ARGENTINE SOYBEAN PRODUCTION: THE OUTLIER IN A WEAK INNOVATIVE ENVIRONMENT

Ramiro Albrieu [*]***, Gonzalo Bernat*** [**] ***and Eduardo Ariel Corso*** [*]

Abstract:

During the last decade, Argentine soybean production showed a high rate of innovation, as farmers adopted state of the art technologies associated with biotechnology without important lags regarding their international launch. This sector's high speed of assimilation of global innovations contrasted notoriously with the pattern observed for the rest of tradable activities. Therefore, the main purpose of this paper is to identify the factors that impelled soybean's development and draw lessons for the rest of the local economy. On this matter, this paper states that soybean production has been able to surpass usual domestic innovative restrictions due to its organization in network systems, that imply coordination between such diverse actors as farmers, suppliers, clients, investors, workers, technicians and science and technology institutions. Besides, this paper examines microeconomic positive consequences of local introduction of GMOs (on yields, production and exports) and, also, its crucial role for recent Argentine macroeconomic sustainability (fiscal and commercial surpluses). Finally, this paper reviews the topics in which this innovative process has failed (lower incidence of national suppliers of inputs, machines and knowledge and scarce advances in value added creation). To achieve all mentioned purposes, different sources of information will be utilized and processed, such as National Innovation Surveys and local and international databases.

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[*] Researchers at Centro de Estudios de Estado y Sociedad (CEDES) [Sánchez de Bustamante 27 / Buenos Aires / Argentina / Tel: 4861-2126 / ralbrieu@cedes.org; ecorso@cedes.org] and Professors at the Universidad de Buenos Aires.

[**] Researcher at Fundación CREAR [Callao 868 2° "A" / Buenos Aires / Argentina / Tel: 4811-0408 / gbernat@fundacioncrear.org.ar] and Professor at the Universidad de Buenos Aires.

I. INTRODUCTION:

International comparisons reveal that innovation investment is relatively weak in Argentina (*Table I.1*): the share of national Research and Development (R+D) expenditure in local GDP was slightly above 0,5% in 2007, percentage that was not only inferior to the figures of developed nations like Japan (3,39% in 2006), the United States (2,62% in 2006) and Germany (2,51% in 2005) but, also, to the rates of emergent economies like Brazil (1,02% in 2006), Chile (0,68% in 2004) and China (1,42% in 2006). Additionally, in the mentioned year, Argentine private sector was only responsible for 30% of total domestic R+D disbursement, behavior that notoriously contrasted with the ones observed in both OCDE countries and the rest of the main Latin American nations.

TABLE I.1.
R+D EXPENDITURE IN SELECTED COUNTRIES. VARIOUS YEARS.
As a share of respective GDPs:

Country	Year	Share
Japan	2006	3,39%
United States	2006	2,62%
Germany	2005	2,51%
France	2006	2,11%
Canada	2007	1,89%
Belgium	2005	1,82%
Holland	2005	1,78%
Australia	2004	1,76%
China	2006	1,42%
Spain	2006	1,20%
Italy	2005	1,10%
Brazil	2006	1,02%
Chile	2004	0,68%
Argentina	2007	0,51%
Mexico	2006	0,36%

Source: based on data from OCDE and RICYT.

Nevertheless, the previous comparison on innovation has two limitations. First, the weak Argentine R+D expenditure is a result of an innovation pattern based on the acquisition of incorporated knowledge. In this respect, domestic industry destines the bulk of its innovative investment (54% in 2004) to the purchase of machineries and equipment, pattern associated with agents whose technological development is sustained by exogenous sources and, thus, act as followers of the knowledge developed by (usually foreign) competitors and providers[1] (Peirano, 2006).

Besides, comparatively low R+D expenditure in Argentina is partially a result of a productive configuration in which high-tech activities (e.g. machinery, transport

[1] This strategy, shared by Brazil and Portugal, reveals an innovative dynamics that fails to take advantage of internal sources of knowledge creation like R+D (Lugones et al, 2005). On the contrary, French, Dutch and, to a lesser extent, German manufacturing firms mainly allocate their innovation budget to R+D activities. In both cases, said agents are not only over the international technological frontier but, frequently, are responsible for expanding the global state of the art.

equipment and precision instruments' manufacturing) have a radically smaller incidence than in developed nations[2] (Chudnovsky et al, 2006).

Secondly, and more importantly, the previous analysis fails to assess that, although a vast fraction of Argentine tradable activities are notoriously below international standards on said subject[3], a few local key sectors in terms of their share in domestic GDP, employment, exports and fiscal revenues were able to adopt state of the art technologies and, exceptionally, expand the global knowledge frontier (Bernat and Corso, 2008).

Regarding the latter, national agriculture was amongst the first to replicate the international state of the art "jump" that occurred in the middle nineties and that was associated with the introduction of genetically modified organisms (GMOs) in said activity. In fact, the amount of hectares sowed with transgenic plants in Argentina during 2008 (21,0 million) was only surpassed by the United States (62,5 million), creator of this technology (*Table I.2*). In that way, domestic farmers exceeded the rest of the main international agriculture producers in terms of their usage of GMOs: Brazil (15,8 million), India (7,6), Canada (7,6) and the European Union.

TABLE I.2.
UTILIZATION OF GENETICALLY MODIFIED ORGANISMS BY VARIOUS NATIONS. 2008.
In million of seeded hectares with GMOs:

Country	Millions of hs. w/ GMO	Crop
United States	62,5	Soybean, maize, cotton, canola, squash, alfalfa, papaya and sugar beet
Argentina	21,0	Soybean, maize and cotton
Brazil	15,8	Soybean, maize and cotton
India	7,6	Cotton
Canada	7,6	Canola, maize, soybean and sugar beet
China	3,8	Cotton, tomato, poplar, petunia, papaya and sweet pepper
Paraguay	2,7	Soybean
South Africa	1,8	Maize, soybean and cotton
Uruguay	0,7	Soybean and maize

Source: Based on data from ISAAA (2009).

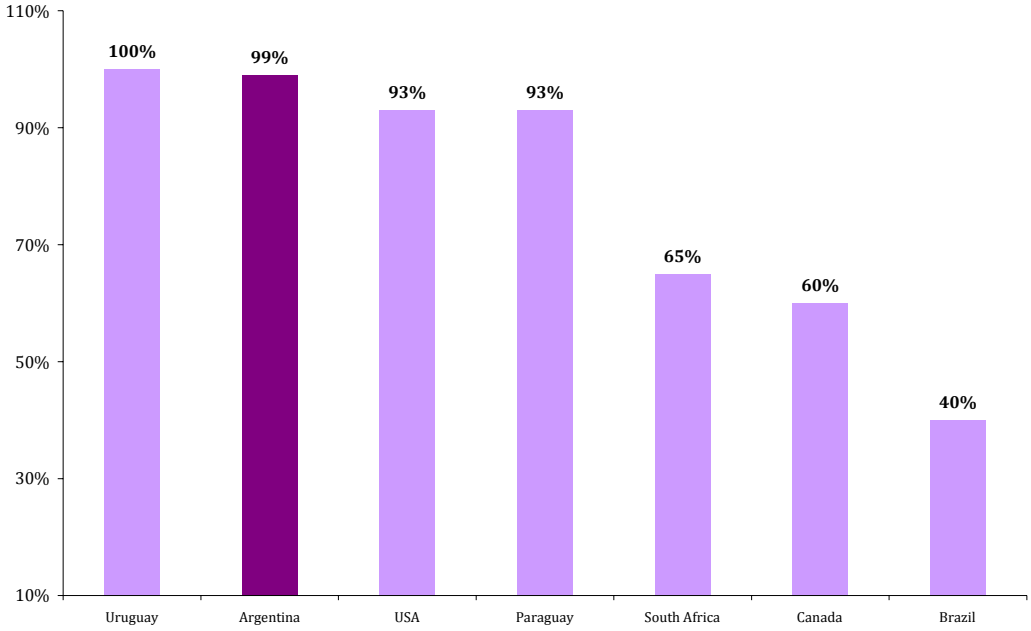
In 2005, only a decade after this new technology was internationally made available, 99% of Argentine soybean production utilized GMOs, percentage that exceeded both United States' figures and, with the exception of Uruguay, the rest of the main producers' performance (*Figure I.1*). Thus, national soybean farmers' behavior has been considerably dynamic regarding their adoption of GMOs, rapidly placing them above the global state of the art. In fact, GM soybean's adoption in Argentina constitutes a

[2] Nevertheless, only 32% of the difference between Brazilian and Argentine industrial R+D investments in 2001 and 2000, respectively, was explained by diversity regarding manufacturing structures between both countries, whereas the remaining 68% was based on asymmetrical expenditures within each activity (Sánchez et al, 2006).

[3] Argentina's comparatively low innovation expenditure is notoriously concentrated in high and medium-high-tech manufacturing sectors and, to a lesser extent, in apple production and bovine cattle breeding. This pattern conspires against the convergence of said activities towards international state of the art, since it is indeed those branches that suffer the greater gap and, even worse, involve product and process technologies that evolve continuously world-wide.

world-wide example regarding a rapid large scale implementation of this new technology (Vicién, 2003).

FIGURE I.1.
UTILIZATION OF GENETICALLY MODIFIED SOYBEAN SEEDS BY MAIN WORLD–WIDE PRODUCERS. 2005.
As a percentage of total seeded hectares with soybean:



Source: Based on data from Brookes and Barfoot (2006).

