Innovation in peanut productive chain in Brazil between 1996-2016

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Abstract

Innovation enables organizations to achieve increased competitiveness, through increased productivity, organization and marketing, with the possible consequence of opening new markets. The case of agro-industrial chains it's not different, in which the innovations along the chain have repercussion in the whole sector. In this way, this article aims to analyze the contributions of innovation in the groundnut production chain between 1996 and 2016, which went from culture with an import profile in the late 1990's to the export profile in the 2000's. It was used a qualitative approach and a descriptive research based on bibliographic research in databases, such as FAOSTAT and CONAB. Through the research it was possible to verify that the technological, marketing and organizational innovations were of great contribution to the recovery of the groundnut culture.

Keywords: Innovation, groundnut, production, productivity

1. Introduction

The peanut (*Arachis hipogaea* L) is a legume that has its origin in South America, in the region between latitudes 10 ° and 30 ° south. Because of its short-cycle crop, wide adaptability (to temperature, water and soil conditions) and because it is cultivated in several tropical regions of the world, it has great economic importance, being highlighted in the world agricultural scenario [1][2]. Peanut production in Brazil has undergone strong oscillation over the decades. In the 1960s, the country was one of the largest producers in the world, while between the 1970s and 1990s, the crop declined sharply, forcing the country to become an importer of the legume. The organizations involved in the peanut productive chain has taken several

actions that have led to improved competitiveness. In 2014 Brazil became the 18th largest peanut producer in the world [3].

In the 1960s, the states of São Paulo and Paraná stood were the main regions to supply peanut oil to the domestic market and peanut bran to foreign market. However, the expansion of soybean crop in the 1970s and 1980s, which dominated the production of oils and by-products in order to supply international demand for proteins, specially destined to animal feed, and the low profitability of the peanut crop, besides the technological lag (mainly in the harvesting process), has contributed to the supply of a low quality product. Between 1977 and 1988, the lack of standards for the control of aflatoxin, a mycotoxin with a high carcinogenic power produced by the fungus Aspergillus flavus, reduced the frequency of transactions with importing countries, leading to a reduction in the competitiveness of Brazilian peanut bran in the international market [4][5][1][6][7][8].

There was a sharp decline in peanut grain purchases by the processing industry in the 1990s. The market opportunity for fresh peanut grain was the candy industry. However, that is a sector with more strict patterns and standards for quality and food safety. The new market demand has implicated in chances in the productive chain, such as new cultivars, management techniques, harvesting and post-harvesting [4][9]. During the 1990s the country had an import profile, reaching 7,342 tons in 1996 and exporting only 332 tons in the same year [10].

Starting in the 2000s, the Brazilian Association of the Chocolate, Cocoa, Peanut, Bullet and Derivatives Industry (ABICAB by its acronym in Portuguese) created the Pró-Amendoim label, with the intention to coordinate actions in the sector. The label has contribute to the creation and adoption of safety standards for human consumption, acting in the control and detection of aflatoxin, aiming at stimulating the productive chain to produce grains in accordance with the established limits of aflatoxin concentration. The companies invested in improving the quality of peanuts produced in Brazil, implementing Good Manufacturing Practices (GMP), Hazard Analysis and Critical Control Points (HACCP) and laboratory monitoring of industrialized products[1][11].

In this period, the improvement in the performance of the crop was evident taking into account the exports. From 2001 the country reversed the balance of exports / imports, registering in that year, 51 imported tons and 5,501 tons exported, remaining positive since then[10][12].

In view of such oscillations regarding crop performance and practices in order to reestablish peanut as a relevant crop in Brazil, the objective of this work was to analyze the types of innovation introduced in the peanut production chain that contributed to the recovery of culture from the late 1990s and early 2000s.

This article has been structured in five parts, including this introduction. In the second part, the methodology used for the elaboration of this work is discussed. The third part brings concepts about innovation and application of such strategies in the peanut production chain. The fourth part shows the results and the fifth part covers the final considerations.

2. Method

To meet the proposed objective this research used a qualitative approach. With regard to the objective, the research has a descriptive character and uses as a procedure a bibliographic research.

