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Reacting to law based technological change: opportunities derived from organizational learning in the Italian poultry sector

1 - INTRODUCTION

An innovation in the institutional environment has been recently introduced in the European poultry sector. A ban on using Antimicrobic Growth Promoters (AGPs) in the poultry sector has recently come into force in accordance with European Union norms; it appears to have had a great influence upon the technology in use. It seems that this is the case of an innovation in the legal system that promotes technological change. The exogenous inducement of technological change determines a need for modification of the production processes and also of the related control activities (Burel, Postollec, 2006). The poultry industry is characterized by a fast rate of innovation, and, considering the diffusion of production contracts, this paper maintains that the contract is a basic tool for promoting the adoption of technological innovation. The poultry industry shows very specific characteristics of specialization and integration (Austic, Nesheim, 1990) and AGPs largely contributed to product safety and productivity (Burel, Postellec, 2006). Nonetheless, given the strong complementarity of inputs in the process, the substitution of AGPs requires identification of the best strategies, a task which appears to be really difficult due to the objective of substituting factors without any loss of productive efficiency. The difficulties in achieving effective technological alternatives increase the uncertainty of future scenarios and significant research efforts are being mobilized at several levels. This paper takes into account the emerging issues concerning the technologi-

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cal changes needed because of the new norms, and argues that the industry's characteristics of specialization and integration oblige it to search for technological solutions. Focusing on some consequences of the EU ban, the paper emphasizes the role of knowledge creation and of the networks within the industry.

The study firstly aims at providing a conceptualization of the poultry industry in terms of technological paradigm and technological trajectory (Dosi, 1982). The first part of the paper is concerned with the identification of the normal design configuration of the poultry sector (De Liso, Metcalfe, 1996).The view adopted focuses only on some critical aspects and it is intended to show that the costs of the expected changes in poultry technology appear to be exceptionally high, due to the specificity of their trajectory. This specificity tends to reduce the number of potential opportunities. For example, there is strong complementarity among the strains and the broiler feeding patterns; efficient allocation of resources has therefore to be identified within the boundaries given by the availability of genetic resources. In this framework, the paper argues that some contribution to resolving the emerging issues should be directed toward the interactions among agents along the supply chain. The interaction is conceptualized in terms of problem solving at company level, paying attention to the relationships among the company's technicians and the growers engaged in production contracts. Egidi (1992) states that problem solving gives a basis for changing technology and organization: planning and carrying out specific tasks allow agents to enhance their conceptualization of the tasks to be carried out and improve the division of labour. Secondly, the paper provides a discussion of the organizational learning process and of its role in the case in hand. We also focus on the factors which appear to influence these processes. The outcome of the process depicted is a set of technological solutions which could be chosen in an efficient allocation. Drawing on interviews carried out at the level of poultry company, the role of the networks of technicians and farmers in the process of knowledge creation is delineated. The poultry industry is usually seen as characterized by a fast rate of innovation: the growers contribution is simply related to their adoption of the innovations promoted *via* contract with the integrator (Knoeber, 1989). Our interpretation aims at emphasizing the possibilities related to the active participation of the grower in the identification and the experimentation of technological solutions. The paper is articulated as follows. The methodology is illustrated in section 2. Section 3 summarizes the key elements of the analytical framework in the light of the technological paradigm approach (Dosi, 1982, 1988). Firstly, we identify the normal design configuration (De Liso, Metcalfe, 1996, p. 81), then we introduce the idea of *scarcity* of technological solutions and suggest that knowledge creation reduces this scarcity. In section 4, we apply the analytical framework to the poultry sector, proposing the sector's normal design configuration and pointing out that the law-based inducements to technological change may posit the problem of identifying the set of potential solutions. Then we take into consideration the interaction between a company's technicians and the growers engaged in production contracts. We argue that this network provides a basis for an organizational learning process in Egidi's sense (1992): our conjecture is that the creation of related skills could contribute to the search for technical solutions to the consequences of the EU ban. The last section proposes the conclusions and opportunities for future research.

2 - OBJECTIVES AND METHOD OF THE STUDY

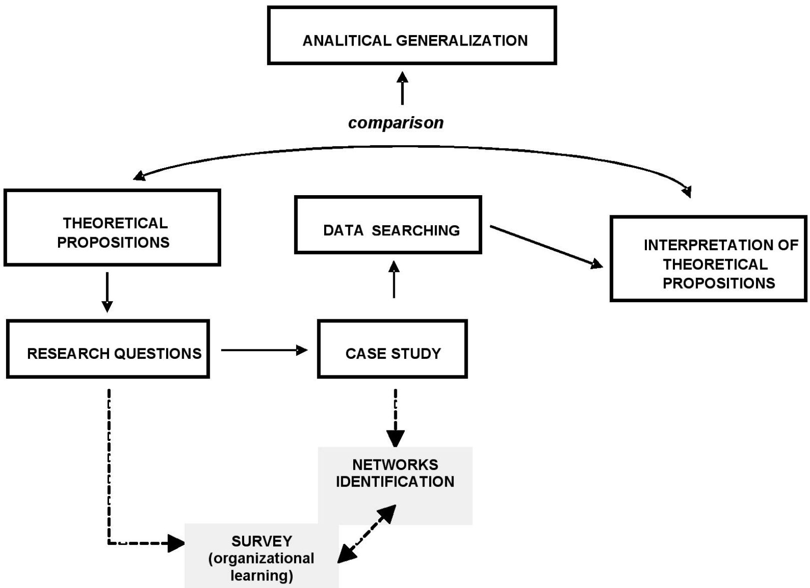
The objective of the study is twofold. On the one hand, the paper aims at conceptualizing the costly consequences of institutional innovation in terms of constraints due to the sector's normal design configuration. On the other hand, we aim at showing that network interactions take place within the organizational architecture of the industry and we delineate the role of this network with respect to the institutional innovation discussed. The method is based on the identification of an analytical framework and on a related empirical investigation. The EU ban on Antimicrobic Growth Promoters (AGPs) is interpreted as an innovation of the institutional environment (Davis, North, 1971), promoting technological change in the industry. Thus, the problem is to take into consideration the way companies react to the innovation, identifying possibilities of efficiently substituting the factors banned. The relationship between institutions and technological change is addressed both at the system (De Liso, Metcalfe, 1996; Geels, 2004) and at the transaction level (Oxley, 1997; Antonelli, 1999). The analytical framework is drawn from Dosi's conceptualization (1982) of technological change (section 3). This perspective highlights the difficulties of identifying adequate substitutions for the factors banned at industry level. In this context we focus upon the idea of *scarcity* of technological opportunities. This idea was discussed by Antonelli (1999) who emphasizes the "discontinuities" along a production isoquant. Nonetheless, we argue that scarcity itself is exacerbated by the exogenous need for change and aims at suggesting that the relationships among technicians and growers in poultry companies provide opportunities for knowledge creation processes. An empirical analysis has been carried out to identify the set of relationships among the companies' technicians and the growers as a technological network. A processor actually manages part of the production by contract and provides technical assistance to the producers (growers). Technical assistance plays an important role in the relationship between the growers and the processing company. The technicians help the growers to reach two objectives: *a*) to implement technology and *b*) to face potential emerging issues. The relationships between the companies' technicians and growers were identified by data collected at two large Italian poultry companies. Criteria for identifying the companies were ascertained in parallel to construct building (van Duren *et al.*, 2003) and according to the structure of the Italian supply chain. Research questions derive from the analytical framework and concern the way of organizing relationships between technicians and growers and the main fields of interaction. The constructs were developed in accordance with these research questions. Pilot interviews were conducted with managers, who were asked to specify how his/her company is dealing with the EU ban and what the critical issues are in their relationships with the growers. We actually maintain that the poultry contract is the main tool for diffusing innovation (Knoeber, Thurman, 1995). Further information has been requested about the general food safety strategy adopted by the company. The predicted pattern (Yin, 1994) focuses on the role of technicians-growers networks in knowledge formation and in organizational learning processes. The latter was directly examined by a specific survey conducted in one of the two companies and was designed to investigate the factors affecting the skills of the growers. The case studies are thus aimed at showing the consistency between the empirical evidence and the predicted pattern.