As a result, between 1996 and 2008, the primary production of soybean grew from 12,5 million tons to 46,2 million, whereas exports (including beans, oil and other sub products) increased from 12,1 million tons to 39,9 million. Hence, in only a decade, Argentina was transformed into the leading exporter of soybean oil and flour, conforming the main world-wide pool of oilseed production in the environs of Rosario, Santa Fe. In sum, soybean production has attained high rates of growth, is fully integrated with international markets, displays a differentiated pattern of innovative activities and has developed a complex structure of contracts that is very difficult to find in the rest of the economy.

Precisely, the objective of this paper is, first (Section II), to study the main causes that determine the innovative performance in Argentine soybean production, evidence that shall become significantly illuminating in order to understand how this sector has surpassed the usual obstacles that local firms from other tradable activities have to deal with and that are engendered and/or deepened by a volatile macroeconomic environment. Later (Section III), this paper will examine the micro consequences of the local introduction of GMOs on yields, production and exports and, also, the former's crucial role for recent Argentine macroeconomic sustainability (fiscal and commercial surpluses). Finally (Section IV), this paper will review the topics in which this innovative process has failed. To achieve all mentioned purposes, different sources of information on the subject will be utilized and processed, such as National Innovation Surveys and local and international databases.

In this paper we take neither a purely macroeconomic nor a exclusively microeconomic approach, but a mixture of the two. More precisely, we consider that the decentralized decisions of economic units regarding investment and technological change (that is, microeconomics) is determined simultaneously with the characteristics and the

performance of the aggregate economy (macroeconomics). To this end we need to detect whether causation runs in both directions: (a) from macroeconomics to microeconomics, we will take into account that macro volatility and shocks are decisive to defining the (micro)economic structure; (b) from microeconomics to macroeconomics, we will analyze how the evolution of the economic structure affects macro sustainability.

Last, but not least, it is important to emphasize that this paper is framed within the evolutionary school. Therefore, it does not suppose that Argentine farmers' innovative strategies are derived from maximizing behaviors, as neoclassic theory of growth would state (Solow, 1957), but that the former are a result of selection processes in which historical and institutional factors, incomplete information and uncertainty acquire a crucial role (Nelson and Winter, 1982; Nelson, 1991; Katz, 2000).

II. SOYBEAN PRODUCERS' "RECIPE" FOR SURPASSING INNOVATION OBSTACLES:

The rapid adoption of GMOs by local soybean producers constitutes a profoundly relevant case study, as it took place in a notoriously volatile macroeconomic environment. Usually, in Argentina, innovation's weak performance is strongly related to the rise in risk perception that constant changes in macroeconomic regimes engender (Bernat, 2006). In those situations, local agents, especially manufacturing SMEs, prefer to delay their investment decisions in order to make a profounder analysis of new macroeconomic "rules of the game".

In that respect, literature on investment irreversibility (Pindyck, 1988; Caballero, 1991; Pindyck and Solimano, 1993; among others) determines that, in highly volatile economies like Argentina, prevailing uncertainty forbids the accomplishment of investment projects. The former is based on the hypothesis that if investments can be delayed, companies are enticed to adopt "waiting and seeing" strategies, avoiding immediate expenditures in endeavors of uncertain returns (Kosacoff and Ramos, 2006). Therefore, possibility of waiting becomes a central component in the process of evaluating when to invest.

In fact, the option value of delaying projects is comparatively greater in volatile economies and, accordingly, so is the threshold yield companies demand to carry out investments (Caballero and Pindyck, 1996). These habitually denominated "defensive strategies" affect innovative projects with a considerably greater intensity, since the latter include costs, maturation periods and risks clearly superior to the rest of investments.

Contradicting the evidence presented previously, domestic soybean producers' fast adoption of herbicide tolerant varieties started in 1996/1997, in spite of the increase in interest rates, of the tightening of credit restrictions and of the fall of international prices that occurred in said period. In that deteriorated and more volatile macro and global context, farmers had to face accumulated commercial and financial debts, that had been engendered by the need to catch up with the "green revolution[4]" in the early nineties, with diminished gains.

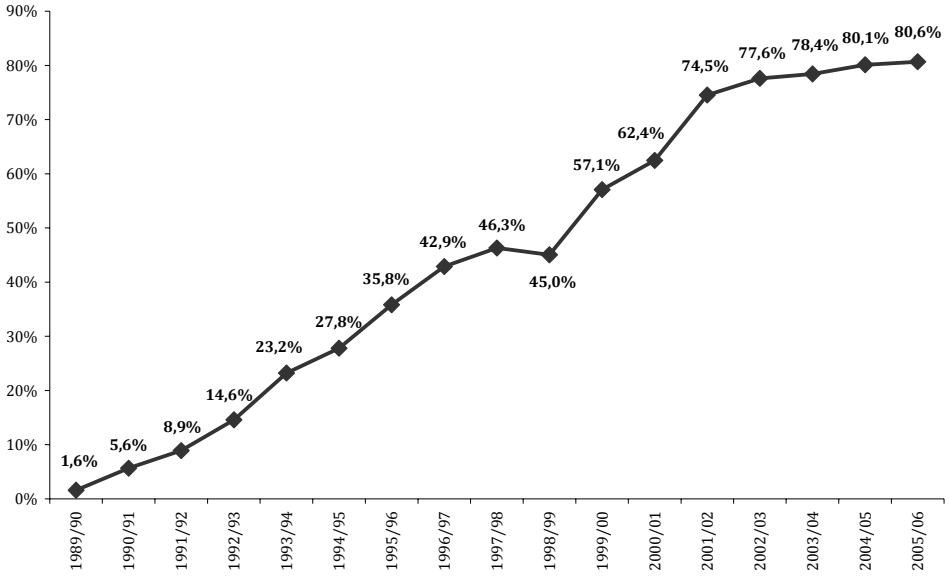
[4] The "green revolution" was associated with the increase in the use of agrochemicals, fertilizers and machineries.

Precisely, soybean cultivators implemented a "forward exit" (Bisang, 2001) as they assimilated GMOs in order to reduce their costs, augment their yields, improve cultivars' management and to enable both a double-reaping in the same year (usually, wheat in early summer and soybean in autumn) and the expansion of this oilseed towards areas of smaller productivity, restoring their profit margins and, therefore, enabling the repayment of contracted debts.

Also, GMOs were complementary of the "direct sowing" technique (DST), that had been introduced domestically during the early nineties, as it demanded the intensive use of the herbicide glyphosate and fertilizers. Synthetically, the DST consists in the implantation of oilseeds and cereals in a single procedure, avoiding surface tillage and associated tasks.

The DST augmented farmers' profits even further, as it allowed for costs reduction (by eliminating activities that were needed in the previous productive system), for laboring cycle diminution (promoting "double sowing" and the expansion towards newer areas) and for both an improvement in soil's humidity (Penna and Lema, 2002) and the long term agronomic sustainability (Crovetto, 2001). Therefore, the percentage of surface sowed with soybeans through DST grew from 27,8% in the 1994/1995 campaign to 80,6% in 2005/2006 (*Figure II.1*).

FIGURE II.1.
DIRECT SOWING TECHNIQUE'S INCIDENCE IN SOYBEAN CULTIVATION. 1989-2006.
As a % of total sowed surface:



Source: Based on data from AAPRESID.

Diverse studies indicate that GMOs (frequently combined with DST) resulted in gain's increase superior to 10% in relation to the previous productive model. On this matter, Bisang (2001) states that, in 1997, the cost of sowing with the conventional package was approximately us$115 per hectare, whereas by combining genetically modified seeds and herbicide it fell to us$90, due to the reduction in labor's (fundamentally, in the control of weeds) and biocides' usage and the comparatively inferior increase in

seeds' (as GMOs are more expensive than traditional products) and fertilizers' expenditures[5].

Later, in 2002, the Convertibility Regime's collapse, that determined the substitution of a fixed nominal exchange rate regime for a "dirty" floating regime, implied a price-competitiveness[6] gain for soybean producers, which was partially diminished by the reestablishment of export duties for these oilseeds[7]. Also, since 2003, the sustained increase in commodities' international prices strengthened said competitiveness rise. Both macroeconomic factors (local and international) implied higher earnings for soybean producers, which in turn led to the deepening of GMOs usage in order to expand said activity's production and exports.

On summary, the study of the soybean case can provide evidence regarding how this activity was able to surpass innovation barriers that continue to be usual within the Argentine tradable sector and which were also customary for oilseeds producers up to the nineties, obstacles that are generated and/or enhanced by the volatility that characterizes the local macro economy.

II.2. MAIN INNOVATION BARRIERS:

Argentine industry's innovative dynamics dealt (and still deals) with six fundamental restrictions during the nineties[8], when GMOs' rapid adoption started (*Table II.1*): long return period, innovation's risks, difficulties regarding credit access, market's size and structure and high innovation costs.

[5] Aggregately, at the national level, the net income gain from GMOs adoption was about us$0,9 million in 1996, rising to us$480 million in 2005 (Brookes and Barfoot, 2006). Cumulatively, the net income gain was us$6.250 million between 1996 and 2006 (Brookes and Barfoot, 2008).

[6] According to Bouzas and Fanelli (2001), competitiveness is defined by a non-price ingredient (productivity, scale and static comparative advantages) and a price component (that depends on factors' dowry and on the exchange rate).

[7] This reform had the purpose of leveling different tradable activities' profit margins, reducing price-competitiveness to the activities that were located on the international frontier (whose performance, therefore, did not depend crucially on the real exchange rate's raise).

[8] No data is available regarding barriers encountered by industrial companies in the new century. Nevertheless, the persistence of these obstacles during the nineties sustains the perception that they should have been relevant after 2001.

