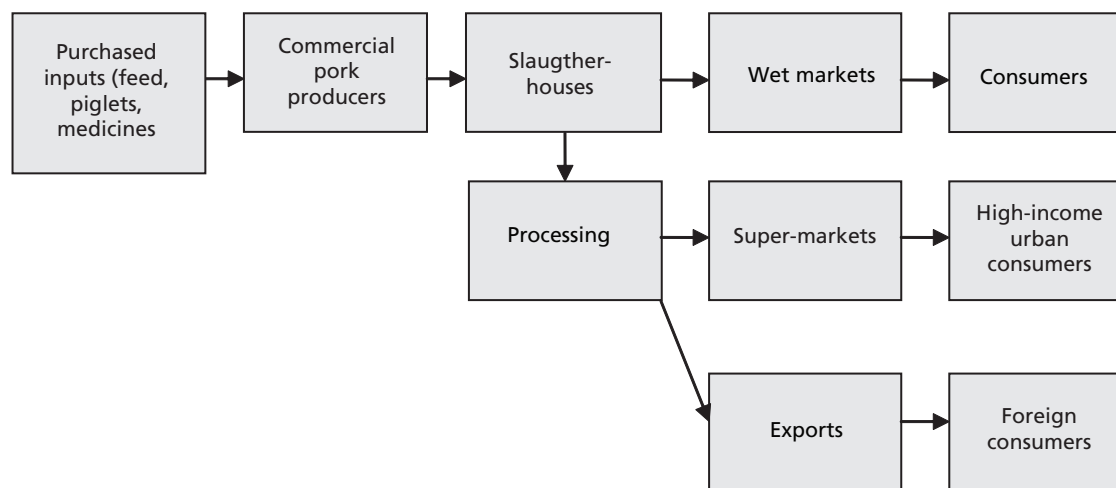
A recent study on the commercial pork value chain in China gives some insights into the functioning of the supply chain for large commercial pork producers. This chain can schematically be represented (see Figure 15).

Commercial pig breeding and finishing farms buy their piglets, feed and other inputs at the market. Once the hogs reach a certain weight, they are sold to slaughterhouses. These slaughterhouses generally just slaughter and eviscerate. The rest of the processing, including the splitting of the carcass into primal cuts, is sometimes done at the retail level.

Wet markets are the most popular places to buy fresh meat. To improve quality and safety, the Chinese Government encourages the establishment of supermarkets. Especially young and high-income consumers purchase their meat through supermarkets. Products include chilled and frozen meat products as well as fresh meat, which are often sold by retailers through rented stalls in supermarkets.

Export of pork products is relatively small. Only about 0.6 percent of total pork production in China is exported. It consists mainly of frozen fresh meat (210 000 tonnes in 2003) and canned pork (52 000 tonnes in 2003).

**Figure 15. Schematic representation of the pork supply chain for commercial producers**



Pork production in Sichuan province is almost entirely done by smallholders, i.e. about 97 percent of total pig production in the province is largely backyard type with less than five hogs per household. Income from pig production is an important contribution to total household income of smallholders; it accounts for up to 80 percent of total household income in Zitong and Anyue Counties. Large-scale production is virtually absent in Sichuan Province. The main advantage of backyard pork production lies in the use of surplus family labour, the limited investments in animal housing structures and the use of table scraps, vegetables, green fodder and unprocessed grains and oilseeds as feed, which keeps production costs low.

The pork produced is mainly consumed within the province. Sales of pork within Sichuan province amounted to 52.4 kg per household in 2002, which is 62 percent above the national average. There are three major quality improvement issues identified with respect to the supply chain in Sichuan Province:

- Drug and additive residue issues; lack of chain coordination on food safety issues. The challenge is how to deal with scattered, small pig farmers.
- Disease control and prevention; farmers do not receive compensation from the government when they slaughter ill animals. Recently dozens of farmers in northwest Sichuan died after slaughtering ill pigs and eating their meat.
- Promoting lean meat; due to the rapid increase in obesity in China, there is an increasing demand for lean meat. New, improved breeds that produce leaner pork are available, but farmers lack incentives for raising such pigs derived from chain connection problems.