The qualitative approach is a method of scientific investigation that seeks to respond broad questions, which are clarified as the study develops [13]. The interest lies in unraveling the events that culminate in a certain outcome, that is, the interest is not only in the results, but how they were reached. The qualitative approach is based on a series of techniques in order to describe, decode and translate the understanding of the occurrence of a particular phenomenon, among the techniques is the descriptive research [14].

Descriptive research objectives to describe the characteristics of a given population or phenomenon or establish relations between variables. One of its most significant characteristics is the use of standard techniques of data collection, being one of the instruments that allow the researcher to describe the characteristics studied. In this research, the data collection has adopted two research instruments: bibliographic research and documentary research [15].

Bibliographical research was based on theoretical references published in books, scientific articles, thesis and dissertations. The content of these documents allows for the researcher to obtain data that will be explored in the course of the development of their research [16][17].

Documentary research uses diverse sources, such as scientific tables, official documents, reports, magazines, among others [16].

In order to meet the research objectives, a theoretical reference related to the theme of innovation and to the peanut productive chain, was developed from scientific articles available in Capes, Scielo and Google Academic Periodic databases. Production, productivity and cultivation data were accessed from the FAOSTAT databases, maintained by the Food and Agriculture Organization of the United Nations (FAO) and the National Supply Company (CONAB by its acronym in Portuguese). FAOSTAT allows for data of exports / imports in the analyzed period, while CONAB offers an overview of peanut production in Brazil. The data collected comprised the 1990s and 2000s, a period that included the decline of peanut cultivation (1990s) and its recovery (2000s), when the country ceased to be an importer and became an exporter.

The year 1996 was chosen for the beginning of the analysis, since the first cultivar (IAC Caiapó) was launched that year. The cultivar has aimed to improve the performance of the peanut crop. It allowed for increases in production and productivity in the period, as well as the gradual increase in exports

3. Theoretical approach

The Organisation for Economic Co-operation and Development (OECD) defines innovationas the implementation of a new or significantly improved product (good or service), or a process, or a new marketing method, or a new organizational method in business practices, workplace organization or external relations [18].

Pigatto and Barcellos [19] argue that, throughout the decade of 2000, the concept of innovation has become broader than the innovations of product and process. Marketing innovation and organizational innovation have also been incorporated into the notion of innovation.

Four types of innovation have been identified: product, process, marketing, and organizational innovations. Product innovation is the introduction of a new or significantly improved good or service, using new knowledge or technologies or relying on existing technologies. Process innovation encompasses the implementation of a new or significantly new production or distribution method, based on techniques,

equipment or software. Marketing innovation refers to the implementation of a new marketing method, including changes in the packaging of the product and the positioning of the product in the shelves of the points of sale. Finally, organizational innovation refers to the incorporation of a new organizational method in the practices of a company, in the work environment or in external relations [18].

The meaning given by Schumpeter [20] to the development of innovation can be defined by new combinations, not necessarily linked to product and process. This concept addresses: (i) introduction of a new product, to which consumers are not yet familiar or with a new quality standard; (ii) introduction of a new production method, not yet experienced by the processing industry; (iii) access to a new market, not yet operated buy the firm; (iv) use of a new source of raw materials or semi manufactured goods, regardless of whether this source already exists or needs to be created; and (v) establishment of a new organization in any industry.

The competition theory proposed by Schumpeter has as main characteristic the functioning of the capitalist economy under a dynamic and evolutionary vision, based on an uninterrupted process of introduction and diffusion of innovations in a broad sense, which can be either changes in the products, in the productive processes, in the sources of raw materials, in the forms of productive organization, or in the markets themselves, even in geographical terms. In this sense, innovation is understood as a result of the constant search for extraordinary profits, by obtaining competitive advantages between agents (companies) [21].

In this sense, it is necessary to distinguish radical innovations from incremental innovations. According to OECD [22], radical innovations can be defined as those that have a significant impact on a market and the economic activity of companies, being a concept focused on the impact of innovations that can, for example, change the market structure, create new markets, or even render obsolete existing products. On the other hand, incremental innovations are characteristic of low and medium technology industries, usually focused on marketing, product differentiation and production efficiency.