TABLE II.1.
ARGENTINE INDUSTRIAL FIRMS' INNOVATION BARRIERS. 1992-1996 / 1998-2001.
As a share of total answers*:

Barrier	1992-1996	1998-2001
Microeconomic		
Long return period	32	51
Shortage of qualified labor	6	37
Innovation risks	43	32
Organizational rigidity	7	28
Mesoeconomic		
Difficulties regarding credit access	63	68
Market's size	32	58
Market's structure	12	55
Limited sectorial technological dynamics	6	40
Limited cooperation with firms and institutions	4	40
Easy imitation by rivaling firms	5	32
Macroeconomic		
High innovation costs	43	51
Weak public policies regarding Science and Technology	10	42
Weak development regarding Science and Technology institutions	2	38
Physical infrastructure	21	29
Insufficient information regarding markets	6	27
Insufficient information regarding technologies	6	22
Intelectual Ownership System	10	14

* This percentage is a result of dividing answers that considered that each barrier had "high" or "medium" relevance by total answers.

Source: Based on data from Indec's various Innovation Surveys.

Notably, five of these six main innovation's barriers (credit access, market's size and structure and innovative costs and risks) were stronger for Small and Medium national manufacturing firms than for bigger companies (*Table II.2*).

TABLE II.2.
ARGENTINE INDUSTRIES' INNOVATION BARRIERS BY FIRM SIZE. 1998-2001.
As a share of total answers:

Barrier	Small Firms	Medium Firms	Big Firms
Difficulties regarding credit access	73,7	58,7	45,4
Market's size	59,1	57,1	52,1
Market's structure	55,6	54,5	49,5
High innovation costs	54,9	43,5	36,8
Long return period	49,3	55,8	60,4
Innovation risks	35,6	25,1	17,6

Source: Based on data from Indec (2003).

Anyway, only one of these six barriers (credit access) was significant for agriculture firms' innovative dynamics (*Table II.3*). Besides, productive scale was another notorious obstacle for farming sector's innovation. As a result, while the former utilized conventional (and frequently obsolete) technologies, bigger farmers usually employed state of the art techniques (INTA, 2002).

TABLE II.3.
ARGENTINE AGRICULTURE FIRMS' INNOVATION BARRIERS. 2001.
As a share of total answers:

Barrier	Share
Difficulties regarding access to credit	15,1
Lack of skills to implement technological upgrade	12,9
Limited profitability of technological alternatives	11,8
Productive scale	10,6
Insufficient coordination with buyers	8,7
Difficulties to commercialize bigger quantities	8,1
Production's social organization	6,9
Shortage of qualified labor	6,8
Lack of training services regarding new technologies	6,5
Lack of private services to carry on innovation	4,6
Limited cooperation with firms and institutions	4,1
Insufficient offer of inputs and technologies	2,8
Inadequate land occupation	1,1

Source: Based on data from INTA (2002).

Therefore, as the majority of industrial barriers do not affect agriculture agents' innovation, in general, and soybean producers' technological upgrade, in particular, the rest of this section will be dedicated to identify the factors which have enabled oilseeds farmers to surpass the main obstacles manufacturing companies still deal with.

- CREDIT ACCESS:

Difficulties regarding credit access represented the main restriction for both domestic industry's (*Table II.1*) and local agriculture's (*Table II.3*) innovation process during the nineties, hurdle that was significantly stronger for small and medium manufacturing companies (*Table II.2*). Even more, although this obstacle's weight is commonly countercyclical, its relevance in Argentina was constant throughout said decade. Remarkably, this barrier shows a smaller relevance in the rest of studied countries: in Italy, Netherlands and Belgium, it was the second factor in importance, whereas for Brazil and Spain, the third, and for Germany, the fourth. This evidence suggests credit rationing is especially deep in our country.

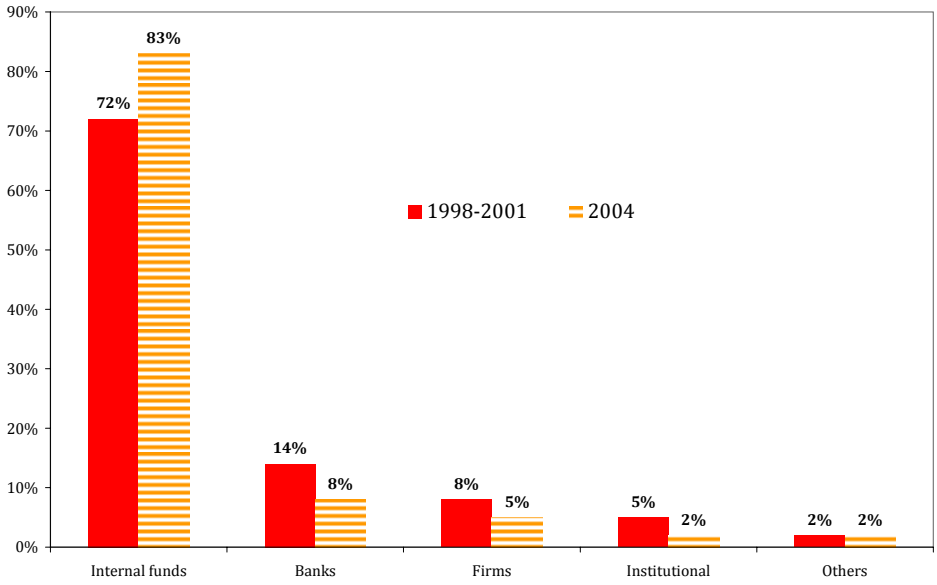
Innovation investment has two financing sources. First, companies can use internally originated funds, like retained earnings and transfers from related firms. Secondly, they are able to access external financing sources provided by the banking system, the capital market, suppliers, clients and various public and private institutions and organizations. On that matter, during 2004, 82% of small and medium industries' innovation investment was funded with internal resources, especially through the reinvestment of profits[9]. Meanwhile, the banking system (main external funding source) only financed 9% of innovation expenditure carried out by Argentine manufacturing SMEs[10]. It is

[9] There is no available data regarding small and medium farming agents, although it is possible to state that their access to bank's credit is similar to industry's. Nevertheless, as it shall be analyzed later, agriculture producers have a fluid funding from their providers and clients.

[10] As the local financial system is bank-based, innovative projects funded through capital markets are notoriously scarce. Therefore, this second external financing source will not be adressed in the rest of this section.

important to acknowledge that this internally based financial structure was similar during the nineties (*Figure II.2*).

FIGURE II.2.
SMALL AND MEDIUM INDUSTRIES' INNOVATION EXPENDITURE FINANCING STRUCTURE. 1998-2004.
As a share of total resources:



Source: Based on data from Indec (2003 y 2006).

Hurdles regarding external financing sources in Argentine agriculture and industry are a result of both supply's and demand's shortfalls. On the one side, the domestic banking system went through a significant restructuring process during the nineties, that was associated with the massive closing or acquisition of provincial, municipal and cooperative institutions (which were specialized in servicing the tradable sector), whereas "surviving" entities preferred to attend consumption's and public sector's funding needs (Albrieu and Fanelli, 2007).

On the other side, credit demand is restricted by three causes: 1) self-financing preference (firms that do not need external resources or avoid them as a consequence of macroeconomic volatility[11]); 2) potential demand (companies that are not satisfied with current funding conditions as interest rates, repayment periods and collateral requests, but that would ask for finance if said terms changed); 3) red-liners (highly indebted firms that do not apply for credit as they would be inevitably denied by financial suppliers).

The main adverse effect of this self-financing configuration is that innovation investments concretion does not depend on its importance (e.g. to take advantage of real exchange rate's depreciation), but on the availability of internal funds to carry out said expenditures. Thus, the execution of strategic innovative projects must be delayed until firms collect sufficient resources as to deal with said costs, turning investment dependent on companies' liquidity (Schiantarelli, 1996). Besides, as the gathering of

[11] Due to the repeated occurrence of phases of intense reduction in activity levels, numerous SMEs that were indebted confronted difficulties to fulfill their financial commitments and, in diverse occasions, fell into bankruptcy by the weight of those liabilities. As a result, this group of firms chooses to self-finance investments, avoiding financial debts that could become unsustainable before a steep and intense macroeconomic recession.

internal funds requires an expanded lapse (since innovations are habitually onerous), this self-financing behavior magnifies the "defensive strategies" mentioned previously.

Nevertheless, financing restrictions have not affected oilseeds producers, which have relied on suppliers' resources to fund their investments. In particular, said sector's financing, that had been scarcely and costly provided by banks in the early nineties, was outstandingly increased by the end of said decade when "Service Centers" developed. Notably, this new figure in Argentine farming was closely associated with the rapid and massive adoption of state of the art technologies like GMOs and "direct sowing".

Service Centers are selling places which concentrate not only the supply of GM seeds, fertilizers and agrochemicals but, also, provide ground analysis and technical advising services and, especially, financing. This companies are usually directly controlled by agriculture input producers, especially, the main international suppliers' subsidiaries. These Centers developed during the last decade, when manufacturers of seeds, agrochemicals and fertilizers started creating exclusive or semi-exclusive distribution channels through the absorption of existing small and medium commercial firms. As the local market evolved towards a greater volume of inputs utilization, Service Centers incorporated the financing service.

Nowadays, these firms have a centralized credit evaluation procedure for the greater clients (approximately 60% of total buyers), that is carried out by a risk analysis team. On the contrary, small producers' funding risk is evaluated decentralizedly through the commercial channel. During the last years, Service Centers have funded nearly 80% of local input consumption, particularly through "exchange plans" that allow producers to pay with oilseeds after harvest (Alvarez, 2003).

