# INNOVATIONS, TECHNOLOGIES AND ECONOMIC DEVELOPMENT: An evolutionary view of the Brazilian poultry industry and its firms[1]

Armando João Dalla Costa[2]
Pascal Petit[3]
Mauricio Vaz Lobo Bittencourt[4]

## Resumo

Novas tecnologias, inovações, pesquisa e desenvolvimento de novos produtos podem ajudar economias e empresas de países em desenvolvimento a transformar modelos de produção e aumentar a produtividade do trabalho. Diversos países das novas economias industriais do leste asiático, assim como de outras regiões, têm mostrado que investimentos em educação, pesquisa, inovação, adaptações tecnológicas, criação de novos produtos, reorganização interna do trabalho nas firmas, contribuem para melhorar o rendimento econômico e ajudar no rápido desenvolvimento. No caso da avicultura brasileira, uma atuação de diversos atores, com destaque para empresas privadas, governos federal, estaduais e municipais e centros de pesquisa transformaram uma atividade artesanal num dos setores mais dinâmicos da agropecuária. A ação combinada destes atores levou a um forte aumento na produção e no consumo, assim como a uma redução significativa dos preços ao consumidor. Além disso, o país se tornou grande fornecedor internacional, assumindo o primeiro lugar entre os exportadores mundiais. Este artigo tem como objetivo verificar como se deu este processo de desenvolvimento, analisando a evolução da avicultura a partir dos atores acima mencionados, tendo como pano de fundo a perspectiva de análise schumpeteriana e da teoria evolucionária das empresas. Merece destaque na análise a criação e adaptação de novas tecnologias e como estas interferiram na competitividade das firmas nacionais que dispõem de um longo histórico de exportações e, a partir do início do novo milênio, começaram a se internacionalizar também através de plantas industriais.

Palavras-Chave: Inovação; Pesquisa & Desenvolvimento; Produtividade; Avicultura Industrial

## Abstract

New technologies, innovation, and research and development of new products can help developing economies to transform models of production and raise productivity. Several countries in Asia have shown that investing in education, research. Technological adaptation and creation of new technology may foster economic development. In the case of the Brazilian aviculture, the interaction between various actors (private firms, federal government, provinces and municipalities, along with research centers), transformed an artisanal activity in one of the most dynamic sectors of agriculture. The combined action of these actors sharply increased production and consumption, and reduced prices. Moreover, Brazil became the largest exporter of aviculture goods to the international markets. This paper analyzes how this transformation happened looking at the development of the aviculture sector, using evolutionary and Schumpeterian theory. Particular emphasis will be given to the study of creation and adaptation of technology as a source of international competitiveness, which contributed to sustain a trajectory of exports and the subsequent process of internationalization of the Brazilian firms.

Key-words: innovation, technologies, research & development, productivity, industrial aviculture

JEL Classification: L11; L22; L25.

---

[1] Paper presented at the III Research Workshop on Institutions and Organizations. São Paulo: USP, IBMEC and FGV-SP, October 13th to 14 th, 2008.

[2] Professor in the Department of Economics of UFPR and Coordinator of Núcleo de Pesquisa em Economia Empresarial (www.empresas.ufpr.br) E-mail: ajdcosta@ufpr.br.

[3] Professor in the Department of Economics of Université Paris 13 (Paris Nord). E-mail: pascal.petit@univ-paris13.fr.

[4] Professor in the Department of Economics and Head of the Programa de Pós-Graduação em Desenvolvimento Econômico da UFPR. E-mail: mbittencourt@ufpr.br

## INTRODUCTION

Science, technology and innovations usually appears in the economic literature as key elements of the industrial competitiveness for the developed economies and new industrial countries. Authors such as Schumpeter (1983,1990), Abramovitz (1976) [5] and Solow (1957) [6] were pioneers who stressed the link between technology and economic development. Kim and Nelson (2000) did the same for new industrialized countries, mainly for the Eastern Asia and Latin America (Argentina, Brazil and México).

Kim and Nelson show that imitation and innovation became important not only for new industrialized countries but also for new industries in developed countries. According to those authors[7], creative adaptations are innovative in the sense that they are inspired by existent products, but they are just produced in a different way, which gives developing countries' firms the possibility to become noticed at the international level, as it is the case of the Brazilian industries in the aviculture sector. Kim and Nelson stress that:

> "Adaptation to another industry illustrates the application of innovations in one industry for use in another. Creative imitations aim at generating imitative products but with new performance features. They involve not only such activities as benchmarking but also notable learning through substantial investment in R&D activities to create imitative products, the performance of which may be significantly better or production cost considerably lower than the original" (KIM and NELSON, 2000, p. 4-5).

Although there are many recent experiences that demonstrate the strength of these principles (LALL, 2000, PACK, 2000), the international scenario shows that only few countries are capable of investing in Research and Development (R&D) that produce *high-tech*[8] *products and services*, which assure the countries' firms the possibility to perform competitively not only in the international market but also in the domestic one. The question becomes: Will the non-developed countries, based in low or medium technologies and traditional exporters of raw materials and low aggregate value

---

[5] Analyzing the American economy until 1980, Abramovitz (1976) shows how important is the impact of technologies in the American economy as key elements for the country development.

[6] Investigating the economic development of the US between 1909 and 1949, Solow showed that only one-eight of the total production increase in the US economy was traceable to the increased capital to man-hour while the remaining seven-eights had to be ascribed to technical change.

[7] The examples of new industrialized countries, mainly the experience of the East Asia, as seen in the book *Technology, Learning & Innovation* are important to understand the relation between investments in education, technology, research, innovation and economic development.

[8] Dietrichs (1995, p. 1) says that we normally use the concepts of 'high-tech', 'low-tech' and 'medium-tech' in the following way: "Sectors that spend less than 1% of sales on R&D are classified as low-tech, those spending between 1 and 4,5% as medium-tech and sectors that spend more than 4,5% are classified as high-tech".

goods, be able to produce high technologies in near future and compete with the today's industrialized countries? According to Dietrichs (1995, p. 2), the answer is 'no'. So how could countries with low tradition in high aggregate value goods exports create technologies, innovate and become an important world market player?

In the case of Brazil, the role of the federal government after the second half of the 20th Century was important in order to Brazil become one of the major world producers and exporters in the agriculture, livestock and non-oil energy production (Proálcool and Biodiesel). In this case, we have to emphasize the role played by EMBRAPA – Empresa Brasileira de Pesquisa Agropecuária[9], with many research unities specialized in different products, spread throughout 20 states[10]. One of these centers does R&D of innovations and new technologies for the aviculture and hog sectors. This is the Centro Nacional de Suínos e Aves - CNPSA[11], located in Concórdia, west of Santa Catarina, the main Brazilian chicken and hog producer, the birth place of firms such as Sadia, Perdigão, Ceval and Aurora, which are among the main Brazilian firms in the livestock sector.

The evolution of the Brazilian aviculture, which is the objective of this paper, has been a result of combined actions of enterprises, government (at federal, state, and municipality levels), research institutions and scientific spillovers. These combined actions of different institutions and a sequence of investments in R&D were very important to the aviculture and other agriculture and livestock Brazilian sectors as well, as Nelson (2006, p. 5) cites: "... that technological progress must be understood as an evolutionary process, and that one needs to recognize the wide variety of institutions that play roles in the process". In Brazil, the combination of R&D, innovations, and

---

[9] Nowadays, the Embrapa network involves ten national research centers with basic themes; 15 national research centers on products; 13 regional research centers on agricultural and forest production; and three centers of special services. All of them are decentralized units and more 17 State Institutions of Agricultural Research that form the National Agricultural Research System - SNPA, along with the universities and private research institutions (http://www.embrapa.br/imprensa/noticias/2007... Access in: 16/6/2008).

[10] Ramos (2005, pp. 381-382), when referring to scientific research in the Brazilian agriculture, says that the public policies affect the development of the agricultural research since the 19th century, with the creation in 1877 of the first Agronomy College in Brazil, in Cruz das Almas – BA. For a deeper analysis about the development of agricultural research and institutions in Brazil see, among others, Ramos (2005); Santos and Silveira (2005); Rivaldo (1986); Freitas Filho et. al. (1986); Malavolta (1979-81).