When investing in technological transformation a firm may access advantages from being the first to develop innovation. While being imitated, the innovator's pioneering approach may result in several potential advantages which will remain after the end of his technological leadership. However, the attractiveness of the implantation of a technological innovation increases with the difficulty of the competition in imitating it [23][24].

Tidd, Bessant and Pavitt [25] emphasize that innovation is a matter of knowledge, creating new possibilities by combining different sets of knowledge. Such knowledge may derive from experience, based on something already seen or experienced, or may result from a search process (by technologies, markets, competition actions, etc.). Knowledge can also be explicable in its form, encoded so that others can access it, discuss it, or transfer it. Or it may exist tacitly, that is, known, but without formulation.

The evolutionary path of Schumpeterian thought can be: (i) the dynamics of economic development understood as the development of new combinations (introduction and improvement of new products and processes, organizational changes and new ways of accessing the market); (ii) the phenomenon of creative destruction driven by entrepreneurs who introduce these combinations in conditions of disequilibrium; and (iii) the process of competition and market structure in which this phenomenon occurs. The emphasis given by this approach to the concept of innovations in a broad sense reflects the idea that it is not only a question

of emphasizing technological change, but any change in the economic space promoted by companies that seek advantages and consequent competitive gains [21][26].

An innovation strategy can have repercussions not only on the firm's activities, but also on the whole sector, that is, a technological innovation, can have repercussion on the dynamics of operation of the whole agroindustrial system. Observing these potential repercussions proves to be an important source of information on the direct and indirect gains from the implementation of innovation and when linked to products, processes or services, is the key to obtaining and maintaining its competitiveness [27][24].

Santos et al.[28] pointed out that, unlike the other sectors of the national industry, agribusiness stands out as one of the main sectors in the global market, in relation to the competitiveness of the production based on technological knowledge, being technological innovation the main factor for the performance of the sector.

Pigatto and Barcellos[19] added that the way innovation is used by farmers and the context of values and norms are of great importance to analyze innovations throughout the value chain, highlighting the need for an efficient flow of information among all the links in a chain, which can result in better chain productivity.

Gianezini et al.[29] state that the theme of innovation and the actions of the various stakeholders have been driven by economic concerns, marketing, demand pressures and investment; and recently for the demand for foods that promote some kind of health benefit.

Agriculture has characteristics which affect its dynamics and, consequently, the occurrence of technological trajectories. Initially, the technical bases of production depend largely on the natural conditions (transport routines, distance to the consumer center and specific cultivation with the use of a technology) that affect the technological trends. The different natural conditions can be compensated by innovations, although they can not be totally eliminated. In agriculture, the degree of technological appropriability is also very low, which implies a lack of attractiveness to research and development and other innovative efforts. In the agricultural sector, the need to increase production and productivity is latent, which consequently requires research and development [19][30].

In this context and in the face of a unfavorable scenario to peanut crop, the introduction of innovations at all links in the chain were of very important for crop recovery. In the following item some forms of innovation in the peanut production chain are verified.

4. Forms of innovation in the peanut production chain

In the 1960s, Brazil was one of the world's leading producers of peanuts, mainly in the production of oil to supply the domestic market. Subsequently, this market was replaced by soybeans, which became the country's main oilseed. The agricultural expansion to the Center-West, an agricultural frontier, due to the available technology and mechanisms of incentives through public policy such as rural credit, allowed for the development of commodities supply chains as of soybeans [31].

The peanut crop was losing its importance in Brazil as a result of the shift of landuse of peanuts by soybean, added to factors that involve the low quality of the peanuts harvested in the country.

Only in the late 1990s the main actors involved in the peanut agroindustrial system realized the need for urgent system-wide changes so that the chain regained its lost competitiveness. The changes occurred

through new techniques of cultivation, primary processing, storage, secondary processing and commercialization of this product in order to increase its profitability and quality [32].