Finally, tractors and sowing and harvesting machines manufacturers tend to provide finance to their buyers. Especially, oilseeds cultivators are able to repay these debts after harvest (either with grains or with the money resulting from the commercialization of said goods), as their investment projects have a maturation period inferior to a year (in contrast with industrial innovations).

- HIGH INNOVATION COSTS:

Elevated costs constituted the second most notorious barrier for domestic manufacturing firms' innovative dynamics during the nineties, restriction that was appreciably deeper for small and medium industries. On the contrary, this hurdle did not significantly weaken soybean producers' innovation.

Innovation costs, usually elevated, are especially high in Argentina due to local tradable firms' preference for apprehending technology incorporated in machinery and equipment, pattern which is frequently more onerous (although less riskier) than endogenous knowledge creation or its assimilation through non incorporated exogenous sources.

More so, the presence of comparatively superior costs in Argentina strengthens other innovation barriers. Particularly, credit restrictions (mentioned previously) become steeper when innovations costs are high, as firms have to delay their investments for a prolonged lapse until they are able to cumulate the internal funds necessary to self-finance their projects.

Since the second half of the nineties, the upsurge of "contractors" within Argentine agriculture has radically contributed to diminish said sector's innovation costs.

Contractors provide machinery and equipment services (e.g. sowing, harvesting and fumigation) for farmers, especially for oilseeds producers. In this way, the latter are able to avoid elevated innovation costs associated with machinery and equipment investments[12].

Contractors are specialized in the ownership and administration of a productive factor (capital), diversifying risks (by working in different geographical areas) and exploiting tacit knowledge, financial capabilities (having credit access with both banks and machinery's manufacturers) and strong relationships with other agriculture agents like Service Centers (Lódola, 2008). Nowadays, contractors harvest more than 60% of total sowed surface.

Although contractors appeared in Argentine agriculture in the early 20th century, their relevance spread out during the last lustrum of the nineties, when "direct sowing" technique (which demanded more powerful, and thus more expensive, machines) and GMOs (that required agrochemical's and fertilizers' application services and allowed productive frontier's expansion) became massive[13].

Besides, contractors contributed to alleviate financing restrictions, as they usually provide funding to their clients (including inputs like seeds, agrochemicals and fertilizers). Finally, contractors' expansion facilitated the last technological leap's rapid homogenization within cereals and oilseeds producers (Barsky and Gelman, 2001).

Last, but not least, the cost of GM soybean for Argentine farmers has been substantially lower than in the United States, about us$4 per hectare compared to us$16, as the provider (Monsanto) was not able to obtain local patent protection for its technology[14]. Besides, Argentine farmers have also been allowed to reproduce GM seeds for their own usage by the local legislation: estimates of the proportion of total soybean used that derive from saved seeds in 2004 were up to 80% (Brookes and Barfoot, 2006).

[12] According to Pucciarelli (1997), agriculture's social and technical organization started mutating since the sixties, as farmers began assigning the majority of labors to contractors, avoiding capital goods' purchases and workers' direct hiring and retaining global production and commercialization process' control and coordination.

[13] Contractors are clearly less relevant for Australian and American producers. In this respect, their importance in Argentina arose as a result of a causal combination: their historical development, capital market imperfections and farmers´ defensive strategies oriented to avoid onerous investments (Lódola, 2008).

[14] The diffusion of soybean resistant to the herbicide glyphosate was started domestically by Asgrow Argentina (later acquired by Nidera), that obtained the license from Monsanto. As such, the latter could not patent their innovation, as it had been previously released, resigning their "technology fee" and the capacity of restricting the usage of producers' own transgenic seeds (Trigo et al, 2002).

- INNOVATION'S RISKS AND RETURN PERIOD:

Innovation's risks and return period represented the third most relevant restriction for Argentine industry's innovative dynamics during the nineties, hurdle that was significantly stronger for small and medium manufacturing companies. Notably, this barrier did not affect agriculture's innovation.

Innovation's risk has both a macroeconomic (cyclical and symmetrical) and a microeconomic (structural and asymmetrical) component. As was stated previously, local macroeconomic volatility raises innovation risks, especially when macro regimes changes occur. In said contexts, local agents choose to postpone their innovative projects until they can make a profounder lecture of the new "rules of the game". This risk is countercyclical, as when macroeconomic fundamentals stabilize, it dwindles. More so, this risk component has a symmetrical effect, affecting the whole tradable sector's innovative investments.

On the contrary, microeconomic innovation's risk is structural and asymmetrical, since it is related to the type of projects firms carry out. On the one side, (medium)high-tech industries execute inherently more hazardous innovative projects. These companies, predominantly SMEs, have to endogenously develop new technologies, frequently associated with product innovations, for the reason that they can not significantly appraise them through exogenous knowledge sources (machinery and equipment, software, hardware, transfers and consultancies). Thus, this segment's innovation entails internal R+D expenditures, design activities and reverse and adaptative engineering, which have a higher risk and, usually, a longer maturation period.

On the other side, (medium)low-tech industries (e.g. Food and Beverage, Basic Metals, Petrochemistry, Paper) and the majority of farming branches (with the exception of cattle breeding, which can be included in the preceding group) are able to innovate almost exclusively via the adoption of exogenously generated technology[15], either incorporated in machinery, equipment, software and productive inputs or unincorporated (external R+D, consultancies and transfers). This segment's projects are usually connected with processes, transport and logistics innovations and production reorganizations. Obviously, the former investments have a considerably smaller risk and a shorter maturation period.

Additionally, soybean producers count with the additional advantage that GMO's usage has been actively promoted by Service Centers. In fact, these suppliers offer complete technological packages per oilseed articulated from GM seeds, which contain codified instructions regarding the adoption of specified products (agrochemicals and fertilizers) and agronomical practices. Usually, these packages include counseling services on the subject of associated cultivation techniques, thus reducing ostensibly this innovation's risk. Consequently, these packages diminish farmers' discretionality when selecting their production function, partly transferring that decision towards Service Centers (Alvarez, 2003). More so, these commercialization agents conform a national technology and knowledge diffusion network (Bisang, 2001).

Finally, non-profit organizations (e.g. AACREA –technology supporter- and AAPRESID –direct sowing promoter-) and private institutions integrated by farming

[15]This unbalanced innovative investment's structure determines an inferior positive effect on these firms' competitiveness, since weak efforts are made regarding the generation of incremental knowledge, in order to adapt the external technology to the idiosyncratic features of local human and entrepreneurial resources.

businessmen (e.g. ACSOJA -soybean producers-) have had (and still do) an active role regarding innovation's encouragement and development in oilseeds cultivation, thus diminishing these investments' risks.

- MARKET'S SIZE AND STRUCTURE:

Market's size and structure constituted the fourth most relevant barrier for local industry's innovative dynamics during the nineties, hurdle that was ostensibly tougher for small and medium manufacturing firms. Again, this restriction did not disturb significantly either agriculture's or soybean producers' innovation.

This barrier's effect on innovation is linked to said investment's profitability. On the one side, innovative projects have a potentially higher gain when firms participate in a bigger market (as the former are more easily amortized) and enjoy a certain amount of market power (as they could translate to prices eventual additional costs). On the other side, innovations are usually less profitable when companies partake in smaller market (as it is more difficult to amortize investments) and lack market power (as they are unable to translate additional costs to prices).

(Medium)high-tech manufacturing firms, excluding Automotive and Petrochemical industries, habitually attend a small fraction of the narrow domestic market (as they have small export levels) and lack market power (due to an intense competition with imported goods that take advantage of lower input costs or better technological standards). More so, their profitability is frequently threatened as a result of their monopolical/oligopolical suppliers' (especially basic input manufacturers) dependence.

On the contrary, oilseed producers participate in big markets, as they not only provide local demand but, also, have a significant presence in foreign markets[16]. Besides, although these agents are price-takers as exporters, they exploit their market power locally, advantage which is founded in their productive structure as monopolies/oligopolies.

Finally, non-exporting firms have to deal with a domestic market that is not only small but, also, highly volatile. Hence, said volatility encourages defensive strategies amongst (medium)high-tech industries, as domestic demand often shrinks while investments mature, making innovative expenditures' amortization strongly improbable. In fact, many manufacturing companies that had awaited until 1997/1998 for the domestic market to be big enough to turn innovations profitable, were unable to amortize their investments when local economy entered a recessive phase and, thus, fell into bankruptcy (Bernat, 2009).

[16] In this respect, some published studies (Yoguel and Rabertino, 2000; Chudnovsky et al, 2006) found a positive relationship between exports and innovation.

- FIRM SIZE:

The previously analyzed innovation barriers do not affect big firms and SMEs equally (*Table II.2*). In particular, larger companies are usually able to overcome these hurdles. In this respect, the former have access to various funding sources, both internal (related firm's transfers) and external (national/foreign banking and capital markets, suppliers, multinational organisms, Governments); face comparatively smaller innovation costs (as they take advantage of large cash flows) and risks (as they have both better information to "read" macroeconomic tendencies and solider patrimonies with which to affront eventual projects failures); participate in bigger markets (as a result of a considerable presence in external markets); and, at least locally, exploit their market power (due to their configuration as monopolies or oligopolies)[17].

Within Argentine industry, big firms predominate in Food an Beverage, Steel, Aluminum, Paper, Automobiles and Petrochemicals manufacturing. The former have innovated during the last decades in order to retain their positions above the international state of the art frontier and, in the automotive industry's case, to rapidly converge to said technological border (Bernat, 2008). On the contrary, SMEs prevail in (medium)low-tech manufacturing activities, like Machinery, Medical equipment and Rest of transport equipment production. These sectors have permanently dealt with mentioned restrictions and, with a few exceptions, have not been able to reach global state of the art.