With rapid economic development in China, food safety and quality is increasingly becoming an issue of concern for its consumers. This poses severe challenges to the organization of pork supply chains in China:



- 1) Collaboration between small-holders to decrease transaction costs and to improve market access by enabling the delivery of larger quantities of hogs to processing industries.
- 2) Upgrade quality and safety at pork producers and pork processing industries through certification programmes and provision of better market information upstream in the chain. An important condition for better quality performance is better collaboration between various government ministries responsible for food safety and quality in China.
- 3) Search for new governance forms, i.e. contracting and vertical coordination. The governance form that prevails in the Chinese pork sector is the spot market. This means uncertainty in quantity, quality and price for chain partners, preventing long-term market strategies and quality programmes.
- 4) Besides difficulties in the collection of hogs, it is difficult for processors and retailers to monitor hog production processes. A major barrier exists with regard to the application of modern monitoring technology because of limited education of most of the producers and processors.

Therefore, firms should forge strategic partnerships and develop closer relationships with their suppliers and customers. By establishing long-term buyer-supplier relationships, firms can also improve quality and logistics management. Attention to quality management throughout the supply chain is critical to improve customer satisfaction and bring benefits to companies.

## **7.2 Case 4: Tops fresh vegetables chain in Thailand**

In this project (1998-2002) businesses (Tops, Ahold Thailand; Syngenta; SGS; producers), research institutes (Katsetsart University, Thailand; Wageningen UR, The Netherlands) and (semi-) governmental organizations worked jointly to develop a high quality and efficient fresh produce chain in Thailand from producer to retailer.

Roughly 250 suppliers were delivering perishable products directly to the backdoor of supermarkets at least three times a week. Incidents of out-of-stock were common and shrinkage in the store was high. The lead times between the farms and the supermarket shelves was up to 60 hours and due to the lack of pre-cooling and cooled transportation, post-harvest losses were high. It was impossible to trace products back to the farm; there was no insight into farming practices and post-harvest practices. There were no clear uniform product specifications that could be communicated throughout the supply chain. The following improvement steps were taken (Boselie, 2002):

- A 'preferred supplier approach', in which a small number of suppliers were selected to have strategic relationships with, reduced the total number of suppliers from 250 to 60 after critically benchmarking their performance and development potential. At farm level solutions generated were among others; Good Agricultural Practices (GAP), a safe use programme for crop protection products, participation in certification programmes (covering 80 percent in June 2001) and improved seeds and technical assistance.

- A distribution centre (World Fresh) was built that also performed productive functions like quality control (GMP, HACCP), washing, packaging and processing. This value-added centre was a complete 24-hour-a-day/ 7 days-a-week green-field operation at the borders of Bangkok city.
- A lead time reduction programme has substantially reduced the lead time between the farm and World Fresh and between World Fresh and the stores. The service level of World Fresh has been improved to 98 percent and standardized pallets & crates and a pool system have substantially lowered handling costs.

Most suppliers (and even competitors) have accepted the standard. However, a lot remains to be done in the fields of inspection, auditing and compliance. There are still suppliers who consider the new label as a kind of window dressing without actual enforcement. It also has proven to be difficult for small holder producers to become a supplier within the retail market segment. The small production volumes, the inability to supply year-round and the non-transparent farming practices are the main problems. So far, structural changes in regional and local social-economic structures have not been reported (Boselie, 2002).

Looking back the Tops management had to operate under rather difficult business conditions. They decided to focus on reduction of transaction costs and improvement of food safety levels. As a result, a selection process among the original suppliers was established. The more professional and advanced growers and traders achieved a preferred position. Their less professional and advanced colleagues had to abandon the field. Consequently the integration of smallholders in the supply chain of Tops was reduced.