The empirical analysis provides two sets of information. First, we analyzed knowledge formation at the level of the technicians-growers networks. Even thought this is just the first step in a more complex process of knowledge creation, we focus on it, framing the data in the conceptual structure identified by Ancori, Bureth, Cohendet (2000). The second step of the analysis is an attempt to provide a contribution that arises from the technological networks. Namely, we take into consideration the organizational learning process as a specific contribution to knowledge and skill creation (Egidi, 2001).

The relationship between empirical data and the theoretical hypothesis proposed is identified within the framework provided by Yin

(1994). The analytical generalization method was applied, in which a previously developed theory is used as a template for comparing the empirical evidence from case studies (Yin, 1994, p. 31) and in which results are generalized into theory (fig. 1).

Fig. 1 - *Analytical generalization* (Yin, 1994, modified)

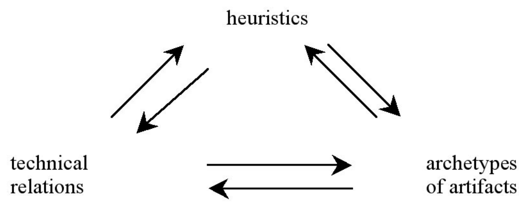


3. ANALYTICAL FRAMEWORK

3.1 - Technological paradigm, technological trajectories, normal design configuration

The consequences of the inducements to technological change determined by the EU norms can be examined by considering the possibilities of making changes at the industry level. In this perspective, we note that a large part of the economic literature deals with the cumulative nature of technological progress and its path-dependent characteristics. Dosi (1982; 1988) introduces the categories of technological paradigm and trajectory. Technological paradigm is a «[...] pattern of solution of selected technoeconomic problems based on highly selected principles derived from the natural sciences, jointly with specific rules aimed to acquire new knowledge […]» (Dosi, 1988, p. 1.127). The concept of technological paradigm emphasises the relation between productive factors, heuristics and artefacts (fig. 2).

Fig. 2 - *Nexus in the concept of technological trajectory*



The relations illustrated in figure 1 indicate that the productive activities are conceived depending on how strongly the possibilities provided by objects, activities and cognitive patterns are interrelated. This category outlines a context where knowledge and capabilities, artifacts and a set of heuristics (Where do we go from here? Where should we search?) define the boundaries of technical change. The technoeconomic characteristics of artifacts and basic exemplars can be represented as a limited number of prototypical bundles. Thus, the technological paradigm restricts the possibilities of combining these characteristics and defines a set of possible trade-offs. The technological trajectory discloses activities of the technological process along the economic and technological trade-offs defined by a paradigm. Basic exemplars can be developed and improved along specific technological trajectories. Very often a major impulse to innovation derives from imbalances between the technical dimensions that characterize a trajectory. The patterns of innovation along a single trajectory show a rather irreversible path. Given that at any point in time the searching process for solutions is restricted to small clusters of possible combinations, cumulative and specific knowledge emerges. Thus, the localised problem solving process generates tacit knowledge that, in turn, links up with codified knowledge at different levels of intensity, depending on the specific sector of economic activities. The cross-fertilization of tacit and codified knowledge allows us to gain ground along the learning curve (Nonaka, Takeuchi, 1995), but at the same time increases the chances of falling into a technological lock in and a competences trap. For this reason, it is not easy to change best practices if you are in the middle of a technological trajectory and the conversion costs are prohibitive. The normal design configuration (De Liso, Metcalfe, 1996) is a more focused concept, coherent with the aforementioned categories, which relates to specific artifacts and their production process. It is a set of fundamental design concepts which, in turn, implies the understanding of how a device works, and how the parts of such a device concur in achieving the desidered purpose. For example, within a technological paradigm we can find a collection of design configurations representing the specific realization of a given technology. The design configurations are different within and between paradigms, but they also change over time because they follow specific trajectories. Each configuration can be depicted in terms of a life-cycle of development in which, after initial rapid progress, specific technology approaches maturity. Therefore, within a specific design configuration, we can have an articulation of single artifacts over time, stemming from the realization of a particular trade-off inside a paradigm and following a specific trajectory.

