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CENTRO DE INVESTIGACIONES SOCIALES  
SOBRE EL ESTADO Y LA ADMINISTRACION

PROYECTO ORGANIZACION DE LA INVESTIGACION AGROPECUARIA  
(PROAGRO)

THE PRIVATE SECTOR IN THE AGRICULTURAL TECHNOLOGICAL DEVELOPMENT.  
SOME CONCLUSIONS AND NEW SUBJECTS FOR ANALYSIS

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Document N° 18  
Preliminary version  
Buenos Aires, December 1985

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## I. INTRODUCTION

In several of our earlier works we have pointed out that the significant updating process which has taken place in Latin American agriculture for the last two or three decades shows a cyclic sequence, where each cycle or stage is marked by a predominant technology.\* The sequential nature of these technological changes appears with its own characteristics in the more developed agricultural areas, such as the Argentinian pampas and the Brazilian south region, where periods of intense technological change have taken place.

In each case, these cycles were determined both by economic and by natural resources conditions, as well as by certain characteristics pertaining to each technology and its relation with other techniques. For example, the introduction of improved seed varieties, which have high local specificity, had to wait until a substantial research capacity was developed in each country. The wide use of agrochemicals, which have low local specificity -on the other hand-, was not related to research capacity but to the adoption of improved seed varieties which, due to their higher production potential, made the use of agrochemicals profitable under the price relations current in Latin America.

Each cycle is characterized by a dominant type of technology. For example, grain production in Argentina progressed according to the following

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\* See PIÑEIRO, M., "Technological cycles in Latin American agriculture", CISEA, PROAGRO Doc. N° 12, October 1984. OBSCHATKO, E.S. de & PIÑEIRO, M., "Política tecnológica agropecuaria y desarrollo del sector privado: el caso de la región pampeana argentina", CISEA, PROAGRO Doc. N° 14, October 1985. And DA SILVA, J.G., "O Progresso Técnico na Agricultura", Instituto de Economía/UNICAMP, Campinas, Relatório de Pesquisa N° 10, Dec. 1984.

sequence: agronomic practices were followed by mechanization, which in turn was followed by improved seed varieties and, finally, by the wide use of agrochemicals. A main fact worth noting is that the principal technological elements were related to incorporated technologies. One of these, namely the production of seeds, is closely connected with agricultural production; while the others, in many cases, depend on industrial production related to an industrial sector highly sophisticated in its organization, and in a few cases (e.g. tractors and agrochemicals) they are dominated by large companies, generally transnational companies.

The progressive importance of incorporated technologies as the main factor in modernization also meant, as it is to be expected in free market economies, the emergence of a private sector which draws benefits from production and/or import and distribution of these technologies. The development rate and the emphasis on production appear to have been more closely related to the importance of the industrial sector in each country and to the policies carried out to this particular effect than to the special characteristics of each market in particular.\*

Together with the growth of private companies, another kind of private organizations also grew during these periods.\*\* Yet, at least in

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\* See OBSCHATKO, E.S. de, "Los hitos tecnológicos en la agricultura pampeana", CISEA, PROAGRO Doc. N° 10, Dec. 1984; BARSKY, O., "La oferta de insumos agropecuarios en el Ecuador", PROAGRO Doc. N° 8, May 1985; and DA SILVA, J.G., "A Relação Setor Público-Privado na Geração de Tecnologia Agrícola no Brasil", Instituto de Economía/UNICAMP, Campinas, Rel. de Pesquisa N° 13, May 1985.

\*\* For a description of the different kinds of private organizations relevant to the technological change process see PIÑEIRO, M., "Agricultural research in the private sector: issues on analytical perspectives", CISEA, PROAGRO Doc. N° 1, Nov. 1983 (available in English).

studies carried out by PROAGRO, these organizations were far less significant than those directly related to the supply of technological inputs. This is the reason why the present article will focus on the latter.

In sections II and III, three main and interrelated questions are discussed, which arise from case studies developed within the project. Firstly, how important was the role of the private sector in the supply of technological inputs and, through them, in the process of technological change? Secondly, was this role limited to the production and distribution sphere or did it also affect research and the generation of new knowledge? Thirdly, which elements in the economic and juridical system seem to have been more relevant to explain the private sector development and the kind of activity to which this sector has given priority? Are these elements specifically related to the agricultural sector or were they related to wider macroeconomic variables which affect the development of the industrial sector and of services in general?

In section IV, taking elements from the previous section as a starting point, some ideas related to policies connected with the development and performance of the private sector are presented.

Finally, in section V, some research areas which, in our opinion, should take priority for further studies, are discussed.

