

From Catching-up to knowledge governance in the Brazilian Agribusiness*

De "Catching-up" para a Governança do conhecimento no Agronegócio Brasileiro

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Resumo

O objetivo deste artigo é apresentar o quadro institucional, a base de conhecimento e da co-evolução de empresas e outros atores em diferentes fases dos processos de transformação agrícolas no Brasil. Estes processos podem ser entendidos como um modelo de *catching up* em curso, a partir da revolução verde dos anos 1940, vindo do exterior, para a recente liderança tecnológica na agricultura tropical. Ou seja: o quadro institucional dessas fases é bem diferente, novos tipos de organizações estão surgindo assim como novas formas de inovar, ao mesmo tempo em que a fronteira tecnológica está avançando.

Palavras chave: catching up; fronteira tecnológica; agricultura; inovação

Abstract

The purpose of this article is to present the institutional framework, the knowledge base and the co-evolution of firms and other actors in different phases of the Brazilian agricultural transformation processes. These processes can be understood as an ongoing catching-up model, from the green revolution of the 1940's, coming from abroad, to the recent technological leadership in tropical agriculture. That is to say: the institutional framework of these phases is quite different, new types of organizations are emerging as far as new ways of innovating, at the same time that the technological frontier is moving ahead.

Key words: catching up; technological frontier; agribusiness; innovation

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Introduction

According to a widely shared belief, in contrast to other sectors such as automobile, pharmaceuticals, telecommunications and software, that are all “modern” industries and often served as leading sectors in national development processes, the agro-food has being characterized, in the past, as a traditional sector and never had played such a role. The roles of the agro-food sector in development were, in short, in providing subsistence foundation and in serving as “catalyst” to successful catch-up. (Sisler and Oyer, 2000:1)

Additionally, leading sectors represent a good range according to the Pavitt taxonomy (Pavitt, 1984)¹, from science based sectors such as pharmaceuticals, R&D intensive such as telecom and semiconductors, scale intensive such as automobiles, specialized supplier and service sectors such as software. Under this classification, agriculture is supplier-dominated, as it relies on sources of innovation external to the sector.

As a matter of fact, and since the 1990's, the agriculture sector should no longer be considered “a traditional sector” as a whole in most developing countries. Some of the new technologies for the agro food sectors might be, instead, classified as: science based - the new and controversial transgenic revolution, the bio-reactors for the production of new bio molecules for agro food sector, plants for the production of vaccines; or R&D intensive – plants with certain “resistances” for salinity, aluminium and process of catalysis for ethanol and biodiesel production; and scale intensive, as the application of GPS (global positioning system) and software for increasing productivity in agriculture and livestock in general.

Summing up, Pavitt taxonomy couldn't grasp the technological transformation of the agro-food system today, a leading “industrial complex” in some developing countries, as it is the case of the Brazilian economy, with higher rates of growth, higher export rates, and leading in biotech, bio fuels and software applications, most of them emergent from inside the agro food system.

It is here defended that the agro-food transformation process could be better understood if we take into consideration the existence of different phases in time, as far as institutions, knowledge base, co-evolution, firms and other actors, networks and demand, are concerned. These transformation processes can be characterized as an ongoing catching-up process, from the green revolution of the 1940's, coming from abroad, to technological leadership in tropical agriculture. That is to say: the institutional framework of these phases is quite different, new types of organizations are emerging as far as new ways of innovating and, at the same time, the technological frontier continues to move ahead. The development of those ideas, applied to the Brazilian case, is the purpose of this article.

My suggestion is to consider the following hypothesis, as far as the Brazilian Agro-food on going catching-up case is concerned:

1. On the contrary of the usual view, there was an important catching-up process in the Brazilian agribusiness system during the second half of the twentieth century.² Not only was the growth intense, but new technological processes had been introduced.
2. The agro-food catch-up is part of a broader catching-up process of the Brazilian economy³ and tended to occur in periods when development strategies come to be implemented,⁴ reinforcing competitiveness on the international markets and at the national and enterprise level. Indeed, the origins of agricultural catching-up – the introduction of the “seeds of change” and the institutions of the “Green Revolution” – institutional research, extension services and rural credit - had even coincided with the starting point of industrial catching-up, in the latter half of the 1940's and the 1950's.
3. The major transformation from the green revolution paradigm to the new ways of innovating relies on the transformed institutions, the new knowledge process and the different forms of knowledge governance, which will be mentioned as stylized facts at the end of this article.