3.2 - *Nexus and scarcity in the theory of technological change*

In this section we adopt the concept of normal design configuration as a base for addressing specific groups of commodities and then we emphasise an idea of scarcity related to it. The normal design configuration relates to a specific group of artifacts and their production processes; but it is also a shared mental framework by means of which the relevant community of practitioners addresses the question of how to improve the performance of technology (De Liso, Metcalfe, 1996, p. 81). Both the fundamental design concepts and the shared mental frameworks lead to an improvement of technology performance and as a consequence, at industry level, the possibilities of identifying alternative technical arrangements of a design configuration are limited in number. We would suggest that the small number of alternatives could be conceived in terms of scarcity. This term is aimed at indicating the reduced set of technical possibilities relative to the emerging necessity of changing the techniques in use. There are at least two reasons for this. Firstly, past selection shapes future technological changes (De Liso, Metcalfe, 1996) and thus a constrained number of solutions to technological problems is available. Design configuration limits the alternatives to be explored and this provides an opportunity for real improvements of the technological combination in use (De Liso, Metcalfe, 1996, p. 82). Furthermore, the technological paradigm integrates material technologies and specific principles and rules aimed at making the acquisition of new knowledge possible, which gives rise to an exemplar (the artifact to be developed and improved) and heuristics, both determining the characteristics of the commodity (Dosi, 1988, p. 1.127). The technological paradigm establishes a strong prescription on the direction of the technical changes to pursue and those to neglect (De Liso, Metcalfe, 1996), according to the restriction of the bundle of the characteristics of the commodity in the notional characteristic space (Dosi, 1988, p. 1.127). Empirical evidence is available in literature which corroborates the interpretation here conjectured: for instance, Souitaris (2002) shows that the determinants of innovation differ for firms in different technological trajectories and that different factors of innovation proved important for different trajectories. This means that the possibilities of identifying technological change paths are limited, according to the conceptualization of the technological paradigm and trajectories.

Thus, one may suggest that, with respect to the normal design configuration, a scarcity of solutions to technological problems exists which is determined by past selection, the restriction of the characteristics of the products and the number of basic scientific principles and rules.

3.3 - *Costs and difficulties of changing in the case of institutional innovation*

A change in the institutional environment determines modifications of the incentives faced by the economic organizations (North, 1990, 2003). Allocation of resources is shaped by the principles and the rules of the normal design configuration. A scarcity of technological solutions can be exacerbated by exogenous inducements due to institutional change. Actually, the more distant the expected change is from the normal design configuration principles and rules, the more severe the difficulties of changing appear to be. The change requested entails a new allocation of productive resources. The new allocation may already be known in technical details or, alternatively, it has to be conceived and experimented. The two cases are very different in nature. With respect to the ban on AGPs, its consequences can be discussed in terms of costs.

Firstly, one has to consider the costs consequential to the impossibility of using a given productive factor (as in this case, the EU's ban on AGPs): the more central the factor is to the normal design configuration, the more intensive the loss of efficiency in the whole process. At company level, the allocation of resources is chosen among the possibilities allowed by the normal design configuration. Antonelli (1999) points out that many factors induce firms to look for a new combination within a small number of potential alternative allocations (localized technological change). The institutional innovation we are dealing with determines the special circumstance in which some resource allocations are not permitted, due to the EU ban. This reduces the set of potential alternative to be explored. A company will thus be forced to choose allocations which will be close to the allocations banned. This determines an increase in costs due, at least temporarily, to inefficient choices.

When the alternative resource allocations are known, the producers' switching costs (Antonelli, 1999) also have to be taken into account; these are caused by the activities necessary to move towards new allocations within the existing map of isoquants. For example, a new equilibrium allocation may require new labour skills, technical information and mobilization of equipment (Antonelli, 1999, pp. 72 ff.).

If the existing alternative allocations cannot be exploited due to institutional innovation, the company is forced to look for new potential allocations. The search process costs relate mainly to R&D activities: the more central the principles and rules of institutional innovation are to the normal design configuration, the higher the search costs are as the search process tends to explore little known aspects and fields, also on the boundaries of the normal configuration. At the end of the process, the firm may also face a new map of isoquants. Figure 3 proposes a synthesis of the costs mentioned.

Fig. 3 - *A broad scheme of the costs caused by institutional innovation*

The potential new equilibrium allocations are already known	*The potential new equilibrium allocations have to be identified*
– Inefficiency (temporary), due to a choice of allocation close to the old equilibrium allocation – Producers' switching costs toward the new allocation within the existing map of the isoquants	– Temporary inefficiency, due to a choice of allocation close to the old equilibrium allocation – Search costs for identifying new resource allocations – Producers' switching costs for moving toward the new allocation within the new map of the isoquants

The strategies identified for facing the costs due to the EU ban can affect the organization. The ability to react also relies on the ability to shape the internal organization in a coordinated manner. In particular, we point out that both the producers' switching costs and search costs are influenced by the knowledge creation processes. For example, new skills (Antonelli, 1999) may require interaction between codified and tacit knowledge (Nonaka, Takeuci, 1995), whereas the same interaction could contribute to implementing substitutes for AGPs (Burel, Postollec, 2006). In the remainder of the paper, we focus on just some aspects of the reaction to the institutional innovation at hand, at the company level: the contribution of the company's organizational structures – its technological networks – and the relative enhancement of the growers' skills.

3.4 - *Identifying solutions to technological issues*

As mentioned above, the change in technology promoted by the institutional innovation requires modification of the production process. Such modification can entail changes in resource allocation, based on existing possibilities or, alternatively, require a costly search process intended to find new potential allocations. We address this field by taking into consideration only a very specific field, where the knowledge creation processes – which of course sustain the search for new allocations – are linked with the organizational learning processes (Antonelli, 1999; Egidi, 1992) which, in turn, contribute to the identification of potential solutions to technological issues and enhancements of skills.

Nonaka and Takeuchi (1995) showed that knowledge creation processes are based upon the integration of codified and tacit knowledge. The key assumption of the model of the creation of organizational knowledge is that tacit and codified knowledge interact and are reciprocally exchanged. This interaction is conceptualized by four processes: socialization is the transformation of tacit knowledge by sharing experience; externalization is the process of forming codified knowledge by means of tacit knowledge; combination is the process of transforming codified knowledge into more complex codified knowledge; internalization is the process by which codified knowledge is embedded in tacit knowledge. Iacoponi (1994) has analyzed in depth the links between organizational processes and knowledge creation in agricultural production and has emphasized the role of agent relationships in this field. This view sheds light on the technological change in agri-food production processes, also in terms of connections between different levels of productive systems. The perspective adopted here suggests that critical relationships among agents are established within the organizational structure of the company. It is recognized that contractual relations with the grower allow the company to diffuse technological innovation, relying on the mechanism of tournaments (Knoeber, Thurman, 1995). We add to this view the fact that the company promotes and manages intensive flows of information and communication. This view is also coherent with other conceptual constructions such as the Scientific and Technological Agri-Industrial System (STAIS), formulated by Vellante (1991, 1995). In this context, the technical knowledge sub-system plays a crucial role in transmitting information between scientific and technological sub-systems on the one hand, and agri-food firms on the other. Technical knowledge sub-systems are made up of advanced business services, also operating within a process of vertical integration (Vellante, 1995). Indeed, the technicians of a company that processes animal products, provide real services to the growers, favour bilateral flows of knowledge between agriculture and industry, and significantly contribute to reducing dynamic transactional costs over the agri-food chain.