## II. THE ROLE OF THE PRIVATE SECTOR AND ITS QUANTITATIVE IMPORTANCE

The relative importance of the public and private sectors in the generation and widespread use of agricultural technology in the last decades has followed a similar pattern in different countries in Latin America, and similar also to that developed in the U.S.A. In spite of differences in time in the different countries, it can be said that the general process has consisted of an initial period characterized by a prevailing participation of the public sector (institutes, universities) in the technological change process, followed by another in which the private sector quickly developed as a supplier of industrial input for agriculture and a correlative decrease of the importance of the public sector.

This process is parallel to the succession of technological stages. During the first moment, as the public sector was the one which led to the generation of innovation, this innovation was preeminently of a non-appropriable kind, centred round agronomic practices. When conditions created by World War II made developing countries adopt industrial protection policies, the government of the larger nations took measures which fostered farming machinery production; these measures, which included some production by the State, were directed to strongly subsidize private production of those goods in each country.

As research in the central countries started to produce improved seed varieties and agrochemicals, i.e. goods which had some technological change incorporated and were, therefore, obtainable by producers, the importance of the private sector grew even more.

This growth and contribution of the private sector to the development of agricultural economy can be differentiated into two main characteristics: the generation of knowledge and technology, and the supply of input which have incorporated these technological changes, either through production or import.

In order to give a feasible generalization about the participation of the private sector in the different countries analysed, it is advisable to observe the evolution undergone by each type of innovation, studying the three main branches: machinery, improved seed varieties and agrochemicals.

In the field of farm machinery, innovation meant the adoption of machines which substituted for both animal and man's work and the introduction of innovation in the machines themselves.

At the present moment in Argentina, Brazil and Ecuador the supply of machinery is exclusively in the hands of the private sector, although there are differences in each country and in each of the three kinds of machinery (tractors, harvesters and farming tools).

In Argentina\* tractors were massively incorporated in the 60's, due to their manufacture by a State company first (between 1952 and 1962) and then by branches of four foreign companies. About 1980 a national company appears and dramatically takes over about 50% of the whole market. As regards the technological side of the question, the branches merely reproduced the models of their head offices, with slight adaptation; this meant that they were merely carriers of technology, not generators. The

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\* HUICI, N., "La industria de la maquinaria agrícola en la Argentina", CISEA, PROAGRO Doc. N° 9, Dec. 1984.



national capital company, on the other hand, used foreign models as its starting point but had a relevant role in the integration of diverse elements which generated innovations in both product and process technology. As to harvesters and farming tools, the whole supply is done by national capital private firms, their models being either adaptation of foreign models or designed by themselves. They also incorporate technology at the components level and carry out agreements for technology transference.

In Brazil\* the supply of tractors is similar to the Argentinian case; they have a national industry which, since 1960, has evolved from foreign company branches and which has been supported by government protection and subsidy policies to tractors' supply and demand.

In 1982 foreign company branches had 82% of the market share (Massey-Ferguson had 27%; Ford 24%; and Valmet 22%) and two national capital firms had the rest. The generation of technology by multinational branches is very little, since they merely reproduce -with some differences in time originated by balance among the national markets which they serve- the models generated in their head offices. The local adaptation they produce, called "tropicalization", is due to climatic conditions (refrigeration capacity enlargement) or more uneven topography (gravity centre lowering). It was only during a short time that these companies created a research and development department; it was when the industry crisis affected sales. At that moment they tried to develop a non-explored segment of the market, namely that of small tractors, but these activities were soon abandoned.

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\* DA SILVA, J.G., "A Relação Sector Público-Privado na Geração de Tecnologia Agrícola no Brasil", Instituto de Economía/UNICAMP, Campinas, Rel. de Pesquisa N° 13, May 1985.

In this oligopolyst market, national factories which manufacture tractors compete "through the absorption or development of production technology ...; they have created research and development departments to adapt technology and face problems derived from a captive market of motors and other equipment".\*

In Ecuador\*\* farm machinery and tools are exclusively imported; there is no national industry. The massive use of machines took place in the 60's, aided by policies which favoured their purchase and import.

There are about 15 private companies grouped under Asociación de Importadores de Maquinaria Agrícola (Farm Machinery Importer's Association). Supply is little concentrated and the largest company covers approximately 20% of the whole supply.

The Ecuadorian public sector, besides deciding on an executing the above mentioned policies, has a stock of machines with which it offers services which are at the disposal of the producers who ask for them.

In the area of seeds the three countries have made phylogenetic advances in the different cultivations, but the participation of the private sector varies in range and intensity.

In the Argentinian pampas, these phylogenetic advances can be observed in maize hybrids, grain sorghum and sunflower, in the incorporat-

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\* ABRANCHES PINHEIRO, F., "A Geração de Tecnologia no Setor de Máquinas Agrícolas", PROAGRO-UNICAMP, Rel. de Pesquisa N° 6, 1984.