Brazilian agro-food catch-up: phases

The first phase – from the late 1940's to the 1970's – could be characterized, on one side, by the institutional setting – research, technical assistance and extension services, credit system – and on the other side, by the introduction of the material base for agricultural modernization – transport and commercial infra-structure, seed companies, machine and tools sector, fertilizers and agrochemicals.⁵

It should be mentioned the catalysing and modernising role played by the Brazil-United States Mixed Technical Commission (the Abbink Mission), from the end of the 40's to the mid of the 50's, which was to a great extent responsible for policy articulation and for setting up institutions that promoted profound technical-economical and social changes: the creation of the BNDES (National Bank for Economic and Social Development) in 1952, and the proposals that were to reach fruition in the Targets Plan (Plano de Metas), during the government of President Juscelino Kubistchek (1956-1961), especially the implantation of a transport and communication infra-structure, as well as some key industrial sectors (basic or heavy industries), which were all requirements for implementing and modernising the agribusiness system (machinery industry and basic inputs such as fertilizers and agro-chemicals).

The public policies and institutions responsible for the catching-up – the early articulation in the beginning of the 50's, of the tripartite structure: 1) Public agronomical research within the DNPEA (National Department of Agriculture and Livestock Research) including the old Institutes – Agrônômico de Campinas (coffee, corn, cotton), Biológico de Campinas, Agrônômico do Paraná (mainly cotton), de

Pernambuco (sugar cane), to mention the most notorious; 2) Technical assistance and extension, from the ACAR system (created in the 1950's); and 3) the modernization of the farmer credit, the Carteira Rural do Banco do Brasil which existed since the 1930's.⁶ The agricultural food sector was still very backward at that moment, and the family farm subsistence agriculture was predominant, as far as rural employment is concerned.

It's also important to mention the study, capacity building and exchange programs abroad, intended for academic and corporate leaderships. They had also a role to play, as was the case in the history of hybrid corn in Brazil, at the beginning of the 1940's.⁷ These academic and entrepreneurial relationships could be considered the establishment of different networks, and one of the elements of the evolution of the knowledge base. Later on, with EMBRAPA (Brazilian Enterprise for Agricultural Research), but even before, training programs abroad, and Professors interchange, were considered part of the capacity building in agro-food technological research.

The successful cases of corporate catching-up, as for example, the leader hybrid corn producer Agrocere, founded in 1945, or the known Sadia/Perdigão or Brazil Foods enterprise,⁸ Brazilian leaders in food industry and one of the presently world's leading producers of chilled and frozen foodmeat, or the Aracruz Celulose, founded in the 1960's, until recently the world's largest exporter of short fibre cellulose,⁹ lead us to the explanatory pioneering elements of these firms: recurrent patterns and technological trajectories, compulsive sequences, search and selection routines for profitable opportunities and new technologies both in country and abroad, their corporate structure and their strategies.¹⁰ (The list should include also firms from other sectors, as agricultural machinery and fertilizers).

The second catching-up phase – during the 1970's – could be characterized by the show-case of soybeans, which boomed with the rapid growth and transformation of Brazilian economy, and by the strengthening of agricultural public research with the foundation of EMBRAPA, in 1973, mentioned before. It could also be seen as part of a broader, two-way, cross linked process which involves the economic conditions and consequences of the petroleum crisis, the Second National Development Plan (II PND) as a strategic response, and the agro-food system and the industry as a whole. The formulation of a science and technology project for the agro-food system within the National Economic Development Plans, was backed by the creation of the EMBRAPA,¹¹ at the eve of the II PND; furthermore, current specific interaction between public research institutes (EMBRAPA, Institutes, Universities) and research institutions from the private sector, both agricultural and agro industrial, as well as the part played by research funding institutions – namely, the FINEP [Research and Projects Financing].

