Enhancing the integration of agri-food supply chains: theoretical issues and practical challenges in the UK malting barley supply chain

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Abstract— **The purpose of this paper is to explore the issues that may affect the integration (i.e., the relationships) between the different actors that comprise a supply chain. Whist the theoretical part of the paper can be referred to any supply chain, the empirical part is focused on the UK barley to beer supply chain. The main motivation behind the topic is that improvements in the relationships amongst the different segments of a chain can enhance its efficiency and effectiveness, (e.g., through improvements in coordination and cooperation), and therefore, its competitiveness and long term sustainability. The paper is based on two complementary analyses: the first one consisted of a structural equation model (SEM) to determine those factors that affect the sustainability of relationships in the chain. The model is estimated based on a survey of 69 chain stakeholders. The second analysis comprised an in-depth case study based on an important malting-barley-to-beer supply chain in Eastern England, and had the purpose of providing further understanding of those aspects that were highlighted by the SEM. The overall results pointed out to five factors affecting the relationships in the malting barley to beer agri-food supply chain: communication, compatibility of aims in the supply chain, contractual relationships backed by professional regard and personal bonds; high levels of trust exist between the chain participants and a willingness to resolve any problems; and commercial benefit.**

Keywords— **supply chain management, malting barley supply chain, supply chain coordination, competitiveness.**

I. INTRODUCTION

Despite their importance for describing the diversity in which an industry or economic sector are organised, issues related to relationships amongst firms (e.g., how they are integrated, how they coordinate their plans) have been a topics absent from the traditional theory of the firm in economics. Instead, according to G. B. Richardson [1], the traditional theory has portrayed firms within the economy 'as islands of planned coordination in a sea of market relations' (p. 895).

Whilst the aforementioned representation allows depicting market structures where the number of firms goes from one (monopoly) to infinity (perfect competition) with the price system as the organising mechanism; it leaves aside the fact that several markets or industries can be described by as a 'dense network of co-operation and affiliation by which firms are inter-related' (Richardson, p. 883) and where prices are only one of possible ways of coordination amongst them. Furthermore, the problem with the traditional view is that it not only does not describe the different relationships between firms, commonly found in the market, but also as a consequence, it is not capable to analyse them and formulate recommendations to improve their efficiency and efficacy. [1]

As pointed out by Hobbs and Young [4] agri-food markets in many countries are moving away from traditional spot markets (where the description of the traditional firm theory fits well) towards closer vertical integration arrangements. However, this process takes a variety forms and involves a diverse number of partners, as spot market and vertical integration could be thought as the two extreme of a continuum of firm arrangements. Thus, in some cases such as the well researched case of poultry in the US, it consists of a fully vertical integrated arrangement; while in others, it may take the form of partnerships, strategic

[1] Within economics a reaction to the traditional theory of the firm can be found in the seminal work by Coase's work on the nature of the firm [2] and which has evolved to become the 'New Institutional Economics'. An overview of the approach to supply chain management can be found in Hobbs [3].

alliances, etc., (for the UK case see, for instance, Hughes [5]).

In this context, the purpose of this paper is to explore the theoretical and practical issues that may affect the relationships of an agri-food supply chain, and therefore their degree of cohesion and coordination. The main motivation behind this topic is that improved supply chain co-ordination and cooperation amongst the different segments of a supply chain can improve its efficiency and effectiveness, and therefore, its competitiveness and long term sustainability.

The paper, which has a focus on the UK barley to beer supply chain, draws on information collected as part of the EU-funded project FOODCOMM. The paper is based on two complementary analyses: first, a structural equation model is formulated to determine those factors that affect the sustainability of relationships in the chain (and therefore its degree of integration). The second analysis, which helped improving the understanding of the results obtained with the model, consisted of an in-depth case study based on an important malting-barley-to-beer supply chain in Eastern England.

The structure of the paper is as follows: it starts with a brief theoretical discussion about the factors that may affect the business relationships within supply chains. This is followed by the empirical section of the paper, which comprises three parts: first, a brief overview of the malting barley supply chain in the UK is provided to set the context of the analysis; second, the results of a structural equation model (SEM) of sustainable relationships are presented; and third, a case study analysis based on the aforementioned English supply chain is developed. Finally, the main conclusions from the analysis are presented.

II THEORETICAL DISCUSSION: COORDINATION OF SUPPLY CHAINS

A starting point of the factors affecting the coordination of supply chains can be found in the 'New Institutional Economics' and one of its major components: the presence of transactions costs in the use of market instruments.[2]

According to Hobbs [3] 'transaction costs, and their reduction, lie at the heart of the interest in supply chain management' (p. 26). In this sense, proactive moves to enhance management of supply chains are fundamentally concerned with improving their efficiency to gain competitive advantage. Thus, on the one hand examples of factors reducing transaction costs can be found in co-operation, teamwork and the rapid interchange of data among companies. On the other hand, adversarial relationships along the supply chain, for instance, increase transaction costs.