The theory of economic organization states that task specification is an iterative process framed within the sequence connecting problem solving, organizational learning and design of the division of labour and co-ordination (Egidi, 1992). Moreover, the correspondence between organizational learning and change (Egidi, 1992; Loasby, 1998) and the connection between the physical and the cognitive acts in the field of production (Dosi, Grazzi, 2006) emphasizes the role of knowledge creation in productive activities. According to Egidi (1992) the organization identifies procedures – i.e. ways of problem solving – by carrying out the organizational learning process. The exchange of knowledge plays a relevant role here in the designing of the internal division of labour of the firm and in determining the internal creation of skills (Egidi, 1992). Skills determine the ability to improve technological performance. The exchange of knowledge appears to be an opportunity for specific problem solving. Knowledge creation and the internal division of labour is thus connected to the ways the organization manages the emerging technical issues.

On the other hand, heuristics are embodied in organizational routines, enabling the firm to explore technical opportunities and translate them into specific products (Dosi, 1988). Therefore the development of procedures can be thought of as internal to normal design configuration, which is, therefore, the conceptual space where solutions to emerging problems must be identified and conceived. In summarizing the argument developed so far, we would like to point out that:

a) the technological trajectory discloses activities of the technological process along the economic and technological trade-offs defined by a paradigm;
b) the scarcity of technological solutions is related to the normal design configuration and may determine a costly search process for a solution to technological problems;
c) knowledge creation processes influence the costs of the change;
d) the organizational learning process contributes to skills creation and thus contributes to identifying solutions within the limits set by the normal design configuration; therefore the ability to shape the internal organization allows for opportunities of reacting to the institutional change.

The analytical framework proposed is applied to examine some possible consequences of the EU's ban on AGPs in the poultry sector. Below, we identify the normal design configuration in the poultry sector and then we model a specific potential opportunity to react to the ban in terms of the organizational learning process. The empirical investigation illustrates knowledge formation at the level of the technicians-growers networks and the internal creation of skills. We suggest that both these interrelated processes can contribute to the search for technical solutions to the consequences of the European Union's ban on AGPs.

4 - THE POULTRY INDUSTRY AND THE EU'S BAN ON AGPS

4.1 - The general characteristics of the poultry industry

The normal design configuration relates to a specific group of artifacts and their production processes; hence reference can be made to a group of commodities sharing the general features of a paradigm (De Liso, Metcalfe, 1996). Therefore, at specific sector level, the recognition of the fundamental design concept can be identified.

The industrialized agri-food sector entails several technological trajectories sharing some basic scientific principles and rules (Chataway, Tait, Wield, 2004; Parayil, 2003). We do not focus here on the specific characteristics of the technological trajectories, nor on their relations with the modernisation and industrialization of agriculture in Europe. Rather, we keep our perspective in the field of industrial issues, relying on the concept of normal design configuration. The poultry industry is characterized by the relevance of genetics in providing high yielding strains. The poultry industry has shifted rapidly and completely from small scale, non-intensive production units to large, highly specialized intensive units, and thus, the modern broiler industry has developed by rapidly applying technology to several areas of poultry production: breeding, feeding, housing, disease control, and management practices, that enabled large concentrations of poultry to be raised in close confinement (Austic, Nesheim, 1990). The poultry industry relies therefore on the opportunities afforded by breeding science which is aimed at using the principles of genetics to develop strains or breeds best suited for the production of poultry meat and eggs (Austic, Nesheim, 1990; Moran, 1999).

A primary function of the poultry industry is the conversion of feed grains, by-product feeds, and protein concentrates to a form that is prized for human food (Austic, Nesheim, 1990). Therefore, the input complementarities in the production process characterise the "poultry design configuration" and appear to be shaped by genetics and by the objective of conversion. The design configuration also relies on the structure of houses whose functions are mainly: *a*) to permit the organization and concentration of the flock into manageable units; *b*) to provide a physical environment that is conducive to optimal egg or poultry meat production. Feeding systems, heating, ventilation, disinfection, disease prevention and control, are connected with the housing system (Austic, Nesheim, 1990). Antimicrobic Growth Promoters in livestock production, especially for monogastric animals, have been used for a very long time and have represented a basic element of technology in the poultry industry (Dibner, Richards, 2005). They contribute crucially to disease control and animal productivity and, therefore, play a central role in the design configuration. The centrality of AGPs to poultry production processes has to be emphasized with respect to input complementarity; scholars point out that the prevention of disease is the key to reducing their costs and that mangement practices have to be conceived emphasizing the strategies of disease control and prevention (Austic, Nesheim, 1990, p. 229). This integral approach is straightforward and conceptualized in terms of managerial control strategies (Mangen, Ardine de Wit, Havelaar, 2007). Poultry chains are usually vertically integrated. Processors integrate the agricultural stage both in meat and egg production (Austic, Nesheim, 1999; Olliger, Mac Donald, Madison, 2005; Sever, 1957). Contractual relationships showing a few basic typologies are often established with growers (Mènard, 1996: Knoeber, 1989; Knoeber, Thurman, 1995) and set out the needs for technological performance. Vertical integration and precisely designed contracts are the basic tools which allow a company to specify the design configuration correctly.

In figure 4, the main elements of the "poultry normal design configuration" are illustrated. The figure suggests that the principles of breeding and housing contribute to shaping the remaining elements. The external position of risk management and assessment indicates that the related activities are performed by many agents, including public agencies.