To a certain degree, the technological and productive transformation, and the rapid acquisition of capabilities by the Brazilian agribusiness, was also accompanied by social changes and possessed common features with other historical experiences. Just to mention, it was remarkable the consequences of international technical

missions, that both advised innovative changes and help to find financial investments. In the case of soybeans, for instance, the introduction of soil correction with the employment of calcareous, initially in the State of Rio Grande do Sul, at the very South, at the beginning of the 1960's, could be considered a major improvement and the starting point for the spread of soybeans in the Cerrados, centre-west of Brazil, almost one decade later. The Federal University of Rio Grande do Sul and the University of Wisconsin, working together, made viable the soil analysis and its "correction" with calcareous. The rural credit by Banco do Brasil was the needed resource to complete the transformation.¹²

The importance of certain agro-industrial chains that work as engines and showcases of the process – such as that of soybeans, or of oranges and of poultry, sugar cane and coffee, had consequences that by far outreach the effects of catching-up. The soybean boom in the 70's, as it was said, caused an agrarian redistribution that enabled small and medium producers in the south of Brazil, mainly by allowing the production of both wheat and soybeans in the same agricultural year. The knowledge base was transformed by the introduction of a biannual crop system, with good results in terms of productivity and profitability. The consequences were not only in terms of the necessary introduction of the modernized production system, but mainly because it made viable the small farm agriculture in the South, and its movement towards the Centre-West (mainly in the 1980's) where the cheap land and the terrain made possible the large scale production of soybeans, corn, cotton and cattle. This movement had redefined, in depth, the space configuration of the Brazilian agro food system.

As well as allowing effective parity with the US and Argentina, the agricultural boundaries shifted to the mid-west and the mid-north,¹³ which dramatically increased Brazilian production potential.¹⁴ This led to finding solutions to the technological problems brought about by the expansion of these frontiers, made production cheaper and put pressure on the build-up of an, as yet inexistent, inter-modal transport network, thus further reducing costs. Brazilian research with soybeans stressed biological nitrogen fixing in the soil, since the beginning, thus reducing the use of fertilisers and allowing continued sustainable expansion.¹⁵

By means of implementing grain-bran-oil and grain-animal feed-meat chains, soybeans enabled the industry to provide more diverse and sophisticated foods, which are not only more competitive but also attend to new consumer demands (functional foods, transgenic versus traditional versus organic). The second phase of catching up was, in short, backed by the demand side, not only for the exports increase, but also thanks to the huge diversification in food industry for the internal market. In the international scene, the trend was for the substitution of animal grass by vegetable oils, at one side, and for the increasing meat consumption (cattle, chicken and pork), in the other, besides non tariff barriers that introduced more rigid quality controls. Supermarkets and food industry were crucial to impose the new products and the quality grades and standards.

The third phase of Brazilian Agro Food System Catching up, it's my concern, started in the middle of the 1990's and could be characterized by the enhanced agro-food capacity in being ready for the increasing international competition, with the following pre conditions:

1. The available resources: land (50 millions of ha utilized versus the potential of 400 millions of ha, and 90 millions of free available land for the production of both bio-fuels and food)¹⁶; qualified technical personnel from the Universities, who wants to live in the country side;¹⁷ a declining supply of labour that will enhance social benefits in the agricultural sector; reasonable supply of credit and capital, but a high level of previous unpaid debts.
2. The international strong demand for agricultural and livestock products supported by a 3% growth rate of the global economy until 2020, and with special role of the Chinese international demand, growing urbanization and aging of the population; strong demand for meat products.¹⁸
3. The existence of competitive firms, well established in global market.¹⁹
4. The existence of the needed institutions, built in the two previous catching up phases, and well established actors, all embedded in almost common shared beliefs – sustainability, export leadership, production cost concerns (including land competition for different crops, as sugar cane and bio-diesel raw materials), grade and standards regulation, WTO rules, demand trends (organics, functional food, other niches) and technological frontiers;
5. The existence of a solid knowledge base, available in EMBRAPA and other Institutes,²⁰ Universities, and a network of research teams including the private sector foundations – as the Fundação Mato Grosso, in the State of Mato Grosso, and the COPERSUCAR, Cooperativa dos Produtores de Açúcar, in São Paulo, as good examples.
6. The existence of huge number of networks in public agro food research (what can be shown by the number of research groups registered in CNPq, National Research Council, data base).
7. The reasonable knowledge of the technological frontier and the capacity to reach it: new hybrid seeds based in the technology protection system (TPS); molecular male sterility; “apomixia”, for the hybrid strength in traditional crops; biotic and no biotic resistances; high nutritional value (vitamins, amino acids, oils and iron); more efficient plants in the capacity for absorption soil nutrients, reduction in fertilizer utilization; plants and animals as bio reactors for the production of new bio molecules; transgenic animals with resistance to common diseases; vaccines and other genetic recombinant inputs for farming; new trends for bio energy. The co-evolution of new technologies, new paradigms, institutional change and capacity building at the level of firms.²¹