\*\* BARSKY, O., "El sector privado en los cambios tecnológicos del agro ecuatoriano", PROAGRO-FLACSO, Doc. N° 10, 1985.

ion of exotic germplasm in wheat and in the introduction of complex technology in soybean, which includes variety selection and seed production based on foreign varieties.

The development of maize hybrids was started by the public sector around 1920, which got the first successful results by 1945. The private sector started working in the 50's. From a strong and direct activity at the beginning the public sector changed to a policy which fostered the private sector; gradually, the latter grew in importance until at present it supplies the 87% of maize hybrid used. In the field of grain sorghum the participation of the private sector has been exclusive from the very beginning because the seeds imported from the U.S.A. demonstrated immediate adaptation and no public adaptative research was necessary. As to sunflower hybrids the situation is similar (great adaptability) in seed crops imported from France and the U.S.A. and the private sector covers the whole production. In the case of maize and sorghum, about 90% of the hybrid supply is in the hands of 3 or 4 companies, branches of multinational seed breeders, while the rest is supplied by a small group of national capital small breeders.

This growth of the private sector in the seed production field was based on the technological policy implemented, which included measures such as free disposal of hybrids created by the public sector, the "closed pedigree" protection system, INTA's assistance to private sector's efforts. Besides, competition between both sectors meant a transference of many official geneticists and technicians to private seed breeders firms.

As regards the generation of technology, basic research in phyto-genetics has so far been carried out by the public sector, basically by

INTA. Private seed breeders do adaptative research on the seeds they import and on their cross with private or public lines already existing in our country. In the case of breeders which are branches of transnational companies, they do not carry out basic research, but benefit from what is done in their head offices and from cooperation between them and branches widespread all over the world.

The "closed pedigree" system prevents us from learning what the composition of the hybrids is and therefore what share of public and imported lines each type of seeds has.

As to the incorporation of exotic or "Mexican" germplasm to wheat, the public sector has had an important role in the generation of knowledge, since 60% of current wheat production belongs to these new varieties, developed by INTA in collaboration with CIMMYT. Two national capital companies later incorporated germplasm, thus generating new varieties. At present INTA produces a third of the seeds with exotic germplasm, and the other two companies produce the rest.

With regard to ~~soybean~~, the public sector was in charge of the initial jobs of variety selection and handling. After a decade, the collaboration between private and public institutions started, its aim being the spread of this crop, the use of adequate technology and the processes of industrialization and marketing. At present, all the activities connected with ~~soybean~~ are in the hands of the private sector, with the peculiarity that the technology is divided into a number of inputs as a result of which the generation of technology originates in many more different sources and is therefore less predictable.

In Brazil, research on hybrid maize was started by the public sector, which adapted both imported lines and crosses of and with native germplasm. Hybrids developed in the U.S.A. for mild climate were not well adapted to climatic conditions in Brazil, therefore its propagation was less significant than in other countries.

The participation of the private sector in maize hybrids took place by the end of the 40's with the foundation of Sementes Agroceres S.A., a company which carried out a slow adaptation work on the hybrids to edapho-climatic conditions in Brazil; the resultant seed crops, although apt to the high temperature in the region, are yet not apt to mechanical harvesting, nor are their yields comparable to those in mild climate.

The process carried out by the public sector until the mid 70's is still the basis for the present development of the private national sector. National capital private companies entirely depend on the public sector's technological support, and since the latter has diminished its activities, future difficulties can be foreseen in the area of competition between national and foreign companies.

By the end of the 70's, the big companies already in the country and new branches of foreign companies started introducing maize hybrids adequate for mechanical harvesting, which affected the preeminence of conventional hybrids used by farmers and marketed by Agroceres and Cargill.

The production of hybrid maize seed is divided as follows: Agroceres (national private company) 39%; Cargill (a branch) 20%; three national companies 12%; other foreign and national companies (with less individual participation) 29%.

In Brazil, the generation of wheat seed crops has been and still is in the hands of the public sector, both in research centres and universities. The private sector, specially the cooperative sector, has played an important role in seed multiplication. However, in the generation and introduction of new technology its role is far less significant; in the case of some introduction by the private sector, the public sector has had to support it.

Research on sunflower and sorghum is just beginning in Brazil. There are no apparent obstacles to the growth of the participation of new companies, national or foreign, in the generation of new seed crops and hybrids. Legislation on seed does not include any regulation as to the need to register private hybrid lines. Thus, companies may keep secret what lines they use. Limitations on expansion are more related to economic problems.