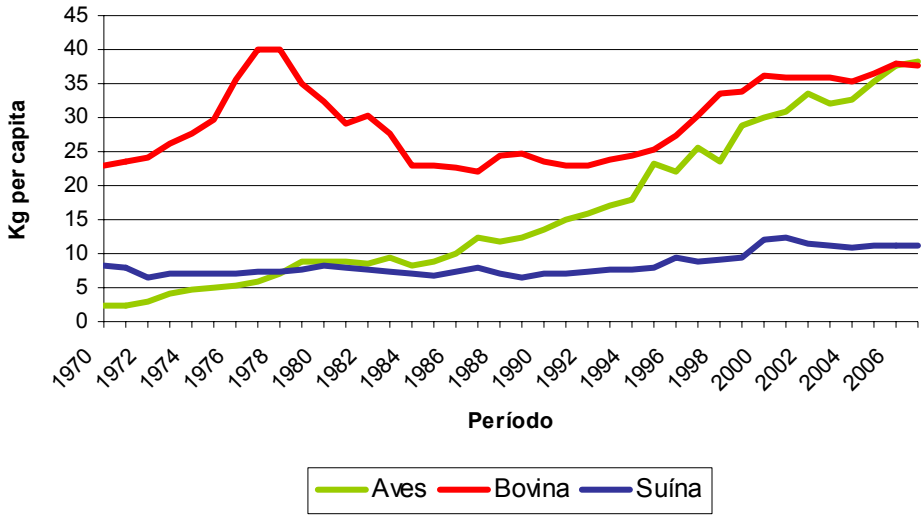
[11] "Innovation, social compromise and scientific excellence are the pillars that hold the daily routine of Embrapa (swine and chickens) and that made it a research center recognized in whole country" (http://www.cnpsa.embrapa.br Access in: 16/6/2008). National Swine Research Center (Centro Nacional de Pesquisa de Suínos) was created in 13 of July of 1975. In 1978 it started to research on poultry as well, and it was called National Swine and Chicken Research Center (Centro Nacional de Pesquisa de Suínos e Aves) or Embrapa (swine and chicken). In the middle of 2008 there were 41 people doing research in different fields in this Embrapa unit.

institutions (research centers, governments, enterprises) was responsible, in a short period of time, for transforming the traditional and amateur aviculture sector – low quality chicken produced in small areas of one's property – to a very high-tech, professional and profitable sector which became able to supply the domestic market (BITTENCOURT, 1995). In 1970, after almost one decade of industrialized production, the production was of 217 thousands of tons, and the annual per capita consumption was around 2,3 kg, while the average retail price was US$ 4,05 per kg (DALLA COSTA, 2000, p. 1). The production reached 9,28 millions of tons in 2006, and the annual per capita consumption was 36 kg, with the average price lower than one dollar per kg[12].

The consumption progress was slow in the beginning of the sector industrialization, but it became more intensified as long as the enterprises were able to implement a scale production, which caused increases in production and fall in prices for consumers. It was necessary 25 years of industrialized production in order to the annual per capita consumption reach 10 kg. This number was doubled in the following decade, reaching 36 kg in 2007. An interesting comparison can be made relating chicken, swine and cattle meat consumptions. The cattle meat is the most consumed meat in Brazil, and it has been this way for the last decades. The swine meat consumption increased in the middle 1990's, while the chicken meat presented the main increase among all types of meat, increasing from 2,3 kg to 37 kg/per capita/per year in 2006, when the annual per capita chicken meat consumption was larger than the cattle meat for the first time.

[12] TALAMINI, Dirceu J.D.; MARTINS, Franco M.; NOVAES, Marcos. "A resposta da avicultura ao desafio da gripe aviária", in: *Anuário 2007 da Avicultura Industrial*. São Paulo: Gessulli, ano 98, n. 11, ed. 1.151, p. 18-26, 2006.

FIGURE 1 – THE CONSUMPTION EVOLUTION FOR THE CATTLE MEAT, SWINE MEAT AND CHICKEN MEAT IN BRAZIL - 1970-2007 (in kg/person/year)




The Brazilian aviculture became an important sector not only in the domestic market, but also in the international one, since many Brazilian enterprises began to export cuts of chicken meat in 1975, when were sold approximately four tons of chicken meat, in a total value of US$ 3,3 millions. Afterwards, the exports was still growing until reach 2,5 millions of tons in 2006, and a value of US$ 3,2 billions, whose numbers put Brazil as the main world exporter (TALAMINI et. al, 2006).

This paper analyzes how innovations interfered in the capacity that enterprises had to transform the aviculture in an important sector in the Brazilian economy in order to supply domestic and international markets. The government policies are taken into account not only in the development of new technologies but also in the incentive to export and, more recently, in the internationalization dynamics of the aviculture enterprises. The analysis is basically Schumpeterian and evolutionary, based on studies such as Nelson and Winter (1982, 2007), Nelson (1993, 2006), Dosi (2000, 2004), Dosi et al. (1998), Dosi and Nelson (1994), Dosi and Marengo (2007), Coriat and Dosi (2000), Freeman (1994), and it is intended to show the evolution of the Brazilian aviculture and the main changes that this sector experienced since the decade of 1960, when the "industrial slaughtering" began. At the same time this paper stresses the activities of the main enterprises, and the public and private sectors in terms of R&D that allowed the necessary development to face the growing demand on internal and external markets. In addition, there exist some sectors, such as the vaccine/drugs

production and the investments in genetics to produce new breeds of chickens, which are still being challenges to sectors doing research, generating and promoting innovations and new products.

## 1 THE BRAZILIAN AVICULTURE SINCE THE MIDDLE OF THE 20TH CENTURY

Brazil became the larger exporter and one of the main world producers of poultry meat[13]. However, chickens are not originated from American territory, and the first breeds came with Pedro Álvares Cabral who "discovered" Brazil in 1500. According to the narrations of the time[14], chickens were the first domestic animals to get in touch with the new continent. Actually this fact was mentioned in the letter that Pero Vaz de Caminha wrote to the Portuguese king when describing the discovery of Brazil[15]. Afterwards, with the exploratory expedition of Gonçalo Coelho in 1503, the crew brought chickens to be raised in the Rio de Janeiro region.

However, there was very little progress with the employed technology, supplied food, and with the livestock handling until 1960. The chickens were raised in an amateur and familiar way, without any breed improvement technology, rations or livestock handling improvements. Consumption was limited to annual events, parties, or expensive restaurants in urban areas, at the time where most of the people lived in rural areas. Those times can be illustrated through a popular proverb: "poor eats chicken only when one of them is sick" [16].

---

[13] According to the United State Department of Agriculture - USDA (November 2007), the largest world producers are (in thousand tonnes/year): USA 18.714; China 10.850; Brazil 10.485; EU-25 9.875, followed by Mexico 2.671; India 2.200; Russia 1.375; Argentina 1.300; others 10.522, totalizing 67.993 tonnes. Among the main world exporters (in thousand tonnes/year): Brazil 3.015; EUA 2.643; EU-25 730; China 353, followed by Thailand 315; Argentina 150; others 526, totalizing 7.732 tonnes. The exports represent 11,4 %, where most of the production is used to supply domestic market of the producer countries.

[14] For a general view of the aviculture in Brazil before the industrial production, that is, since the beginning of the 1960s, see among other, Osny Arashiro. *A história da avicultura no Brasil*. São Paulo: Gessulli Editors, 1989.

[15] Anchored in Porto Seguro, the captain's ship was visited, in the night of 24 of April of 1500, by two natives brought by Afonso Lopes. Among other things that were showed to the natives, wrote Caminha, "A parrot was showed to them by the captain. They held the parrot and pointed their hands to the land as a way to say that there were parrots there. They showed them a sheep; they were surprised. They showed them a chicken, and they almost got scared from it; they did not want to put their hands on it and later they took it frightened." (ARASHIRO, 1989, p. 17).

[16] A famous sentence from Barão de Itararé, which became a popular proverb. Osler Desouzart (1994). "the quo vadis of the aviculture industry for the year 2000: Advances in meat consumption and the perspectives of the international market", in: *Anais da Conferência Apinco de Ciência e Tecnologia Avícolas*. Campinas, São Paulo, p. 152.

In this first period, which starts from the discovery to the beginning of the industrial slaughtering in the decade of 1960[17], the main innovations were the introduction and adaptation of international researches aiming to produce chickens for public exhibition, with variety of colored feather in an attempt to participate in chickens contests. Additionally, the first association of chicken growers was created and also a magazine called *Chácaras e Quintaes*, in 1910, which is known nowadays as *Avicultura Industrial*[18].

In the decade of 1960, when Sadia and Perdigão began to diversify their activities and started to produce chickens, there was a key change: the aviculture changed to an industrial activity, with innovations in technology and in labor organization in all levels of the productive chain.

The enterprises, however, could not employ the technology used so far in the new production plans. One way to have a 'technological jump' was trying to get new successful experiences adopted in developed countries, as Lall (2000, p. 17) cites:

> "In a developing country, knowledge of traditional, stable, and simple technologies may not be a good base on which to learn how to master modern technologies. Thus, enterprises may not be able to predict if, when, how, and at what cost they would learn enough to become fully competitive, even when the technology is well known and mature elsewhere. This adds to the uncertainty and risk inherent in the learning process".