### 7.3 Case 5: The supply chain for beans in Central America

Common beans (*Phaseolus vulgaris*) are an important ingredient in the daily diet of many people in Central America. The three largest producers of beans in Central America are, in descending order, Nicaragua, Guatemala and Honduras. Most farmers cultivate beans together with maize on the same plot as an intercrop or in pure stand. Yearly supply data per capita show that consumption is highest in Nicaragua (27 kg/capita/year), followed at some distance by El Salvador and Costa Rica (10-15 kg/capita/ year). In Costa Rica, average daily consumption amounted to 31 g per person in 1996 (Rodríguez and Fernández, 2004). However, daily consumption of 28 g per person in urban areas was strikingly lower than that of 43 g per person in rural areas. Moreover, some decline over time is apparent, as the average daily consumption in 1966 was 57 g per person. The decreasing bean consumption in general and in urban areas in particular, is considered to be undesirable from a nutritional point of view. It is attributed to the fact that more women are integrated in the work force and therefore can no longer prepare the beans, which is highly time-consuming.

Beans are often consumed in combination with a starch-rich food, usually with rice (e.g. as gallo pinto) or along with maize tortillas. Beans thus constitute an important source of supplementary plant protein in the daily food intake. Although beans are a highly acceptable commodity, utilization is prevented by several factors such as low and variable agricultural productivity, post-harvest losses, limited industrial processing for different food products and several nutritional deficiencies affecting

consumers' choice. The Bean Improvement Programme of the Centro Internacional de Agricultura Tropical (CIAT) in Cali (Colombia) is an important international collaborative effort to enhance the utilization of beans in developing countries (see [www.ciat.cgiar.org/beans](http://www.ciat.cgiar.org/beans)).

There is considerable potential for increased bean supplies originating from small farms in Central America, but logistic limitations act as one of the major constraints. FAO recently published a report in which rural transport in developing countries is evaluated and strategies and guidelines are developed to increase marketing opportunities of small-scale farmers in these countries (Gebresenbet and Oodally, 2005). Major attention needs to be given to post-harvest management (especially moisture control) and wholesale storage and packaging infrastructure and services to reduce losses and improve product quality.

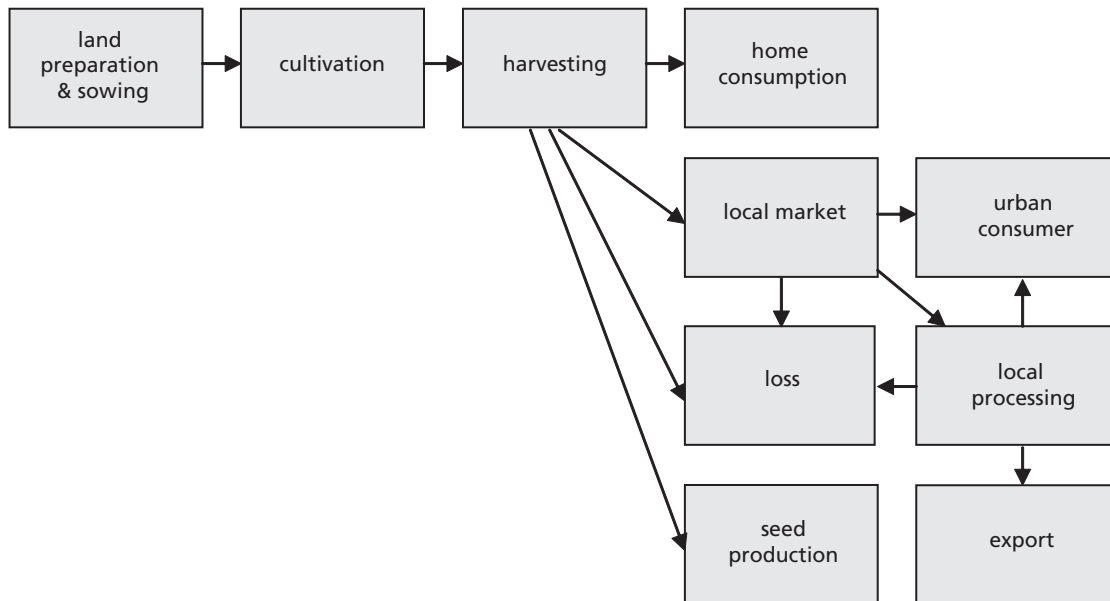
Beans are predominantly produced by smallholders. Beans are offered for sale on open markets and in supermarkets in various forms. They may be simply sorted and packed as whole beans, but they are also available in processed forms. These range from cooked whole beans to mashed beans (*frijol molido*), which are especially appreciated by consumers who are looking for convenience. Processing is done at local plants, and the required quality of the beans depends on the product to be made. New technologies in the field of food processing and packaging seem to offer opportunities for the development of new products that can serve the demands of urban consumers on the national and international markets.