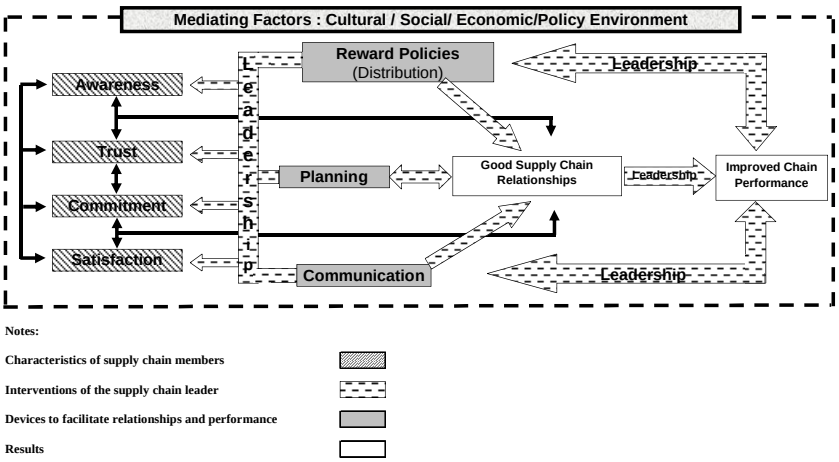
Whilst the literature on 'New Institutional Economics' has focused more on understanding the reasons behind the existence of different types of firm arrangements using economic analysis (see for instance Milgrom and Roberts [6] for an overview), it has not deepening on factors affecting the business relationships within supply chains. In this respect, as pointed out by Hobbs [3] 'supply chain management offers many insights into how industries are organised and into efficiency gains which can be made under different organisational structures, pointing out that this is a multidisciplinary concept, drawing on aspects of marketing, economics, logistics, organisational behaviour, etc.' (p. 15). Therefore, the supply chain management literature is the appropriate source to search for factors affecting the business relationships, and consequently, the degree of integration of supply chains.

Figure 1, taken from Leat and Revoredo [7] and derived from research in FOODCOMM, is an effort to summarise the interaction of factors which influence

[2] Transaction costs can be divided into three main categories: information costs (i.e., costs faced by firms and individuals in the search of information for information about products, prices, inputs and buyers and sellers) negotiation costs (i.e., costs that arise from the physical act of the transactions such as negotiating and writing a contract or paying the services of an intermediary to the transaction), and monitoring or enforcement costs (costs that arise after that the terms of the contract have been negotiated and may involve controlling quality of the products to ensure that the terms of the contract are satisfied or the costs of legally enforce the terms of a contract) [3].

the development of good supply chain relationships and performance based on elements in the literature.

As shown in the figure, the supply chain relationships within which decision making is integrated, invariably involves the development of inter-organisational relationships. Such relationships, if they are to be sustainable, should be stable and mutually beneficial amongst the partners. Furthermore, in recent times it has become widely recognised that the pro-active management of such relationships can present a critical source of competitive advantage (e.g. Dyer and Singh [8]; Sahay [9]; Power [10]).



Source: Leat and Revoredo-Giha (2008)

Fig 1. Relationships in an effective supply chain (conceptual framework)

The different elements in Figure 1 can be categorised as follows: characteristics of the supply chain members including awareness, trust, commitment and satisfaction; devices to facilitate relationships and performance such as communication, planning and reward distribution policies; and the interventions of the chain leader or focal enterprise.

At the outset it should be recognised that supply chain relationships take place within a social, cultural, political and economic environment, which in the figure is represented by the dotted line that frames the diagram. In the wider scope of economic activity - be it production, exchange or consumption - such activity is regarded as "embedded" in patterns of social organisation, relationships and cultural characteristics (Granovetter [11]).

A fundamental pre-requisite of good marketing performance is that of awareness of the customer, and their needs. Harmsen et al. [12] note that market orientation involves a focus on and responsiveness to customers and competitors, as part of an external orientation. Within the context of supply chains and their performance, this awareness should be extended to embrace the needs of other chain participants as well. Such awareness invariably involves information sharing (Brown [13]; Peterson et al. [14]).

Assessing the quality of inter-firm relationships has been the focus of many recent studies. Roberts et al. [15] reviewed several of them, which along with other studies have illustrated the importance of "soft" factors - as opposed to "hard" economic or financial measures of performance - as indicators of relationship quality (Lagace et al.[16]; Moorman et al.[17]; Wray et al. [18]; Bejou et al. [19]; Hennig-Thurau and Klee [20]; Boles et al. [21]; Dorsch et al. [22]; Rosen and Suprenant, [23]; Lang and Colgate [24]; Bennet and Barkensjo [25]). Collectively these studies show the importance of: satisfaction (cognitive and affective evaluation based on the personal experience across all episodes within a relationship, Storbacka et al. [26]); commitment (an enduring desire to maintain a valued relationship, Moorman et al. [17]), and trust (willingness to rely on an exchange partner in whom one has confidence, Lewin and Johnston [27]).