Sadia, pioneer in the adoption of integrated system[19], tried to stimulate the industrial aviculture through sending one of its employees, Ivo Reich, to the United

---

[17] For an analysis of this period, with its ways of production, producers organizations, expositions, contests, familiar enterprises connected to chicken production, eggs and commercialization, see Dalla Costa, 2000, chapters 2 and 3, pp. 59-111.

[18] With almost 100 years old, this magazine is one of the oldest in the agricultural sector in Brazil. Created by Conde Amadeo Barbiellini, an owner of a Poultry Store in Vila Ema, São Paulo. It was important to organize and promote poultry activities in the first national expositions. The Chácaras e Quintaes kept this name between 1910 and 1970. In 1948 Osvaldo Gessulli started to work in the magazine and, with the death of its creator in 1955, he became the main partner, editor, and promoter of the magazine. In 1967, the publisher was bought by the Gessulli family that, from 1971, changed the name to Chácaras e Quintaes – Avicultura Industrial. Today, they publish two specific magazines due to the advances of swine and chickens production: Avicultura Industrial and Suinocultura Industrial.

[19] The production of the integrated system is a mechanism through which a rural property, generally family agriculture, grows animals (or other products, such as tobacco, milk, …) to be slaughter and industrialized in association with the agro industry. Farmers, chicken and turkey growers, and others, are responsible for the construction of the growing houses, equipments, labor, and use of the factor of production, such as electricity, water, gas, nests, management and care of the chickens. The agro industry delivers the one-day chicks, supplies technical assistance, drugs, vaccines, rations and transportation. The main role played by the integrator is to raise the chickens, under directions of the agro industry and sell them exclusively to the agro industry, which will slaughter, industrialize and sell them." (DALLA COSTA, 1993, p. 154).

States in 1961 to learn about the integrated system. When he returned, the new system was implemented:

> "Recently returning from the USA, Ivo Reich started to implement in Concórdia the new American model of 'integrated aviculture'. He could find, eight kilometers from town, a farmer willing to try the new method. Diomédio Bósio built a small 3x3 meter chicken farm, hard floor, bedding material and wood heated. Ivo brought 100 chicks, which were treated and feed with special ration. During the first weeks Ivo walked many times to the chicken farm to check the livestock development. In 85 days, a record at the time, Diomédio Bósio was taking back the chickens in his Jeep to the chicken slaughter at Sadia. It did not take long for others follow his example" (TEIXEIRA, 1994, p. 47).

It is how the Sadia historian describes Sadia's first experience with the integrated production of chickens, based on international technology. Lall, when analyzing the enterprises' trends in new industrialized countries says that: "…developing countries obtain industrial technologies mainly from the industrialized world, and their main technological problem, at least initially, is to master, adapt, and improve on the imported knowledge and equipment" (LALL in: KIM and NELSON, 2000, p. 15). This adaptation process of new technologies allowed to Sadia a pioneer advance over its competitors, imitated by other firms just right away.

Analyzing the efficiency and the data from this new experience, other farmers followed the example and, at the same year of 1961, the firm produced more than 90 thousand chickens (TEIXEIRA, 1994).

What happened with the second largest enterprise of the sector was very similar. The Perdigão's chicken production in 1960 was based on the effort of two women who used to process manually approximately 120 chickens per week (TASSARA e SCAPIN, 1996, p. 65). In the same year, Perdigão sent an employee to the USA to study in an aviculture specialization course. As a consequence of the advances brought by the employee, the daily production went up to 500 chickens in 1962. The chickens were frozen, transported and sold in São Paulo. After little more than five years, Perdigão invested in a small semi-automatic machine which contributed to reach a production of 1500 chickens per day[20].

[20] To have an idea of the difference in slaughter volume, in the largest slaughter house in Brazil, located in Toledo – PR, which belongs to Sadia, in 1999 there were 360.000 chickens slaughtered per day (interview with a Sadia's director, in Curitiba in 28 of March of 1999). This amount was not larger than the one from the slaughter house of Dois Vizinhos – PR, also belonging to Sadia, which amount was around 650.000 of chickens per day starting in 2007 (Interview 3).

To give support to this new system of production, it was necessary to put in practice a set of new actions that allowed the transition between the use of different technologies and the labor processes, as says Dosi (2000, pp. 116-7):

> "Very broad interpretative questions which are well beyond the domain of the economic discipline concern the relationship between new technologies and labor processes; the cultural and social structures which favor or hinder the introduction and diffusion of new technologies; the scientific and educational context within which innovation and innovation diffusion take place".

In order to 'introduce and disseminate these new technologies' among raw material producers, the firms needed to review their structure. Sadia organized its Assistance Department, responsible for the technical and economical coordination of the swine and chicken meat production. To perform these new functions and attend a larger number of integrated producers, the firm assembled a structure with specialized machinery and workers. In the beginning there were a small number of technical employees. Later, the firm hired a whole team who was responsible for importing, caring and assisting parent and grandparent stock breeders.

> "With a group of 87 technicians, among them 14 veterinarians, 11 agronomists, 55 agricultural technicians, 3 zootechnicians, 2 forest engineers and 2 administrative employees, Sadia was sill loyal to the objectives defined in its creation, 20 years ago, which were to generate and transfer technology to the producers and integrators who raise swine and poultry and also to the subsistence agriculture and reforestation activities[21]".

More recently, the Executive Board of Sadia is consisting of 23 members, and one of them is responsible for the *Agriculture Technology,* which takes care of the raw material production (chickens, swine, cattle, …). In addition to this director, the sector consists of a team of technicians who assist the poultry producers: chickens, backyard chickens, ducklings, and turkeys. Following what happened with the enterprises in the cattle meat sector that adopted the vertical integration model, first implemented by Swift in the end of the 19th Century (CHANDLER, 1989, pp. 56-60), one century later it was the turn of the other Brazilian poultry enterprises to follow the Sadia example.

The knowledge and new technologies adopted by pioneer companies in Brazil – Sadia and Perdigão – was obtained from other countries, which was important to establish the necessary adaptations to the Brazilian specificities, as we can see from the following paragraph:

> "*National technological capability* is the complex of skills, experience and effort that enables a country's enterprises to efficiently buy, use, adapt, improve and create

[21] Sadia Concórdia S.A. Annual Report, 1977.

> technologies. While the individual enterprise remains the fundamental unit of technological activity, national capability is more than a sum of individual firm capabilities. It comprises the nonmarket system of interfirm networking and linkages, ways of doing business, and the web of supporting institutions. This affects significantly how firms interact with each other and the efficacy with which they exchange the information needed to coordinate their activities and to benefit from collective learning" (LALL in: KIM and NELSON, 2000, p. 14).

As the southern enterprises were occupying other regions[22], this model started to be implemented in other regions as well and became the standard model in the Brazilian aviculture until middle of the 1990s (Table 1).

**TABLE 1 – STEPS OF THE PRODUCTION, MARKETING, AND MANAGEMENT ACTIONS IN THE VERTICAL INTEGRATION SYSTEM IN THE BRAZILIAN AVICULTURE – 1995**

| STEPS OF PRODUCTION | MANAGEMENT ACTIONS |
|---|---|
| Genetic research "grandparent breeders" | **Import** (mainly from the US and Europe), obtained out of vertical integration |
| Breeders | **Enterprise**. Importing eggs, enterprises produce their own breeders. First step in the vertical integration process of the main national enterprises |
| Hatchery (One-day chick production) | **Enterprise**. Vertical integration in the main enterprises (occasional purchases from outsourced producers to complement their own production). Many medium to small size enterprises purchasing from third part producers, mainly in São Paulo and Minas Gerais |
| Ration Production | **Enterprise**. Vertical integration. Many large companies produce all ration used to their integrators (they occasionally sell it to outsourced companies). In São Paulo there exist many enterprises that are out of the vertical integration system, which are specialized in ration production and sell it to "independent producers" and "backyard producers" as well |
| Vaccines and treatments | Acquired by firms out of the vertical integration system. The one-day chicks came vaccinated from hatchery. The following treatments are made by the firms and charged from the integrators |
| Poultry growing and production | **Farmer**. Vertical integration, with third-party services, since the beginning of the industrial aviculture in the south and adopted by small integrators producers. In São Paulo and other states this step of production was carried out by large independent producers. The expansion of the south firms was an incentive to the production to be also made by small integrators producers. |
| Slaugther | **Enterprise**. Vertical integração, being carried out in the enterprise's own installations. The slaughter house is located in the 'center' of the productive chain. This is the starting point from which the vertical integration is organized, not only backward but forward |