From the moment that the bean seeds are sown by the farmer until the time that they have been prepared for consumption, the produce passes many stages with different actors and different environmental circumstances (Figure 16). When the crop is still in the field, it may suffer from adverse environmental conditions, such as drought, and also from pests and diseases. After harvest, losses in quantity and in quality occur during storage and transportation. This is true for the home situation, but also for produce taken to the market and used for further processing. Adequate storage facilities and improved logistics could reduce these losses significantly and open new market segments for the smallholders. Regarding infrastructure, Immink and Alarcón (1992) - based on a study in Guatemala - advocate to increase access to markets by planning rural roads in areas where smallholders are concentrated rather than where large production units are located. They also state that collection facilities need community-based organization to facilitate marketing and joint investments for quality upgrading.

There are several important bottlenecks for supply chain development for beans in Central America:

- Absence of uniform, vigorous seed for production and thus heterogeneity of the crop in the field and heterogeneity at harvest
- Processing problems, of which the time-consuming preparation of beans is regarded as one that seriously restricts consumption.
- The absence of dedicated supply chains from smallholder to market outlets that can reduce product losses and open new market segments for specific quality batches; this requires the improvement of logistic infrastructures and supply chain management practices.

**Figure 16. Production and supply chains for beans in Central America**



The supply chain research for beans in Central America perceives as its main aim to identify appropriate and effective alternatives for small-scale farmers and processors of beans in Central America that enable them to cope with the existing diversity in production systems and management regimes through improved matching of quality requirements for different market outlets. In this regard, an interesting option for these farmers and processors would be the establishment of producer organizations (POs). POs can support quality programmes for their members thereby achieving more uniform quality of products. They can also improve market access and bargaining position of small holders. Moreover, POs can establish sustainable and trusted trade relationships with buyers in the chain.

#### **7.4 Case 6: Quality management in the dairy supply chain in Brazil**

A major concern with regard to food production in Latin America countries is that food control is not adequately performed, since there are very few activities involving preventive inspection, little attention is paid to education and quality standards and sanction systems are weakly developed (EU CA, 2005). Therefore, the design of new quality management and organizational infrastructures to ensure food safety and quality receives a high priority.

Due to unequal income distribution and large differentiation in dairy production systems, products offered to different markets as well as requirements on these markets show large variability with regard to quality and price. This has resulted in the development of separate supply chains for local, national and international deliveries. Especially small-scale companies that have little capital to invest, using traditional techniques, mainly depend on family labour and lack the capabilities to connect with alternative markets.

During the last fifteen years, the Brazilian dairy sector has developed within the background of deregulation of prices, trade liberalization and the emergence of new public

and private regulations and standards. Deregulation of the dairy market from 1989 to 1993 led to increased competition in price and cost cutting and to a drop of relative prices of dairy products by 35 percent between 1994 and 2002. Private standards were instituted by leading processors to reduce costs through raising efficiency and providing incentives for investments in cooling technology, by farmers. Simultaneously, public standards became more stringent with regard to collection and refrigeration facilities at the farm level.