Moving away from the attributes of supply chain participants to the mechanisms which can further supply chain relationships and performance, communication has emerged as an important factor in achieving successful inter-firm co-operation (e.g. Bleeke and Ernst [28]; Mohr et al. [29]; Tuten and Urban [30]). Since communication allows chain participants to learn about and react to changes in the requirements and expectations of other chain participants, superior chain performance, enabled by modern information technologies, is of prime

importance to the continued development of inter-firm relationships. Enhanced transparency, through an information sharing mechanism linking supply chain partners, is one of the most critical drivers of supply chain success (Min and Zhou [31]). Increasingly communication of comparative performance information, which enables benchmarking, can also play a role in furthering enterprise and chain performance.

The concept of sharing rewards and penalties within the chain is a mechanism for driving chain efficiency and unity (Peterson et al. [14]). This might be regarded as particularly important within agri-food chains where the overall supply chain margin is under pressure. O'Keeffe [32], in presenting lessons from supply chain partnerships in Australian agribusiness, identifies the importance of rewards being shared equitably for partnership success. Similarly, Fearne [33], in looking specifically at supply chain partnerships in the British beef industry, stresses the importance of the premise that all will benefit and all will be winners.

Peterson et al. [14] stress that whole chain planning is necessary for whole chain success and all chain members should be involved in the planning process if a chain's potential is to be realised. Similarly, Fearne [33] in his British beef sector research concludes that partners need to share a common vision of how to work together and to meet their volume and quality requirements. The practical details of such planning activities in the meat industry are reported by Sadler and Hines [34], who conclude that "it is necessary to work with all partners in a number of supply chains to complete the design and practical steps required to enable the whole supply chain to plan its operations and logistics in one process" (p. 238).

The value of leadership to successful supply chain relationship, which appears in Figure 1 facilitating the interaction of all the elements in the supply chain, has been highlighted in a number of studies related to marketing channels (Brown [13]) and it is summarised by (Peterson et al. [14]) as … "leaderless chains lack vision, direction and unity and are characterised by a high failure rate. The leader's role is to provide the focus and coordination and to ensure that all participants know, and are committed to, the customer's objectives" (p. 10). Furthermore, the quality of leadership within supply chain firms is an important driver of development and improvement as this helps to shape the culture of the firm as well as managing the perceptions held by staff of "us and them" in their alliances (Kidd et al. [35]).

III. EMPIRICAL RESULTS

A. Overview of the UK malting barley to beer chain

The purpose of this section is to provide a brief overview of the UK malting barley to beer chain and the relationships amongst the different agents that comprise it.

Malting barley is grown mainly down the (drier) east side of Great Britain, with the distilling industry being a major buyer of malt in Scotland and brewers being the main customers in England. Of the total usage of barley in 2006, 1.7 million tonnes were classified as used in domestic brewing and distilling, with the remainder of the crop going for feed (about 3.5 million tonnes), seed, other uses and export (between 0.7 to 1.0 million tonnes). Specialist growers in the main production areas produce high quality malting barley, although new varieties have widened the geographical area where malting barley can be successfully grown. However, the recent CAP reforms and the increase in the price of other cereals may probably lead to a reduction in malting barley production in marginal areas and those more distant from customer outlets.

Malting barley is normally purchased from farmers through co-operatives and merchants. Such purchases are most frequently made using contracts, which may set 'relative' prices (relative to other grain prices) along with conditions relating to quality and service. These contracts tend to be issued by merchants on behalf of maltsters. They provide maltsters with some predictability regarding prices, quality and service attributes.

While many specialist growers have good relationships with their merchants, a significant proportion fails to meet quality or service requirements. Moreover, the small size of the malting barley premium (usually in years when grain prices are high) can disrupt the spot market, with farmers reluctant to release grain.

Table 1 presents the demand-supply balance of malt in Great Britain. There are three types of maltsters: brewer-maltsters (own and operate maltings for their own brewing needs, they represent 11 per cent of the total production), distiller-maltsters (own and operate maltings for their own distilling needs, 12 per cent of the total production) and sales maltsters (make malt to customers' specification, for the brewing, distilling and food industries, 78 per cent of the total production).

Table 1: Great Britain - Malt production, usage and trade, 2003 - 2005 (thousand tonnes)

	2003	2004	2005
Malt Production:	1,608	1,577	1,451
Brewer-Maltsters	164	163	129
Distiller-Maltsters	179	166	163
Sales Maltsters	1,265	1,248	1,159
Malt Imports	11	17	4
Total Availability	**1,619**	**1,594**	**1,455**
Malt Requirements:	1,184	1,183	1,190
For brewing	661	666	637
For distilling	458	448	481
Other purposes	65	69	72
Malt Exports	381	403	288
Total Usage	**1,565**	**1,586**	**1,478**

Source: Maltsters' Association of Great Britain (MAGB)

The malting sector is generally operating with relatively old plant and is achieving low margins. There is a degree of integration in the upstream part of the chain: some maltsters own, or have a stake in, their merchant suppliers. However, there is little vertical integration through ownership between maltsters and brewers. Only two significant brewers own maltings.

