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FOOD STANDARDS, TECHNOLOGY TRANSFER AND KNOWLEDGE AMONG SMALL AND MEDIUM AGRO-FOOD COMPANIES IN BRAZIL

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Introdução
Recently, highly publicized breakdowns in food industry contributed to consumer concerns about food safety and quality in a number of countries. As a result, governments, institutions, and firms in food chains propose and adapted to a number of standards to reduce risks linked to food contamination. However, costs of modernization, staff training, and certification fees hinder the adoption of standards for small and medium firms, compromising their ability to remain competitive or survive.

Problema de Pesquisa e Objetivo
Despite the challenges faced by these enterprises to comply with standards, technology transfer and access to knowledge enable some of them to develop resources and capabilities that make it possible. This paper reports evidence gathered from researching small and medium agro-food companies from northwest of Rio Grande do Sul state in Brazil. This paper explains how knowledge and technology transfer can influence these companies to adopt food standards to remain competitive.

Fundamentação Teórica
Nurturing SMEs success seems an appropriate strategy to policy makers that aim to improve food safety and facilitate socioeconomic development (Benkerroum and Tamime, 2004). Fundamental to this strategy is increase the stock of useful knowledge and the efficient transfer of applications (Teece, 1998), leading many countries to create technology transfer institutions to disseminate knowledge, improve production process and foster competition of agro-food SMEs (Algieri, Aquino, and Succurro, 2013)

Metodologia
A qualitative multiple case study method was used based on interviews with managers and staff from small and medium food companies, academics, and professionals from institutions involved in health inspection and technical support to entities in the supply chain.

Análise dos Resultados
Company’s interaction with suppliers, customers, competitors, and assistance institutions can facilitate the acquisition of the upscale and encoded knowledge necessary for implementation and adaptation to food standards. The lack of technical support and a regular assistance program, lack of employee education, and resistance in making changes to the production processes limit knowledge dissemination and the capacity to adapt to food standards, which can exclude firms from the market.

Conclusão
Results provide insights about the role of technology transfer and knowledge to small and medium firms comply with food standards, pointing out difficulties and suggesting a need for a coherent policy with regard to health inspection and technology transfer in food chains. Future research should explore the role of collaboration in firm networks in the learning processes and achievement of resources and capabilities that make possible for these companies to comply with standards.

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1. INTRODUCTION

In recent years, a series of highly publicized breakdowns in the food industry have contributed to consumer concerns about food safety and quality in a number of countries. These include the BSE scare in Europe, the *E. coli* O 157-contaminated burgers in the United States, dioxin-contaminated poultry and pork in Belgium, foot and mouth disease in Argentina and southern Brazil, and the addition of water and urea in raw milk in the Rio Grande do Sul state in Brazil. Media is increasingly emphasizing the impact of contamination and sanitary problems related to inappropriate handling or adulteration of food products, making consumers and governments more aware of food safety and raising the institutional complexity within the agro-food supply chains.

As a result, governments are responding by imposing new legislation banning the sale of any item that does not meet the minimum criteria, making it imperative that companies implement and certify management systems that comply with safety, legality, and product quality to protect the consumer and strengthen the trust in food chains (Escanciano and Santos-Vijande, 2014; Vieira, 2006b).

Regulatory requirements associated with consumer demands and changes in agro-food supply chains lead companies to enhance efforts to implement good manufacturing practices (GMP) and hazard analysis and critical control point (HACCP) guidelines into their management systems to improve safety control, traceability, and product quality, reducing risks linked to food contamination and foodborne illnesses (Luning et al., 2009). These improvements in safety and quality control make food products safer than ever, from a technical point of view, and contribute to firms' competitiveness through increased production efficiency, lower prices, reduced transaction costs in the food chain, and eliminated barriers in the global market (Trienekens and Zuurbier 2008). However, the costs associated with modernization equipment and infrastructure, staff training, and certification fees end up hindering the adoption of food standards for small and medium enterprises in developing nations, compromising their ability to remain competitive or even survive (Akkerman, Farahani, and Grunow 2010; Karaman et al. 2012).