Fig. 4 - *Poultry industry - Elements of the normal design configuration*

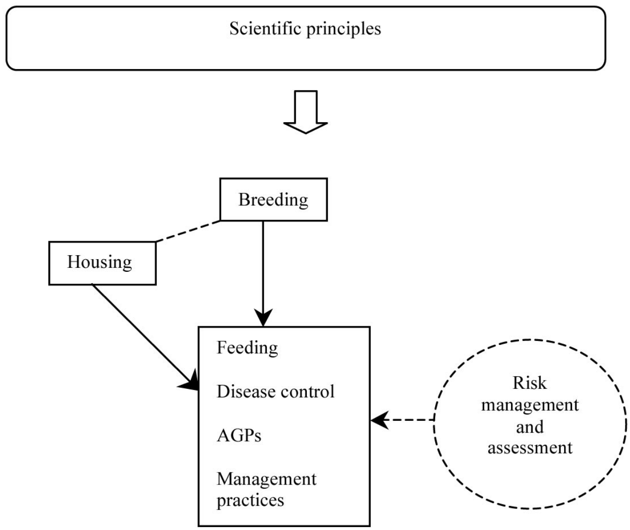


Figure 4 also suggests that AGPs were a central item of the configuration, strictly connected to the remaining components (Burel, Postollec, 2006). In the following section we elaborate on the analytical framework taking the interpretation of the empirical data as a starting point.

The basic idea is that institutional innovation (the ban on using AGPs) can alter the normal design configuration, inducing agents to react. We would like to point out that, among other things, opportunities for dealing with the consequences of the ban arise from interactions within the poultry supply system network. We focus on the network among processing companies and growers and identify it as the technological network.

4.2 - *Knowledge creation and ability to comply with the EU ban*

The European Union ban directly influences the normal design configuration of the industry and gives rise to the expectation of improving the safety of poultry industry products (Burel, Postellec, 2006). To comply with the ban, companies will have to modify their production processes and management practices. The previous analysis shows that changes are originated by moving from principles defining the normal design configuration, but they entail costs. Nonetheless, the AGPs are central to the poultry industry's principles, thus the emerging issue is how to combine efficiency and safety in a renewed supply chain context. Three strategies have been identified to face the problems posed by the EU ban that has been in force since 2006 (Burel, Postollec, 2006): *a*) pathogen reduction; *b*) augmentation of the immune response; c) nutritional strategies and/or additives that either improve performance in their own right, or help directly to modify the gut microbial flora. At any rate, each of these strategies is characterized by specific problems and opportunities and this increases the uncertainty of future scenarios. The variety of the poultry industry in the enlarged European Union tends to shape the competition process and makes the search for efficient solutions more urgent. The substitution of AGPs appears *prima facie* to be a technological problem. However, the centrality of AGPs in the poultry normal design configuration exacerbates the scarcity of technological solutions. In order to investigate this field, we summarize the information collected at two large Italian poultry companies. Case descriptions run as follows.

4.2.1 - *Case Alpha*

The company was established in the second decade of the 20th Century, the initial business being the trade in seeds and grains. After the end of the World War II, the company began to run a business of animal feeds and, during the '80s, it entered the new field of animal growing activities (pigs, cattle, poultry and rabbits). In the 90's, the company started to manage the subsequent stages (slaughtering, processing and trading of pork, rabbit and, more recently, chicken meat).

The company employs around 1,400 persons while the annual average sales are about 550 million euros. It supplies around 10,000 tons of selected seeds and 21,000 tons of maize for the beer industry.

Animal feed production is carried out in six plants in Central and Southern Italy and produces around 800,000 tons/year. Animal raising activities involve: pigs (300,000 head/year), rabbits (2,500.000 head/year), poultry (14,000,000 head/year) and cattle (6,000 head/year). The poultry processing is concentrated in Emilia-Romagna.

The poultry chain is organized according to a different architecture. The stage of genotype production, growing and processing are vertically integrated, except for a very small amount of production managed by means of production contracts in different growing stages. Integration has been recently completed by the acquisition of a cooperative of growers involving about 70-80 growers (some of them manage poultry houses of about 20,000 m^2; the remaining growers manage houses from 2,000 to 5,000 m^2).

Relations with large retailers entail about 30-35% of the total supply and are usually based on contracts, legally renewed each year, concerning products which are being sold with a specific brand and with the brand of large retailer companies. The managers interviewed emphasized the strong integration between the activities of specification of technological directions and the activity of monitoring, both being centralized by the company's management. This connection helps the company to keep a good reputation as regards the final markets. Nonetheless, the poultry sector is just one of the activities carried out by the company, playing its role within the whole context of a strategy based on growth by differentiation.

Food safety is a strategic focus in the sense that it fosters the growth process. A clear link exists between the need of the company to keep its reputation and the need to manage food safety risks. Three main tools are currently adopted by the company in order to reach this goal:

- vertical integration: vertical integration of the poultry chain protects the company from safety risks by direct control of the activities carried out;
- centralization of monitoring activities: centralizing the monitoring and control activities helps the company to reduce the related costs; due to difficulties of identifying the sources of risk and the increasing complexity of the tools needed, "scale economies" allow the management to increase the effectiveness of the monitoring and to enhance the degree of safety applied.
- HACCP, certification and traceability: these systems allow the company to frame activity and to provide a basis for its own liability.

These three pillars also operate in supporting quality strategy. The company relies on both the two basic competitive strategies: the search for cost reduction and for differentiation, the latter being more focused. The implementation of a tight vertical coordination of different stages

– as shown by the supply chains illustrated above – represents one the fundamental managerial instruments the company has progressively and accurately developed over the last decades. The organizational and economic advantages resulting from vertical coordination are at least:

a) the possibility of economizing on transformation costs in critical stages and productive tasks, due to the scale of input managed through coordination (examples are: efficiency in feed production and in the slaughtering stage);
b) the possibility of developing a detailed model of monitoring and controlling the quality and safety characteristics of the products, e.g. in the case of the well-established Quality System.

On the other hand, scale economies and accurate monitoring systems also represent strength in contractual relationship with large retailers and in the strategy for differentiation. Innovation activities have progressively assumed a pre-eminent role, improving the basis of the competitive advantage of the company.

4.2.2 - *Case Beta*

The company is one of the main Italian companies in the field of production, transformation and marketing of poultry, turkey and pork products. Since 1930, it has stood out for research on product quality, implementing controls at each step of the production chain. The company is particularly able to meet its clients' requests in the field of quality and safety. The company was established in 1930 and started poultry breeding destined for the market of North Italy. In the beginning, its main activity was poultry trading, but in the 1960s, the company progressively exanded the use of its own resources, widening its set activities. In the 1980s, its strategic focus became brand promotion, relying on marketing and the enhancement of the quality of its products. The basis of the competitive advantage of the firm is mainly the reputation the firm has gained and the diversification of the product supplied.