The contracts issued by a merchant on behalf of a maltster are normally matched by those of brewers for malt purchase. Relationships between maltsters and brewers are well established and close associations have developed. However, UK barley suffers from high drying and storage costs, and price remains a key factor in maltster-brewer relationships.

The beer brewing sector is generally achieving modest returns. Differentiation within particular segments of the market (e.g. premium lager) is limited, so brand promotion and efficiency in production and cost control are very important for business performance.

The biggest differences in brewers' cost bases occur between the large national brewers and small local and regional breweries. The largest brewers have achieved most of the readily available efficiencies in production and the biggest future improvement in performance appears to be in packaging.

The economic relationships between brewers and major pub chains tend to be based on supply agreements (contracts) of 3-5 years. Brewers also act as wholesalers, selling their own beers and beers and spirits of other producers. Brewers frequently have supply agreements with retailers.

There is a long-term trend away from beer consumption in pubs and clubs (the On-Trade) towards consumption through the Off Trade (e.g. supermarkets and off-licenses). Beer retailing is also under pressure from personal imports, which may account for 8 per cent of UK beer consumption.

Overall, the barley to beer chain produces good quality malting barley and malt but has been under economic pressure, which stems largely from international competition and challenging domestic demand conditions. Moreover, weaknesses exist in the supply of barley from farms, and in the generally old plant and low margins of the malting sector. Most improvement can probably be achieved through 'vendor assured grain', which should facilitate cost savings further down the chain. However, adoption of this approach will require some of the benefits to be passed back to farmers in enhanced prices.

The greatest area of weakness in the barley to beer chain is generally at the interface between producers and their customers. Farmers rely on personal contact with the staff of their purchaser (merchant or maltster). Improved two-way communications on issues such as farm production costs, quality and performance standards, market conditions, customer requirements, etc., are widely regarded as important for relationship development and improved chain performance.

B. Determinants of sustainable chain relationships for the UK malting barley to beer supply chain

In order to study the determinants of sustainable relationships in the UK malting barley to beer supply chain, a postal survey was undertaken. The survey resulted in 69 stakeholders' responses (58 farmers, 7 processors and 4 middlemen).

Before proceeding to the structural equation modelling (SEM) analysis some results from the survey are worth noting. According to the survey, the most important relationships in the supply chain were 'formal contracts' and 'repeated transactions with the same partner'. The main reason for the use of formal contracts was that they give farmers security of demand, and to processors, security of supply and cost predictability.

The respondents' main relationship (i.e., that relationship that explained more than 50 per cent of the respondent turnover) was considered to be 'commercially rewarding' and also based on a 'strong personal relationship(s)' component. Furthermore, it was mentioned that the main relationship has a positive effect on different firm performance aspects such as 'profitability' (70 per cent of the respondents mentioned a positive effect), 'product or process quality' (60 per cent) and on 'turnover' (44 per cent).

As regards communication, the most common means used were 'telephone' and 'e-mail'. Respondents indicated that they were quite satisfied with the communication features (e.g., frequency, quality, relevance.) that they operated with. Moreover, they asserted that communication had a positive effect on 'profitability' (77 per cent of respondents indicated it) and 'product quality' (60 per cent).

The determinants of sustainability in economic relationships in the malting barley to beer agri-food chain were studied using the information collected in the survey using SEM. The model consisted of one structural equation for the explanation of the latent dependent variable 'sustainable relationships'. The full model is presented in Table 2.

Table 2: SEM estimation results– standardised parameters† and significance level

	Barley to Beer SEM (n = 69)	
	Parameters	Significance
Structural model for sustainable relationships		
Communication quality	0.777	***
Personal relationships	0.063	0.43
Equal power	-0.033	0.73
Age of relationship	-0.112	0.17
Age of business	0.041	0.61
Competition	-0.103	0.20
Commercially rewarding	0.358	***
Risk aversion	-0.147	*
Local embeddedness	-0.073	0.47
Use of repeated transactions	0.002	0.16
Measurement models for latent variables		
• Sustainable relationships		
Relationship quality	1.000	+
Relationship strength	1.000	***
• Relationship quality		
Trust	0.863	+
Commitment	0.745	***
Satisfaction	0.925	***
• Relationship strength		
History of collaboration	0.909	+
Endurance of conflict	0.781	***
• Communication quality		
Communication frequency	0.819	***
Information quality	0.766	+
• Local embeddedness		
Local products	0.667	***
Local suppliers	0.671	***
Local buyers	0.479	***
Other local ties	0.372	+
R^2 Relationship strength	0.802	
R^2 Communication frequency	0.641	
R^2 Information quality	0.613	
R^2 Endurance of conflict	0.609	
R^2 History of collaboration	0.826	
R^2 Satisfaction	0.856	
R^2 Commitment	0.555	
R^2 Trust	0.744	
R^2 Local products	0.139	
R^2 Local suppliers	0.450	
R^2 Local buyers	0.445	
R^2 Other local ties	0.230	
Overall fit indicators	Parameters	Sig.
CMIN/DF	1.505	***
NFI	0.634	
RMSEA	0.086	

Notes:

† Standardised coefficients (coefficients divided by their standard deviations) are used to eliminate the effect of different units. R^2 are squared multiple correlations in the structural model and communalities in the measurement models. CMIN/DF is the minimum sample discrepancy divided by degrees of freedom, NFI is the normed fit index, which varies from 0 to 1 and RMSEA is the root mean square error of approximation.