Table 1 shows the increase in national peanut production and productivity, based on data from FAOSTAT[33], with increases of approximately 124% in production and 59% in productivity, demonstrating the growth of the crop in relation to these two variables over the last 15 years (between 1999 and 2014).

Table 1: Brazilian peanut production and productivity between 1999 and 2014.

Year	Production (thousand t)	Productivity (t/ha)
1999	179,421	1,772
2014	402,626	2,816

Source: prepared by the authors based on FAOSTAT[3][33].

Regarding production, technological innovations played a major role. In this phase, the demand for cultivars that better served the requirements of the candy industry became the great challenge, as well as the adoption of other technologies that could guarantee the quality of peanuts, such as new techniques of handling, harvesting and post-harvesting. Research led to the cultivars IAC Caiapó, IAC Tatu-ST and IAC Runner 886, the most cultivated in the State of São Paulo [9].

Martins [9] and Vicente and Sampaio [34] highlighted that the cultivar IAC Caiapó was launched in 1996, while the cultivar IAC Tatu-ST was officially launched in 2000 and the cultivar IAC Runner 886 was launched in 2002. In the period from 1998 to 2005, when the new technologies were being introduced, the instability of the area and production variables was remarkable; there were no significant changes in productivity, demonstrating that the effect of technological variations was not immediate. There was also an increase in production between the years 2000 and 2001, since at that time, 53% of the area was cultivated with the new varieties, representing an increase of 9.81% in production. Between 2011 and 2016, peanut production in the state of São Paulo increased by 111%, from 178.9 thousand tons in 2011 to 377.5 thousand tons in 2016. During this period, the area planted was increased by 88%, from 57.3 thousand hectares in 2011, to 102.8 thousand hectares in 2016. Table 2 shows the data of planted area and production between 1996 and 2016 in the state of São Paulo.

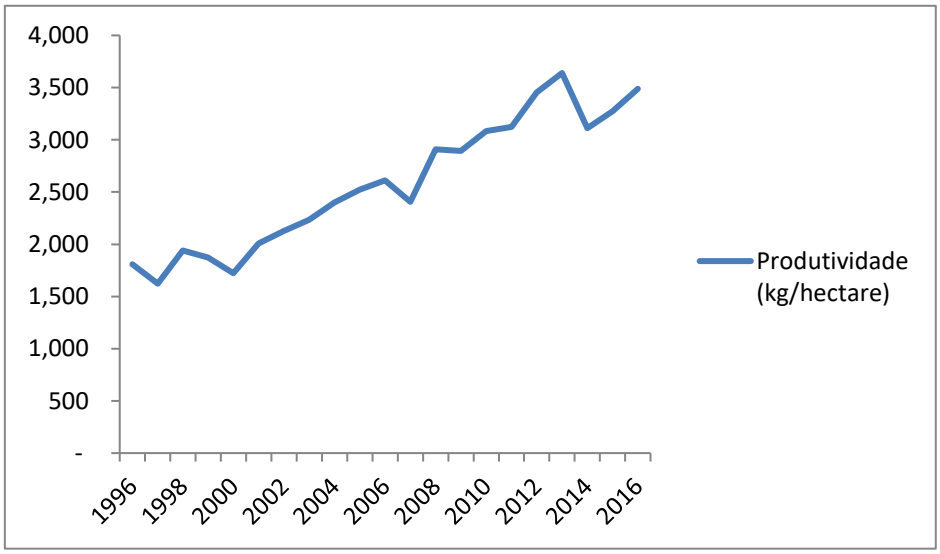
Productivity in the state of São Paulo between 1996 and 2016 was marked by instability. The period between 1996 and 2000 presented numbers ranging from 1,808 kg/ha in 1996 to 1,722 kg / ha in the year 2000 (decrease of 4.7%). It should be observed that the first new cultivar (IAC Caiapó) was introduced in 1996 in the state of São Paulo. However, its adoption has reflected in increasing productivity from 2001 on. From 2001 to 2006, productivity has increased, reaching its apex in 2006, with 2,611 kg/ha, representing an increase of approximately 44% when compared to 1996). The next period, from 2007 to 2016 has presented some instability but the increase in productivity was remarkable, over 300% (Figure 1).