Despite the challenges in complying with food standards faced by small and medium companies, nurturing their success and growth seems an appropriate strategy to policy makers in developing countries that aim to improve food safety, enhance added-value products, expand the local availability of food, generate new job opportunities, and facilitate economic and social development (Benkerroum and Tamime, 2004). A fundamental factor in promoting this strategy is an increase in the stock of useful knowledge and the efficient transfer of these applications (Teece, 1998). However, the process of knowledge creation and transference is complex, takes a long time, carries a high risk of failure, and can incur significant costs, making it infeasible for small and medium enterprises (Bozeman, 2000). To assist these companies and spread technical knowledge, many countries have created research and development (R&D) institutions and encourage universities to develop methods of improving agro-food companies' production processes, and transfer their research findings to the market. In this context, technology transfer has gained considerable attention because of its ability to spur business innovation, disseminate knowledge, and foster competition among medium and

small companies, taking into account their structural conditions of operation (Algieri, Aquino, and Succurro, 2013; Cribb, 2009).

This paper reports the preliminary evidence gathered from researching small and medium agro-food companies in the northwest of Rio Grande do Sul state in Brazil, examines the barriers and strategies adopted by these companies to comply with food standards, and provides a broader view of how technology transfer and knowledge allows some of these companies to develop resources and capabilities that make it possible to benefit from business opportunities associated with the adoption of these standards while remaining competitive. The paper is structured as follows. First, are provided the theoretical background of food standards, with emphasis on the regulatory environment regarding food security in the Brazilian agro-food chain, followed by the definition of technology transfer adopted by this study and the actors traditionally involved in this process. Next, provides insight into the methodology and data collection, followed by the results of the data analysis. Finally, are presented the conclusion remarks and offer suggestions for future research.

2. THEORETICAL BACKGROUND

2.1. Food standards and the regulatory environment in Brazilian agro-food chains

Standards are rules of measurement established by regulation authorities that specify characteristics expected of products and processes (Reardon et al., 2001). Food supply chains tend to be long and highly interconnected, leading to a number of vulnerabilities that expose people to a series of health risks linked to the products' perishable nature if not managed in a safe manner, as well as intentional or unintentional adulteration (Marucheck et al., 2011).

To assure consumer confidence in food chains and increase the information available on food products, governments, institutions, and companies in agro-food supply chains have proposed and adapted to a number of food standards to reduce the risks linked to food contamination. The Food and Agricultural Organization (FAO), World Health Organization (WHO), and World Trade Organization (WTO) play a central role in food safety issues at a global level. In 1963, FAO and WHO established the *Codex Alimentarius* to develop harmonized international food standards, with the purpose of protecting consumer safety and promoting fair trade in food chains, covering everything from raw and processed material characteristics to food hygiene, pesticides, residues, contaminants, and labeling, as well as analysis and sampling methods (Trienekens and Zuurbier, 2008).

Although legislation at global, international, and national levels provides basic guidance for quality assurance systems, food companies have also implemented safety management systems to improve the quality and safety of their products, respond to external pressures, improve brand image, and access new markets (Escanciano and Santos-Vijande, 2014). Two of the most important quality assurance systems are HACCP and Good Agricultural Practices (GAP). HACCP principles are the basis of most food quality systems (*Codex Alimentarius),* providing a systematic approach to the identification, evaluation, and control of critical food safety processes in manufacturing. GAP consists of a set of agricultural practice guidelines to meet minimum standards for production and storage (Trienekens and Zuurbier, 2008).