*** (**, *) means statistically significantly different from zero at the 99% (95%, 90%) confidence level.

+ Parameter was constrained to 1 before estimation; therefore, no significance levels are available.

The path diagram considering only those variables that were significant in the regression (Table 2) is presented in Figure 2.

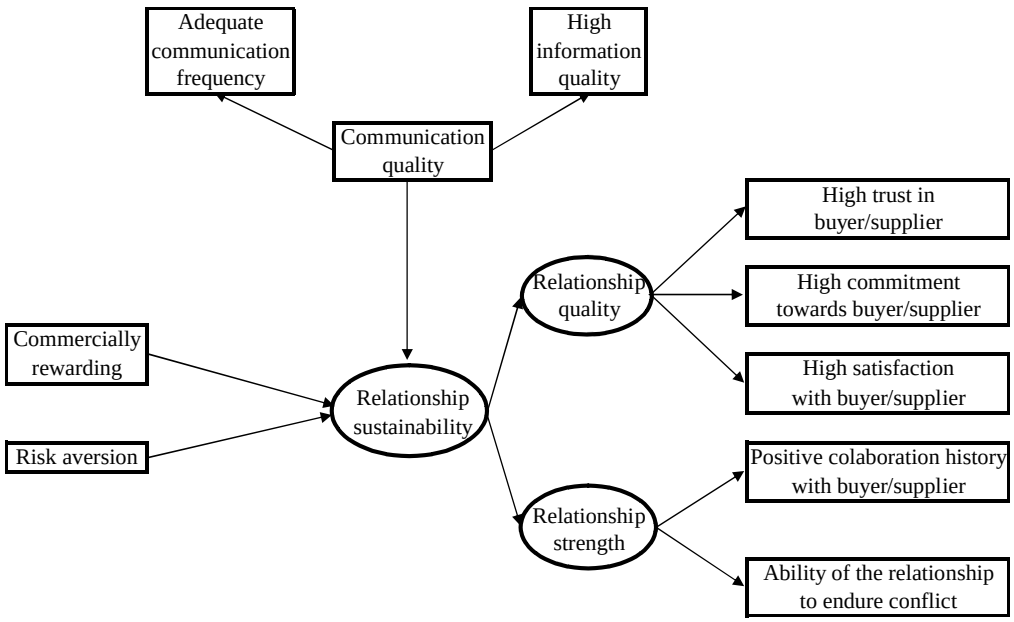


Fig 2. Path diagram of the SEM for the malting barley to beer supply chain

The variable 'sustainable relationship' was constructed based on two latent variables: 'relationship quality' and 'relationship strength'. On the one hand 'relationship quality' was built using indicators from the survey related to 'trust in the buyer/seller', 'commitment towards the buyer/seller' and 'satisfaction as regards the relationship with buyer/seller'. On the other hand, 'relationship strength' was constructed on the basis of the 'collaboration history of the partners' and the 'ability of the relationship to endure conflict'.

Several variables were included in the model for 'sustainable relationships' in order to test a number of hypotheses (the names used in Table 2 appear in bold). These variables were: '**communication quality**', 'the relationship is characterised by strong personal bonds' (**personal relationships**), 'both partners have equal power in the relationship' (**equal power**), '**age of relationship**', '**age of business**', 'the company operates in a market under strong competition' (**competition**), 'the relationship with the partner is commercially rewarding' (**commercially rewarding**), 'the company tries to avoid uncertainty whenever possible' (**risk aversion**), whether 'the firm has important roots in the local economy' (**local embeddedness**), and percentage use of repeated transactions with the same partner (**use of repeated transactions**).

Two variables entering into the structural model were constructed as latent variables. The variable '**communication quality**' was constructed based on two indicators from the survey: 'information quality' and 'communication frequency'. The factor '**local embeddedness**' was constructed using four indicators: 'whether the products of the firm are part of a local brand' (**local products**), whether the firm's suppliers were from the local area (**local suppliers**), whether their buyer was from the local area (**local buyer**) and whether the firm participates in the local community (**other local ties**).