Table 2: Area and production between 1996 and 2016 in the state of São Paulo

Year	Area (thousand hectares)	Production (thousand tons)
1996	62,5	120,2
1997	72,5	117,8
1998	85,1	165,1
1999	81,9	153,4
2000	87,0	149,8
2001	81,9	164,5
2002	74,0	157,4
2003	65,5	146,4
2004	73,2	175,7
2005	89,6	226,1
2006	79,6	207,8
2007	72,0	173,4
2008	81,3	236,4
2009	80,9	234,1
2010	55,3	170,5
2011	57,3	178,9
2012	75,9	262,3
2013	80,5	293,0
2014	92,2	286,8
2015	95,1	311,5
2016	108,2	377,5

Source: prepared by the authors based on CONAB [35].

Figure 1: Productivity (kg/ha) in the state of São Paulo between 1996 and 2016



Source: prepared by the authors based on CONAB [35].

Although the relation between production, cultivated area and productivity increase is one of the most important contributions of the innovative peanut cultivar, other elements must also be addressed, such as grain characteristics and quality, which has allowed for value aggregation to the grain and new marketing channels, both for the domestic market and for the external market. This innovation is considered the main reason for the increase in peanut exports, after a period in which Brazil was characterized as an importing country [9].

Regarding harvest and post-harvest introduced technology, Martins [9] and Scalco, Machado and Queiroz [6] argue that the use of these technologies contributed to the increase of productivity and to the improvement of the quality of the grain, turning the culture into a profitable choice for farmers. Investments in new storage technology, such as big bags, and in aflatoxin detection tests were elements that sought to guarantee the quality of the grain and its possibility of access to external market.

The consumer market have raised its standards, which demanded not only technological changes in the peanut chain, but also organizational changes of great importance for the adoption and creation of products destined for human consumption. In 1999, the European Union established that the permitted amount of aflatoxin in the grains should reduce from 20 ppb (parts per billion) to 4 ppb [36]. Such change has lead the sector to create the Pro-Peanut Program by The Brazilian Association of Cacao, Chocolates, Candies and Byproducts Industry (ABICAB, by its acronym in Portuguese). The Program have established grades and standards related to food security. A label created to communicate final consumers that the product was industrialized according to strict quality control.

Other important factors were the public standards. The Resolution RDC-172 was published in 2003, and provided the technical regulation of Good Manufacturing Practices for firms that use peanuts and its byproducts. Further, in 2009, the publication of Normative Instruction n.3 by the Ministry of Agriculture established several requirements to regulate the peanut production chain as adequate packaging and conditions to maintain final product quality. Other requirements were storage minimum conditions, total aflatoxin concentration, adoption of Hazard Analysis and Critical Control Points (HACCP), traceability, certification, amongst others)[37] [7][38].