In Ecuador, the supply of improved seed varieties is of national production and of import origin (both legal and clandestine). Seed production is organized by the public sector combined with national private multipliers, under different systems. One of these systems is INIAP (National Institute of Agricultural Research) which creates and develops seed crops and produces small quantities of original seed. The main producer of seed is ENSEMILLAS, which is administered as a private company, although 99% of its capital belongs to the State. This company produces seeds marked "national priority" by the government: wheat, rice, barley, soybean and maize.

Main seeds imported in Ecuador are forage seeds, vegetables, soybean, maize and barley. The private sector imports 60%, the rest is imported by the State. Seed smuggling means the clandestine introduction of potato and bean improved seed varieties from Colombia.

As to agrochemicals, the characteristic feature of the last decade has been an ever increasing use of fertilizers, new herbicides and, in tropical cultures, of fungicides.

With regards to herbicides, there are common elements in the three countries which refer to how and how much the private sector participates, which in turn is due to technical characteristics of the goods consumed. The high cost of developing new chemical products, and the fact that new pesticides depend on active products of multiple use besides agriculture, is the determining factor which makes large multinational chemical companies dominate the different national agrochemical markets. This participation is shown in the production of active compounds at the head offices and in the importation and formulation of the final product in the consumer countries. This mechanism is reinforced by the monopolic control that many of these companies exercise on intermediate products and by legislation on patents. All this accounts for the fact that this industry does not carry out research to generate technology in these countries.

In Argentina, for example, the new pre- and post-emergency herbicides quickly incorporated over the last decade, specially for soybean, were not the result of research done in this country; the active products were directly imported thanks to a duties and exchange rate policy which lowered their relative price. It was an exclusively commercial process carried out by private companies, most of them branches of multinational companies. At present, a 90% of the pesticide market is estimated to be in the hands of less than 20 firms, most of them transnational firms.

In Brazil, an imports substitution policy stimulated national pesticide production, but most of it is based on import of the active com-

pound. In 1980, 80% of the production was controlled by branches of multinational companies.

In Ecuador, the origin of pesticides is totally imported. Herbicide and fungicide imports have dramatically grown over the last decade. Pesticides are imported by 20 large distributors. The technical department of these companies carry out experimental operations on adaptation of imported products and information operations on how to use them, through experiments in producers' fields.

As to fertilizers, the situation in the three countries is different, partly due to differences in types of crops. Considering that fertilizers are basically a combination of three basic nutritious elements (nitrogen, phosphorus and potassium) in different proportions, innovation is related more to process technology than to the product itself.

In Argentina the use of fertilizers in the pampas -for wheat exclusively- started to be intense only in this decade, particularly over the last two years, as a result of the Fertilizers National Plan, based on importation of nutrients through official organizations and cooperatives which implied a reduction in its relative price.

In Brazil, the state-owned company PETROBRAS ensures local supply of nitrogen from oil, ammonia and urea, and of phosphorus from calcareous rocks. Potassium, natural resources lacking, is totally imported. Five out of the fifteen large companies (both producers and mixers) are multinational. National companies are mainly engaged in mixing the elements. The private sector does not do research on fertilizers but it exercised some pressure for the creation of CEFER in 1976, a public centre of studies on



fertilizers which aims at developing new processes and non-conventional fertilizers.

In Ecuador the consumption of fertilizers has been steadily growing for the last 20 years. Its supply comes from national and imported production. National production -based on imported raw material- is monopolized by FERTISA, a formally mixed company, but controlled by the State in practice; it supplies about 20% of the demand. FERTISA has also a share of imports; together with other three private companies, it supplies 75% of the imported product. In Ecuador, the use of fertilizers is stimulated through duties exemption measures and loans to usage.

An analysis of the experience of the three countries in the incorporation of technological change over the last decade and in the participation of the private sector shows that it is not possible to arrive at an all-embracing generalization. Agricultural production characteristics, types of crops, diversification to a greater or lesser degree, size of input market, technology types, technological and economic policies, are a number of factors which have influenced the process and made it different in each case. Yet, there are some common significant elements that can be pointed out:

1. The private sector's participation is widely dominant in the supply of farming machinery or inputs which incorporate some technological change, either through its participation in local production or in import.
2. The private sector's participation in the generation of technology is closely conditioned by the supply structure of these inputs, which depends on the kind of companies that compose it. In fact, both in the case of tractors and hybrid seeds as in new herbicides, the branches of multinational companies have a considerable weight on the market. There-

fore, technological advances are, to a great extent, imported from their head offices and only adaptative research is done when direct transference is not possible due to ecologic conditions (e.g. maize hybrids in Argentina and Brazil). As a consequence, the participation of the private sector in the generation of technology within the countries analysed is limited to these seeds.