Company Beta has 5,500 employees and workers and sales receipts in the range of 600-800 million euro. In particular, the company produces 60% of all the poultry supplied under vertical integration, the remaining being managed by a network of selected growers. The company's strategy is largely based on product diversification and on quality production. A key factor of its economic performance in the poultry sector of the company is its degree of integration and monitoring activity. The control of its poultry production process has been obtained by an approach implying grower selection and vertically integrated production of materials. The company directly manages 60% of its poultry production by vertically integrated processes. The remaining fraction is obtained by contract-based relationships with growers distributed in different territories. Relationships between growers and the company are based on a contract which has a formal duration of 1-3 years. Nonetheless, the relationships between the farmer and the company are designed as long term relationships whose terms are periodically specified in a formal contract. Such long term relationships are the consequence of the process of selection of suppliers undertaken by the company. Supplier selection assures that origin, source and traceability of production lots are introduced into the production chain. As for the specific tasks of the production process, the feed, water, air, and environmental conditions are monitored in depth. In particular, feeds are obtained in vertically integrated stages, directly managed by the company. The incubation phase is very critical; for this reason the company built its incubators in "pure places", far from pollution. Feeding is based on vegetable feeds. All phases of production have ISO 9001 certification and therefore, external audits periodically evaluate production processes. Quality Assurance is a strong point of the firm: the cold chain is guaranteed by frequent controls and short delivery times. In order to increase the degree of safety of its production process, the company has set the following rules:

1. subjects are fed only with plants, minerals and vitamins;
2. food never contains GMOs;
3. no meal or fat from animals;
4. no antibiotic growth promoters;
5. all animal reared in Italy;
6. direct control in all phases;
7. traceability of every broiler;
8. slaughtering with ISO 9001 certification;
9. brief delivery time;
10. product certificated CSQA DTP.

Focus on product differentiation and quality is a distinctive characteristic of the company's strategy. In the poultry sector, new brands have been created during recent years in order to meet consumer requests. The company seeks to give a base to its competitive advantage by integrating high quality safe foods and product differentiation (also at the second and third level of transformation). The firm's main objective is customer satisfaction, reached through product quality and safety certification. A traceability system allows the company to be in touch with its supplier and also to meet the standards requested by the largest retailers. Over the years, the firm has developed technological solutions to reach safety requirements. In its slaughter houses, CO_2 is used for stunning. In this way animal welfare is respected and cross contamination is avoided. Moreover, all the chain operations are managed by automation, to minimize microbial contamination. Furthermore, the company has enlarged its borders to the whole area of the country, establishing new distribution platforms, developing better logistics performance. All technological innovations have been adopted in collaboration with other firms; in this way better solutions for problems have been detected over time. Its logistic activities have also been recently improved by a specific innovation programme. These changes, based on implementing a specific software, allows the company to reduce the time interval between the end of the production process and the delivery of the product to the distributing agent. The safety of the product delivered is a basic characteristic of its poultry products. Nonetheless, the company's decision to obtain this degree of food safety has involved several types of activities and strategic focuses:

- Vertical integration: in order to economize the costs of monitoring the production of feed, the incubation stage and the growing stage;
- Centralization in monitoring the supply chain: the activities of technical monitoring are carried out by the specialized sectors of the Group, achieving scale economies but especially economizing on monitoring costs due to information asymmetries. Except for the vertically integrated processes, the main tool is the technical grower's duties included in the contract.
- Technical enhancements: technological innovation helps the company to obtain its planned degree of food safety in two main ways. Firstly, innovation operates to improve single productive tasks; secondly, technological change supports the enhancement of the degree of control of the company along the various stages of the chain. Technological innovation regarding freezing systems, cooking and packaging, is the key to reaching food safety requirements.
- HACCP and traceability: these systems have required considerable resources; although they meet the existing legal standards they also represent a tool for enhancing the firm's knowledge creation about possible uses of its resources and about the way of improving its relationships along the stages of the supply chain.
- Human resources: the company's history clearly shows that there is a strict relationship between the search for strategic goals in the

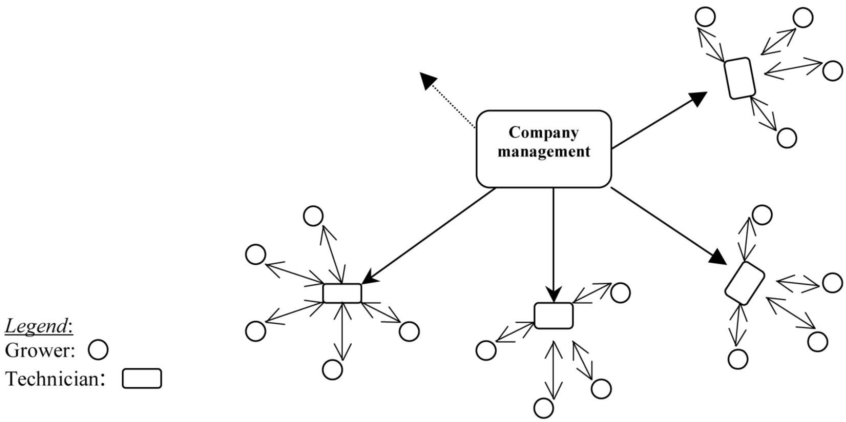
field of quality and safety and improvements in the skills of people employed by the company. The codified knowledge delivered by the growers integrates their knowledge on field experience, providing new insights and opportunity for changes and enhancement when facing safety shocks. The technicians involved in these relationships accumulate knowledge and experience which, in turn, provide a basis for new knowledge derived from scientific and technological sources. For example, prohibition of the use of animal meal determined an economic draw-back due to the changes in flavour and texture of the meat. This kind of trouble has been managed within the complex set of relationships involving growers, R&D personnel and technicians.

4.2.3 - *Technological networks*

The data collected in the two cases confirm that the European ban operates at a critical level of production and safety. The two companies' reaction strategies entail several possibilities. The basic tool is the search for the best use of available substitutes. This in turn implies: *a*) experimenting potential substitutes within the productive environment, engaging internal specialized personnel and external research units; *b*)designing and implementing new productive tasks; *c*) designing and implementing the related new organizational arrangements. These processes are managed in two complementary ways. A vertical approach is chosen where the search process strictly relies on the company's plan and decisions. A horizontal network approach is also adopted, under the steering capability of the company, where structural interaction is allowed. Provided that uncertainty affects the outcomes of these alternative means (Burel, Postollec, 2006), it is necessary for the companies to sustain a search process intended to enhance technological performance by means of knowledge creation. In other words, for companies, complying with the ban is both a technological and a knowledge creation problem. In the poultry industry these processes are articulated at several levels, involving internal R&D activities, relations with external research agencies and the relational structures among growers and company.