As Table II.3 showed, agriculture's innovation is also affected by firm's size, as a limited productive scale was the main innovative dynamics' barrier for 10,6% of total farming companies. Nevertheless, the upsurge of new productive agents allowed soybean producers to surpass said hurdle.

During the early nineties, "Sowing Pools" and "Direct Investment Funds" (DIF) arose with the objective of increasing productive scale without concentrating land ownership (which is significantly atomized in Argentina). Sowing Pools are associations in which proprietors rent their lands to farming labors administration companies, that carry out production with both their own funds and capitals from clients or investors (often external to the primary sector). In spite of a great heterogeneity in terms of sizes and legal forms, the conformation of a Sowing Pool requires the involvement of three agents: 1) land owners, 2) a technical consultant or agronomist, and 3) investors (Ghezán et al, 2001).

Direct Investment Funds differ from Sowing Pools mainly due to their stronger legal base, that requires the participation of considerably more actors: 1) investors; 2) capital market's agents (responsible for selling the participations in the DIF); 3) organizer or technical operator (in charge of production); 4) societal manager or administrator; 5) auditor and 6) land owners (IICA, 1997).

Regarding innovation, both productive organizations are able to take advantage of scale economies and to diminish climatic and economic risks. In the first case, they exploit their productive scales to cheapen their technology access from input and capital goods providers, increasing innovative investments' profit margins (third most relevant restriction according to Table II.3).

[17] This statement is in line with Schumpeter's latest hypothesis (1942), that established that bigger oligopolical firms have an advantage to carry out formal R+D activities, in opposition to said author's first hypothesis (1934), which affirmed that small entrepreneurs are the key actors in the innovative process.

In the second case, both diversify geographical areas and crops, growing mainly soybean, sunflower, wheat and maize in Argentina's most productive region ("nucleus"), but also cultivating sorghum, cotton, peanut and forages in marginal zones (like the North East). Besides, due to the presence of highly qualified technical consultants, these agglomerations cumulate the necessary skills to implement technological upgrade (second most important hurdle for farmers).

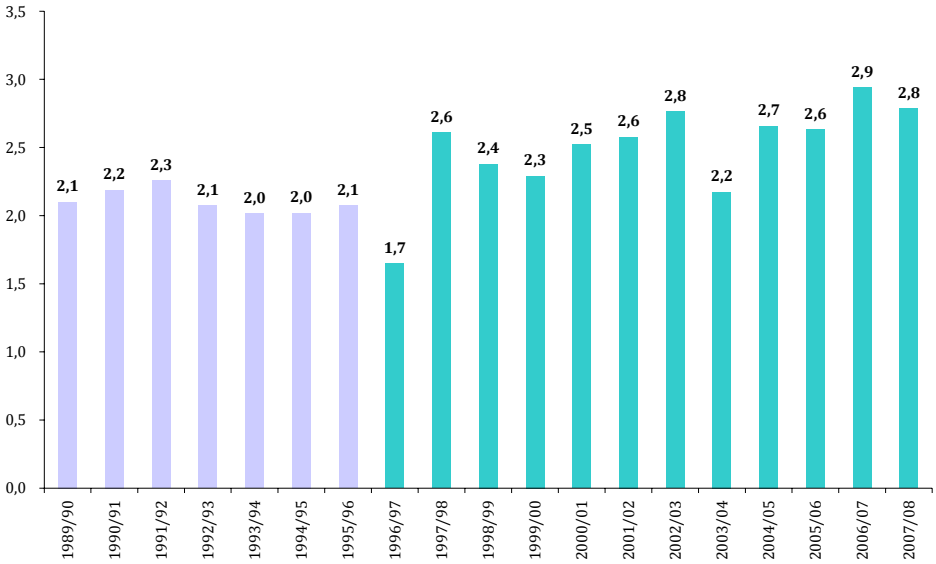
As a result, these associations have been able to surpass several innovation barriers, converging to the global state of the art. Unfortunately, domestic macroeconomic volatility has limited the development of both agents in farming productions that have longer maturation periods, like fruits growing and cattle breeding (Nava, 2003).

III. SOYBEAN PRODUCERS' INNOVATION MICRO AND MACROECONOMIC EFFECTS:

III.1. MICROECONOMIC EFFECTS:

Logically, the adoption of GMOs implied the growth of soybean cultivation's productivity, therefore increasing this activity's non-price-competitiveness (which was historically elevated as a result of the existence of natural static comparative advantages). In fact, average yields augmented from a range between 2,0 and 2,3 tons per seeded hectare in the early nineties, to nearly 3,0 tons per sowed hectare during the last two campaigns (*Figure III.1*).

FIGURE III.1.
SOYBEAN'S AVERAGE YIELD. 1990-2008.
Tons per hectare:

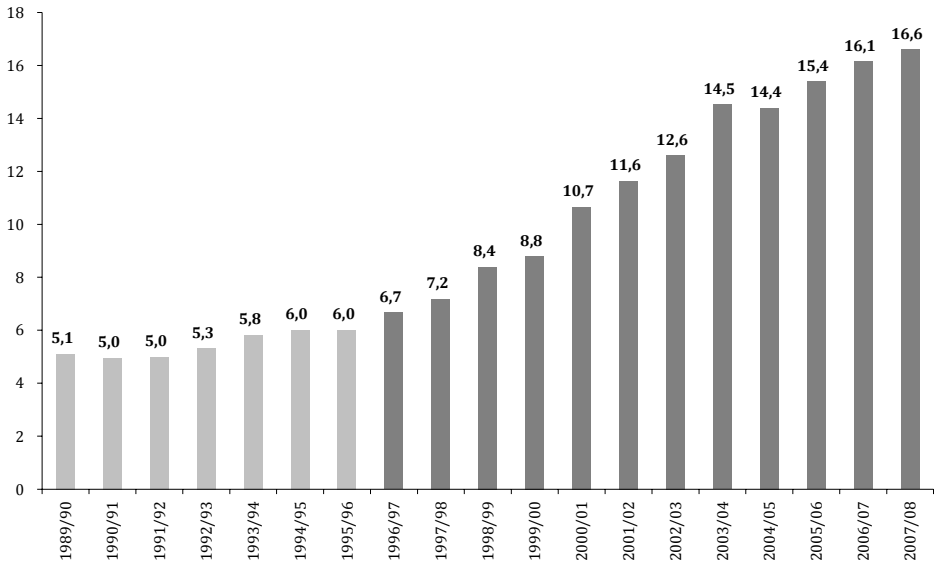


Source: Based on data from the Argentine Agriculture Secretary.

More so, the rise in the level of said indicator was attenuated by the diffusion of "double sowing" and the expansion of soybean production towards regions of smaller yields, both of which determined a partial fall in the mean productivity. In that way, yields grew substantially in the Nucleus Region (the most fertile lands), although its national average augmented comparatively less as a result of soybean cultivation's extension towards fringe areas (like the Argentine North East) and as a consequence of this oilseed's increasing role as a second crop.

Additionally, the surface sowed with soybean enhanced significantly since the introduction of GMOs, growing from approximately 6,0 million hectares in the middle nineties to 16,6 million hectares in the 2007/2008 campaign (*Figure III.2*). On the one hand, this process was related to the explosive surface expansion in non traditional soybean producing Provinces, like Entre Ríos and Santiago del Estero. On the other hand, the "double sowing" system allowed for this rise, as the dimension of the surface destined to cultivate soybean as a second crop augmented from 0,5 million hectares in 1996 to nearly 3 million hectares during the present decade.

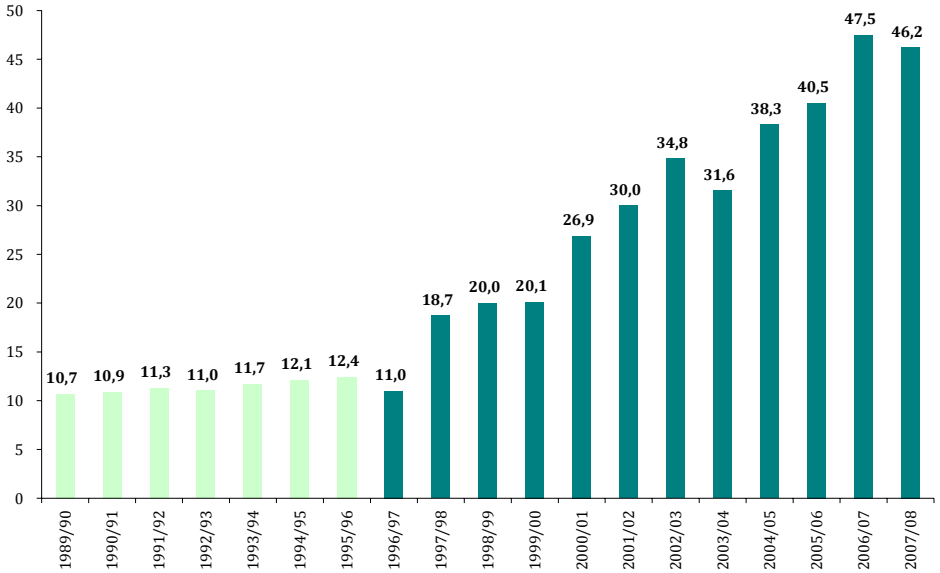
FIGURE III.2.
SURFACE SOWED WITH SOYBEAN. 1990-2008.
Million of hectares:



Source: Based on data from the Argentine Agriculture Secretary.