8. The renewal of the Brazilian Innovation System with a new set of policies: the Industrial and Technology Policy; the Innovation Policy; the Biotechnology Program; the innovation incentives and financial support at BNDES; the strengthening of the Fundos Setoriais [Sector Funds] at FINEP; the new incentives and policies at the INPI (Brazilian Patent Office), the establishment of a capacity building in intellectual property with special concerns on development and catching up, amongst others innovation incentives. The case of the production of transgenic soybean cultivars, in a successful business model carried out by EMBRAPA, Monsanto and Brazilian producers can illustrate new forms of distribution of the royalties derived from intellectual property.

Summing up, the Brazilian agro-food system can be viewed as a successful case of technological leadership in tropical agriculture, as far as its performance during the entire period is considered: comparative growth rates; competitiveness (measured by increase participation) in the global markets; work productivity and land yield; prices and product diversification; and finally by its resources to face the new trends and innovation challenges of the third Millennium.

Looking ahead: conjectures on the needed knowledge governance.

In the world we live in today, processes involved in knowledge governance, learning, and innovation are being profoundly renewed.²² These changes are not only happening in the companies, Universities, and research institutions that forge technological innovations. New types of organizations, hybrids composed of markets and companies, known as “networks and knowledge markets” are emerging.²³ In these new types of organizations, knowledge is both proprietary and incorporated into intangibles assets, whose value they seek to seize.²⁴ These intangible assets are marketed under different forms and in emerging market structures that require further study. However, not all knowledge is proprietary or is capable of being appropriated – the channels of knowledge can also circulate freely in cooperative research and innovation networks, such as in open databases and programming code, in “wikis,” and the “creative commons” and “science commons” movements that seek to constitute alternative intellectual property regimes.²⁵

The first obstacle in considering knowledge assets is to define them clearly. Knowledge circulates in the economy in several ways: as part of material goods – machines, equipment design; or incorporated into work, capital, human resources that flow between organizations and companies, organizational processes, and in business models. Knowledge can be seen as intangible, tacit, or incorporated, as for example in patents. Knowledge produces overflows that, by definition, are not controllable.²⁶

Another one of the widely known knowledge's fundamental traits (but also of its assets) is that knowledge is a public good. More than that, it is a global public good, whose local or national offering is not guaranteed without its global offering also. Herein lies the importance of global knowledge governance institutions (World Intellectual Property Organization and World Trade Organization) whose mission is to regulate the solution of global conflicts, stimulate production and guarantee (some prefer to say "protect") the appropriation of knowledge.

Insofar as it is a public good, as pointed out by economists, knowledge has two fundamental characteristics: 1) knowledge is "non-rival" – its use by someone does not impede others' use of the same knowledge; 2) usually, knowledge is "non-exclusive." The characteristic of its being non-rival is impossible to eliminate, but its non-exclusive aspect is not. In some situations, knowledge can become exclusive, and this is the precondition to constitute knowledge markets and networks.

Managing knowledge assets inside companies and public institutions is usually termed "strategic management" or "knowledge management." At this level, new forms of producing innovation – such as open innovation and innovations introduced by consumers²⁷ – have become ever more relevant and frequent, renewing "in door" forms of research and development, as well as the business ecosystem itself. At the level of companies, universities, and research institutions, the goal is to generate and seize the value of intangible assets. A company continuously feels, evaluates, reconfigures, faces threats, rethink the boundaries of its own business and even changes the business models valued up to that point (David Teece, 2009). At companies like these, characterized by dynamic capacities, the benchmark is simply the starting point.