3. The private sector composed by national companies has a quantitative lesser participation in the technology transference process due to difference in human and material resources when compared to multinational companies. Yet, their role is important in harvester and farming tools industry, both in their production as in the incorporation of novelties. Besides, there are some exceptions worth mentioning, as has been this sector's participation in the generation of technology for wheat and tractors in Argentina for the past few years.

III. DETERMINING FACTORS IN THE PRIVATE SECTOR'S EMERGENCE.  
SOME HYPOTHESES

In general, the development of the private sector as a supplier of agricultural inputs has followed a pattern common to capital investment in general. Thus, the appearance of innovation which means a potential surplus seizable by the private sector, and the existence of markets (demand), generate profit expectancies which induce expansion of private investment.

Within each sector, a cycle in the activity undertaken by the private sector can be distinguished. The cycle starts with the importation of machinery or inputs which incorporate some technological change. The next stage is the production of these goods in the consumer country, using imported technology. The third stage adds technology generation to the production of inputs. Each stage implies a higher economic risk and a larger period for investment maturity than the previous stage.

A determining factor as to the stage in which the private sector will operate is the size of the market. It seems reasonable to assume that higher risk and longer periods for investment maturity will require a larger volume of the potential demand in order to make decisions on investment.

Ecuador, where machinery, a great portion of seeds and all agrochemicals are imported, is a good example of how a small market influences the way in which the private sector operates.

With regards to the private sector's growth in agricultural inputs in the last two decades, these general determining factors (profitability, market size) have been influenced by two kinds of facts. One of them, which goes beyond this specific sector, is a wave of investment in foreign coun-

tries by the large European and American industrial companies in the 50's and 60's. Their expansion and market take-over needs coincided with the structural crisis of developing countries, which considered that an imports substitution policy was the most appropriate measure to solve the crisis. Due to a shortage of national capital, these countries adopted a number of measures so as to draw foreign capital to the creation of industries, measures which coincided with the needs of large foreign companies.

But besides this general process, which influenced Brazil and Argentina\* similarly, there are other specific factors which account for the differences in the private sectors' development, depending on the inputs considered.

The first of them refers to technology characteristics, which notoriously influence the way in which the private sector operates. For example, in the case of seeds, when seeds improved in one country demonstrate good adaptability to receptor countries, local production based on imported seed crops usually develops rapidly, since it requires rather small investment which can be made at different times. That is the case with sorghum and sunflower hybrids in Argentina.

When, on the other hand, seed adaptability is poor, importation is impracticable and local production cannot develop without a previous, rather long process of adaptative research, closely related to local ecological conditions. In this case, adaptative research is a necessary con-

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\* See OBSCHATKO, E.S. de & PIÑEIRO, M., "Política tecnológica agropecuaria y desarrollo del sector privado: el caso de la región pampeana argentina", CISEA-PROAGRO, Doc. N° 14, Oct. 1985.

dition to develop production activities in the country. Investment required for adaptative research is greater than what is needed for production and its maturity period longer. Therefore, it needs a critical combination of capital and human resources, which may mean a restriction on the development of national capital private companies; only a few have made an attempt.

As to the factors which favour foreign private companies' investment on this activity, there are several to be mentioned: besides potential profitability expectancies and the companies' greater disposal of financial, human and technological resources, there is the influence of their market take-over policies and decisions made to this effect at their head offices. The kind of support that the private sector may expect from the public sector (technicians, research results, etc.) is also important. Although this is a factor which favours both the national or multinational private sector, the latter is usually under better economic and technical conditions to make good use of this support.

As pointed out before, in Argentina and Brazil the national private sector has intervened in adaptative research and autogamous seed production -a field of lesser profitability expectancy- whereas multinational private companies have centred their activity round adaptative research and hybrid seed production.

Herbicides serve as another example of how the technological characteristics of the product determine the modality of the private activity. The "modern" herbicides widely used over the last decade are based on complex active compounds, which were the result of already applied basic research developed by multinational companies in their head offices. Research is not carried out exclusively in the field of farming pesticides, but in

multiple fields. Investment required for each principle is very high (about u\$s 30 million); research is far apart from the final consumers; in general, no adaptation difficulties arise, therefore it is not necessary to do field work. As a rule, when a company is owner of a patent, it controls the market of chemical intermediaries needed to evolve these new products, which prevents other companies from using alternative supply sources. All these factors inhibit research development in receptor countries. It can be said that, in general, herbicides are imported by the private sector and then, in some cases, branches of those companies which originally developed them set up formulation plants, but this does not mean national production.

This situation is closely connected to the patent system; therefore, the other determining factor as to the way in which the private sector developed should be considered: namely, legal framework and technological and economic policies.