Naturally, the conjunction between yields' increase and surface's expansion implied a continuous enhancement in soybean primary production, that augmented from 12,0 million tons in the middle nineties to 47,5 million tons in the 2006/2007 campaign and 46,2 million tons in the 2007/2008 campaign (*Figure III.3*), achieving an average annual growth rate of 13,3% during the last decade.

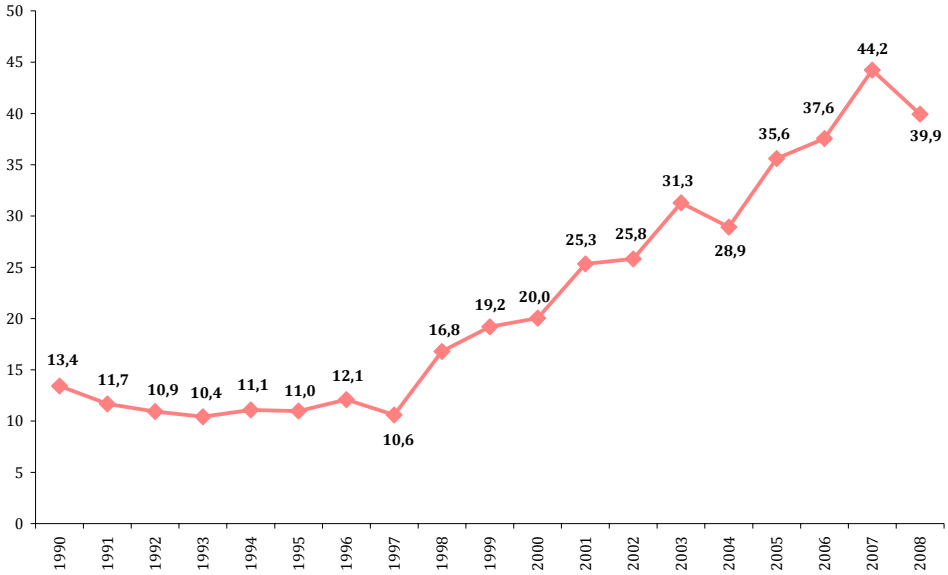
FIGURE III.3.
SOYBEAN PRIMARY PRODUCTION. 1990-2008.
Million of tons:



Source: Based on data from the Argentine Agriculture Secretary.

Finally, as both beans and its sub products have a weak domestic demand, the systematic increase in this oilseed production allowed for the continuous growth in these goods' exports, that rose from a total of 12,1 million tons in 1996 to 44,2 million tons in 2007 (*Figure III.4*). In turn, this result allowed for the expansion of the local soybean complex's participation in external markets, reality that contrasted with the (on occasions failed) efforts of diverse Argentine manufacturing branches to gain productivity in order to dispute the internal market with imports.

FIGURE III.4.
SOYBEAN EXPORTS (INCLUDING BEANS, OILS AND SUB PRODUCTS). 1990-2008.
Million of tons:



Source: Based on data from Indec.

Nevertheless, in 2008, a failed increase in export duties originated an extended conflict between soybean producers and the Government, which (in conjunction with primary production's fall) explained the diminishment of exports registered in said year (minus

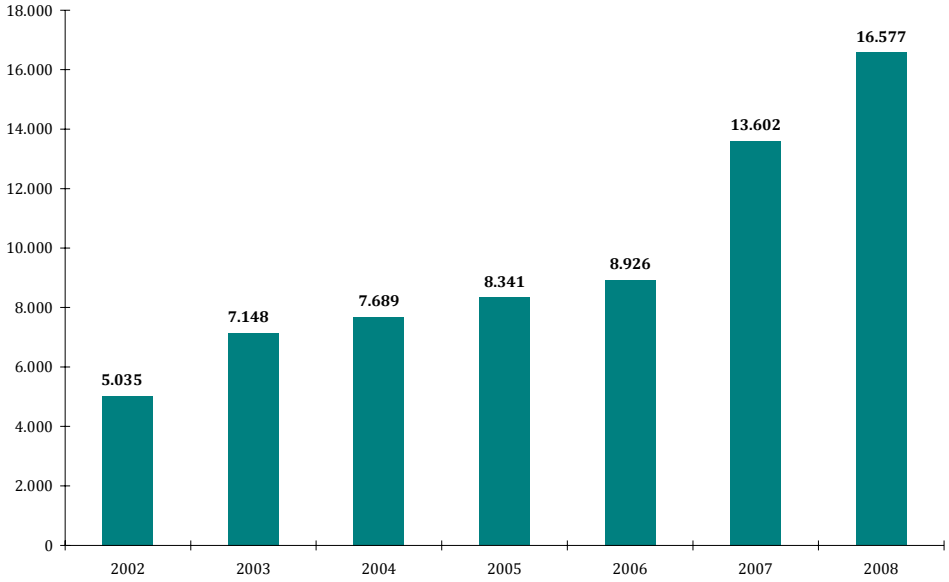
4,3 million tons). The implemented strategy of temporarily delaying soybean sales was made possible by the diffusion of the "silo-bags" storage technology, innovation that was created precisely to allow farmers to regulate their trade in the short term, in order to protect them against cyclical fluctuations in the internal and foreign markets' conditions (Bisang, 2007).

III.2. MACROECONOMIC EFFECTS:

It is possible to establish three basic links between soybean innovative and productive dynamics and the Argentine macroeconomy (Albrieu and Bernat, 2008): (a) changes in external sustainability; (b) variations in fiscal sustainability; and (c) effects in inflation. Naturally, although this section will focus exclusively in the three links mentioned above, it is not possible to ignore that the evolution of this activity had other consequences, such as changes in labor demand and the emergence of dualism within the agricultural sector[18].

Regarding the first link between soybean's evolution and macroeconomy, due to a symmetrical increase in quantities and international prices, the dollar value of soybean's exports (including beans, oils and sub products) triplicated between 2002 and 2008, increasing from us$5.035 million to us$16.577 million in that period (*Figure III.5*).

FIGURE III.5.
SOYBEAN EXPORTS (INCLUDING BEANS, OILS AND SUB PRODUCTS). 2002-2008.
Million of us$:



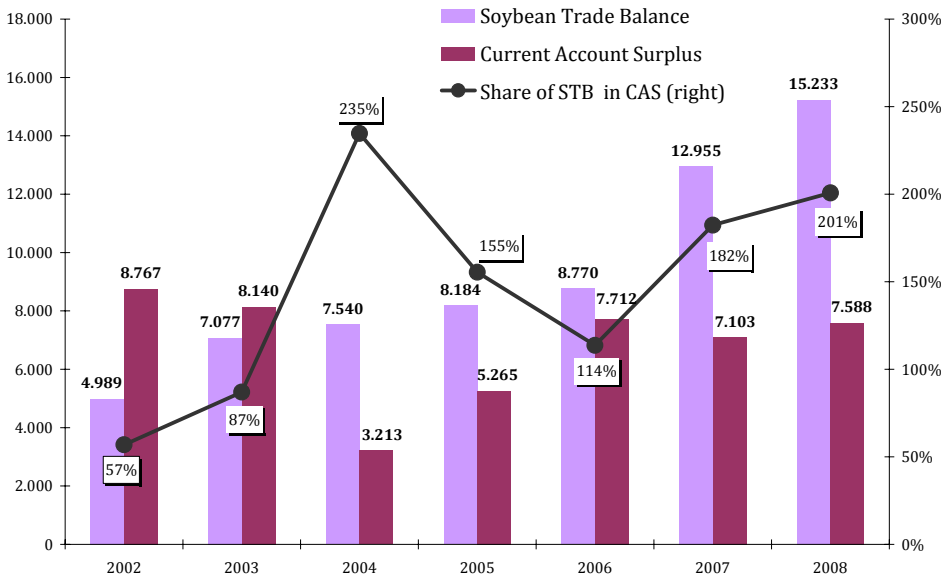
Source: Based on data from Indec.

The consequent positive effect of said evolution on global exports improved sensibly local macroeconomic external sustainability. Since Díaz Alejandro's (1970) seminal work on domestic economic history, several authors have pointed out that one of the main problems Argentina faces in trying to achieve a high long run growth rate is its

[18] Regarding the former, there is no consensus: some authors argue that the effects of soybean's dynamics are positive (Llach et al., 2005; Bisang, 2007), while others state just the opposite (Rodriguez, 2005). Regarding the latter, there is evidence that it has not been easy to replicate the high productivity soybean's pattern in other branches of the agriculture sector (Teubal and Giarraca, 2005; Bernat and Corso, 2008).

external (balance of payments) constraint. More precisely, potential output cannot be achieved because the exportable sector fails to provide enough dollars to buy the needed imported machinery and related inputs. As a result, once the country is growing fast, the trade balance turns negative and the growth process stops. Nevertheless, during the last six years, the soybean sector has provided a steady positive trade result, that averaged us$.6500 million[19] and that explained more than 100% of the global Argentine persistent current account surplus (*Figure III.6*).