The growing importance of knowledge assets²⁸ and processes to seize knowledge in the economy, in businesses and in society, require responses that influence the regulatory framework (or institutional molds) in generating, diffusing, and appropriating these assets.²⁹

"Knowledge governance is a broad concept which embraces different forms of governance mechanisms influencing the production, dissemination and protection of knowledge. As a provisional definition, 'The "knowledge governance approach" is characterized as a distinctive, emerging approach that cuts across the fields of knowledge management, organization studies, innovation and competition policies, and human resource management. Knowledge governance is taken up with how the deployment of governance mechanisms influences knowledge processes, such as sharing, retaining and creating knowledge.'³⁰

"As an analytical perspective, it encompasses intellectual property rules and regulations but supersedes it by drawing on those fields and disciplines in order to identify the contours of the new knowledge ecology, and to support alternative governance mechanisms for organizational and business models which are emerging as complements – or alternatives – to the instituted intellectual property regime we now have"

(Burlamaqui, L. 2009).

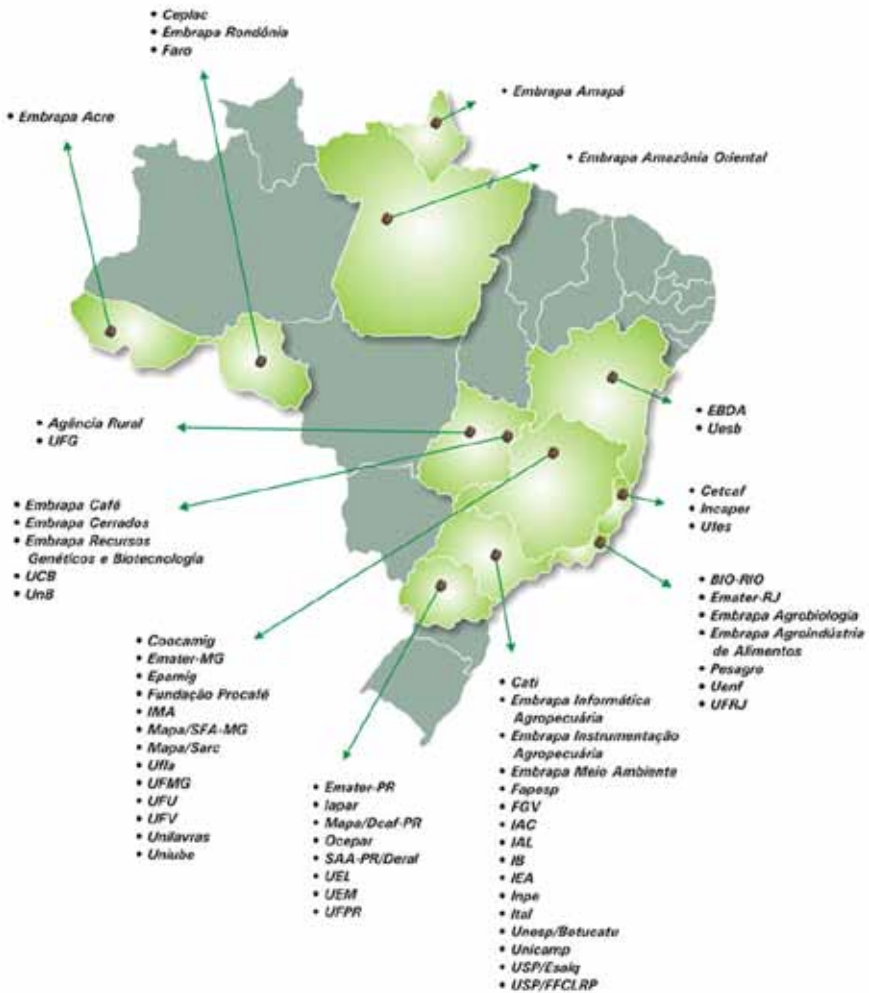
Insofar as innovation can be considered a superior form of knowledge for its unarguable effects on productivity and economic growth, the concept of knowledge governance and innovation³¹ (or its regulatory features or incubating policies) should consider, among other questions, but especially, the relation between: 1) innovation and industrial development policies; 2) the regulation of competition and its institutions; 3) the different forms of knowledge appropriation, among which the current intellectual property regime is the main, though not the only one.³²