[22] Sadia had 12 factories in the end of 1990s: in Concórdia and Chapecó (SC), Três Passos (RS), Dois Vizinhos, Francisco Beltrão, Toledo, Paranaguá and Ponta Grossa (PR), Várzea Grande (MT), São Paulo (SP), Duque de Caxias (RJ), Uberlândia (MG). In the end of 2004 Sadia acquired Só Frangos Produtos Alimentícios, in Distrito Federal. In 2007, Sadia purchased Big Foods in Tatuí – SP. With new acquisitions Sadia have 14 industrial units in Brazil. In 2007, a new factory was launched in Kaliningrado, Russia, with the Dutch unit, became the second industrial unit abroad. (http://www.sadia.com.br/br/empresa/historico_2000.asp Access in: 23 Feb. 2007 and Annual Report, 2007). Perdigão has 37 industrial units in ten Brazilian states, producing different types of meat (poultry, swine, cattle), milk and subproducts, and other products. Perdigão has three industrial units in Europe: UK, Holland and Romania, and also a cheese factory in Argentina (Perdigão. Annual Report, 2007).

| | |
|---|---|
| Cuts and industrialization | **Enterprise**. Vertical Integration. The cuts are generally made in separate rooms from the slaughter house. The industrialized chicken meat products are often obtained in specific industries, near by the slaughter houses |
| Transportation | **Outsourcing**. In the beginning all transportation used to be made by firms. In 1995, with the exception of some specialized services, everything was outsourced, from the transportation of the one–day chicks, rations, chicken loading, transportation to the slaughter houses, until the distribution to the retailers |
| Marketing | **Enterprises and outsources**. Vertical integration. The main firms have commercial affiliates in the regions where the consumption is more important (South, Southeast, and Center-West). In North and Northeast the products are distributed by exclusive representatives, with the exception of Sadia, which keeps commercial affiliates in this regions as well |
| Market | **The main market is the domestic one**. Starting in 1975, the firms began to export whole chickens and, since 1984, started to export chicken pieces. However, the external sales represented around 13 % of the national production until 1995 |

SOURCE: Dalla Costa, 2000, p. 338.

After the second half of the 1990s, while other firms of the poultry productive chain were established in production regions, some parts of the process were outsourced, such as the transportation, one-day chicks production, breeders, and hatchery. Consequently, the agricultural industries concentrated their activities in their core business, keeping their strategic steps, such as ration production unit, slaughter houses, meat and subproducts industrialization, and part of the commercialization. There are two exceptions in the vertical integration, which were never performed by the agricultural industries. The first one is the genetic development (it requires high investments and technology, which is made by multinational companies). The second exception is the poultry growing and fattening (high investments, high demand for labor, low aggregate value, made by the integrators).

## 2 THE IMPACTS OF INNOVATIONS AND TECHNOLOGICAL TRANSFORMATIONS

### 2.1 Technological transition and aviculture industry

The three main transformations occurred in the Brazilian aviculture since the 1960s were in the poultry genetics, feeding (the use of balanced rations) and in the growing process, which started to be made in automated poultry houses with temperature control (DALLA COSTA, 2007).

The combination of these three factors with the technological innovations and with the labor organization introduced in the slaughter houses, which implemented the scale production techniques – first introduced by other sectors such as industrial and

automobile - (TAYLOR, 1957; FORD, 1925; OHNO, 1997), was responsible for very important advances in production, productivity, and fall in retail prices, as we can see in Table 1.

TABLE 1 – THE EVOLUTION OF THE PRODUCTION PROCESS IN THE BRAZILIAN AVICULTURE INDUSTRY, ACCORDING TO WEIGHT, CONVERSION RATE, SLAUGHTER AGE, AND PRICE: 1970 – 2007.

| Years | Weight (in kg) | Conversion Rate (kg ration/kg meat) | Slaughter Age (in days) | Average Price (in US$/kg) |
|---|---|---|---|---|
| 1930 | 1,50 | 3,50 | 105 | - |
| 1950 | 1,80 | 2,50 | 70 | - |
| 1970 | 1,70 | 2,00 | 49 | 4,05 |
| 1989 | 1,94 | 1,96 | 45 | 2,32 |
| 2001 | 2,24 | 1,78 | 41 | 1,00 |
| 2007 | 2,27 | 1,73 | 39 | 1,00 |

SOURCE: CONAB / DIGEM / GEAME apud IPARDES, 2002; LEDUR and SCHMIDT, 2005 and survey data. Note: Organized and adapted by the authors.

According to the firms involved in this transformation, we can distinguish three groups: leader, imitator, small and medium firms[23]. The leader firms are Sadia and Perdigão, which are the leader firms in the domestic and international markets, innovative in products, processes, R&D, and these firms have the larger capacity to invest, as we can see in Table 2.

TABLE 2 – SADIA AND PERDIGÃO – MAIN INDICATORS – 2003-2007

| Year | Domestic Market Sales (in %) | International Market Sales (in %) | Gross Sales (R$ millions) | Net Profits (R$ millions) | Employees in Brazil | Investments (R$ millions) | Productivity per Worker (tonnes/year) | Firm Units Abroad |
|---|---|---|---|---|---|---|---|---|
| **Sadia** | | | | | | | | |
| 2003 | 55 | 45 | 5,855 | 447 | 34.400 | 110 | 48,3 | - |
| 2004 | 51 | 49 | 7,317 | 439 | 40.600 | 246 | 51,0 | - |
| 2005 | 51 | 49 | 8,328 | 657 | 45.380 | 686 | 51,4 | - |
| 2006 | 56 | 44 | 7,940 | 377 | 47.630 | 1,056 | 48,4 | 1 |
| 2007 | 54 | 46 | 9,844 | 689 | 52.422 | 1,085 | 47,9 | 2 |
| **Perdigão** | | | | | | | | |
| 2003 | 58 | 42 | 4,371 | 124 | 27.951 | 69 | 36,1 | - |
| 2004 | 51 | 49 | 5,567 | 296 | 31.406 | 110 | 36,3 | - |
| 2005 | 52 | 48 | 5,873 | 361 | 35.556 | 280 | 36,1 | - |
| 2006 | 59 | 41 | 6,106 | 117 | 39.048 | 637 | 39,7 | - |
| 2007 | 54 | 46 | 7,789 | 321 | 44.752 | 857 | 41,4 | 4 |

SOURCE: Table constructed by the authors from Sadia and Perdigão – Annual Reports, 2007.

[23] For a detailed analysis about the differences among the leader, imitator, and small firms, see Dalla Costa, 2000, pp. 339-347.

Sadia and Perdigão represent more than one fourth of the national production, in a market that the ten largest firms are responsible for half of this production, as showed in Table 3. It is important to stress that small firms, generally focused on production towards local, regional and state markets, are responsible for the half of the total production. Exports are due to approximately 30 firms, which the three main exports are responsible 56,21 % of the total (Sadia 25,87%, Perdigão 18,28% and Seara 12,06%)[24].

TABLE 3 - THE 10 LARGEST POULTRY SLAUGHTER FIRMS IN BRAZIL – 2006

| | **Firm/State** | **Slaughter (in thousand chickens)** | **% Total** |
|---|---|---|---|
| 1 | Sadia SC-PR-MG-MT-RS-DF | 645.452 | 14,68 |
| 2 | Perdigão SC-RS-PR-GO-MT | 530.111 | 12,06 |
| | **Sub-Total** | **1.175.563** | **26,74** |
| 3 | Seara SC-PR-SP-MS | 257.490 | 5,86 |
| 4 | Frangosul RS-MS | 214.471 | 4,88 |
| 5 | Avipal RS-MS-BA | 174.229 | 3,96 |
| 6 | Dagranja PR-MG | 114.665 | 2,61 |
| 7 | Aurora SC-RS | 108.743 | 2,47 |
| 8 | Diplomata PR-RS-SC | 87.636 | 1,99 |
| 9 | Penabranca SP | 75.173 | 1,71 |
| 10 | Copacol PR | 70.089 | 1,59 |
| | **Sub-Total** | **2.278.059** | **51,8** |
| | Others | 2.118.254 | 49,2 |
| | **TOTAL** | **4.396.313** | **100,00** |

SOURCE: UBA – Annual Report 2006/2007, p. 45.

The market for machinery and equipments supplied for the poultry sector is an open market, in which there is competition among domestic and international firms.

Next, we will investigate the main technology transformations in each step of the productive chain that allowed the main transformations in the chicken meat industry seen in this first section.

[24] Annual Report of the Brazilian Aviculture Union, 2006/2007, p. 56.

## 2.2 The new technologies in the productive chain

### Genetic research, "parent and grandparent" production and the first national lineage

The Brazilian companies are still importing most of the "parent and grandparent" [25] chicken breeders used in the Brazilian aviculture. However, there is a lot of research being done not only by public institutions, but also by private enterprises. The most important public research institution is Centro Nacional de Pesquisa de Suínos e Aves – CNPSA. In 1985, with the purchase of the Granja Guanabara by the Agricutural Ministry, this became a unit of EMBRAPA, and the genetic materials developed by that company became available and were incorporated to the CNPSA research[26], among them there were two white egg lineages, three red egg lineages, and two chicken meat lineages.