In Brazil, the *Ministério da Agricultura, Pecuária e Abastecimento* (Mapa) represents the government in international forums about food issues. It also regulates the production and trade of food products, both fresh and processed. The *Ministério da Saúde* oversees sanitary control in production and trade, while the *Instituto Nacional de Metrologia, Qualidade e*

Tecnologia (InMetro) examines and regulates technical barriers along with conferring data and specifications on product labels.

The inspection system at the federal level for food products follows the guidelines established by the *Codex Alimentarius*, while states and municipalities may use alternate inspection systems, creating significant differences in the three levels of inspection due to varying quality control procedures (Vieira, 2006a). Because of these differences, only products inspected at the federal level can be exported, while products that pass through state or municipal inspection may only be traded in the territories covered by these inspections.

The complexity of regulatory environments is associated with the high cost of adapting production processes, which hinders the adoption of food standards for small and medium enterprises, compromising their ability to remain competitive and establish safe food production systems. Technology transfer represents a source of knowledge and technical resources that are normally out of reach for these companies. These resources induce productivity improvements achieved through cooperation with R&D organizations, create conditions for small and medium food companies to remain competitive at the same time they promote economic and social development, facilitate access to safe food, and improve the economic conditions of local communities. Facing this reality and the risk of a breakdown in the food chain that could compromise consumer health or safety, Brazil established a number of public and private R&D organizations aimed at technology transfer, providing scientific and technical assistance on production processes, training of the workforce, and support to small and medium agro-food companies' formalization processes (Cribb, 2009). To understand the dynamics of the relationship between R&D organizations and small and medium food companies, the next section discusses the role of technology transfer and knowledge in the development process of firm resources and capabilities.

2.2. Knowledge and technology transfer

Technology transfer is the transmitting of knowledge, know-how, or technology from one organization to another. Bessant and Rush (1995) emphasize that it is a long-term process involving several stages, multiple actors, and elements and patterns of interrelationship, with a different set of interests and participants in each stage.

Knowledge can be transferred through informal communication channels or by formal mechanisms. Formal and informal mechanisms of technology transfer have a complementary relationship, where the transfer of codified knowledge in the form of a license or patent is followed by the tacit knowledge through the interaction between the sources of technology, intermediaries, and technology users (Grimpe and Hussinger, 2013). Formal transfer mechanisms involve legal contracts that allocate property rights, such as patents, licensing technologies, and R&D agreements, which allow companies to access codified knowledge that can assist in improving current capabilities. However, contracts are costly and can be sold to competitors, limiting their access to small and medium companies and decreasing the potential to create unique firm resources. Informal technology transfer utilizes personal contacts and provides access to technical knowledge such as tacit knowledge, technical assistance, consulting, workshops, and collaborative research without mobilizing substantial firm resources.

Technology transference is not a simple imitation of know-how and knowledge but a creative process of development and adaptation that takes into account the firm's capabilities of

absorbing the technological improvements and the local conditions of production and development (Cribb 2009). Kogut and Zander (1992) recognized that competitive advantage is founded on the ability to create and transfer knowledge efficiently. Firms learn to recombine their current capabilities to get new information and know-how that provides options in dealing with uncertainty. Firms cannot fully rely on internal sourcing for knowledge and innovation, making the ability to recombine a firm's capabilities dependent on their interactions with external agents that provide new knowledge for the development and improvement of product and process innovations (Spithoven, Clarysse, and Knockaert 2011), making technology transference a critical factor in improving productivity and innovation (Reisman 2005).

Firms differ in their technological competence and their ability to absorb and assimilate knowledge, requiring high levels of managerial skills to identify, select, and implement knowledge on an operational level. A lack of managerial capabilities represents one of the main barriers to knowledge assimilation, requiring policies that focus on closing the managerial gap through technology transfer that compensates for the lack of innovative capabilities, especially in small companies (Bessant and Rush, 1995). To circumvent these barriers, firms monitor their environment to recognize new valuable knowledge and technology, absorb it, and apply it to company operations. However, small and medium enterprises that have limited absorption capacity might need assistance in assimilating technology (Spithoven et al., 2011).

