CONTROL MECHANISMS IN CHAIN MANAGEMENT

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INTRODUCTION

An important trend in European agriculture and agribusiness is the increasing coordination of planning and decision making in agricultural chains. This vertical coordination can include one or more components of production, marketing and logistical management. Logistical management is an area that can profit considerably from vertical coordination in the agricultural chain.

Understanding the vertical coordination of decision making in agricultural chains is a must for agribusiness managers. Agricultural politicians, scientists and extension officers can also benefit from a basic understanding of this process. In this paper the coordination of decision making in agricultural chains is analysed with special reference to agrologistics. The teaching of agrologistics by agricultural faculties is also discussed.

The paper is organized as follows. First, basic concepts and theories concerning vertical coordination in agricultural chains are reviewed. Our discussion of coordinated decision making and planning in this area will focus on decision making as it relates to physical product flows, i.e. agrologistics. The general characteristics of logistical management and the special features of agrologistics will also be described and attention is given to teaching agrologistics in agricultural faculties. Some future social and technological trends, which increase the importance of agrologistics, will be identified in the conclusion.

CONCEPTS AND THEORIES OF VERTICAL COORDINATION

The structure of agricultural marketing channels, i.e. of the sequence of independent companies involved in production and marketing of specific agricultural products, is the result of the division of labour between these companies. In cases of perfect competition, prices and costs coordinate the performance of functions in the marketing channel. Various well-known marketing theories concerning the structure of the marketing channel take this approach (Alderson, 1965; Balderston, 1964; Mallen,1973; Bucklin, 1965). When markets are imperfect and consumers and retailers, have specific needs, coordination by market prices is often not satisfactory. As a result, additional coordination mechanisms will be used in the marketing channel. This is especially the case when producers and retailers follow specific market strategies, such as product differ-

entiation or market segmentation. The continuous need for cost reduction also enhances the coordination of decision making in agricultural marketing channels. In fact the minimization of production and transaction costs at each stage of the marketing channel does not guarantee total cost minimization. A total cost approach (LeKashman, Stolle, 1965) to the agricultural chain from farmer to final consumer is appropriate.

Concern that product quality is not optimal and anxiety about efficiency levels have stimulated the further coordination of decision making in agricultural marketing channels. Such coordination embraces decision making by two or more successive companies in the channel and may include one or more functions, for example marketing, quality control, or logistical management. We will call two or more successive companies in a marketing channel, which coordinate decision making with respect to one or more functions in order to strengthen their joint economic performance, a chain. In marketing theory the term vertical marketing system is used for successive companies in a marketing channel which coordinate their marketing strategy (Stern and El Ansary, 1992).

The study of agricultural chains can make use of contributions from various scientific disciplines, including economics, the behaviourial sciences, management and marketing. Economic theory, in particular the economic theory of industrial organization, has developed models and concepts about the coordination of exchange processes. Coordination mechanisms can range from anonymous spot markets to contractual arrangements and vertical integration, the latter being understood as control over the entire production and distribution process. According to Perry (1989) transactional economies, technological economies, and market imperfections are the determinants of vertical integration. Economic models of vertical integration differ in their assumptions about the incentives for coordination. The assumptions made include price discrimination, barriers to entry, elimination of successive mark ups, imperfect or asymmetric information, assurance of supply, and reduction of agency problems (Perry, 1989). Economic analyses of contractual relationships between buyer and seller have, for example, emphasized quantity-dependent pricing, the tied sale of products, royalties and exclusive dealing (Katz, 1989).

The transaction cost theory developed by Williamson (1975, 1985) has become particularly popular in investigating the coordination of exchange processes. Williamson (see Williamson, 1989; Douma and Schreuder, 1991) assumed that economic actors are bounded rational, display opportunistic behaviour and value a specific atmosphere in transactions. According to Williamson transaction costs depend on asset specificity, uncertainty/complexity and frequency of transactions. For instance, farmers who make specific investments in growing a certain type of vegetable for a particular food retailer may be anxious to diminish investment risks by a contractual relationship.

Another important field of economic theory, which seems relevant to coordination of decision making in agricultural chains, is the economics of information (Phlips, 1988). Topics relevant to agricultural chains include hidden information about adverse selection by customers and information asymmetry about hidden actions after a contract has been negotiated. Agency theory about the relationship between a principal and an agent, making decisions on behalf of the principal (see Tirole, 1988), seems useful for the analysis of the relationship between a chain leader and other channel members.