Public universities also do applied research and prepare new professionals in aviculture, in many different areas, mains through masters and doctorate programs. For instance, in the first symposium about evaluation of science and technology program in animal production, in September 1989 in Belo Horizonte – MG, it was possible have an idea of the number of institutions involved in poultry research in Brazil. Among them there were EMBRAPA, ESALQ - Escola Superior Luiz de Queiroz from Piracicaba-SP, with their chicken meat lineages; the Universidade Federal de Viçosa-MG that research chicken meat and eggs production; the Universidade Federal de Santa Maria-RS, with their research results about egg production and the Instituto de Zootecnia of São Paulo, which also research eggs production. In addition to produce new lineages of chicken meat and egg production, the universities aim to train specialized labor, mainly engineers on different fields and new researchers through master and doctorate programs.

The main research results produced by EMBRAPA - CNPSA (swine and poultry unit) were in the genetics, with the launch of two chicken lineages in 1996, of which one is special to produce meat as chicken whole and the other to produce chicken meat as cuts. However, the possibility to increase the market share with these two lineages is

[25] "Parent and grandparent" – terminology used to imported eggs by national firms and that contain the *state-of-art* technology in genetic research. These chickens produce the eggs that will generate breeders, which will produce the one-day chicks to be sent to the integrators.

[26] For more information about the genetic research in Brazil see "Linhagens avícolas brasileiras", by Gilberto Silber Schmidt and Valdir Silveira de Ávila, Embrapa-Cnpsa researchers, in: Sociedade Brasileira de Zootecnia (1990), *Avicultura*, FEALQ, Piracicaba, São Paulo, p. 31-36.

very unlikely, because of the lack of a competitive marketing service and a post-sales assistance service. According to information from Embrapa Promotion Service[27], they do have potential to reach one percent of the market, mainly with a possible partnership with cooperatives in the poultry sector. Nowadays, CNPSA has the technology, but their two lineages are adopted for few chicken growers, and their production is not associated to the larger companies in the industrial poultry sector (INTERVIEW 4). CNPSA has 41 technicians, doctors and master professionals in many different fields of the aviculture (www.cnpsa.embrapa.br).

This knowledge was developed by public and private institutions, following model analyzed by Pack:

> "The success of some countries after the World War II has been due to their ability to tap the existing backlog of technology and to efficiently absorb it. Most of this success was attributable to firm-level efforts, abetted by a well-educated labor force. Little, if anything, was due to government-sponsored technology institutions" (PACK, in: KIM and NELSON, 2000, p. 91).

Among the private institutions, Sadia started applied research in the decade of 1970s through Sadia Agropastoril Ltda[28], in Faxinal dos Guedes – SC, aiming to "adapt the imported lineages to the local conditions, test different rations, and disease resistance" (DALLA COSTA, 2000, p. 218). When Sadia started to diversify its activities and began the industrial slaughter turkey production, the firm did a *joint-venture* with Canadian Hybrid. The main goal was to produce a more adapted turkey breed to the production conditions seen in the west of Santa Catarina. After this, the group started to dominate the turkey's genetic research and this allowed Sadia to produce breeders to supply its own integrated system, and sell to the domestic market and to other Latin American countries (TEIXEIRA, 1994).

---

[27] Interview with the Embrapa's Director of the Publicity Service, Concórdia-SC, 21 of March 2006 (DALLA COSTA, 2000, p. 211).

[28] Sadia Agropastoril was created in the 1970s with the objective of doing applied research in the adaptation of lineages of chickens, turkeys, and ducks to the local production conditions, taking into account the temperate weather in the South. They also researched swine, which resulted in the *Hiper Sadia*, a hybrid swine SPF – Specific Pathogen Free, as a result of matting different breeds, without importing breeders. According to Mior (1992, pp. 306-316) "in 1987 Agropastoril had seven veterinarian, two agronomists, two zootechnicians, and 15 agricultural technicians. They have the support from CNPSA, which was developing the same research program in a smaller scale". Other experiences were made with grains: corn and soybean. The last experience was in the cattle sector, when Agropastoril got the first results, in July 1991, of embryos transfers (Revista *Integração*. Órgão interno da Fundação Attilio Fontana, São Paulo, year 15, n. 129, Mar/Apr 1993, p. 9).

The experiences developed by national companies in terms of research, adaptation, and generation of new technologies were complementary to the foreign technologies, as we can see below:

> "Technology import is not, however, a substitute for indigenous capability development; the efficacy with which imported technologies are used depends on local efforts. Domestic technological effort and technology import are largely complementary. However, not all modes of technology import are equally conducive to indigenous learning" (LALL in: KIM and NELSON, 2000, p. 20).

Beyond those activities cited before, the Sadia's R&D area is responsible for new products and quality improvements of its retail products. The main focus is the development of industrial final goods. One example is the *Hot Pocket*, which was very well accepted by the consumers. "This area searches for innovations and better industrial processes, aiming to reduce production costs. It also gets support from universities and a financial support institution, Financiadora de Estudos e Projetos – Finep" (Sadia. Annual Report, 2007, p. 15).

The research-learning-adaptation of technologies and innovations in products is part of a knowledge process that is a result of many international experiences, as Lall mentions when referring to Asia, but also valid to Brazil and Latin American countries. "Though Asian countries are highly dependent on technologies imported from the mature industrial countries, they undertake significant technological activity to absorb complex technologies adapt and improve upon imported knowledge and, increasingly, create new technologies" (LALL in: KIM and NELSON, 2000, p. 46).

Trying to compete with Sadia's turkey, Perdigão launched *Chester*[29] after having imported a "technological package" from the USA, since the R&D to produce its own product would be more expensive and more time demanding. In general, in the middle of the 1990s, the companies administrators used to think that the market was too small, and the investments were too high to justify the development of own new genetic lineages. "The imports of 'parent and grandparent' chickens in 1994 was less than US$ 20 millions, while the chicken meat exports reached US$ 588 millions. So the value of the imports is relatively smaller for firms that invest in genetic research" [30]. Similar

[29] *Chester* is a chicken developed genetically to concentrate its meat production in the chest and thighs. It is a larger bird, which is slaughtered around 80 days, to compete with turkey. In Brazil, after Sadia entered the market with its turkey, Perdigão was the first to launch a type of chicken to compete with Sadia's turkey in the end of the year's festivities, mother's day, easter… The other firms followed Perdigão example, even Sadia did that when it launched *Fiesta* to increase market share.

[30] Interview with the president of the Brazilian Aviculture Union (União Brasileira de Avicultura) and director of Frangosul. Montenegro-RS, 27 of Abril 1995 (DALLA COSTA, 2000, p. 212).

position was used by another firm director, in September 2008: "… the costs are too high and the expenses with imports are small, which does not justify R&D of new lineages by the firm" (INTERVIEW 5).

**Breeders and chicks production**

When the industrialization of production began, there were two different experiences. In the Southeast there was an increase of chicks' production firms, while in the South companies installed their own hatchery houses. Sadia had continued to implement its breeder and hatchery houses, which get started in Concórdia in the 1950s when they built "Granja Santa Luzia" (FONTANA, 1980) to test the poultry production with New Hampshire chickens. After that, the industrialization continued when "Sadia expanded the hatchery houses, increased the one–day chicks' production and strengthen its agricultural department" (TEIXEIRA, 1994, p. 47).

Sadia increased substantially its production capacity when started to build new industrial units and slaughter houses: Chapecó-SC for chickens and turkeys (1973); chickens in the units of Américo Brasiliense-SP (1979); Toledo-PR (1979); Dois Vizinhos-PR (1981); Francisco Beltrão-PR (1991); Várzea Grande-MT (1992); Uberlândia-MG (2000); Brasília (2004).

The other large southern companies followed Sadia's model, and they also built their own breeder and hatchery houses close to the slaughter houses. In the Southeast there was an increase of three companies in order to supply the prominent regional market. The first was Granja Rezende from Uberlândia – MG, which has almost 50% of the breeders market. Its closer competitor is Agroceres from Rio Claro-SP, in a partnership with Ross Breeders, which increased from 7 to 35% of the market between 1990 and 1995. The last one is Granja Planalto, which is also from Uberlândia, in a partnership with the American Avian Farms, "it has the expectation of reaching 5 to 6% of the breeders market until the end of 1995"[31].

Today there are many independent companies, such as Globoaves (Cascavel – PR) that produce chicks and sell them to slaughter houses that did not invest in their own breeders. "Sometimes even the large integrator firms buy part of the chicks delivered to the associated integrators, in order to complement its own production" (INTERVIEW 4).

[31] "Disputa de gente grande", in: Revista *Avicultura e Suinocultura Industrial*, São Paulo: Gessulli, March 1995, p. 43-44.