In the same period the introduction of Ultra High Temperature (UHT) milk substituting pasteurized milk has led to a restructuring of the dairy chain in Brazil. UHT milk was first introduced by the multinational Parmalat and has now covered most of the Brazilian milk market. The introduction of this new processing technology combined with new packaging materials has made long-distance transportation of milk possible, both national as well as international, leading to a move of processing capacity to concentrated production regions, occasioning stronger competition, cost reductions throughout the chain and lower prices in the market.

The consumer end of the chain pictures a steady increase in demand for new products. In the Brazilian food market in general, product assortments have shown average yearly increases of 200 percent from 1995/1997. In the dairy market middle- and high-income consumers show increasing interest for new products and improved packaging modes. For example, modern carton packages of UHT milk are valued because of practicality, hygiene, safety, etc. Another example is that in 2002, approximately 10 percent of the UHT market was already covered by milk with additives like calcium, iron, vitamins, etc.

Supermarkets account for the major share of dairy product distribution, although highly fragmented. The modern retail market in Brazil pictures a strong concentration and consolidation of supermarket chains. The largest 10 supermarket chains in Brazil had a market share of almost 50 percent in 2002. However, independent supermarkets (fewer than 5 stores, located in rural areas and poorer areas in cities) that compete on service and price, are becoming an alternative outlet for processors and wholesalers and have gained some ground in the last years. Besides these chains, there are still many traditional stores aiming at the poorer consumer with medium to low quality products.

Processing industries vary from small and medium size, focusing on local markets, to large size, focusing on the national and international market. The type of company in most cases determines the market outlet. Due to economies of scale and the increasing stringency with regard to quality grades and standards of supermarkets, large processors and food service franchises such as McDonalds, have reduced their supplier base. Consequently, large dairy producers and processors have increasing scale advantage over small companies. Moreover, pressure on UHT milk prices have lead to low profitability margins, again favouring industry concentration.

Average dairy farm production in Brazil is less than 40 litres per day; such low output does not justify investments in milk tanks and farmers have to collaborate. However, although an increasing number of small farmers invest in joint milk tanks, many problems still remain regarding traceability (mixing of small batches), logistics (timely collection and transportation), contracting (of farmer groups by processing companies) and necessary investments.

Furthermore, small farmers have limited access to market information and lack the capabilities to implement new production methods and systems which would enable them to take part in alternative chains.

Most primary producers are small or medium size. Smallholders produce less efficiently with low productivity and often sell their products to informal markets, focusing on products like cheese due to their traditional production techniques, inefficient distribution channels and lack of market access. Large producers have a broader range of products and are also connected to large national processing industries (such as Nestle, Parmalat and Danone). Cooperatives account for approximately 40 percent of Brazilian milk. However, fragmentation is high; over 350 cooperatives with varying management and marketing skills are involved in milk collection.

Small producers that are excluded from the modern channels move to smaller processors or to the informal business or have to go out of business. The informal market represents still 40 percent of the total volume of milk produced. However, many problems exist in this market segment: tax avoidance, addition of water, bad working conditions, lack of certification, bad quality and sanitary conditions, etc.

The Brazilian dairy sector shows a diversified picture of production systems and market outlets, with a number of specific bottlenecks. It is characterized by heterogeneity in production systems and marketing channels and large variation in quality among producers and production batches. Collection and storage of dairy products from small- and medium-size farmers is characterized by inefficiencies leading to loss of product and product value. Inspection and control at farm level, in particular small and medium size, is insufficient and therefore bears food safety risks. Moreover, there is little attention to standardized quality systems throughout the chain and an integrated quality approach of chain participants is lacking, each level focusing on quality aspects in their link, not taking into account what happens further in the chain.