The leadership in the new agricultural technological frontier is a hard place to keep. The ways of organizing research points out to different forms to do science and technology. Knowledge collaborative platforms are the main example to be mentioned and EMBRAPA has the governance of some remarkable experiences³³: (i) the Network of the National Research Project of the *Eucalyptus genome* (Rede Genolyptus); (ii) the Brazilian Consortium for Research and Development of Coffee (CBP&D/Café or Consórcio Café) which congregates more than sixty different institutions; (iii) and the Fundo de Defesa da Citricultura (Fundecitrus), just to mention a few but important successful experiences.

These are only some examples of the on going collaborative innovation – open, with the contribution of users, using hard science, generating technological spinoffs and mixing different intellectual property solutions - with huge consequences for the future. Many other examples could be brought to the discussion, but they are not the main concern we want to flag. To keep the chair of technological leadership a tight knowledge governance will be needed. This includes an industrial and innovation policy that chooses strategic venues, a juridical framework to solve conflicts and a more flexible intellectual property regime that induces and rewards greener and sustainable technological options.

Conclusion

Catching-up processes does not solve anymore the problems of tropical agriculture. There is always the risk of catch-up and fall behind (Hikino and Amsden, 1994), in an endless sequence that leads to a technological trap of medium income countries (Wu, Ma and Chu, 2010). Taking into consideration the high speed of innovation in agriculture, the moving technological frontier, the new forms of doing science and technology, and the consequent challenges posed to knowledge governance, it will be crucial to define where is the tropical agriculture technical frontier. Better to say, who defines it? Without answering these questions, the frontier will necessarily take into account a low carbon and sustainable agriculture. In this scenario, Brazil seems to be very well located.