**Medical and animal drugs industry**

According to SIDAN – Sindicato Nacional de Indústrias de Defensivos Animais, the sector increased its sales from US$ 293 millions in 1986 to US$ 750 millions in 1995. "We are already the third market in the world for medical and animal drugs , behind the USA and France" [32].

The poultry sector was responsible for 15 % of the animal drug market and the competition among large firms happens with the assistance services associated when vaccines and drugs are supplied. All companies are multinational in this sector with affiliates in Brazil[33]. The larger one in 1994 was Tortuga, with a market share of 15 %. The ten largest companies had 70,4 % of the market. According to SIDAN, in 1994, there were a total of 43 companies in this sector.

The main poultry firms make supplying contracts with the above companies. Vaccines are administrated while the chicks are still in the hatchery houses, before they are transported to the integrators' growing houses. The other treatments and drugs are distributed to the integrators by technicians who supervise the production. In the Southeast, and where there is no integration, firms sell those drugs and treatments directly to the independent producers, breeders, and hatchery houses, and the treatment monitoring is performed by the technical assistance supplied by the selling medical companies.

**Rations production**

Just like happened with the breeders and hatchery sectors, when the firms implemented their new slaughter houses they also built a ration factory near by just to supply the integrators. Sadia initiated its rations factory back in 1954 in order to face its swine integrators demand. Sadia expanded the rations factories built with the expansion of the poultry production.

In addition to the production volume that allowed reaching a scale economy, another point of interest is the use of new technologies. Since 1976, not only the quantitative importance of supplying ration in an ideal and enough proportion would be

[32] Declaration of the President of Sidan, published in the Magazine *Avicultura Industrial*. São Paulo: Gessulli, year 85, n. 1028, December 1995, p. 28.

[33] In 1994, the ten largest firms of the sector were: Tortuga, MSD, Pfizer, Rhodia, Mallinkrodt, Sarsa, Bayer, Ciba-Geisy, Cyanamid and Vallée (Magazine *Avicultura Industrial*. São Paulo: Gessulli, year 85, n. 1028, December 1995, p. 29).

able to expand the chicken production, but also "the quality of the product has its importance and it is obtained through electronic computation, which allows one to formulate more economical balanced rations to the chicken growers with better nutritional outcomes" [34].

The main reasons alleged by a firm to produce its own rations are very similar among them (DALLA COSTA, 2000, p. 297-9). Sadia makes its own rations for three reasons. "First, it is because we produce and consume large amounts of it. In this case, we can have scale economies and our own production becomes relatively cheaper. Second, because we can easily control the rations our animals are consuming. Third, because we can formulate an ideal ration for every type of animal (swine, cattle, chickens), for every breed and every animal's life[35] stage" [36].

Similar arguments were used by one of the directors of the rations factory of the Aurora's, who said that "… we produce our own ration because its cost represents around 80 % of a chicken 'cost; because we produce the quality and formulation that is more interesting for us; because we adapt the ration to the growing stages of the chickens (pre-starter: until 12 days; starter: 13 to 22 days; growing: 23 to 35 days; finishing: 36 to 45 days); because we do not want to be at risk due to the lack of rations; because we produce everything we consume" (INTERVIEW 5).

**Poultry production: chicken, backyard chicken, special chicken, turkey**

The poultry firms basically produce four types of birds. The standard chicken, terminated at age of 25 to 45 days, depending on the market, and it is the most common type. The second type is the "backyard chicken" or "colonial chicken", special lineage bird, which production must allow the chicken the access to external areas, and the chickens need special ration and the terminated age is more than 80 days (norm MAPA). The third type is the "special chicken", with larger size, which aims to compete with the turkey, the fourth type of bird produced[37]. The last two types are

[34] Sadia. Annual Report, 1976, p. 6.
[35] There are three types of rations: starter, growing, and fattening. From the growing ration, firms use rations in pellets shape. The soybeans pellets are produced through a process in which are eliminated occasional bacteria that would be potential source of diseases in chickens, and also in the consumers, which could bring health risks to humans ("Integração avícola completa 32 anos de vida e de alta tecnologia", in: Revista *Aves e Ovos*. São Paulo: APA, August 1993, p. 9).
[36] Interview with the sector manager of the Fomento Agropecuário da Sadia. Concórdia-SC, 18 of April 1995 (DALLA COSTA, 2000, p. 217).
[37] Some firms produce "special birds".

produced for special consumption occasions such as Christmas, Easter, Mother's day and also to produce industrial subproducts.

To grow these types of birds there was not only a physical evolution of the growing houses throughout the years, but also the technologies involved. The first buildings followed the logic behind the backyard chickens growing, in which the buildings are made by wood, without technology, as it was the case of the first chicken grower of Sadia. Slowly, the primitive buildings were replaced by modern ones[38], with standard lenght of 100 meters by a width of 12 meters, with a production capacity of 15 to 22 thousand chickens, depending on the slaughter age and automated equipments.

The technologies employed went through four stages. In the beginning of the 1960s, the chickens were treated manually, through the use of primitive feeding and water equipments. The heating was made by wood, as described by Diomédio Bósio: "the work required around 7 hours per day for a family person" (Interview 2, 2007).

The second stage began in the end of the 1970s and it was characterized as the first attempt to make the tools more updated. For instance, a floor belt was implemented in the growing houses to transport ration, but water was still supplied as in the first stage. There was a reduction in the necessary time to supply ration, since before the worker used a wheelbarrow to transport and distribute ration to the chickens in a very slow pace to avoid scaring the birds. But the system was still inconvenient.

> "First, it was about the homogeneity of the ration distribution. The chickens that eat just in the beginning of the process grew faster, because they eat the main ingredients of the ration, and the chickens in the end of the process eat the leftovers, contributing to have heterogeneous flocks. Another inconvenient was that the belt used to kill small chickens when the birds head got stuck in the belt rings. Lastly, the noises caused by the belt engine contributed to scare the chickens and reduce the good expected development of the flock." (Interview 2, 2007).

To avoid these problems, tubular feeding equipment was developed, although it was manually loaded. This new system solved the problem of the homogenous distribution and chicken deaths, but it also had some disadvantages.

> "It was placed in the floor and it used to get dirty when the chickens scratched its bedding. Second, it required a good ration supply control to avoid having lack of ration, which was not good for the chickens close to the feeding equipments, since the lack of ration could stop the chickens close to these equipments to eat, reducing the growing process." (Interview 1, 2007).

---

[38] Today, the cost of building a standard growing house is around R$ 144 mil. It has Nippels' drinkers, automated feeders, nebulizer (equipment that spreads fog during the summer to reduce the heat). For safety reasons due to the "chicken flu", the growing house is surrounded by wire netting, it has an office for the technician responsible, disinfection room, manure house, and computer that controls the temperature (Interview 1, 2007).

Together with the tubular feeding equipment it was developed a tubular water drinker, better than the previous ones. However, "the dirty and heating water problems during the summer were still unresolved, which was not good for the chickens development, and required a lot of daily hours of work in order to keep the water clean and fresh. The nest[39] was wet very often, due to water leak from the water floater". (Interview 1 e 2, 2007). In the ration supply, cleaning and washing the drinkers, removing dead chickens, and nest cleaning, the integrator worked between four to five hours daily.

The most recent advances were in the fourth stage in the 1990s. There was a combined introduction of two techniques from the ration production. The tubular feeding equipments were still being used with automatic ration distribution in the feeding equipment. With this,

> "... the problem of ration waste was over, the problem of dirty and lack of ration was also over, since the lack of weight would turn the equipment on to keep the feeders full of ration. Another advantage is that the distribution of ration is more homogenous, such that there is no growth difference in the flock." (Interview 2, 2007).

The tubular drinkers were replaced by an automatic system, known as Nippel type of drinkers. In this case the water is supplied through pipes inside the growing houses. Each pipe has small "nipples" below, such that the chickens can "beak" to drink water. This way, water does not need to be supplied by the integrator; it does not get dirty, the nests do not get wet, and there is no lack of water.

In the last combination of technologies, "the integrator spend half hour per day to take care of the chickens, since his main tasks are to remove the dead chickens, control the temperature, and open and close the curtains, when necessary" (Interviews 1 e 2, 2007).

The technologies development took into account the daily work needed, producers' suggestions, and producers of new products for chicken management suggestions as well, as we can see from Teece (2000, p. 111):

> "Learning is perhaps even more important than routinization. The two concepts are obviously linked. Learning is a process by which repetition and experimentation enable tasks to be performed better and quicker and new production opportunities to be

[39] "Nest" is a kind of floor cover made by dry wood shaving, straw, rice hulls, or any other agricultural raw material, that allow the chickens to rest comfortably and absorb the chickens' wastes. After four or five flocks the nests need to be replaced and the old nests can be used as fertilizers in the grain production.

> identified (…). The organizational knowledge generated by such activity resides in new patterns of activity, in "routines", or a new logic of organization. As indicated earlier, routines are patterns of interactions that represent successful solutions to particular problems. These patterns of interaction are resident in group behavior, though certain subroutines may be resident in individual behavior".