The overall results indicate a good fit to the data in terms of the minimum discrepancy divided by its degrees of freedom (i.e., CMIN/DF), which was equal to 1.5, the normed fit index (i.e., NFI) equal to 0.634 and the square error of approximation (i.e., RMSEA) equal to 0.086. Despite that the fact that the model seems appropriate in statistical terms, the main purpose of the SEM analysis performed here was to test hypotheses related to the impact of various variables on the sustainability of relationships, and not necessarily to pursue a 'good fit' in the models (Hair et al., [36], p. 758).

The results indicate that the two major factors influencing the relationships in the malting barley to beer supply chain were (with coefficients significant at 1 per cent): communication quality, with a standardised coefficient of 0.78 and whether the partners believe that the relationship is commercially rewarding (with a coefficient of 0.36), both factors have a positive effect on sustainability. The variable

risk aversion (with a standardised coefficient equal to -0.15) was significant at 10 per cent and the coefficient was negative, indicating that the more a company tries to avoid uncertainty the less sustainable is the relationship. All the other variables (and therefore the hypotheses associated with them) were rejected by the SEM.

C. *Case study of a UK malting barley supply chain*

This case study examines the operations, supply chain communication and relationships of a UK malting barley supply chain. It is centred on a grain cooperative and its members. The cooperative (Camgrain) supplies malting barley via its marketing distributor (Gowlett Grain) to a major maltster (Greencore Malt based at Bury St. Edmunds, England), which in turn supplies malt to a brewer (Greene King, also at Bury St. Edmunds, England).

The cases study endeavours to identify: first, the nature of the relationships and communication between the various supply chain participants from farmers to the brewer and pub chain owner (Greene King); second, the benefits of the supply chain relationships to the various participants; third, the key factors in good supply chain relationships and operations.

The major source of information for the case study was a series of eight face to face interviews held with chain participants in October 2007. In addition, this was complemented with available data at the websites of the various businesses and with documentation that the interviewees volunteered.

Each interview lasted about an hour and was assisted by the use of a discussion guide (i.e., the data collection followed a semi-structured interview).

The interviews were with: Malting Barley Growers (3 Camgrain members); Gowlett Grain, a merchant operating Camgrain Malting Barley Pool (1 member); Camgrain staff (2 members, chairman and managing director); Greencore Malt (1 member, commercial manager); Greene King, a brewer (1, head brewer).

Three topics where explored in the interview: First, nature of the relationships amongst the member of the chain; second, communication along the supply chain; and third, perceived benefits of the supply chain relationships. The choice of topics was based of the results from the survey and the statistical analysis.

Nature of the relationships

The relationships between the different segments of the supply chain are analysed below.

The farmers and Camgrain - The relationship between Camgrain and its farmer members is one in which the farmers are co-operative society members, who have a financial investment in the co-operative's storage facilities. The farmer members have a commitment to use these storage facilities and to notify the cooperative each season of their planting area and variety intentions. In joining the co-operative and using its services, most farmers are seeking to simplify the management of the storage, transport and marketing of their grain and to achieve good grain prices by offloading the complexities and risks of the grain market to professional marketers.

For its part the cooperative seeks to store and handle its members' grain to the highest assured standards required by its members and customers, to market its members' barley to best effect, and to run its business in a way which both protects its assets and strategically develops the business in ways which meets its future needs.

A high level of trust exists between members and Camgrain's management personnel. Very few problems have arisen with members. Where they have, they have tended to be due to a misunderstanding of commercial procedures. Problems are resolved by reference to the Managing Director of Camgrain, who is highly regarded for his personal relationships with members, efficient running of the business and willingness to help farmers when they have problems, or another Board member, most commonly the Chairman.

Camgrain and Gowlett Grain - In appointing Gowlett Grain as its marketing distributor, Camgrain is seeking a high quality marketing service for its members' grain which will secure good returns, and a service which will maintain and further its standing with major commercial customers. Gowlett Grain's aim in marketing Camgrain's malting barley is to achieve the best possible market prices for the qualities of grain

that exist in the pool, and in doing so achieve a better than average market price.

There is a very high level of trust between both parties, and Gowlett's books are open to Camgrain for auditing purposes. Only very minor problems have arisen between the two and these have been easily resolved.

Gowlett Grain and Greencore Malt – The relationship between Gowlett Grain and Greencore Malt is one of a key supplier and its customer. The requirements of Greencore Malt for a season, initially take the form of a verbal agreement with Gowlett Grain, which is then backed up by documentation and contract notes. Greencore Malt is aiming to secure enough barley, of the right varieties and qualities, for its malting capacity to be fully used, and the pricing of the barley to be appropriate for the malt to be produced. Again, high levels of trust exist between the parties.

Greencore Malt and Greene King - Greene King has a 3 year rolling contract with Greencore Malt for malt supply with open book arrangements in which Greene King can see the composition of the malt price, including barley to malt conversion costs and margins. This enables Greene King to establish that it is paying a fair price. The biggest driver of the malt price is the cost of malting barley and energy; the volume of malt required also affects price. The contract between the two companies is a commitment to supply malt, and Greencore Malt will secure barley to meet the demands of the Greene King malt specification. The variable in the arrangement is price, which is negotiated annually. If Greencore Malt should overpay in one year (because its financial year spans two harvest years and barley prices can be very variable), the arrangement allows it to recover some of the overpayment in the following year, and vice versa.