Notas

- ¹ Pavitt, K. (1984) "Sectoral patterns of technical change: towards a taxonomy and a theory". *Research Policy* 13: 342-373.
- ² Catching-up is deemed as the technological parity or equivalence to international "state-of-the-art" standards. It is a process that tends to occur in a concentrated manner within a determined time span, and is accompanied by high economic growth rates, with an increase in productivity and international competitiveness for both sectors and firms. The most important reference texts for the catching-up studies are: Gerschenkron, A. (1960); Abramovitz, M., (1986); e Hikino, T. e Amsden, A., in Baumol, J. Nelson, R.R. and Wolff, E. (Editors), (1994). See also Nelson, R. R.; Mazzoleni, R.; Cantwell, J.; Bell, M.; Hobday, M.; Von Tunzelmann, N.; Metcalfe, S.; Henry, C.; Odagiri, H. (2006)
- ³ Antonio Barros de Castro was the author responsible for introducing this approach and who interpreted the Brazilian industrial development as a catching-up process. The article *Renegade Development: Rise and Demise of State-led Development in Brazil*, in Smith, W. et al (Organizer), Miami: Transaction Publishers, 1993, inaugurated this discussion, which was developed, for example, in Castro, A.B. and Proença, A. in Velloso, J. P. R. (Coordinator) (2001), as well as in Castro, A.B., (2003).
- ⁴ Both historical periods were relevant as far as national strategies are concerned: the JK Presidency and the II PND (National Development Plan).
- ⁵ The "Green Revolution" knowledge base depends on the introduction of the new seeds and plants, necessarily adapted to the environmental conditions of the tropical and sub tropical agriculture. The case of corn is a paradigm: seeds coming from the USA couldn't be grown in Brazil (because of the higher incidence of the sun) unless re adapted to local conditions. In short, the pre-condition was the existence of a research background, public and private.
- ⁶ Castro, A.C. (1984). See also Castro, A.C. in *Pensamiento Ibero Americano, Revista de Economía Política*, (1985), p. 171-212.
- ⁷ The hybrid corn introduction and adaptation in Brazil was possible after an exchange program abroad, when Antonio Secundino de São José, at the time teaching at the University of Viçosa, Minas Gerais, went to Purdue University and brought to Brazil some Mexican maize strains, that gave birth of the first commercial crops of the Sementes Agroceres S.A., enterprise founded in association with Rockefeller and a group of University geneticists, in 1945.
- ⁸ The Sadia enterprise was bought by Perdigão enterprise during the 2008 financial crisis and merger in a new enterprise named Brazil Foods.
- ⁹ The recent crisis also affected Aracruz economic performance. For the previous period, see Gertner, D., May, P., Castro, A.C., Vinha, V. and Leme, C. (1997).
- ¹⁰ Castro, A.C. in Teixeira da Silva, F. C.; Santos, R. e Costa, L.F.C. – *Mundo Rural e Política, Ensaios Interdisciplinares*, (1999), pgs. 177-208. Castro, A.C. - in Costa, L.F., Moreira, R.J.; Bruno, R., Orgs. *Mundo Rural e Tempo Presente*. (1999).
- ¹¹ The foundation of Embrapa, in 1973, gave unprecedented impulse to the Sistema Nacional de Pesquisa Agropecuária [National Agriculture and Livestock Research System], but should not be taken as being its start. The state research institutes, such as the Instituto Agronômico de Campinas [Campinas Institute of Agronomics], established at the end of the 19th century, the IAPAR (Paraná) at the 1930's, the Agronômico de Pernambuco [Pernambuco Agronomic], as well as the IAA (Instituto do Açúcar e do Alcool [Sugar and Alcohol Institute] existed before as part of the DNPEA (Departamento Nacional de Pesquisa Agropecuária [National Agriculture and Livestock Research Department]) when Embrapa was created.
- ¹² The correction of the soil was a local government program, known as Operação Tatu, with the participation of the University of Wisconsin through Professor John Murdock. *Soja 80 Anos de Produção 1924-2004 (Soybeans 80 Years of Production 1924-2004)*, Edição comemorativa aos 80 Anos de produção de Soja em Santa Rosa, RS, promovida pela 15ª Fensoja.
- ¹³ See Castro, A.C. and Fonseca, M.G.D., in *Revista de Economia Política*, (Jan.-Mar. de 1994), p. 63-84.
- ¹⁴ Castro, A.C. (1995).
- ¹⁵ The biological nitrogen fixing in the soil is still today an important trend of the biotechnological research. The Embrapa Soybeans, had founded an alternative to increase the biological nitrogen fixing in the soy production, by the utilization of the soybean seed enriched with molybdenum. The new technology will introduce the element in the process of seed production, avoiding its application in the process of planting the soybean seeds.