To assist the learning process in firms and other technology users, various types of actors, such as transfer offices housed in universities, research organizations, regional economic development agencies, professional associations, advisory bodies, and knowledge workers, act as knowledge and technology transfer intermediaries, connecting the sources to the users of knowledge (Landry et al. 2013). Technology sources include private firms, government agencies and laboratories, universities, and nonprofit research organizations, while technology users include schools, public offices, small businesses, legislatures, cities, states, and nations (Bozeman 2000). An example of a technology transfer office operating in Brazil is Emater/RS-Ascar, a non-profit civil society established in 1955 with the purpose of promoting rural development through technical assistance and rural extension. Today, the organization is present in 497 cities of the Rio Grande do Sul state, emphasizing the use of technical assistance in strengthening family farming, and seeking the sustainable development of the communities where it operates. The company has strong ties with universities, research organizations, and the government, promoting partnerships that seek to develop research and technology transfer to rural areas as a way to enable the adoption of better production and marketing techniques in agriculture and livestock, adding value to family agriculture products through the industrialization of local production.

The growing importance of knowledge to remain competitive and the presence of a large number of actors in the technology transfer process make it crucial for firms to establish adequate relationships between the different actors of the knowledge infrastructure to effectuate combinations of knowledge, know-how, and technology for sustainable competitive advantages (Klerkx and Leeuwis, 2009). As firms form and maintain relationships with these different actors, they weave a network of direct and indirect relationships through which they gain access to information and knowledge (Schilling and Phelps, 2007). The flow of information and know-how among firms in the network is fundamental to small and medium businesses due to resource constraints that limit the possibilities for absorbing knowledge and

realizing innovation, allowing them to access critical resources, extend their technological competencies, and build legitimacy and reputation (Brunswicker and Vanhaverbeke, 2015).

3. METHOD

This paper takes a qualitative case study approach to understand how technology transfer and knowledge make small and medium food companies able to develop resources and capabilities that make it possible to benefit from business opportunities associated with the adoption of mandatory food standards while remaining competitive. First, published secondary data looking for systematizing the regulatory environment for food security and quality in Brazil was collected, participants in agro-food supply chains were identified, and their role in the technology transfer process was determined. After this first step, interviews were conducted with seven informants from institutions involved in health inspection, technical support, and technology transfer in the northwest of Rio Grande do Sul. The interviews were semi-structured with open-ended questions. Five of the interviews were informal; the remaining two were recorded and transcribed. The interviews contained questions about the organization and performance of the supply chain, drivers and barriers to local companies' compliance with food standard regulations, and how these factors triggered the technology transfer process.

Interviews with managers and staff were conducted between December 2015 and January 2016. From those interviews, four companies were selected to highlight as case studies. The respondents were professionals who deal daily with food safety issues and are responsible for their companies' management and production processes. At the same time, these professionals deal with issues related to the purchase of raw materials and commercialization of the final product. These interviews were also semi-structured with open-ended questions related to difficulties faced in implementing food standards, strategies adopted for standards adaptation and business opportunities resulting from this process, the process of seeking and acquiring knowledge, and their interactions with transfer technology offices. These interviews were recorded and transcribed. The next section presents the main findings of this research.

4. THE TRAJECTORIES AND CHALLENGES IN FOOD STANDARDS COMPLIANCE

In this section, we provide deeper insight into the challenges faced by small and medium agro-food companies in complying with food standards, and learn how technology transfer and knowledge provide new resources and capabilities that make it possible to improve production processes and benefit from new business opportunities. Table 1 below provides insight into the interviewed companies.