In Ecuador, the legal framework has favoured farm machinery and inputs supply through importation. The "Ley de Fomento y Desarrollo Agropecuario" (Agricultural Fostering and Development Act) exempts organic and chemical fertilizers' import from all kinds of duties. Loans through the Banco Nacional de Fomento (National Promotion Bank) stimulate the use of fertilizers. FERTISA, a formally mixed capital company but controlled by the State in practice, plays a significant role in basic fertilizers import and in compounds production. The use of pesticides (totally imported) is stimulated through duties exemption, preferential exchange rate, tax exemption, promotional credits offered by the Banco Nacional de Fomento. As to seeds, the importation of those which are not locally produced

(forage, soybean, maize, barley) is authorized and protected by a rigorous control of licensed importers. The State, on the other hand, participates up to a 40% of imports. National production of seeds considered "national priority" (wheat, rice, barley, soybean & hard maize) is also supported by a number of official measures.

As to the use of machinery, exclusively supplied through importation by the private sector, policies implemented in Ecuador have been: credits, duties exemption and preferential exchange rate. Different acts for the promotion of agriculture have determined exchange rate and duties advantages. At present, there is a total duties increase exemption on importation of farm machinery and tools, and there is a 30% margin on cost price for importers. On the other hand, the State holds a considerably large amount of machinery (205 tractors and 20 harvesters) with which it offers services to producers and which originates a constant demand for the importation of inputs.

In the case of Argentina and Brazil, policies leading to the introduction of technological change in farming practices were part of a wider industrial protection policy leading to import substitution. Therefore, they tended to punish imports and reward domestic production of those goods or areas considered a priority. Thus, it can be said that the development of the private sector as a producer of agricultural inputs is a consequence of a general macroeconomic policy under which these industries were not the only ones to be favoured. This does not mean, however, that there were not specific objectives to develop the agricultural sector which favourably coincided with industrial development policies.\* These consider-

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\* In different Argentinian documents the "close coordination of industrial and farming development" is set as an objective. (See, for example, Dis-

ations are applicable in the case of farm machinery and seeds in Brazil and Argentina, and of fertilizer in Brazil. It is not the same case (in these countries) with herbicides which, though locally formulated, depend on active products imports favoured by duties exemption, as previously analysed.

The following chart is a synthesis of the agricultural objectives which, broadly speaking, have been common to Brazil and Argentina over the last two decades, and of the kinds of policy instruments used which, as pointed out above, were not exclusive of the farm sector but part of an industrial protection policy. Through an analysis of the instruments used it can be assumed that they have been one of the major determining factors for the development of the private sector.

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./.. cursos del Secretario de Estado de Agricultura y Ganadería -Speeches by the Farm and Cattle Raising Secretary of State-, 1964).



ARGENTINA AND BRAZIL. Common elements in their agricultural policies over the last 20 years

MAIN OBJECTIVE	Increase farm productivity		
SPECIFIC OBJECTIVES	Providing producers :		
	Profitable technology	Financial surplus or cash flow	Capital assets and goods
I N S T R U M E N T S	Research done by the State	Credits for the purchase of machines and inputs based on	Direct manufacture by the State
	Transference to agricultural producers	low or negative actual interest rates	Tax benefits to the industrial sector: duties exemption for importation of industrial equipment and inputs; tax-lowering on returns re-invested in the company, etc.
	Transference to the private sector inputs producer	Tax benefits to producers for their investment on machinery, inputs and technology introduction in agriculture	Limits to competition in tractors  Secrecy guarantee in hybrids  Seed act

SOURCE: OBSCHATKO, E.S. de & PIÑEIRO, M., op. cit.

IV. SOME IDEAS FOR THE DEVELOPMENT OF A TECHNOLOGICAL POLICY  
WITH REGARDS TO THE PRIVATE SECTOR

The work carried out in Argentina, Brazil and Ecuador for the PROAGRO project, summarized in the previous sections, has made it possible to deepen the analysis of: a) the technological change process in the agricultural area; b) the quick growth of the private sector as a supplier of farm machinery and industrial farm inputs; and c) the dominant role played by multinational company branches, though there are very few but remarkable exceptions of national capital companies.

From the study of the determining factors of these phenomena two major conclusions can be drawn, which may be taken into consideration when adopting technological policies.

The first is the structural nature of this phenomenon since each country -according to its economic structure, the development degree of its different sectors and their interrelation- has peculiarly processed the world change originated in scientific and technological discoveries, in the technological and economic expansion of the power of multinational corporations and in international public centres of agricultural research.