- ¹⁶ See Rodrigues, R. in Reis Velloso, J.P., *O Desafio da China e da Índia. A Resposta do Brasil*, (2005).
- ¹⁷ The number of undergraduate courses related with agribusiness in Brazil increased from 3 in 2000, to 100 in 2005 (Gepai/UFScar) in Anuário Exame, Agronegócio 2006/2007.
- ¹⁸ Contini, E.; Gasques, J.G.; Leonardi, R.B.A; Bastos, E.T., in *Revista de Política Agrícola, EMBRAPA*, (Jan/Fev/Mar 2006). References: FAPRI, FAO, IFPRI, OCDE, USDA, IBGE.
- ¹⁹ Cargill, Bunge, Sadia, ADM do Brasil (Archer Daniel Merchants), Louis Dreyfus Commodities, Aracruz Celulose, Klabin, Perdigão, several cooperatives as Itambé, Coama, Cocamar, in the seed industry, Syngenta, Monsanto, Pfizer, Agrocerec, between others.
- ²⁰ Good examples are the Institute for Technological Research - IPT, the Institute of Metrology - INMETRO, the National Institute for Technology - INT, besides other private Foundations, organized by large agribusiness companies. See, Zackiewicz, M ; Bonacelli, M B M ; Salles-Filho, S. L. M. . in *São Paulo em Perspectiva*, v. 19, n. 1, p. 115-121, (2005).
- ²¹ Contini et al, op. cit.
- ²² The changes alluded to are the product not only of new technological regimes, such as in Coriat and Wallerstein (2002), but, especially, the result of changes in institutions, organizations, and governance structures that accompany them. Science-based type II model is, in short, characterized by the crucial role of finance and intellectual property.
- ²³ OECD circulated a document titled "Knowledge Network and Markets" for discussion between specialists, where this concept and its relevance is discussed. The document does not represent the OECD's official position.
- ²⁴ Teece, D. – *Managing Intellectual Capital*, Oxford University Press, 2000.
- ²⁵ These conjectures come out from the results from two previous efforts. First, it follows the research undertaken by the network on industry catching-up processes, led by Richard Nelson and Franco Malerba. Secondly, we sought to incorporate the products of a research project organized by MINDS/IMDE (Multidisciplinary Institute for Development and Strategy/Instituto Multidisciplinar de Desenvolvimento e Estratégias) on the operations of patent offices as part of the knowledge governance institutional framework.
- ²⁶ All of the characteristics of knowledge mentioned above derive from its most problematic trait: it always originates in the individual, where, as Stan Metcalf had pointed out, it is ungovernable, restless, and in a state of permanent change. This problematic nature results from the fact that knowledge is a fictitious commodity that must be, as labor, capital and land, regulated by social institutions. The Polanyian thesis states that fictitious commodities, left to the whims of market forces, produce systemic crises, such as the repeated financial crises after notorious periods of deregulation.
- ²⁷ Chesborough, H. – *Open Innovation*, Harvard Business School Press, 2006, Boston Massachusetts, and Von Rippel, E. – *The Sources of Innovation*, Oxford University Press, 1988, New York - Oxford.
- ²⁸ "Knowledge assets" is an evolutionary economic concept introduced by Richard Nelson and Sidney Winter in 1982. Cf. *An Evolutionary Theory of Economic Change*. Cambridge: Harvard University Press, 1982.
- ²⁹ Knowledge assets already occupy a central position in the literature on companies and organizations known as "resourced-based view," as well as on dynamic capacities. However, academic works and case studies supporting this literature adopted companies, organizations, and/or knowledge itself as units of analysis, tending to emphasize internal company or organization processes without adequately considering regulatory instruments, government policies and strategies capable of inducing, stimulating and/or "governing" knowledge.
- ³⁰ In this microeconomic perspective, which we do not explore in this article: "It insists on clear micro (behavioral) foundations, adopts an economizing perspective, and examines the links between knowledge-based units of analysis with diverse characteristics and governance mechanisms with diverse capabilities of handling these transactions. Research issues that the knowledge governance approach illuminates are sketched": DRUID – The Emerging knowledge governance approach: Challenges and Characteristics – Nicolai J. Foss and Department of Strategy and Management. Norwegian School of Economics and Business Administration.
- ³¹ Knowledge is, in principle, ungovernable, but its assets are not necessarily. Stanley Metcalfe pointed out knowledge's restless and agitated character. Cf. *The Entrepreneur and the Style of Modern Economics*. Journal of Evolutionary Economics, Springer, vol. 14(2), pages 157-175, 06. On the other hand, and moreover, Peter Drucker called attention to the moment in which experience that has not been codified becomes knowledge, which for him is the publication of *Encyclopédie*, by Diderot. "In Drucker's words, 'the *Encyclopédie* converted experience into knowledge, apprenticeship into

textbook, secrecy into methodology, doing into applied knowledge' (Drucker, 1993). On the basis of such abstract, objective, codified results-oriented, publicly available knowledge, modern individuals would be able to control their destiny in a way that had never been possible before. More than anything else, knowledge was power to change the world'. Cf. Hardimos Tsoukas, Nikolaos Mylonopoulos – Organizations as Knowledge Systems: Knowledge, Learning and Dynamic Capabilities. Oxford University Press, 2004.

³² The project "Capacity Building for knowledge Governance Institutions," is being developed by MINDS (Multidisciplinary Institute for Development and Strategies)/IMDE (Instituto Multidisciplinar de Desenvolvimento e Estratégias), financed by the Ford Foundation.

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