Table 1 – Characteristics of interviewed companies

Characteristics	Company A	Company B	Company C	Company D
Establishment	2012	1997	1997	1996
Company size	Small	Small	Small	Medium
Core products	Peanut based products and biscuits	Sausage	Sausage	Fresh meat
Management	Family-run	Family-run	Family-run	Family-run
Employees	15	7	5	30
Productive capacity (monthly)	8,500 packs - peanut based products; 3,500 biscuits	5 ton	3 ton	1,100 heads
Level of health inspection	State	Municipal	Municipal	State
Principal market	Northwest of Rio Grande do Sul	Local sales	Local sales	Rio Grande do Sul
Distribution channels	Direct sales, wholesaler, independent sellers	Direct sales	Direct sales	Direct sales and sales agents
Source of raw materials	Local producers	Independent producers from different locations	Independent producers from different locations	Independent producers from different locations
Principal sources of knowledge and technology	Universities, transfer technology office, and consulting firms	Additives and equipment suppliers and other companies	Universities and other companies	Consulting firms and universities
Business networks or associations	Local commercial and industry association	None	Informal business networks, movement of small farmers	Industry association
Interviewee	Owner	Owner	Owner	Quality director

The companies are located in four different small cities from the northwest of Rio Grande do Sul, with a population ranging from 5,500 to 14,000. The economy is based on agriculture, mostly grain production focused on the export market, pork integrated to a large exporter company, and raw milk production. In recent years, a number of small farmers attempting to reduce their dependence on traditional agriculture and aggregate value began to industrialize their production.

Company A, the youngest company analyzed, is the result of an acquisition, performed by an entrepreneur farmers' son, of a company with unrelated business activities to those of his family. They started producing *rapadura* (or molasses) to the local market and now trade more than 20 different products, mostly peanut based products and biscuits, to seven different states of Brazil. They use different market channels depending on region, performing direct sales to customers from cities nearby and using a wholesaler for distant markets. In addition to these distribution channels, sales through independent vendors have been key to access and dissemination of products in new markets, allowing a market test of their products in different regions of Brazil. The firm is inspected once a year by state inspectors who normally require a series of adjustments in production structures and manufacturing procedures.

In contrast, Companies B and C, which produce sausage and other pork products, prefer direct sales to eliminate intermediaries and obtain a higher value for the commercialized product. The companies started their activities in an informal way, commercializing their products in the neighborhood and formalizing activities through public incentives. Currently, these

companies experience a clear limitation of growth because they can only trade their products in their hometowns or, eventually when authorized by other cities, in family farming product fairs. To overcome this limitation, both companies planned to expand their production capacity and meet the state inspection requirements. However, excessive bureaucratic procedures to get permission to expand production and move to a higher level of inspection, along with the high costs of making the necessary adjustments, forced Company C to cancel their expansions plans, while Company B has been making investments in another city that offers tax benefits and has simpler bureaucratic procedures.

Due to differences in traded products and company size, sanitary inspections and food safety standards are considerably stricter for Company D, a slaughterhouse specializing in beef. The state has a legal obligation to perform daily monitoring in the company through a veterinary inspector hired by the state who attests to conformity in the slaughter process with food safety standards; however, the inspections do not often occur due to staff shortages. In addition to the daily monitoring, the company is regularly inspected by a regional supervisor focused on compliance in the company's production facilities. The firm insists that their production processes and structures always comply with the legal obligations, although the inspectors' varying interpretations of food security legislation cause the company to change its procedures regularly. Despite being minor changes, the company faces employee resistance in implementing them in the work routine. As a way to educate employees about the importance of proper food safety practices and translate knowledge in a way that facilitates absorption by their workforce, considering their low educational level, the company regularly provides GMP training through private consultants and universities. These actors also facilitate the acquisition of upscale and encoded knowledge necessary to implement and adapt to food standards.