There are many other new developments associated with the new technologies just mentioned, which were created in the beginning of 1990s. Among them are the nebulizers that combined with large ventilators can help to reduce the heating and increase the air movement. In the winter (mainly in the South) there is a combination of heating (from wood or gas burning), which is less time consuming, and the closing of curtains from the top and sidewalls to keep the heat. Totally automated houses control everything by computer, reducing the time necessary to grow chickens.

**Automated slaughter houses and scale prodcution**

In the today's slaughter houses, the scenario described in the beginning of the activity, as it was the case of Perdigão in 1960, when the production was "based on the effort of two women who used to process manually approximately 120 chickens per week" (TASSARA e SCAPIN, 1996, p. 65) is totally part of the past. The main firms implemented automatic and modern industrial systems, as we can observe in the description of the Sadia industrial unit:

> "In Concórdia, we replaced the first growing houses, more primitive and less sophisticated, by others rigorously modern and fast, which allow us to have 14.000 slaughter chickens per hour. Everything based on proportionally well built installations and large automated storage chambers, in a more economical system possible, which allow us to be in a competitive market producing chickens according to a system with the best hygiene and presentation possible" (FONTANA, 1980, p. 170).

An interesting fact about the technological modernization of the slaughter houses was in the beginning of the exports in 1975. Due to the competition with the American and European firms, the Brazilian firms were forced to update their industrial equipments, paying more attention on hygiene, producing goods more adapted to the consumers' taste, and increasing the labor productivity in order to compete at lower prices.

With respect to the machinery employed, "the majority of them were imported form Holland and the USA, and they exactly the same as the ones used by the international competitors. The use of modern automated machines and computer based weighing, which was a stronger technological change, just happened in the second half of the 1980s." (DALLA COSTA, 2000, p. 213).

The main innovations in the last years were more on the introduction of modern machineries that mechanically separate meat from bones, and high precision cutting machines (INTERVIEW 4).

**From own transportation to outsourced transportation**

Sadia and Perdigão had aviation firms to transport its perecible products from Santa Catarina's countryside to São Paulo and Rio de Janeiro. Later on, with the improvements in the Brazilian roads, these firms bought their own trucks firms to transport not only their products from their industrial units to their commercial affiliates, but also from these to the retailers.

In the middle of the 1990s, the whole transportation activity became outsourced and the poultry companies did not transport their own production anymore.

**Internal market sales**

The poultry firms do not sell directly to consumers. In order to attend the consumers' demand in the domestic market, they started to have their own commercial affiliates and exclusive representatives in most of the Brazilian states. These firms did something similar in the international market as well, with sales offices in the main importer countries.

**QUADRO 2 – STAGES OF PRODUCTION AND TECHNOLOGIES EMPLOYED IN THE BRAZILIAN AVICULTURE – 2008**

| STAGES OF PRODUCTION | TECHNOLOGY EMPLOYED |
|---|---|
| Genetic research "parent and grandparent" | International technology. Firms import eggs from Ross, Agroceres, Cobb and started to built their own hatchery houses. Embrapa (swine and chickens) has their own lineages for small chicken producers. |
| Breeders | Breeders owned by integrators. Large specialized firms produce for the integrators that do not have breeders, for independent producers, using imported technology. |
| Hatchery(one-day chicks production)) | Adapted technology from standard international imports. |
| Vaccines and treatments | Imported multinational technology. |
| Rations production | Firms import vitamins, proteins, and mineral components for rations. These were adapted according to the components available and clients' demands. |
| Poultry growing and production | Recent technologies separate the male from female chickens; provide specific food for each lineage; equipments such as ventilator, nebulizer, and automated curtains are used to improve and control temperature. |
| Slaughter | In the slaughter houses there is a mix of imported tools from Germany, Holland, Denmark, with others produced in Brazil. |
| Cuts and industrialization | In the factories of meat subproducts most of the tools employed are made in Brazil, but it is an open market. |
| | There are specific trucks to transport live chickens; ration and other products; |

| | |
|---|---|
| Transportation | meat and subproducts – cold chambers. Brazil has technology and firms that produce these trucks. |
| Marketing | The larger companies have their own structure (commercial affiliates and exclusive representatives) to supply the domestic market and commercial sales offices (some abroad) to supply the international market. |

SOURCE: Elaborated by the authors.

## CONCLUSIONS

In the last 40 years the Brazilian aviculture changed from an amateur activity and became one of the more dynamic sectors of the agribusiness. In addition to contribute to a strong increase in domestic consumption (Figure 1), Brazil became the world largest poultry exporter in 2004. This was possible thanks to an arrangement among the main agents involved: national public institutions, such as Embrapa (swine and poultry), public universities, private firms, and the government actions at federal, at state and at municipality levels. Even though this technological development in many stages of the productive chain allows Brazilian firms to compete with multinational firms, there are still some challenges to be overcome.

In many sectors the Brazilian aviculture still being dependent of multinational companies: genetics, rations components, vaccines/treatments, production equipments, chicken slaughter and processing. Embrapa (swine and chickens) developed genetic technology with new commercial chicken lineages and breeders. However, due to the fact that Embrapa is a public research institution, it does not have the goal market its discoveries and developments in a way that would allow competing with multinational companies. The poultry produced by Embrapa are employed by small chicken producers, who basically are not part of the integration system. Hence, Brazil is still dependent of the abroad technology and still imports the 'parent and grandparent' chickens.

The Vaccines/treatments is another sector that is very dependent of the multinational companies. Although Embrapa is still researching on diseases (its causes and identification), its research does not offer new, alternative and competitive products. Since Brazil is the second world largest chicken producer and the largest exporter, there is a large and attractive market to multinational companies, which could also be a good niche for national companies as well. The point here is to think in a feasible partnership between public and private institutions to produce animal drugs and vaccines taking advantage from the accumulated experience from two well known institutions: Fiocruz

and Butantan[40]. In this case, it would be possible to have a *joint-venture* between these institutions and the private companies to make possible to produce vaccines and animal drugs to all sectors involved in the poultry production chain.

Some authors, such as Ferraz, Kupfer and Haguenauer (1997, p. 353-4) investigating Brazilian firms that compete with multinational firms in the same sector, conclude that "since the technological innovation is and still will be crucial in the competition standard, even in the presence of close interrelations among international partners, the firms willing to become competitive will need to invest in development of specialized products through the use of well trained personnel with focused in some *core capabilities*, of technological nature". Sadia actually formed a research team in Faxinal dos Guedes – SC where they developed breeds of swine and turkey, and genetic research with imported chickens, adapting the chickens to the weather and food conditions of Brazil. In the case of *Chester*, Perdigão formed a R&D area originally in Videira –SC, which was transferred to Arceburgo – MG in 1992. In this research center, the technical staff was responsible for "stabilizing 11 lineages that guarantee some genetic advantages to the Chester produced by Perdigão" (GIORDANO, 1995).

The questions that can be raised about these two main Brazilian firms are about all gathered experience, theoretical and practical knowledge from its researchers, investments that were made, results obtained so far … Would not also worth develop genetic studies on chickens that is a key area for both firms? These researches could be done as a combination between the two firms and/or in a partnership with Embrapa (swine and chicken) and other public institutions as mentioned before.

As reminds us Dosi (2000, p. 147):

> "In order to assess better what one has found so far 'inside de blackbox' of technological change, it is useful to distinguish between four (albeit interrelated) objects of analysis, namely, first (the changes in) innovative *opportunities* (strictly speaking, the 'sources' of technical change pertain to this domains); secondly, the *incentives* to exploit those opportunities themselves; thirdly, the *capabilities* of the agents to achieve whatever they try to do, conditional on their perceptions of both opportunities and incentives and, fourthly, the *organizational arrangements* and *mechanisms* through which technological advances are searched for and implemented".

[40] The Instituto Soroterápico Federal – which originated Fundação Oswaldo Cruz – was created in 1900 to produce vaccines aiming to fight bubonic plague. In 1976, Fiocruz created a unit to produce vaccines that responds for a third of the vaccines consumed in Brazil. (http://www.fiocruz.br/cgi/cgilua.exe/sys/start.htm Access in: 5/9/2008). The Instituto Butantan, created in 23 of February 1901, is a biomedical research center of the Health Secretary of São Paulo, responsible for production of more than 80% of the total sorus and vaccines consumed in Brazil. (http:www.butantan.gov.br Access in: 5/9/2008).

In this case, the challenge is to make feasible for the interested agents to invest in new technologies that can generate desired products (genetic, vaccine, drugs), have incentive to look for investments, allocate available capacities and make the necessary institutional arrangements.

## REFERENCES

ABRAMOVITZ, M. "Resource and output trends in the US since 1870". *American Economic Review*, Papers and proceedings, pp. 5.23, 1976.