FIGURE III.6.
SOYBEAN TRADE BALANCE (INCLUDING BEANS, OILS AND SUB PRODUCTS) AND ARGENTINE CURRENT ACCOUNT SURPLUS. 2002-2008.
Million of us$:



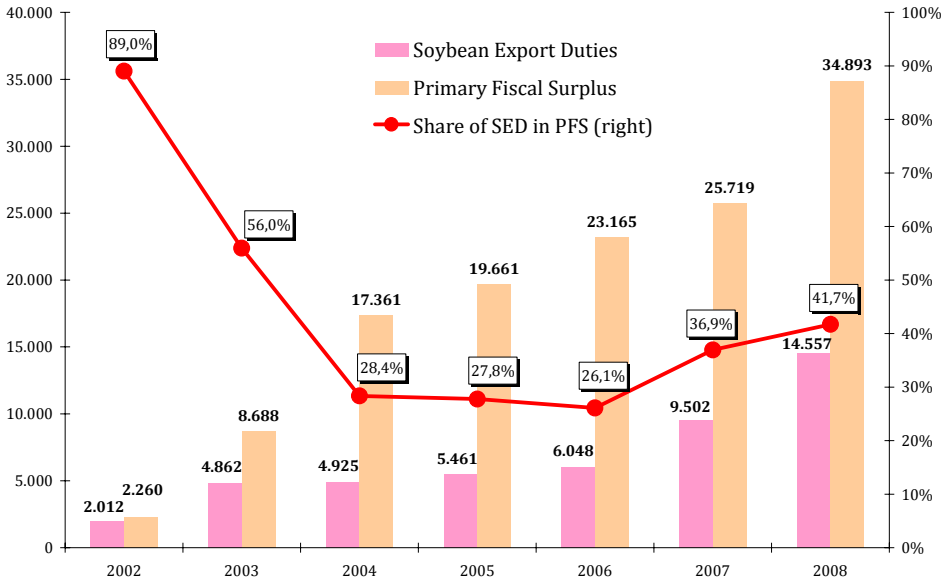
Source: Based on data from Indec.

Regarding the second channel, in Argentine recurrent macroeconomic crises, there was continuously a problem of "external transfer", in the sense that the economy as a whole has been unable to pay its external obligations. There was also a problem of "domestic transfer", as the agent who had the obligation to pay the external debt had to first manage to get the foreign currency from other domestic agents. More specifically, the Government has been historically the debtor and the exportable sector, the provider of foreign currency.

In 2002, export duties were reestablished for beans, oils and sub products, which, after some later adjustments, were fixed at levels over FOB values of 35%, 32% and 32%, respectively. Notably, revenues associated with export duties on soybean and its byproducts increased from $2.012 in 2002 to $9.502 in 2007 and to $14.557 in 2008, explaining 36,9% of the National Government's fiscal primary surplus in 2007 and 41,7% during the last year (*Figure III.7*).

[19] The local vegetable oil industry imported us$1.345 million in beans during 2008, in order to avoid the diminishment of local sales originated by the conflict between producers and the Government and, consequently, utilize the maximum of their installed capacity.

FIGURE III.7.
REVENUES IN CONCEPT OF SOYBEAN EXPORT DUTIES (INCLUDING BEANS, OILS AND SUB PRODUCTS) AND ARGENTINE PRIMARY SURPLUS. 2002-2008.
Million of $:



Source: Based on data from the Argentine Finance Ministry.

Last, the third channel relating soybean's innovative performance with macroeconomic conditions is through inflation, phenomenon that is damaging because it affects negatively key social indicators, such as poverty and income distribution. In this respect, many of the products that contribute to the local exports basket (e.g. meat, maize and wheat), which have risen their domestic prices in the last years, have a preponderant role in the basic consumption basket. It is important to acknowledge that this is not the case of soybean, whose participation in the basic food basket is practically null.

Nevertheless, soybean's constant trade surpluses has determined a continuous excess supply of dollars in the domestic market, which, in turn, led the Government to implement active policies in order to maintain the real exchange rate at competitive levels. By all means, the cost of this policy was not null: the need to buy the excess supply of foreign currency had a counterpart in the rapid expansion of domestic liquidity, which required active policies as well, regarding the sterilization of the inflationary component of the monetary base's increase. Consequently, the decision to control the nominal exchange rate and, by this mean, the real exchange rate at a competitive level, has generated repressed inflation. Thus, the positive and relatively high rate of inflation that is currently observed in Argentina is closely related to the reaction of the monetary authority to the significant surplus in trade balance engendered as a result of soybean's innovative dynamics.

IV. CONCLUDING REMARKS:

During the last decade, soybean production showed a high rate of innovation, as domestic farmers adopted state of the art technologies associated with biotechnology (herbicide tolerant varieties) without important lags regarding their international launch. This sector's high speed of assimilation of global innovations contrasted notoriously with the pattern observed for the rest of the primary activities and the majority of manufacturing branches. Therefore, the study of soybean's case became essential in trying to understand this innovative dualism. More specifically, one of the purposes of this paper was to identify the factors that impelled this development and draw lessons for the rest of the local economy, in order to transmit the high innovation pattern to the whole tradable sector.

In Argentina, tradable sector's innovation faces several barriers that are engendered and/or enhanced by macroeconomic volatility and that promote the adoption of "defensive strategies", restricting or delaying investment projects' implementation. On this matter, this paper showed that soybean production has been able to surpass mentioned restrictions during the last decade. As it was analyzed previously, the former activities' innovative dynamics counted with the collaboration of its providers (machinery, inputs, contractors), clients (Food and Beverage industries), investors (sowing pools and Direct Investment Funds) and different private organizations[20].

More so, soybean production is nowadays organized in network systems, that imply coordination between such diverse actors as farmers, suppliers, clients, investors, workers, technicians and science and technology institutions. These networks allow the improvement of each link's profits through formal or informal contracts, which specify not only transactions' financial conditions and prices but, also, include tangible and intangible flows of information, productive experiences and knowledge (Bisang and Kosacoff, 2006).

Consequently, the study of the soybean case revealed that innovation is usually not an individual (and frequently incremental) behavior's result, but a collective processes' consequence (Yoguel et al, 2006). In soybean's experience, the own agents' (farmers, suppliers, clients and private organizations) coordination was enough to promote innovation. Contrarily, in (medium)high-tech manufacturing activities and beef and apple production, firms have not been able to surpass obstacles by themselves (Bernat and Corso, 2008).

Regarding microeconomics, as a result of a decade of continuous innovation, soybean managed to constitute itself in the national sector with the best external integration. In fact, between 1996 and 2008, the primary production of oilseeds grew from 12 million tons to 46 million, whereas exports increased from 12 million tons to 40 million. In that way, Argentina transformed into the leading exporter of soybean's oil and flour, consolidating the main worldwide pole of oilseed production in the environs of Rosario (Province of Santa Fe).

Regarding macroeconomics, this innovative dynamics had two positive effects and one negative consequence. On the one hand, during the last six years, the soybean's sector steady trade surplus, that averaged us$.6500 million, explained more than 100% of the persistent national current account surplus, while the reestablished export duties on

[20] This segment's innovation is not observed by R+D based international comparisons, as these firms' innovate primarily through the adoption of exogenous knowledge incorporated in inputs and machinery.

beans, oils and sub products generated revenues that explained 41,7% of National Government's fiscal primary surplus in 2008. On the other hand, the monetary policy carried out by local authorities to avoid the real exchange rate appreciation associated to the systematic current account surplus represented one of the main causes that generated a positive and relatively high rate of inflation.

However, recent soybean's dynamics has exhibited three weaknesses which are important to state. First, the irruption of soybean tolerant to the herbicide glyphosate implied a significant change in the model of diffusion of innovations within local agriculture, since this transgenic was propagated directly by the subsidiaries of seeds' producers multinationals. On the contrary, the role of the INTA (Agricultural Technology National Institute), that had carried out the spreading of innovations during the previous fifty years, declined significantly, as biotechnology implies high investments in R+D and this public center suffered the loss of its resources and the reorientation of its activities against basic investigation.

Due to the transformation mentioned above, our country is nowadays a "fast follower" of the advances generated world-wide. Therefore, the innovative development of local soybean production depends on the (pecuniary) interests of seeds' subsidiaries to spread the new technologies. This dynamics offers a high power to multinational seeds producers, as they can charge high prices or, by default, forbid national farmers from technological advances. In this sense, the present dispute between Argentina and Monsanto is a paradigmatic case. Independently of the suitability of the company's argument, a final solution that does not satisfy its objectives could mean the exclusion of national producers from the new varieties of transgenic cultures developed by the firm.

Additionally, it is relevant to take into account that the fast diffusion of transgenic soybean has been feasible in our country due to some exceptional conditions, mainly the impossibility to patent locally this innovation (which reduced the price of herbicide tolerant seeds) and the high adaptability of the culture. Consequently, when new varieties demand higher expenses to be adapted to certain regions (characterized by worse climatic conditions) or types of producers, the propagation of innovations could be significantly smaller.

One second weakness of this innovative process consisted in the lack of advance towards the construction of new links in the soybean value chain (for example, nutritional products of high added value based on this oilseed's flour). The concentration of exports in food commodities (beans, oils and flour) implies that the yield of primary and secondary production is notoriously exposed to the volatility of international prices. This risk is considerably greater for small primary producers, that lack the financial capacity necessary to confront a prolonged cycle of low international prices.

Finally, the third fragility of soybean's innovative process resides in the weakening of primary producers' relation with their national suppliers of seeds, agrochemicals, fertilizers and machinery. In this respect, the diffusion of genetically modified soybean caused a transformation in the supplying system, since subsidiaries began to commercialize "technological packages". Consequently, the participation of national suppliers has reduced and, in many occasions, they were absorbed by foreign companies.