Leadership of the commercial side of the arrangement varies. Two to three years ago, when malt supply was greater, Greene King as a buyer was in a slightly stronger position. Under the current situation that demand is outstripping supply, Greencore Malt as a malt supplier is in a slightly stronger position. On technical issues, Greene King is the leader.

The relationship between the two businesses is regarded as contributing to each other's credibility and they both recognise their commercial importance to each other. The relationships between them have a strong element of trust and a willingness to resolve any difficulties when they arise.

It is apparent in the relationships that there is a strong presence of contractual relationships of one form or another within the chain. These ensure commitment to the relationship from both parties, which is important where financial investment is being made or risk reduction is sought. However, these contractual relationships are reinforced by a high degree of professional regard (embodying technical and commercial competence), trust and in many cases personal acquaintances and friendships (similar point can be found in [13]).

Communication

Similar to relationships, the communication among the different stakeholders are analysed below:

Farmers, Camgrain and Gowlett Grain - The. communication between the farmer members and Camgrain takes several forms such as: First, the farmers have to make an annual grain return by 31 March each year, indicating their likely tonnages and varieties. This is a key input into the planning of the malting barley pool's marketing activities; Second, Camgrain issues a Newsletter (currently in hard copy) 5 or 6 times in a year, with the period of greatest frequency around harvest. These newsletters indicate information on practical aspects of delivery / pick-up of grain, grain specifications, the demand for varieties, market developments, pool performance, etc. Third, Camgrain holds an Annual General Meeting for its members and has periodic meetings and visits to key customers (maltsters, brewers etc.). There are also social trips. Fourth, a farmer member can contact the Managing Director of Camgrain at any time; similarly the key person at Gowlett Grain can be contacted at any time. However, both parties make regular efforts to communicate with members.

With this policy, in the longer term, Camgrain is sharing its strategic vision with its members so that they are able to understand and support the future direction of the business. Camgrain and Gowlett Grain are generally regarded as proactive in their

communications with farmers, with key personnel being readily accessible.

Camgrain and Gowlett Grain - For its part, Gowlett Grain requires good communication with its malting barley customers - to determine the details of their full requirements, and with Camgrain farmers so as to inform them of what the market requires (specific customers). This is essential if Gowlett is to enable Camgrain to add value to the basic grain with correctly specified, dried and dressed barley, which is vendor assured.

Gowlett Grain makes presentations to farmers at Camgrain meetings, and reports to the Camgrain Board at monthly Board Meetings on issues such as: domestic and international market conditions, pricing issues, developments with customers and 'pool' performance.

For its part Camgrain lets Gowlett Grain run the marketing operation unhindered, so that customers should go through Gowlett on marketing issues. Some technical issues might be raised directly by customers with Camgrain.

Gowlett Grain and Greencore Malt – They have major meetings twice a year. A meeting at the end of the season (May /June) sets aims for the next year and confirms requirements in terms of varieties, quantities, specifications, delivery periods, etc. The other major meeting (before Christmas) is to confirm what further barley is available in store for late season delivery. There may then be up to 8 ad hoc meetings and regular telephone conversations to facilitate business. Communication is very open between the parties.

Greencore Malt and Greene King – The two firms operate on a system of quarterly liaison and other ad hoc meetings. There is also regular email and telephone communication, and key players in each firm interact through local social events within the business community.

Overall, communication involves set events complemented by ongoing activity and it involves: understanding and communicating the needs of each chain participant; facilitating regular logistical issues; rapid problem resolution where problems arise; maintaining the required quality of service; maintaining trust and friendship.

Perceived benefits by the supply chain members

Throughout the chain there is a high level of satisfaction with respect to the nature and performance of the supply chain activities.

Farmers can readily identify a series of benefits from the arrangement, including the quality, cost and robustness of their storage asset at Camgrain, the cost-effectiveness and efficiency of the grain handling operation, greater on-farm flexibility in cropping (larger areas of crops which are harvested at the same time are possible) and barley husbandry (nitrogen levels are not quite so critical as 'grade segregation' can take place at the store) and more rapid harvesting (larger combines can be used because grain is moved off-farm rapidly). There is a high level of satisfaction with the type and efficiency of the services provided and members generally feel very committed to Camgrain. The membership continues to grow.

Of crucial importance to farmers is the fact that the malting barley pool delivers very good grain prices. The premium over malting barley prices at harvest range from 20 to 40-50 per cent, although higher levels have been achieved, notably in 2006/07. Part of this premium is a return to storage, but a large part of it is due to good marketing and the added value of drying, dressing and delivery to an assured specification, and the large scale of deliveries that Camgrain can engage in.