The second conclusion is that policies implemented in the analysed countries have decisively influenced the process, making it easier, either through direct action by the State in the generation of technology and in some cases, in the production of the inputs which incorporated the technological change, or through measures to promote the private sector, socializing production costs and subsidizing the demand of such goods. The conjunction of structural elements with the kind of public policies implemented have determined, to a great extent, the particular panorama presented

by the private sector in each case.

In spite of the fact that the development processes pointed out made it possible for these countries to incorporate new technology and to enlarge their agricultural sectors, the new circumstances under which the world economy and technology develop incorporate other elements which question the continuity of these incorporation and growth processes. Then, the need to design policies to guarantee them arises strongly.

One of such new circumstances is the speed at which world scientific and technological changes in different areas take place (in biotechnology, computing, robotics, etc.). In addition to the quantitative changes in product ion functions this process produces qualitative modifications which alter both intersectorial relations and traditional comparative advantages. Industrialized countries compete among themselves and struggle to keep the control over these processes. At present, in the developing countries, the predictable access to these new discoveries is -as was the case with most of previous novelties- through transference via multinational company branches. But this means a repetition of the already existing uncertain situation, as to whether the production and market policies of these companies will coincide with the countries' interests. Besides, taking into account the competition process between companies, there is nothing to ensure that the companies already settled in these countries will be the ones to incorporate high technology. These branches, as has already been pointed out, were very active as carriers of technology generated by their head offices but they did very little as technology generators in the receptor countries.

As to national companies -with the exception of those cases where there is a control of elements of certain local specificity, or situations

with a strong personal initiative-, they are at a great disadvantage with regard to the technological and economic competition offered by multinational corporations. This competition is difficult to overcome without the assistance of the State or without agreements -so far little developed- with the big companies.

A third element which has been significantly modified when compared to what the situation was like 20 years ago is the state of public finance, both in industrialized countries as in the developing ones. In the latter, the chronic deficits of the national treasuries have been worsened by huge external debts incurred over the last years, a situation which is not independent of the evolution of the private and public economy of industrialized countries. Anyway, the consequence is that the active participation of our governments in technology or production generation is strongly limited by this situation. Simultaneously, in connection with these events, there is a re-flourishing of liberal political theories which press against State intervention in economy.

Under such circumstances, the need of the developing countries, food producers and exporters, to increase production and productivity and to keep their international competition level increases. The growing participation of industrial inputs in the final product adds the need to obtain such inputs at competitive prices.

Taking into account the development stage reached by the private sector, the elements which have been considered its main determining factor and the questions introduced by the new conditions in world science and economy, the objectives of a technological policy for these countries should take into account three fundamental issues:

- availability and adoption of new technology
- a certain degree of autonomy of the country in technology generation
- continuity in the generation of technology.

In order to arrive at availability and adoption of profitable technology, the measures must be aimed at three objectives:

- technology generation: this is related to the development of research at different levels, from basic to adaptative, plus inputs tests and verification;
- inputs supply, related to their production and distribution, and which implies coordination with industrial policies;
- innovation adoption, related to policies which foster demand of technological innovations either incorporated or non-incorporated (agricultural policies) and transference actions to users.

As to the achievement of autonomy and continuity in the generation of innovation, three basic objectives appear:

- the development of a significant bulk of basic and strategic research to allow the country to reach new productivity levels, since innovations incorporated over the last decade might be near their top yield and Argentina's competitor countries in the world market are actively working on new scientific areas (e.g. biotechnology);
- design of some mechanisms through which some control on private research might be exercised, so that the public sector will be the only one to handle the technological strategy;
- design of some mechanism so that the private sector activity may be guided by the public sector.

Therefore it is utterly important to progress on the description of the public sector's actions aimed at the above mentioned objectives. The

public sector may guide, exercise control or act directly. Under the present conditions the justification for its greater or lesser participation derives from the need to guarantee autonomy and continuity conditions. The public sector must create the necessary conditions to this effect trying to strengthen national private companies and to set mutually convenient relations with transnational companies.

With regard to the public sector, there are five fundamental items: strategic and basic research; public sector institutional organization; human resources' difficulties; political support to public research; formulation of action proposals.\*

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\* For a deeper analysis of these topics, see OBSCHATKO, E.S. de & PIÑEIRO, M., op. cit.

V. SOME SUBJECTS PENDING FOR RESEARCH

PROAGRO project has tried to analyse and understand the role played by the private sector in the agricultural and technological change. We were interested not only in describing and characterizing this role but also in understanding the institutional and economic forces which can explain both speed and quality of emergence and growth of the private companies which have directly participated in the technological process.

The three studies done so far throw some light on this subject but fail to definitely answer a number of important questions, upon which more empirical work and thought will be needed.

Before discussing the pending subjects, we would like to point out the main conclusions and perceptions arrived at through this study.