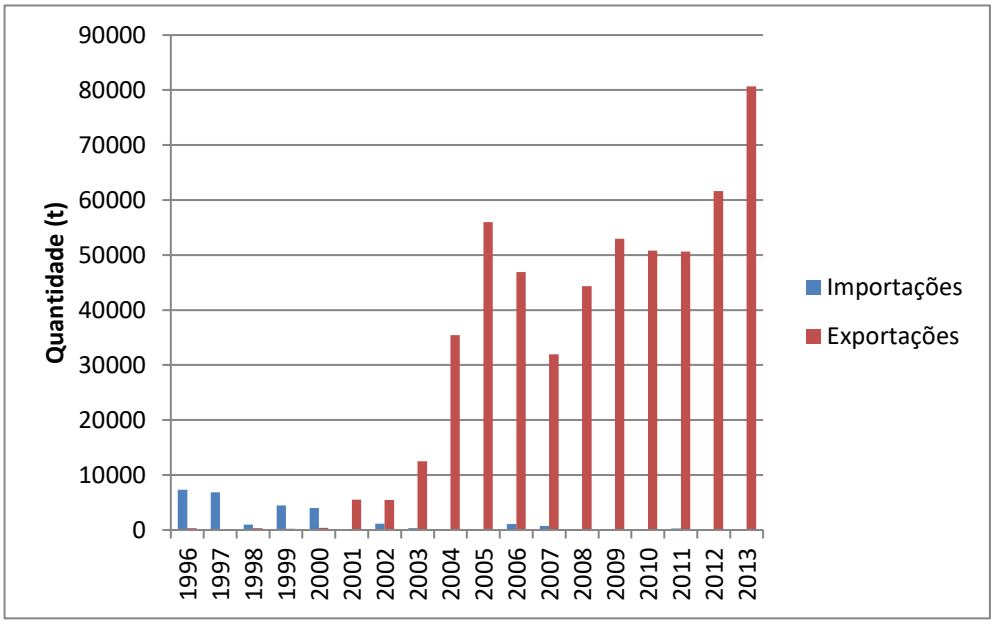
The Pro-Peanut label is awarded to companies that meet the requirements of the legislation and manufacture fully safe peanut based products and focuses on the prevention of aflatoxin, a toxic substance that can cause cancer and other diseases [39]. It is a label placed on the packaging in order to communicate compliance with the quality parameters, seeking to create safety for consumers and distribution channels, to give credibility to the industry, to facilitate the identification of good manufacturers, to develop a good image and to increase the consumption of peanuts [38].

João and Lourenzani [32] pointed out that the monitoring of product quality, through the Pro-Amendoim label, has as a result, the recognition of product quality, both in the domestic market and in the external market. Actions such as HACCP, Good Manufacturing Practices and ISO certifications are requirements of the external market.

Such actions helped Brazil to move from a importing country in the 1990s to an exporter in 2013. Figure 2

shows the exports and imports of Brazilian peanuts in shell between 1996 and 2013. Between 1996 and 2000 imports were much larger than exports. The largest quantity imported in this period was 7,342 tons in 1996, against 332 tons of exportation. The situation began to reverse in 2001, when the country exported 5,501 tons, while importing only 51 tons of peanuts in shell. From 2001 on the exports were higher than imports. Thus, it is observed that the creation of the Pro-Amendoim label, Good Manufacturing Practices, HACCP and certifications have contributed for meeting the international demands regarding the hygienic-sanitary quality of the grain.

Figure 2: Exports and imports of peanuts in shell between 1996 and 2013



Source: prepared by the authors based on FAOSTAT[10][12].

5. Final remaks

The innovations were a very important factor for the recovery of the peanut crop in Brazil. The contributions were not restricted to product technology as genetics, harvesting and pos-harvesting, but also to the organizational aspect, which were altogether responsible for production increase.

With the advent of new cultivars, production and harvest were positively affected, mechanized harvesting was also a key part of crop recovery. The increase in exports between 1996 and 2013 shows the positive result of technological innovations in the peanut production chain. In addition, the post-harvest technology is of great importance to ensure the quality of the final product. Therefore, technological changes related to the processing are relevant. These changes involved new artificial drying techniques, which involved controlled storage, maintaining relative humidity of the air and the tamperature in optimal conditions. Those factors are revelant to combat the high levels of aflatoxin.

It was observed that the increase in exports was not only result of technological innovations, implemented in the production and processing of peanuts, but of several organizational innovations adopted by the chain agents throughout the decade of 2000, especially the creation of the Pro-peanut label. The label was an innovative way to communicate, through visual information, about quality of product and of process in a

symbol that could be perceived by consumers. Thus, it is considered that the seal was also a source of innovation, in this case marketing innovation.

With the organization of the peanut production chain, the guarantee of product quality, the positive production numbers and the marketing strategy, through the Pro-Amendoim label, new markets were accessed. This was one of the directions given by Schumpeter to development. Since 2001, with the recovery of exports as a result of all the changes already mentioned, the natural consequence was accessing new markets.

Finally, it is concluded that the contribution of the different types of innovation were of great importance for the recovery of the peanut crop. It should be noted that the actions have involved the agents of the whole production chain, characterizing innovation as an important tool to increase competitiveness for the peanut chian, but also demanding governance and coordination.

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