The processing companies – which play the main role in the poultry supply chains – are induced to search for new solutions by complex processes of knowledge creation entailing internal R&D activities as well as external, private and public research partners. In other words, knowledge creation is carried out at several levels – i.e. at the company's laboratory level and in partnership with private and public research bodies – but here the focus is on stages taking place at the level of interaction between the companies and the growers involved in contract production. Poultry production under contract is characterized by an intensive process of learning by using – this refers to the analysis of Rosenberg (1982) that points to the learning process that takes place in the use of complex products (for instance, complex production factors). The use of genetic strains and their correlated means of production (feed, equipment, *etc.*) determines uncertainties in the performance of the capital invested along the chains. Production risks are often borne by growers (Bogetof, Olesen, 2001) who thus have an incentive to be involved in the search process for enhancing technological performance, even within their restricted domain of action. Production contracts characterize the organization of the poultry industry (Knoeber, 1989; Bogetof, Olesen, 2001) and often imply that a stable relationship is established between the processing company and the grower. The production strategy of the company also implies that groups of growers tend to be involved in the relationship in a stable manner. The continuity of the relationship entails the possibility that their practices tend to influence the codes of behaviour. Therefore, the first reason why the set of technicians-growers should be considered as a network is that it is a configuration creating culture and able to influence behaviours, a configuration in which, technology is noticeably embodied in technical relationships (Castells, 2000). Secondly, these agents do not interact throughout the whole domain of company's action, but only in the part of it related to the grower's domain. Thus, they act within a weak interdependency whose content consists mainly of sharing cognitive resources. A further factor is related to the strong communication flows among the agents. Both communication and weak interdependency are recognized as antecedents of the emerging network (Grandori, Soda, 1995). Relational structures are supported by the activities of technicians who keep the growers in touch with the company in order to control the supply chain stage and to ensure the expected technological and quality performance. The technicians are a key resource in the organization of companies. They establish contact with separate units (growers) of a production stage (growing); they also connect growers of different units and manage a complex flow of information and exchange of knowledge which directly contributes to technological performance. The technicians guide the grower in applying the contractual production protocols and in coping with emerging issues. Under this the technicians enhance the potential of information inherent in the special social relation ships they activate (Coleman, 1988). The relational structures identified in the investigation thus appear to be social devices contributing to knowledge creation. More precisely, the set of growers and technicians can be thought of as a technological network supporting the organizational framework of the company. The concept is aimed at referring to a network involved in contributing to the technological knowledge creation process in various potential stages[1]. The standard configuration of the technicians-growers relational system has been re-constructed by information collected in the case studies, and it is illustrated in figure 5.

Fig. 5 – *The standard technicians-growers relational systems*

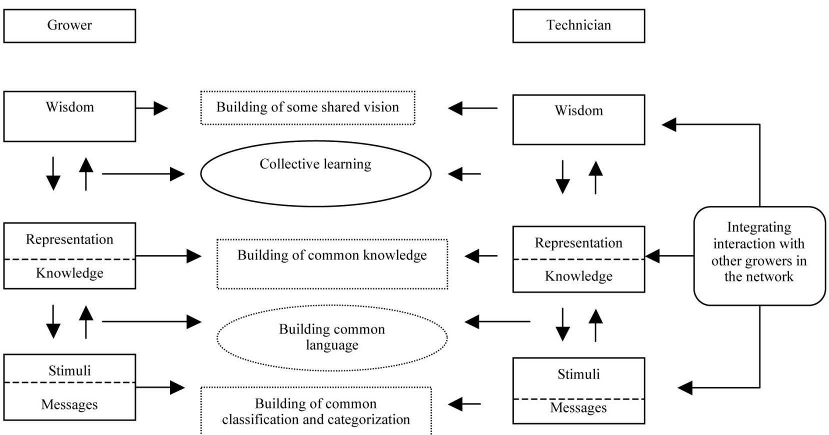


The arrows connecting the technicians and the growers indicate that a flow of information takes place between a pair of agents. According to Borgatti and Cross (2003), relational characteristics allow an agent to know what other agents know, what the other agent knows about his/her work and to gain timely access to personal views about technological issues. This relationship also allows the agent to evaluate the other agents and identify relevant knowledge and skills. The technological network contributes to technological knowledge creation at a more general level. Ancori, Bureth, Cohendet (2000) provide a conceptualization of these kinds of interactions in the field of knowledge creation. The information collected at the level of the two case studies indicates that directions and information are shared by the growers in each group (technician egonet-

[1] It is the case to point out that the production contract can be thought of as a basic determinant of the emerging network, both because it causes the link between the company and the growers and because it entails tasks relevant to the production techniques.

work) and determines the emergence of common perspectives and the definition of shared assessment criteria about critical issues: productivity, hygiene and animal health practices, feeding patterns, heating and ventilation, etc. The head of the technical staff organizes weekly meetings with the technicians, aimed at discussing the main technological issues to be addressed and planning the week's objectives. The meeting also allows the technicians to be in contact with each other, address common issues and discuss potential solutions. Basic common knowledge allows the group to address technical and organizational issues at the production stage and to elaborate common courses of action. Each technician then meets each grower of his group systematically (see fig. 6) and examines technical problems, checks the activities carried out, give suggestions and so on. Knowledge formation is presented in figure 6. Attention is paid to the building of common knowledge: it mainly entails the technology in use and safety, hygiene and animal health practices. The common language is elaborated via systematic interaction and represents a critical tool for managing the relationship. Common classification and categorization are achieved by communication and management of flows of information.