V. REFERENCES:

- Albrieu, R. and G. Bernat (2008), "Innovation and Export Dynamics in the Argentine Soybean Production Chain: a Study in Micro-Macro Interactions", presented at the 6th International Globelics (Global Network for the Economics of Learning, Innovation, and Competence Building Systems) Conference, México D.F., México.
- Albrieu, R. and J. M. Fanelli (2007), "El sistema financiero argentino", mimeo, CEDES, Buenos Aires, Argentina.
- Alvarez, V. (2003), "Evolución del mercado de insumos agrícolas y su relación con las transformaciones del sector agropecuario argentino en la década de los '90", Oficina Buenos Aires, Argentina.
- Barsky, O. and J. Gelman (2001), "Historia del Agro Pampeano. Desde la Conquista hasta fines del siglo XX", Grupo Editorial Grijalbo, Buenos Aires, Argentina.
- Bernat, G. (2009), "Innovación en la Industria Manufacturera Argentina", in "Del Ford Taunus a la soja transgénica. Hacia la Argentina del Siglo XXI", Katz, J. (coordinator), Secretaría de Cultura de la República Argentina and UNDP, Buenos Aires, Argentina.
- Bernat, G. and E. A. Corso (2008), "Some reasons for innovative duality among Argentine productive sectors", presented at the 6th International Globelics (Global Network for the Economics of Learning, Innovation, and Competence Building Systems) Conference, México D.F., México.
- Bernat, G. (2008), "Greater Buenos Aires Cluster: A Summary", Background paper for UNIDO 2008 Report.
- Bernat, G. (2006), "Interacciones entre la Macroeconomía y la Microeconomía en la Argentina de los noventa: efectos sobre el crecimiento, el desarrollo y la distribución del ingreso", Desarrollo Económico, Revista de Ciencias Sociales, N°183, Vol.46, octubre-diciembre.
- Bisang, R. (2007), "El desarrollo agropecuario en las últimas décadas: ¿volver a creer?", in "Crisis, recuperación y nuevos dilemas. La economía argentina 2002-2007", B. Kosacoff (ed.), Oficina de la CEPAL-ONU, Buenos Aires, Argentina.
- Bisang, R. and B. Kosacoff (2006), "Las redes de producción en al agro argentino", in the XIV Congreso AAPRESID, Rosario, Santa Fe, Argentina.
- Bisang, R. (2003), "Las tramas de carnes bovinas en Argentina", CEPAL, Oficina Buenos Aires, Argentina.
- Bisang, R. (2001), "Apertura económica, innovación y estructura productiva: La aplicación de biotecnología en la producción agrícola pampeana argentina", Idel, Universidad Nacional de General Sarmiento, Buenos Aires, Argentina.
- Bouzas, R. and J. Fanelli (2001), "MERCOSUR: Integración y Crecimiento", Fundación OSDE, Siglo XXI, Buenos Aires, Argentina.
- Brookes, G. and P. Barfoot (2008), "Global Impact of Biotech Crops: Socio-Economic and Environmental Effects, 1996-2006", AgBioForum, 11(1).
- Brookes, G. and P. Barfoot (2006), "GM Crops: The First Ten Years - Global Socio-Economic and Environmental Impacts", ISAAA (International Service for the Acquisition of Agri-biotech Applications) Brief 36.
- Caballero, R. and R. Pindyck (1996), "Uncertainty, Investment. and Industry Evolution", International Economic Review, vol. 37, No. 3.
- Caballero, R. (1991), "On the Sign of the Investment-Uncertainty Relationship", American Economic Review, vol. 81, No. 1.
- Chudnovsky, D., A. López and G. Pupato (2006), "Innovation and productivity in developing countries: A study of Argentine manufacturing firms' behavior (1992–2001)", Research Policy, Volume 35, Issue 2 (March).

- Crovetto, C. (2001), “La siembra directa y su relación con la fertilidad de los suelos”, AAPRESID, Mar del Plata, Buenos Aires, Argentina.
- Diaz Alejandro, C. (1970), “Essays on the Economic History of the Argentine Republic”, Buenos Aires, Argentina.
- Eurostat (2004), “Innovation in Europe. Results for the EU, Iceland and Norway. Data 1998-2001”.
- Ghezán, G., M. Mateos and J. Elverdín (2001), “Impacto de las políticas de ajuste estructural en el sector agropecuario y agroindustrial: el caso de Argentina”, Serie Desarrollo Productivo N°90, CEPAL, Santiago de Chile.
- IBGE (2005), “Pesquisa industrial de Innovação Tecnológica 2003”, Río de Janeiro, Brasil.
- Instituto Interamericano de Cooperación para la Agricultura - IICA (1997), “El sector agroalimentario argentino en los 90”, Buenos Aires, Argentina.
- INDEC (2006), “Encuesta Nacional a Empresas sobre Innovación, I&D y TICs 2002-2004. Análisis de sus resultados”.
- INDEC (2003), “Segunda Encuesta Nacional de Innovación y Conducta Tecnológica de las Empresas Argentinas (1998-2001)”.
- INDEC (1998), “Encuesta sobre la Conducta Tecnológica de las Empresas Industriales Argentinas”.
- INTA (2002), “Perfil Tecnológico de la Producción Agropecuaria Argentina”, Instituto de Economía y Sociología, INTA, Buenos Aires, Argentina.
- International Service for the Acquisition of Agri-biotech Applications - ISAAA (2009), “Global Status of Commercialized Biotech/GM Crops: 2008”.
- Katz, J. (2000), “Reformas estructurales, productividad y conducta tecnológica en América Latina”, CEPAL, Santiago de Chile.
- Kosacoff, B. and A. Ramos (2006), “Comportamientos microeconómicos en entornos de alta incertidumbre: la industria argentina”, Documento de Proyecto, CEPAL, Oficina Buenos Aires, Argentina.
- Lema, D. and J. A. Penna (2002), "Adoption of herbicide resistant soybeans in Argentina: an economic analysis", in "Economic and Environmental impacts of Agbiotech", N. Kalaitzandonakes (ed.), Kluwer Academic Publishers.
- Llach, J.; M. Harriague and E. O’Connor (2004) ”La generación de empleo en las cadenas agroindustriales”, documento de la Fundación Producir conservando, Buenos Aires, Argentina.
- Lódola, A. (2008), “Contratistas, cambios tecnológicos y organizacionales en el agro argentino”, Documento de Proyecto, Oficina Buenos Aires, Argentina.
- Lugones, G., F. Peirano and P. Guitti (2005), “Potencialidades y limitaciones de los procesos de innovación en argentina”. Documento de trabajo Nº26, Centro Redes, Buenos Aires, Argentina.
- Nava, O. (2003), “Políticas de financiamiento de la producción agropecuaria en la Argentina”, CEPAL, Oficina Buenos Aires, Argentina.
- Nelson, R. (1991), “Why do firms differ, and how does it matter?”, Strategic Management Journal, vol. 12.
- Nelson, R. and S. Winter (1982), “An Evolutionary Theory of Economic Change”, Cambridge University Press, Massachusetts, United States.
- Peirano, F. (2006), “La contribución del sector industrial al cambio tecnológico. Un análisis comparado de los casos de Argentina y de Brasil”, Documento de trabajo Nº28, Centro Redes, Buenos Aires, Argentina.
- Pindyck, R. and A. Solimano (1993), “Economic Instability and Aggregate Investment”, NBER Working Paper Series No. 4380.
- Pindyck, R. (1988), “Irreversible Investment, Capacity Choice, and the Value of the Firms”, The American Economic Review, vol. 78, No. 5.

- Pucciarelli, A. (1997), “Estructura Agraria de la Pampa Bonaerense”, in “El agro pampeano. El fin de un período”, Barsky, O. and A. Pucciarelli (coordinators), EUDEBA/FLACSO, Buenos Aires, Argentina.
- Rodríguez, J. (2005), “Los complejos agroalimentarios y el empleo. Una controversia teórica y empírica”. Documento CENDA Nº3, Buenos Aires, Argentina.
- Sánchez, G, H. Rufo and P. Nahirñak (2006), “La innovación en las empresas argentinas. Una mirada comparativa entre países”, Documento de Discusión N°6, Serie Competitividad Sistémica, IERAL, Fundación Mediterránea, Córdoba, Argentina.
- Schiantarelli, F. (1996), “Financial Constraints and Investment: Methodological Issues and International Evidence”, Oxford Review of Economic Policy 12.
- Schumpeter, J. (1942), “Capitalism, socialism and democracy”, Harper, New York, United States.
- Schumpeter, J. (1934), “The theory of economic development”, Harvard Economic Studies, Cambridge.
- Solow, R. (1957), “Technical change and the aggregate production function”, Review of Economics and Statistics, vol. 39, N° 3, Harvard University Press, Massachusetts, United States.
- Teubal, M. and E. Giarraca (2004), “El campo argentino en la encrucijada. Estrategias y resistencias sociales, ecos en la ciudad”, Alianza Editorial, Buenos Aires, Argentina.
- Trigo, E.; A. Chudnosky; A. López and E. Cap (2002), “Los transgénicos en la agricultura argentina. Una historia con final abierto”, IICA-Libros del Zorzal, Buenos Aires, Argentina.
- Vicién, C. (2003), “Tendencias en el desarrollo e introducción de materiales genéticamente modificados en el sector agrícola argentino”, CEPAL, Oficina Buenos Aires, Argentina.
- Yoguel, G., J. Borello and A. Erbes (2006), “Sistemas Locales de Innovación y Sistemas Productivos Locales: ¿cómo son, cómo estudiarlos y cómo actuar sobre ellos?”, Documento de Trabajo 04/2006, Littec, Instituto de Industria, Universidad Nacional de General Sarmiento, Buenos Aires, Argentina.
- Yoguel, G. and R. Rabertino (2000), “El desarrollo de las capacidades tecnológicas de los agentes en la industria manufacturera argentina en los años noventa”, in “El desempeño industrial argentino” , Kosacoff, B. (comp), CEPAL, Oficina Buenos Aires, Argentina.