Concepts and theories have also been developed in the behavioural sciences which are useful for understanding the coordination of decision making in agricultural chains. Resource dependence theory "..views interfirm governance as a strategic response to conditions of uncertainty and dependence" (Heide, 1994; Pfeffer and Salancik, 1978) and French and Raven's theory on the bases of social power - rewards, coercion, expertness, reference and legitimacy - has been applied to power in marketing channels (Stern, El Ansary, 1992). Another contribution to the coordination of decision making in a chain is Mintzberg's classification (1989) of coordination mechanisms, which include, amongst others, mutual adjustment and direct supervision.

The contributions from the behaviourial sciences to the coordination of decision making in chains are often conceptual and are based less on formal models than contributions from economic theory.

Marketing theory has always displayed great interest in the coordination of decision making in marketing channels. Various analyses concerning the structure of marketing channels have been based on economic concepts and theories (see Heide, 1994). These include economic efficiency (see Bucklin, 1970) and transaction cost theory (Williamson, 1975, 1985). Other analyses of the coordination of decision making in marketing channels are based on concepts and theories from the behavioural sciences, such as role performance, sources of power, dependence, conflict and satisfaction in channel relationships (Stern, 1969; Hunt, Nevin, 1974).

Coordination of decision making in agricultural marketing channels has become important for many agricultural products. Theory on the structure and evolution of agricultural chains is still poor. Applied general equilibrium models of the relationship between the various stages in the agricultural chain have been developed at sector level (Peerlings, 1993). We suggest the following hypothesis as a potential contribution to the body of theory relating to agricultural chains. Agricultural chains from farmer to the final consumer can be structured in two subsystems: one subsystem in the production stage {Supplying industry-Farmer-Processing industry} and one in the distributive stage {Wholesale companies and Retail companies}. The first system has to organize the production appropriate to the distributive system while the latter builds the assortment on the basis of needs and wants of target groups. This hypothesis implies a hierarchical coordination in the agricultural chain: first a coordination of the subsystems and subsequently coordination within the subsystems, or vice versa.

COORDINATION OF DECISION MAKING WITH RESPECT TO THE FLOW OF GOODS IN THE AGRICULTURAL CHAIN: AGRICULTURAL LOGISTICS

General aspects of logistics

Logistics is defined by Bowersox (1986) as: "..a single logic to guide the process of planning, allocating and controlling financial and human resources committed to physical distribution, manufacturing support and purchasing operations." Logistics as a planning device originates from military science (Van Goor, 1993). According to Bowersox (1986),integrated logistical management has become important for the following reasons: "...interdependence between all logistical areas.....a narrower or restricted approach creates the potential for a dysfunctional interface.....control requirements for each operation are similar.....increasing awareness that many trade-offs exist between

manufacturing economies and marketing requirements that can be reconciled by a well-designed logistical system....the complexity of contemporary logistics".

Logistical management is important in agricultural production and marketing because material handling and physical distribution make up a large proportion of the total product cost. The distribution component in total consumer expenditure on food and luxuries in the Netherlands, for example, increased from 35% in 1961 to 45% in 1988 (LEI-DLO, 1992). Logistical operations contribute to efficiency and, especially in the case of fresh produce, to quality maintenance and customer service.

Table 1. Consumers' expenditure on food and luxuries 1961 - 1988 in the Netherlands and their distribution over processing, distribution and primary sector.

	Food Expenditure in million guilders	% Processing	% Distribution	% Primary Sector
1961	9,700	24%	35%	41%
1970	18,850	26%	39%	35%
1975	30,030	27%	40%	33%
1980	41,910	26%	45%	29%
1985	49,880	26%	44%	30%
1988	52,240	27%	45%	28%

Source: LEI-DLO (1992), calculated from Input-Output Tables.

The logistical operations of a company cover the sequence of purchasing input, material handling in the factory, and the physical distribution of the final product to the customer. Logistical operations involve many functions. Some of the most important are demand forecasting, buying, order processing, transportation, material handling, inventory management, warehousing and packaging.

Logistical processes have already been analysed for a long time and this has resulted in many inventory models, transportation models, queuing and warehousing. Logistics as a scientific discipline is broadening and deepening research and theory on these topics. But logistics as a scientific discipline is particularly concerned with trying to analyse the total influence of separate components in a comprehensive way.