The regions where Company A experienced the fastest growth have a large number of emigrants that come from the Rio Grande do Sul. These customers traditionally give preference to products from the state, making the adoption of the label *Sabor Gaúcho* a relevant factor in the market expansion of the company. The label is a Rio Grande do Sul initiative to identify and disseminate family agro-industry products manufactured in the state. Beyond identifying their products, the companies that adopt the label receive assistance from universities and technology transfer offices in improving their management processes, preparation and routing of credit, health and environmental projects, tax legalization, and training in GMP implementation and improvement. From interactions with universities, transfer technology offices, and other firms, the firm can identify new products that are likely to be quickly accepted in the established markets, taking advantage of economies of scope by developing new product lines with underutilized resources from its current products. However, currently, they operate at full capacity because the achieved market growth in recent years has exceeded their expectations and their ability to make new investments. Available funds are allocated for the improvements ordered by sanitary inspectors, which compromises the ability of the company to continue to grow and invest in new products.

Even with the necessary requirements to join the program, Companies B and C are not currently active because the market in which they operate does not require identification, and the assistance given by the program is insufficient to relieve bottlenecks currently faced in their production and food safety processes. The main sources of technical information for Company B are the suppliers of additives and machinery. These partners transfer knowledge formerly available only to large companies, and using the information transferred by their suppliers, the company's owner investigates in detail the technical aspects required by food

law, as well as new production processes and equipment. For cultural reasons, the entrepreneur tends towards self-sufficiency: relying on other sources of knowledge and opportunities for business improvement can harm business performance.

In contrast, Companies C and D have a wide network of other companies, universities, and organizations, which has facilitated the implementation of food safety standards through the exchange of information within the network. Their participation in producers' associations allows interaction with other companies from various sectors and different sizes, and from the exchange of experiences, they have been able to anticipate bottlenecks already faced by their partners. Additionally, from partnerships with universities, they have been able to codify previous knowledge on food safety and security.

5. CONCLUSIONS

This article analyzed the barriers and strategies adopted by agro-food companies to comply with food standards, providing a broader view of how technology transfer and knowledge can assist small and medium companies in developing resources and capabilities that make it possible to benefit from business opportunities associated with the adoption of food standards while remaining competitive.

As the experiences of the analyzed companies indicate, the lack of an adequate public policy for food security and inspection of small and medium companies compromises their ability to comply with public demands and create incentives to act in an opportunistic way, endangering food chain security and the public health. Excessive bureaucratic procedures and inconsistencies in the inspection process lead to companies repeatedly trying to adapt production structures and processes, consuming significant resources and jeopardizing the ability of these businesses to grow and remain competitive. Although these companies count on a series of public support entities that seek to facilitate the process of adaptation to standards, management teams, reduced technical assistance, and fragile methods of technical assistance provision impede the guidance process in agro-industries.

The four trajectories are characterized by the combination of various learning processes and the interaction of a wide range of different actors. As Malerba (1992) indicated, external sources of productive knowledge play a major role in technical advancement. Food safety compliance is the result of a continuous improvement process where knowledge codification and dissemination in an applicable way is fundamental for small and medium firms to remain competitive. The experience exchange inside the firms' networks provides access to information that accelerates the adaptation process of food safety standards, obtaining knowledge that makes it possible to improve product quality and production efficiency. At the same time, relationships with these companies have enabled the identification of new business opportunities by expanding into new markets through partnerships or developing new products.

However, low employee education, along with resistance in making changes in production processes, limit knowledge dissemination and the capacity to adapt to food standards. Even though the workforce receives GMP training, it continues to use improper food safety practices, making it necessary to constantly reinforce the importance of GMP. The assistance of universities and technology transfer offices is fundamental in facilitating the acquisition of upscale knowledge necessary to implement and adapt to food standards.

These results provide some initial insights about the role of technology transfer and knowledge in adapting to food standards by Brazilian small and medium companies, pointing out some of the difficulties faced by these companies in the adaptation process and suggesting a need for a more coherent public policy with regard to health inspection and technology transfer in food chains. Future research should explore the role of collaboration inside company networks in the learning processes and achievement of resources and capabilities that make it possible for small and medium companies to comply with food standards.

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