1. The technological change played a fundamental role in the development of agricultural production and land productivity over the last two decades. In most of the cases, the initial stages of the process were dominated by agronomic practices, developed by adaptative research. Over the last years, the incorporated techniques grew in importance and were responsible for productivity growth. The sequence according to which these incorporated techniques were adopted followed a pattern influenced by: a) local specificity of technology and research capacity of national programmes; b) the relative availability of domestic factors and economic policies; and c) certain technical relations among dominant technologies.
2. The role played by public institutions was very important during the first stages of the innovative process, due both to their participation in adaptative research aimed at the development and propagation of

agronomic techniques and in the development of human resources, and to the general approval on the importance of science and technology. These institutions also played an important role during the first stages of development and promotion of improved seed varieties. However, under greater modernization, private institutions grew in importance, particularly in the production of industrial technological inputs.

3. The development of the private sector responsible for the production and distribution of technological inputs has been dominated by transnational corporations. This has meant a progressive internationalization of the innovative process, and a greater and more complex dependence of the developing countries upon research in industrialized countries.
4. The private sector has grown in importance as a technology carrier, due to its active participation in the importation, production and distribution of incorporated technology which is protected by patents or other commercial or institutional mechanisms which protect private property over the knowledge involved. But it is important to point out that the role played by the private sector in the creation of new knowledge (research and development) in developing countries has been insignificant. This holds true even in the case of improved seed varieties, where the contribution of private firms has been significant but probably less than what is commonly expected.
5. The development and emergence of the private sector appears to show a pattern closely related to an up-dating general process and its qualitative characteristics. There seems to be a dialectical relationship between the interrelated sequence and propagation of the main technologies and the emergence and growth of the private sector which is its main carrier. The importance of this perception is that it implies that the de-



termining factors for the development of the private sector are of a structural nature and are related to the economic development level, industry development, services and infrastructure, and demand of technological inputs which this produces, rather than to specific political instruments such as patent regulations or investment credits for the industrial sector which produces technology.

This hypothesis brings about two important consequences. Firstly, it provides a new and more useful meaning to the concept of suitable technology. It implies that the technology used by the agricultural sector must be suitable not only to agricultural production conditions but also to the country's general development level, which must be able to answer its requirements for new services. Secondly, it illustrates the limited reach and efficacy of specific political instruments directed to the industrial sector which produces technological inputs for agriculture, when they are not part of a wider industrial development policy.

6. The idea of an up-dating process which evolves in sequential stages characterized by dominant technologies and with growing importance of incorporated techniques has a number of implications both for the organization and for research priorities of the public sector's institutions. These implications have been discussed to a certain extent in a special report\* and will not be dealt with here.

7. There are still some subjects which have not been deeply analysed and which might broaden the range of political recommendations. These subjects are:

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\* PIÑEIRO, M., "The Development of the Private Sector in Agricultural Research: implication for public research institutions", CISEA, PROAGRO, May 1985.

a) Exploration of the technological panorama of the Pampean agricultural sector for the middle and long term. The technological landmarks reached over the last decades, specially with regard to improved seed varieties, has reached the diminishing returns phase. Agrochemicals (fertilizers and herbicides), on the other hand, are only partially developed. As a consequence, new questions arise:

- which will be the technological pattern for the agricultural business in the near future?
- to what extent will its dependence upon inputs increase?
- will this mean a reduction for producers alternatives?
- will the "agriculturization" and specialization of agricultural production grow?

b) Decisions on research priorities. The agricultural sector's technological progress is closely associated with an increase in research on different levels and areas of productive activity (agriculture and industry). Social resources to face this challenge are scarce: public funds are limited by severe restrictions, multinational company branches develop little technology generations in our country, and national capital companies are, in general, not large enough to afford the cost of up-dating activities. Bearing in mind this lack of balance between requirements and resources, the State must decide on a clear scientific and technological research policy, one of its first actions being the selection of areas of greater interest because of their probable consequences. The decision on priorities will define the sector's technological route for the middle term. An advance on research on those priorities, at different levels, can be done.

c) Genetics has been the principal cause for the dramatic increase in agricultural productivity over the 70's. The recent progress in bio-

technology made by the main world scientific centres may produce drastic changes in products, in production volume and even in the countries' comparative advantages. Phyto-genetics is one of the first research priorities for Pampean agriculture, and it is absolutely necessary to progress in the design of the public and private sectors' role. So far, multinational company branches have not shown any special interest in developing this research locally. International Centres of Agricultural Research, on the other hand, already have plans in this field, which could be used as a basis for coordinating national programmes. The public sector should, at least, decide which activities will be fostered, which will not be, which control measures will be taken, and what kind of research should be directly carried out to ensure efficacy of the research system.