Besides quality improvement through hygienic measures, economies of scale are of intrinsic importance in the dairy sector. This implies investments in milk tanks and cooled transportation and collaboration between small producers in the collection and sales of milk. Furthermore, a good transportation infrastructure is necessary. This means that probably many small-holders with limited means of investment and from remote areas will have to leave the sector in the next years, as quality and safety demands from consumers, both local and regional, and government will further increase.

## **7.5 Case 7: Thai Fresh project**

The Thai Fresh project was initiated in 1999 when Golden Exotics Holland and KLM Cargo established a distribution and packing centre in the vicinity of Bangkok airport. In previous years, Golden Exotics had already built up a good reputation in the distribution of exotic vegetables from Thailand, in Germany, United Kingdom, Netherlands and Belgium. In those years fresh products were purchased from wholesalers and brokers. This mode of sourcing was no longer workable, owing to the increasing quality and safety requirements of the international



end-markets in the EU and Japan. In fact Golden Exotics Holland faced increasing problems with the Dutch Inspectorate for Health Protection regarding pesticide residues.

The Thai Fresh project aimed at the development of an integrated quality chain for export of exotic vegetables. The challenge of developing such an integrated quality chain is translating the quality and safety requirements at retail level into good agricultural practices at producer level and to develop a supply chain structure for a reliable tracing and tracking system. The challenges concerned were tackled in two successive actions: (1) the establishment of a distribution and packing centre at Bangkok airport, and (2) the establishment of a regional post-harvest centre in Ratchaburi province.

The establishment of the distribution and packing centre at Bangkok airport was a first step in getting a better control on product quality and food safety. In the beginning, the fresh products were purchased from Bangkok based wholesale traders. After delivery at the distribution and packing centre the products are graded, sorted, washed, packed and temporarily stored in a cold room, where pallet build up for freighting, inspection by customs department and the quarantine service are executed. The centre can be considered as a value added facility, where grades and standards are implemented and where compliance with these standards are enforced. Hazard Analysis and Critical Control Point (HACCP) has been introduced at the distribution and packing centre in order to achieve Good Manufacturing Practices (GMPs). Introduction was accompanied by the development of Standard Operating Procedures (SOPs) and the implementation of a training programme for the managers and the workers at the centre.

The establishment of the distribution and packing centre was prompted by developments in the international end-markets in the EU and Japan. In the late 1990s consumer confidence in EU and Japan reached an all time low. Consumers started to demand more transparency in the food chain. This transparency included the verification of the composition of the product, its origin and traceability, its safety and the claims that were made concerning product features like nutritional values, health effects, etc.

Sourcing from Bangkok based wholesale traders, implied a number of weaknesses regarding quality and safety assurance:

- The lack of quality control at the farm led to a variable quality of vegetables. Subsequently, this resulted in a relatively high level of rejection of substandard quality at export destination and hence financial loss due to waste;
- The fact that there was no recognized standard of quality in Thailand also resulted in a decreasing access to the EU markets and prevented new access to the high-value Japanese market.

The distribution and packing centre in Bangkok was not sufficient to solve these weaknesses. Therefore a further upward integration of the supply chain was considered to be necessary. For that purpose a regional post-harvest centre was built in 2003 in the production region of Ratchaburi province. The post-harvest centre also serves as a knowledge centre for the growers. The centre provides the growers with extension services and farming inputs so