According to Bowersox (1986) the integrated logistical concept began to crystallize in the period 1956 - 65. He characterises the evolution of logistical management as follows: "The challenge for the future is to fully integrate the inherent complexities of physical distribution, manufacturing support, and purchasing operations." (Bowersox, 1986).

Logistics has come of age both as a management tool and as a scientific discipline. It is by nature a multidisciplinary science, and this is illustrated in Table 2.

The disciplines involved in the science of logistics are management science, marketing, operations research and information systems. These provide the scientific building stones for logistical models. Technological sciences supply the technical parameters

for logistical models. Logistical management borrows from these basic disciplines the following concepts and theories:

- management science: general concepts of planning and coordination, concepts and theories concerning production management, methods of quality control, including the lay-out and planning of warehouses.
- marketing theory: theories concerning industrial purchasing, distribution strategies, demand forecasting and customer service.
- operations research: programming models, such as linear programming, dynamic programming, transportation models, inventory models and models of facility location.
- information systems: technology, models and concepts dealing with the collection, processing and transfer of information.

Table 2. The multidisciplinary nature of logistical science.

Discipline Function Category	Management sciences	Marketing	Operational research	Information systems	Technology
Purchasing	Order management	Buying process	Decision making models	Information systems	Transport storage packaging technology
Material Handling	Production management	-	idem	idem	idem
Physical Distribution	Warehouse lay out	Distribution strategy, service, forecasting	idem	idem	idem

Logistical science is multidisciplinary because it combines a network of disciplines in the analysis of logistical problems. However, many logistical analyses still focus on specific components of the logistical process, for example, inventory management, packaging and demand forecasting. Truly integrative logistical models, which include all components of a logistic operation, are scarce.

Within the domain of logistics as a discipline new concepts and theories have been developed. JIT (just in time), OPT (optimized production technology), MRPII (Manufacturing Resource Planning), DRP (Distribution Requirements Planning) and Reverse Logistics are some examples of these.

Finally it should be stressed that logistical output, in terms of customer service, product quality and logistical efficiency, not only depends on the logistical management of companies but also on logistical infrastructure. Logistics as a scientific discipline should

also study the interdependence between logistical decision making and logistical infrastructure.

Special features of agrologistics

Agricultural logistics has special features because of the characteristics of the production method, the product and the market structure in agriculture.

The special features of the **agricultural production** processes are:

a) Seasonality of production, harvesting wheat, sugar beets and fruit, for example. As a result logistical management has to cope with seasonal demand for logistical services and with seasonal stocks. The financial risks associated with seasonal stocks are important in commodity markets, and stimulate futures trading.

b) Production is concentrated in specific regions and as a result the costs of transporting agricultural products from production centres to consumption centres are high.

c) Annual variation in production because of changes in acreage and in yield per hectare gives rise to variation in the demand for logistical services such as storage and transportation.

The following characteristics of **agricultural products** have specific consequences for agrologistics:

a) The perishability of fresh agricultural products means that quality maintenance and speed of logistical operations are crucial instruments in effective marketing.

b) Many agricultural products are commodities which have a low value/volume ratio. This makes logistical efficiency extremely important for price competition.

Also specific to agrologistics is the **market structure** of many family farms on the supply side and on the demand side many food consumers. As a result, the task of reconciling a narrow conglomeration of products from single sources into a wide inventory assortment at the point of retail sales, is considerable.

Agrologistics is changing because both agriculture and the environment in which it operates are changing. These changes can be illustrated by using Alderson's Sorting concept (1957, 1965). In **conventional agricultural marketing channels**, for example, a marketing channel of fresh fruit, the logistical process starts with **sorting out**, dividing a heterogeneous lot of harvested product by grading and sorting it into smaller homogeneous lots. These small lots are brought together into large homogeneous lots by wholesalers: **accumulation**. Subsequently these large lots will be broken into smaller lots by distributive wholesalers: **allocation**, and combined with other food products for sale by retailers: **assorting**. This pattern has changed because of changes in market structure and production planning. In the last twenty five years, at least in Western Europe, farms have become larger and more specialized and agribusiness companies have become big concerns that operate internationally and focus on core competences. Food retailing has also become dominated by large, international food chains. As a result of these developments farms and agribusiness industries produce larger homogeneous quantities, and this has reduced the need for **sorting out** and **accumu-**

lation in the first stages of the agricultural chain. However, **allocation** and **assorting** have become more important because the number of food products, varieties and brands carried by one food outlet, has increased. Today, the greater importance attached to product quality and customer service as marketing instruments makes effective logistical planning necessary. In fact agrologistics has become an important competitive weapon in marketing agricultural and food products.