For its part, Camgrain knows the qualities of grain that it has to handle and can plan its operations accordingly. The good performance of the 'pool' and the storage facilities keeps the membership satisfied. The arrangement with Gowlett ensures access to, and use of, high quality marketing expertise.

For Gowlett, the Camgrain agreement provides over a quarter of its total malting barley business, and Camgrain is its largest single customer. The success of the relationship and the performance of the pool have encouraged Camgrain to give Gowlett a bonus on the normal trading margin on malting barley of £2 per t. This bonus provides an on-going incentive for good performance in securing dried and dressed contracts. The association with Camgrain also helps give the merchant a good profile with malting barley buyers.

Greencore Malt derives benefit from the chain in that it provides a reliable and continuous supply of good quality barley, with very quick access to large quantities in the latter part of the year when supplies are more difficult. Greencore Malt sees itself as rewarding Camgrain and Gowlett appropriately for the quality of service they provide. The reliability and scale of the service has enabled Greencore Malt to relinquish its own local malting barley store, thereby effecting major cost savings. Such a store may have had a drying and storage cost of £13-15 per tonne whereas Camgrain's scale and plant efficiency may achieve a cost of £10 per tonne. Moreover, the value of drying and delivering to specification, without fail, may be worth an extra £5 per tonne. These are benefits that are shared between the businesses with Greencore Malt regarding itself as rewarding Camgrain fairly for the services it provides.

The relationship between Greencore Malt and Greene King offers both parties benefits. Greencore Malt has a significant customer who is taking 10,000 - 12,000 tonnes of malt a year out of a production of 175,000 tonnes. It is able to make an acceptable margin on that malt. For its part Greene King has been able to rationalise its supply base because of having a reliable local supplier in Greencore Malt. The low haulage costs (£3 per tonne) for locally produced malt and the savings from dealing with fewer suppliers may give rise to a saving of £20-22 per tonne on malt costing approximately £300 per tonne.

Each party in the chain derives clear benefit from the supply chain relationships. These take the form of both direct financial benefits and improved business service (on the input and/or output side of the business).

As a conclusion from the case study, the following factors appear as key ones in this supply chain for its relationships and operations.

As regards the businesses, the following elements were found important: investment to keep facilities modern and efficient and good quality grain handling and marketing management; the businesses are all in close proximity to one another, enabling speed of responses/service; all the businesses represent a significant part of each other's business activities (they are important to each other).

With respect to the relationships, the following factors were identified: the aims of the supply chain parties are strongly compatible; contractual relationships, which ensure commitment, are backed by professional regard and personal bonds; high levels of trust exist between the chain participants and there is a willingness to resolve any problems.

Regarding communication, it involves set events complemented by ongoing activity such as: understanding and communicating the needs of each chain participant; facilitating regular logistical issues; rapid problem resolution where problems arise; maintaining the required quality of service; maintaining trust and friendship.

With regard the perceived benefits by the chain stakeholders, it is clear that each party in the chain derives clear benefit from the supply chain relationships. It is important to note that benefits take the form of both direct financial benefits and improved business service (on the input and/or output side of the business).

IV. CONCLUSIONS

The results from the two empirical analyses: the SEM and the case study, point out to five factors affecting cohesion of the malting barley to beer agri-food supply chain: communication, compatibility of aims in the supply chain, contractual relationships backed by professional regard and personal bonds; high levels of trust between the chain participants and willingness to resolve any problems; and commercial benefit.

As regards communication, this was found to be focused on facilitating regular logistical issues, rapid problem resolution, maintaining the required quality of service and trust and friendship amongst the partners.

With respect to the quality of the relationship, this was maintained/enhanced if the aims of the supply chain parties are strongly compatible; if the existing contractual relationships are backed by professional regard and personal bonds; and if high levels of trust exist between the chain participants and there is a willingness to resolve any problems.

Finally, commercial benefit -direct and indirect financial benefit - was found to be an important determinant of supply chain collaboration and

sustainability. Each party has to derive clear benefit from the relationships if businesses are to be readily attracted into a particular set of supply chain arrangements and they are to be maintained. Consequently, market power issues that affect the distribution of rewards amongst the partners, require careful consideration in the maintenance of sustainable chain relationships.

ACKNOWLEDGEMENTS

This publication derives from the research project on 'Key factors influencing economic relationships and communication in European food chains' (FOODCOMM, SSPE-CT-2005-006458) which is funded by the European Commission as part of the Sixth Framework Programme. The collaborating laboratories are: Institute for Food and Research Economics, University of Bonn, Germany (Co-ordinator); Land Economy and Environment Research Group, Scottish Agricultural College (SAC), Aberdeen, UK; Institute for Agricultural Development in Central and Eastern Europe (IAMO), Germany; The Ashtown Food Research Centre (AFRC), Teagasc, Dublin, Ireland; Ruralia Institute, University of Helsinki, Finland; Institute of Agricultural and Food Economics (IAFE), Poland; and Department of Agricultural Economics, Agri-Food Research and Technology Center (CITA), Spain.

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