BITTENCOURT, M. V. L. **Formação de preços e caracterização do mercado de frango em São Paulo**. Piracicaba: ESALQ/USP, 1995. Dissertação (Mestrado em Economia Aplicada). Escola Superior de Agricultura "Luiz de Queiroz", Universidade de São Paulo.

CHANDLER Jr, Alfred D. **Stratégies et structures de l'entreprise**. Paris : Les Éditions d'Organisation, 1989.

CORIAT, Benjamin; DOSI, Giovanni. "Learning how to govern and learning how to solve problems: on the co-evolution of competences, conflicts and organizational routines", in: DOSI, Giovanni. **Innovation, organization and economic dynamics**. Massachusetts: Edward Elgar Publishing Inc, 2000, pp. 294-324.

DALLA COSTA, Armando. **A Sadia e a produção integrada**. O lugar do agricultor no complexo agroindustrial. Curitiba: UFPR, 1993. Dissertação (Mestrado em História). Faculdade de Filosofia, Letras e Ciências Humanas, Universidade Federal do Paraná.

DALLA COSTA, Armando. **L'agroindustrie brésilienne contemporaine**: innovations organizationnelles et transformations technologiques dans l'aviculture. Villeneuve d'Asq : Presses Universitaires du Septentrion, 2000, 481 p.

DALLA COSTA, Armando. "Inovação, tecnologia e produtividade do trabalho: o caso da avicultura brasileira". *Anais do V Congreso Latinoamericano de Sociologia del Trabajo*. Montevideo, Uruguai, abril de 2007.

DALLA COSTA, Armando. "Sadia e Perdigão: diferentes trajetórias administrativas nas empresas familiares". In: DALLA COSTA, Armando; FERNANDES, Adriana Sbicca; SZMRECSÁNYI, Tamás (orgs.). **Empresas, empresários e desenvolvimento econômico no Brasil**. São Paulo: Hucitec/Abphe, 2008, pp. 205-226.

DIETRICHS, Espen. **Adopting 'High-Tech' Policy in a 'Low-Tech' Industry**. The case of aquaculture. STEP GROUP - Studies in Technology, Innovation and Economic Policy. R-02, Oslo, June, 1995.

DOSI, G. et al. (eds.). **Technical change and economic theory**. London, Printer, 1988.

DOSI, Giovanni. **Innovation, organization and economic dynamics**. Massachusetts: Edward Elgar Publishing Inc, 2000.

DOSI, Giovanni; NELSON, Richard R. "An introduction to evolutionary theories in economics". *Journal of Evolutionary Economics*. Springer-Verlag, 1994, pp. 153-172.

EMBRAPA (1975-1995). **Centro Nacional de Pesquisa de Suínos e Aves**. Edição comemorativa dos 20 anos da entidade. Concórdia: Embrapa, 1995.

ENTREVISTA 1. **Entrevista** concedida aos autores por um produtor integrado da Sadia, desde o início da década de 1980. Francisco Beltrão-PR, 22 de fevereiro de 2007.

ENTREVISTA 2. **Entrevista** concedida aos autores por um técnico que trabalha na Epagri – Empresa de Pesquisa Agropecuária e Extensão Rural de Santa Catarina desde 1982. Concórdia-SC, 26 de fevereiro de 2007.
ENTREVISTA 3. **Entrevista** concedida aos autores por um produtor integrado da Sadia. Francisco Beltrão-PR, 24 de maio de 2007.
ENTREVISTA 4. **Entrevista** concedida aos autores por Dirceu João Duarte Talamini, Engenheiro Agrônomo, PhD, responsável pelo setor Sócio-Econômico na Embrapa Suínos e Aves de Concórdia-SC. Curitiba, 4 de setembro de 2008.
ENTREVISTA 5. **Entrevista** concedida aos autores por um dirigente da fábrica de rações da Aurora. Chapecó-SC, 17 de setembro de 2008.
FERRAZ, João Carlos; DUPFER, David; HAGUENAUER, Lia. **Made in Brazil**: desafios competitivos para a indústria. Rio de Janeiro: Campus, 1997.
FONTANA, Attilio. **História da minha vida**. Petrópolis : Vozes, 1980.
FORD, Henry. **Ma vie et mon oeuvre.** Paris: Payot, 1925.
FREEMAN, C. "The economics of technical change". *Cambridge Journal of Economics*, vol. 18, pp. 463-514, 1994.
FREITAS FILHO, F. et al. **O modelo institucional da pesquisa agropecuária do Ministério da Agricultura**: fundamentos e regiões. Departamento de Difusão de Tecnologia. Brasília: Embrapa, 1986.
GIORDANO, Samuel Ribeiro. Perdigão: tecnologia e reformulação dos negócios. São Paulo: USP, 1995. Texto apresentado no V Seminário Anual do PENSA. Disponível em: http://www.pensa.org.br/anexos/biblioteca... Acesso em: 5/9/2008.
KIM, Linsu; NELSON, Richard R. (eds.). **Technology, learning & innovation**. Experiences of newly industrializing economies. Cambridge: Cambridge University Press, 2000.
LALL, Sanjaia. "Technological change and industrialization in the asian newly industrializing economies: achievements and challenges". In: KIM, Linsu; NELSON, Richard R. (eds.). **Technology, learning and innovation**: experiences of newly industrializing economies. Cambridge: Cambridge University Press, 2000, pp. 13-68.
LOPES, J. **Análise econômica de contratos de integração usados no complexo agroindustrial avícola brasileiro**. Viçosa : UFV, 1992.
MALAVOLTA, Eurípedes. "As ciências agrícolas no Brasil". In: FERRI, M.G.; MONTOYAMA, S. **História das ciências no Brasil**. São Paulo: EDUSP, 1979-1981.
MIOR, Luiz Carlos. **Empresas agroalimentares, produção agrícola familiar e competitividade no complexo carnes de Santa Catarina**. Rio de Janeiro : UFRRJ, 1992.
NELSON, Richard R. (ed.). **National innovation systems**. Oxford, University Press, Oxford, New York, 1993.
NELSON, Richard R.; WINTER, S.G. **An evolutionary theory of economic change**. Harvard University Press, Cambridge, Massachusetts, 1982.
OHNO, Taiichi. **O sistema Toyota de produção**. Além da produção em larga escala. Porto Alegre: Artes Médicas, 1997.
PACK, Howard. "Research and development in the industrial development process". In: In: KIM, Linsu; NELSON, Richard R. (eds.). **Technology, learning and innovation**: experiences of newly industrializing economies. Cambridge: Cambridge University Press, 2000, pp. 69-94.
RAMOS, Soraia. "Sistemas técnicos agrícolas e meio técnico-científico-informacional no Brasil. In: SANTOS, Miltonnes; SILVEIRA, Maria Laura. **O Brasil**: Território e sociedade no início do século XXI. 7. ed. Rio de Janeiro: Record, 2005, pp. 375-387.

RIVALDO, O.F. **Estratégias para o fortalecimento do sistema brasileiro de pesquisa agropecuária**. Departamento de Difusão de Tecnologia. Brasília: Embrapa, 1986.
RIZZI, Aldair. **Mudanças tecnológicas e reestruturação da indústria agroalimentar: o caso da indústria de frangos no Brasil**. Tese de Doutorado. Campinas : Unicamp, 1993.
SANTOS, Miltonnes; SILVEIRA, Maria Laura. **O Brasil**: Território e sociedade no início do século XXI. 7. ed. Rio de Janeiro: Record, 2005.
SCHUMPETER, Joseph Alois. **Histoire de l'analyse économique**. III. L'âge scientifique: de 1870 à J. M. Keynes. Paris: Gallimard, 1983.
SCHUMPETER, Joseph Alois. **Capitalisme, socialisme et démocratie**. Paris: Payot, 1990.
SILVA, Harryson. **A gestão do território pelo grupo Sadia no município de Concórdia Santa Catarina**. Dissertação de Mestrado. Florianópolis : UFSC, 1991.
SILVEIRA PAULILO, Maria Ignês. **Produtor e agroindústria**: consensos e dissensos. O caso de Santa Catarina. Florianópolis: Co-edição Secretaria de Estado da Cultura e do Esporte e Editora da UFSC, 1990.
SOLOW, R. "Technical change and the US since 1870". *Review of Economics and Statistics*. Vol. 39, no 3, pp. 312-320, 1976.
SORJ, Bernard et. al.
TAYLOR, Frederick Winslow. **Princípios da administração científica**. São Paulo: Atlas, 1957.
TASSARA, Helena e SCAPIN, Alzira. **Perdigão uma trajetória para o futuro**. Videira: Empresa das Artes, 1996.
TEIXEIRA, Francisco M.P. **Sadia, 50 anos construindo uma história**. São Paulo: Prêmio Editorial Ltda, 1994.