The importance of logistics as a management tool has also increased because of the expansion of agricultural markets and the continuous search by agribusiness companies for cost reduction, especially in the area of distribution costs.

Thus it can be concluded that developments in agricultural markets make effective and efficient logistical management extremely important for the competitive position of agricultural chains.

TEACHING LOGISTICS IN AGRICULTURAL FACULTIES

Logistics is emerging as a discipline in its own right. Separate fields of logistical research such as inventory management, transportation and quality control are being elaborated and these components are being integrated into one comprehensive analysis of logistical problems. This evolution of logistics and the importance of logistical problems in agriculture justify the running of courses in logistics at agricultural faculties. The teaching of agrologistics at university level should prepare students for management and research in agrologistics both at the strategic and the operational level and contributes to fulfilling the demand of agribusiness companies for logistical specialists. Not only large agribusiness companies but consultancy firms too employ logistical specialists. Courses in agrologistics are necessary for students who want to become logistical managers or logistical researchers, but they can also be useful for students who are preparing themselves for jobs in general management or marketing.

A prerequisite for students taking courses in agrologistics is a basic knowledge of general management, marketing and operations research. Students of logistics should also have a basic understanding of the technical parameters of agrologistical processes. The latter prerequisite gives agricultural faculties a competitive edge as far as the teaching of agrologistics is concerned. Agricultural faculties are better equipped to teach agricultural and food technology in agrologistic courses than general business faculties.

The subjects necessary in an agrologistics course can be classified on the basis of:

- **functions** performed in the successive stages of purchasing, order processing, material handling and physical distribution. Important procedures include forecasting demand, information collection and processing, order processing, transportation, inventory management, quality control, warehousing and packaging,
- **concepts and theories** about management, marketing, information processing, operations research and forecasting applied to the analysis and optimization of logistical problems.

Logistics courses at the introductory and intermediate level should present a broad view of the various functions and research methods involved in logistical management.

Advanced courses in logistics will probably include specializations and the mathematical modelling of logistical problems is a case in point.

Logistics is a multidisciplinary science. Therefore teaching agrologistics requires a teaching staff with expertise in the various functions and research methods relevant to logistical management. Intuitively one might argue that the integration of the various components of logistical management in one course can best be performed by one person. However, logistics covers a great many subjects and disciplines which cannot possibly be mastered in depth by one single individual. A profound treatment of specific logistical subjects requires teachers with specific expertise in particular fields. These include operations research, information systems and marketing. Therefore, the teaching of logistics should be the responsibility of a multidisciplinary team.

In order to grasp the complexity of logistical problems, students of agrologistics should carry out case work and confront the opinions and experiences of experts in the field.

FINAL OBSERVATIONS

The development of agrologistics as a scientific discipline has accompanied actual development in logistical management in agricultural chains. A number of trends in society will make agrologistics even more important in the future than it is today:

- international competition in food markets will bring agrologistics increasingly to the fore. Competition in food markets on the basis of customer service will also increase further, and improvements in efficiency are necessary in order to meet price competition.
- the importance of agrologistics will also increase because of expanding international trade.
- the growing concern of Western societies about the sustainability of agricultural production and marketing will have a great impact on agrologistics: the scarcity of energy, air pollution and the environmental aspects of packaging stimulate "Green Logistics" (see amongst others Cooper, a.o. 1994).
- progress in electronic information technology offers new opportunities for logistical management. Communication between producers and buyers will become more extensive, faster and cheaper.
- the infrastructure of logistical processes will internationalise still further. The changing structure of international air transport, internationalization of railway networks and international regulations with respect to road transport are examples of this.

This small selection of developments which can be expected to occur in the future, supports the prediction that agrologistics will become even more important for agricultural chains. Agricultural faculties will have to put more effort into teaching agrologistics in order to satisfy the demand of agribusiness for qualified experts in this field.

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