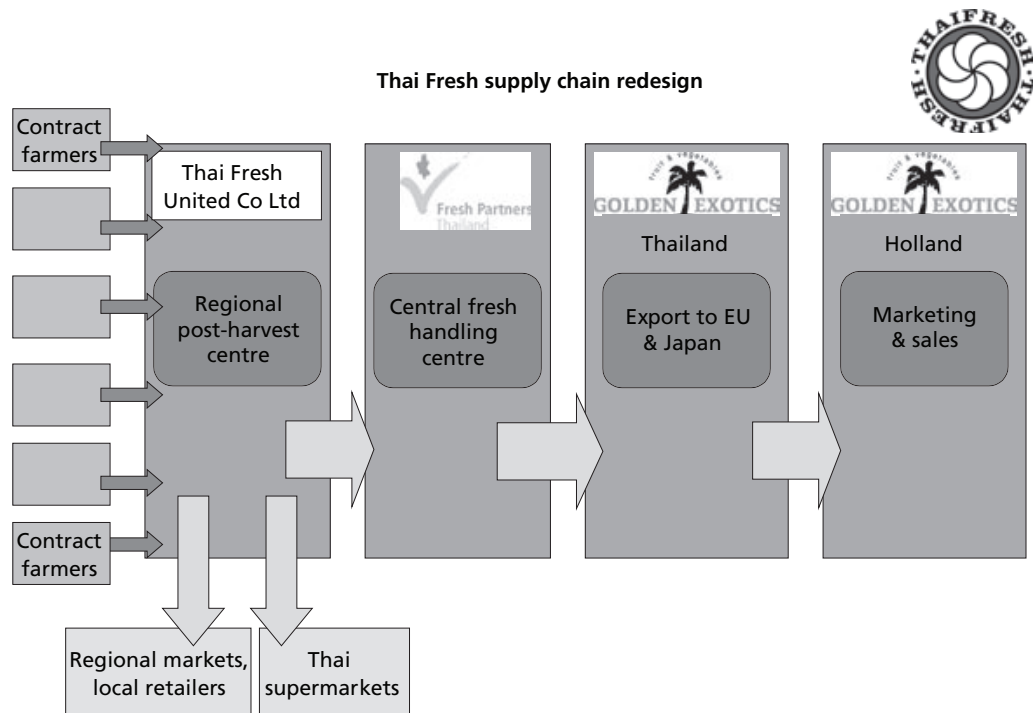
that they can apply good agricultural practices and integrated crop management techniques. The services concerned have the target to get the growers certified according to European Retailer Produce Good Agricultural Practices (EUREPGAP).

Pesticide residues are the most important food safety concern in the vegetable supply chain. For that reason farmers are being trained in GAP with regard to pesticide application. The GAP terms of reference implies: (a) minimizing the use of agro-chemicals and implement a traceability system, (b) becoming aware and taking care of environmental protection and efficient use of resources, (c) assure the workers' health, safety and welfare. The training is provided by a team of experts consisting of a full-time extension worker of Thai Fresh, an agronomist from Kasetsart University and back-up support from Bureau Veritas (certification company) and LEI (Wageningen UR). The training includes the preparation of a pesticide-policy manual for the contract growers and assistance in setting up a record keeping system.

The establishment of the regional post-harvest centre in Ratchaburi implies a shortening of the supply chain, due to the bypassing of the wholesale traders. As for the primary production level, commitment from the growers is created through contractual agreements on purchases and by making them shareholders of the regional post-harvest centre.

The organizational structure of the Thai Fresh supply chain has been depicted in Figure 17.

**Figure 17. Organizational structure of the Thai Fresh integrated quality chain**





The Thai Fresh Business model, combined with the strategy for building competences along the various levels of the supply chain, appears to be quite successful. The export volumes to Europe show an impressive growth rate. The present export results are considered so promising, that export to Japan has no priority for the time being.

In the near future a demonstration garden on the land adjacent to the post-harvest centre will be established to further support the suppliers/growers. Follow-up investments in Thailand and Vietnam are under consideration. So the focus is on application of the business model to other products and other countries.

We can conclude that the Thai Fresh management is operating in the rapidly growing market of exotic vegetables in Europe. Such a position makes investments in buildings, certification systems and human resources easier. Management decided to make such investments in order to maintain their access to the market for exotic vegetables in Europe. In fact the increasing need for food safety assurance was the driving force to develop an integrated quality chain. The strategy for building competencies along the various levels of the supply chain has enabled numerous smallholder growers to link up with international standards. Simultaneously the involvement of wholesale traders has been reduced.