Fig. 6 - *Knowledge formation in the technological network (adapted from Ancori, Bureth, Cohendet, 2000)*



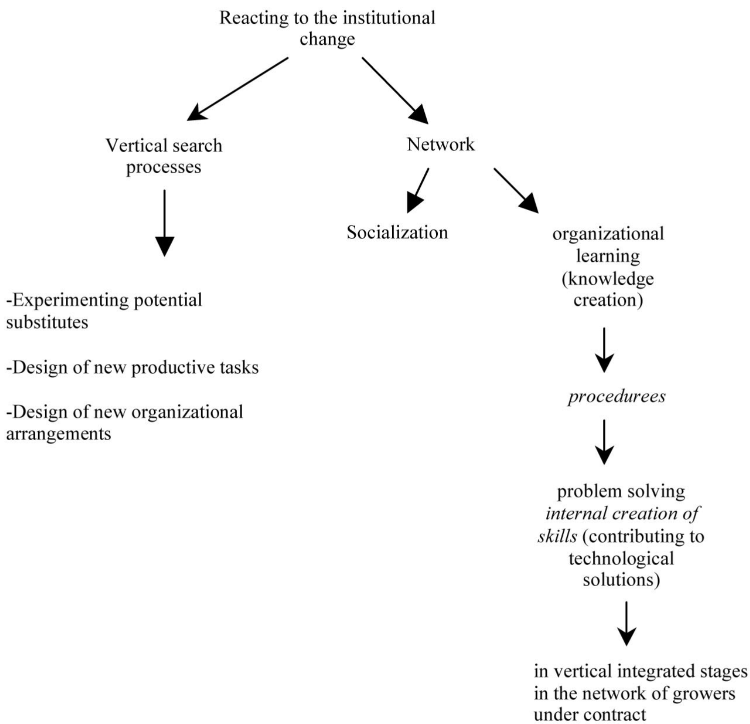
Consider, for example, the management of a new hygiene practice. The related issues are: *a*) to diffuse the practice, i.e. to promote its adoption by each grower; *b*) to train each grower in applying the practice; *c*) to collect appropriate information from growers, in order to assess the outcomes. The contractual mechanism allows for higher prices for the more skilled growers, however, the company is interested in being informed about the outcome, even though the grower bears the cost of unsuccessful individual action (Bogetoft, Olesen, 2001). As the grower carries out the practice by himself, a common classification and categorization is necessary in order to ensure that the action corresponds to the technicians' directions and in order to ensure uniform behaviour across the group of growers. We conjecture that this network contributes to the search for solutions to the technological issues and, thus, it could contribute to finding solutions to the efficiency posited by the Eu ban. Our hypothesis is that this network contribution arises from the organizational learning process promoted. From an organizational point of view, the way adopted by contractors (growers) and by the company to realize each task represents just one stage of the problem solving related to the specific task. Figure 7 summarizes the relations drawn from the analytical framework. A third aspect emerged during the interviews and the survey which shows how specific tasks, stemming from the interaction among agents of supply chains and finally performed by the growers, contribute to shaping the skills of the latter. To this purpose, to some extent, we propose a specification of the conceptualization of Egidi (1992).

According to Egidi (1992), the company identifies the task τ_j (e.g., disinfection of the total number of productive houses), then the task can be seen as recursively decentralized structuring the procedures into parametric connected subtasks (τ_j' in house 1, τ_j'' in house 2 and so forth, with the houses managed under contract). Procedure structuring determines the creation of skill which, in turn, represents opportunities for technological solutions. The opportunities that arise are classified and assessed within the network. Procedure structuring determines the creation of skills which, in turn, fosters the search opportunities for technological solutions[2]. It corroborates the idea that a viable interaction exists within the technological network which is explained in terms of organizational learning and gives raise to skill enhancements. The evidence collected shows that the variables expressing the task are influential to enhancement of the growers skills. As this specification takes place within the technological network interaction, the hypothesis that a viable interaction is promoted should not be rejected. In our view, this, in turn, contributes to dealing with the issues posited by the EU ban, as summarized in figure 7. In summarizing the empirical evidence we point out that:

[2] For the sake of brevity we neither report not fully discuss here the entire outcome of the survey carried out. It involves more than 150 growers engaged in production contracts with one or both of the companies interviewed. Details are available on request.

a) the strategic choices of the companies examined reflect the causal relation between the normal design configuration and the scarcity of the solutions to EU ban issues;
b) horizontal searching processes may be promoted through the contractual relationships between the company and the growers;
c) a technological network emerges among growers and company technicians, which may exhibit viable interaction through organizational learning.

Fig. 7 - *Organizational learning as an opportunity to react to institutional change*



5 - CONCLUSION

This paper proposes an analysis of the technological change promoted by the recent European Union ban on AGPs. The contribution of the paper is based on a specific theoretical perspective and emphasizes some critical aspects of the field investigated, without aiming at providing a comprehensive view. The analytical framework suggests that the poultry industry is facing high costs due to the scarcity of technological solutions. This intermediate conclusion is supported by the conceptualization of the poultry industry in terms of technological paradigms and trajectories, emphasizing the business perspective. Our analysis is articulated in two parts. First we proposed the main characteristics of the normal design configuration in the poultry industry and introduced the concept of scarcity of technological solutions. The costs caused at company level by the EU ban – an example of institutional innovation – are thus classified with respect to the possibilities of identifing new technological solutions (Antonelli, 1999). Secondly, we interpret the relationships among the growers and the company's technicians in terms of technological network (Ancori, Bureth, Cohendet, 2000) and suggest the idea that this network contributes to an organizational learning processes. Therefore, our contention is that the reactions to the institutional innovation take place in both a vertical and a horizontal direction, the former concerned with the selection of specific solutions and the latter due to network-based skills enhancement. The empirical analysis suggests that possibilities of interaction and of organizational learning exist. In other words, the analysis of task identification and of organizational design seems to support the interpretation proposed from an empirical point of view. Opportunities for future research may be found in the field of empirical analysis – e.g., in order to collect data from larger samples – and in theoretical investigation, namely with respect to the possibilities of enhancing organizational learning and knowledge creation processes through coordinating strategies.

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Summary

Cambiamento tecnologico indotto dalla legge: opportunità promosse dall'apprendimento organizzativo nel settore avicolo italiano

(JEL: D12)

Nel settore avicolo un divieto all'uso di antimicrobici promotori della crescita (AGP= è stato recentemente introdotto dall'Unione europea. Questa innovazione dell'ambiente istituzionale influenza grandemente la tecnologia in uso. Questo studio propone una concettualizzazione dell'industria avicola in termini di paradigma e di traiettoria tecnologica e suggerisce che i cambiamenti attesi a seguito del divieto sono costosi, a causa della scarsità di possibilità tecnologiche. L'idea che si propone è che l'interazione tra agenti lungo la catena di offerta potrebbe contribuire alla soluzione dei problemi emergenti. I risultati empirici forniscono una mappa della creazione di abilità individuali all'interno di reti di tecnici e allevatori attive nello scambio di informazioni e nella creazione di conoscenza. Si suggerisce anche che l'interazione tra allevatori e tecnici prevede la possibilità di migliorare la conoscenza tecnologica e di contribuire alla soluzione dei problemi emergenti.