## 8. Critical success factors for supply chain management

SCM is to a large extent still only a target, despite considerable efforts by organizations and their customers and suppliers. Lack of visibility of true consumer demand and collaborative relationships based upon joint decision-making remain significant barriers to the goal of supply chain integration (Barratt and Oliveira, 2001). Some other barriers to the implementation of SCM are the lack of trust and sharing information, no shared targets, scalability and getting critical mass and insufficient information technology to communicate relevant data throughout the supply chain. Zuurbier *et al.* (1996) add two basic qualifiers for partner selection: strategic complementarities referring to the degree of compatibility of the partners' assets, competencies, goals and strategies; and cultural congruence, referring to the degree of congruence of the partners' beliefs, value systems and norms. We also refer to the eight management components presented earlier, with the focus on compatibility of managerial philosophy and techniques and a balance in power. The last aspect is an unfinished discussion in the management literature and is related to the definition of true partnership, which requires a certain symmetry in power.

Organizations often try to weaken a supplier or customer to ensure their own control of profits. This is understandable, given that the widely followed competitive model suggests that companies will lose bargaining power - and therefore the ability to control profits - as suppliers or customers gain strength. Naturally, such companies tend to share as little information as possible and consequently managers often lack knowledge of the activities elsewhere along the value-added chain.

The first step the trading partners should take to enable the implementation of SCM is to develop an adequate environment founded on two concepts; trust and technology. Such concepts can be considered to be co-dependent, in that the development of information technology interfaces between trading partners cannot be completed without the development of trust between the trading partners. Developing trust is a long-term objective for organizations, although it must start somewhere. Barratt and Oliveira (2001) suggest a possible approach:

1. Define single point of contact for each trading partner; this ensures that the information is neither lost nor deteriorates during its flow between the trading partners.
2. Define agenda for collaboration (short-medium-long term); stabilizing the collaborative goals across the time.
3. Expand collaborative projects (scope and complexity); to gain critical mass the initiative must expand its scope and complexity across time.
4. Ensure continuous sharing of information; the need to keep continuous information flow is paramount.

5. Trust develops: a real trust-based relationship will only prevail after a relatively lengthy period. Meanwhile, small barriers are removed from the path, which brings confidence to the trading partners that their long-term vision is tangible.
6. Expanding the scope of collaboration: expand the number of processes, increase the number of products, the level of detail and/or add trading partners

Because each relationship has its own set of motivating factors driving its development as well as its own unique operating environment, the duration, breadth, strength and closeness of the partnership will vary from case to case and from time to time.

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## Agro-industrial Supply Chain Management: Concepts and Applications

This publication was conceived as an introduction to the discipline of supply chain management (SCM), with particular reference to the agro-industrial domain. It introduces fundamental SCM concepts and illustrates them with selected agrifood related cases from different regions of the developing and developed world.

SCM concepts are already consolidated as an essential part of modern management thinking. Its tools and techniques have helped companies in traditional areas such as manufacturing and retailing to achieve unprecedented levels of operational performance and efficiency in transaction coordination with suppliers and customers. Yet, the discipline is still rather incipient in the agrifood domain. While the managerial literature abounds with textbooks and publications about SCM in general, publications specific to agrifood enterprises are few and far between. The present publication represents a contribution to fill this gap.

The text has been planned to constitute a basic reference source for agrifood professionals seeking information on this relatively new area of work. It should address not only the needs of the traditional audience of FAO publications - field project managers, extension officers, Non-Governmental Organization (NGO) personnel, officers at Ministries of Agriculture, etc, but also managers of agroprocessing plants, agribusiness development service providers and others with professional responsibilities in agro-industrial enterprises and support services. The publication may also be used as reference reading for agribusiness management training purposes and academic programmes.

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