

ANNEX D6

**PITA Project: Policy Influences on Technology for Agriculture:
Chemicals, Biotechnology and Seeds**

**SMEs in the Spanish Agrochemicals, Seeds
and Plant Biotechnology Industries**

Annex D 6

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Introduction to the PITA Project

Technological innovation in the agrochemical, biotechnology and seeds industries and in associated public sector research establishments (PSREs) has the potential to deliver more socially and environmentally sustainable farming systems and to improve the quality of life of citizens in Europe. This is particularly true of farms on the most fertile land. However, although policies developed in different areas may all aim to improve the quality of life, in practice, in their influence on company and PSRE strategies, they frequently counteract one another and so attenuate the desired effect.

Market-related factors also influence decision making in industry and PSREs, the most important for this project being the policies of food processors and distributors and also public attitudes and opinion, which often set more demanding standards than those of national governments and the EU.

The PITA project (see Project Structure) is developing an integrated analysis of policies and market-related factors relevant to the agrochemical, biotechnology and seeds sectors. The core of the project is an investigation of the impact of these factors on the strategies and decision making of companies and PSREs and the downstream implications of these decisions on employment, international competitiveness and environmental benefits. The final outcome will be feedback of our conclusions to policy makers and company managers.

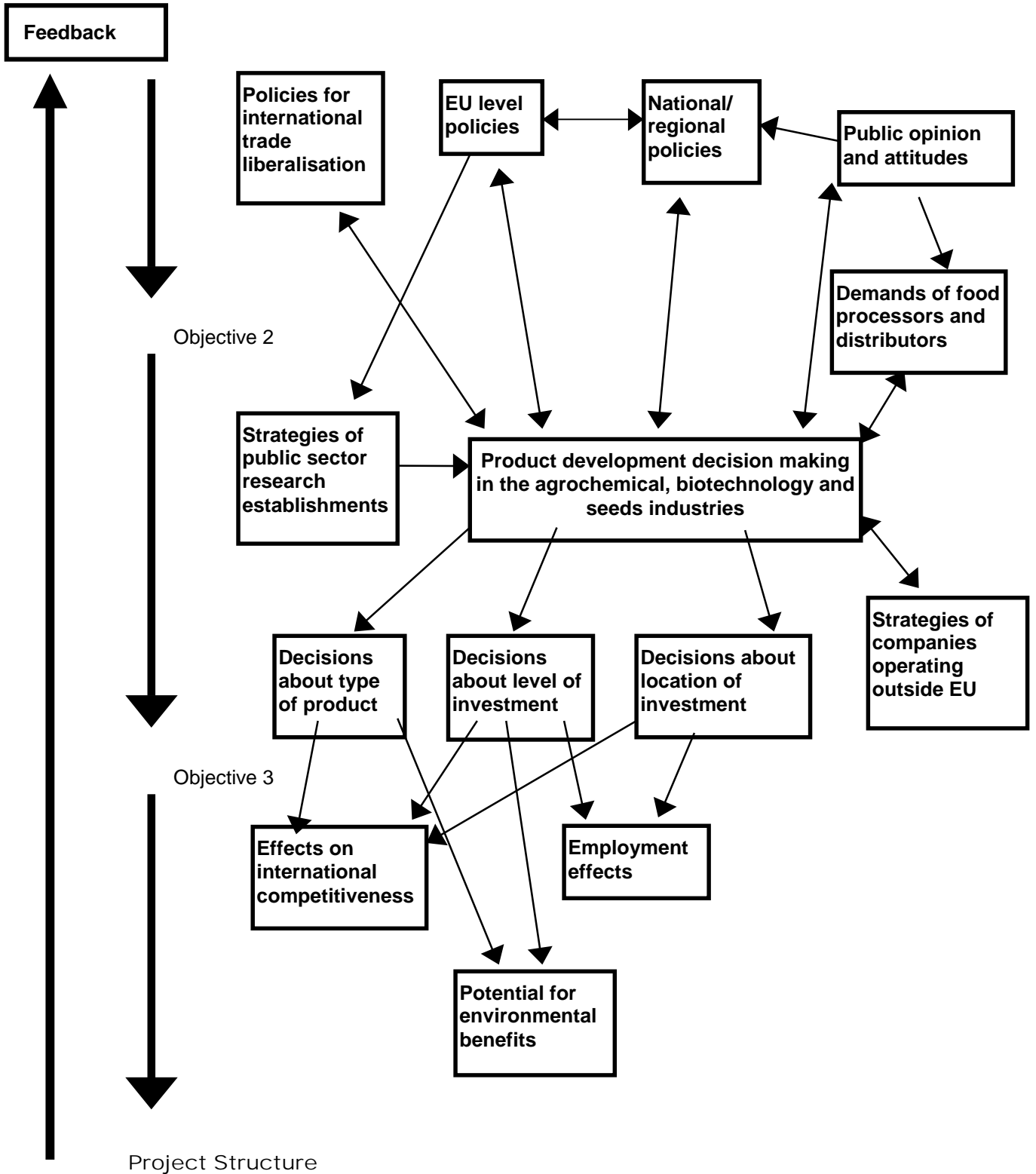
The range of policies and other influences studied includes:

- policies to stimulate innovation in the agrochemical, biotechnology and seeds industries;
- purchasing policies of food processors and distributors;
- policies for international trade liberalisation;
- policies for the regulation of industry and farming (for environmental protection and public health and safety, particularly for pesticides and biotechnology);
- agricultural and farming support policies, particularly for crop production;
- policies to promote environmental sustainability and wildlife biodiversity in arable farming areas;
- public opinion and attitudes.

The overall aim of the project is to contribute to the development of sustainable industrial and farming systems and an improved quality of life by encouraging the development and uptake of 'cleaner' technology for intensive agriculture. Its objectives are:

- to develop an integrated analysis of policies and market-related factors relevant to technological innovation in the agrochemical, biotechnology and seeds sectors, to study their interactions and to develop hypotheses about their impact on strategic decision making in industry and PSREs.
- to study the influence of policies and market-related factors on innovation strategies in the agrochemical, biotechnology and seeds industries and PSREs, and their impact on decisions about product development, levels of investment and location of investment.
- to study the outcomes of the industry decisions investigated under objective 2, in their effects on employment, on international competitiveness and on their potential to deliver environmental benefits.

Objective 1



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Introduction

Objective 2 of the PITA project is to study the influence of policies and market-related factors on the innovation strategies of companies in the agrochemical, seed and biotechnology sectors, and their impact on their decisions to develop new products, investment levels and allocation of investments. In this report we will focus on the factors and agents that determine the SMEs' decisions on innovation and that can affect their capacity to implement innovations successfully. This report tries to answer two questions: What is the role of SMEs in the innovation processes in these three sectors (the agrochemical, biotech and seed industries) in Spain? What is the influence of policies and market-related factors on innovation strategies of Spanish SMEs there?.

The classification criteria of SMEs vary considerably, depending on countries and sectors. That is why in our report we have considered as SMEs those which, not taking into consideration their size, fulfil these two requirements: they are not a multinational corporation (MNC) or part of one, and they have a high degree of independence in defining their strategies. Then, in each sector we have chosen SMEs with: 1) in-house R&D activities; 2) products protected by intellectual property rights; and 3) a significant share of national market in the case of agrochemicals and seeds sectors, while considering all the biotech firms as innovative.

In conducting this study two instruments have been used: i) a literature review; ii) interviews with the most representative business organisations and relevant SMEs. Interviews have been conducted with the following: AEPLA (main Spanish business organisation in the agrochemical sector); APROSE (main Spanish business organisation in the seed sector); and with five SMEs (three agrochemical ones and two in the seed sector). Information from interviews has been supplemented with secondary information.

For the agrochemical and seed sectors, this report studies the following aspects: general features; innovation strategies; impacts of public policies on decision making; and attitudes towards environmental issues and biotechnology. The biotechnological sector is not studied because we have not found any independent SME focused on plant biotechnology in Spain.

Very few SMEs do R&D activities in these sectors and have independence in defining their strategies. Rather than quantify the features and innovation strategies of the Spanish SMEs, our results provide a qualitative analysis on their role in the innovation processes in these three sectors, as well as the policy influences on their innovative behaviour.

The agrochemical sector

General situation of SMEs in Spain

The Spanish agrochemical market has had a significant growth in recent years. Total sales have increased by 60% between 1993 and 1999 (from 356 million to 578 million euro, according to agrochemical producers). Table 1 shows the progressive increase of the value of plant protection products (PPPs) sales during recent years. The drop in 1999 could be due to the adverse agri-climatic conditions in that year: *"this drop is clearly a temporary circumstance and does not mean a change in trend, but is rather related to atypical agri-climatic conditions, with a very dry spring that has negatively affected the fungicide market (-8,1%) and the herbicide market (-4%)"* (AEPLA, 2000). Although the increase of agrochemical sales shown in the table may reflect an increase of agrochemicals prices, there is no evidences of reduced agrochemical usage in Spain.

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Table 1 Evolution of agrochemical sales in Spain between 1993 and 1999 (million euro at current prices)

Product	1993	1994	1995	1996	1997	1998	1999
Insecticides	128.4	152.7	174.2	179.2	190.0	208.6	204.8
Fungicides	76.2	84.4	85.7	104.6	118.3	135.3	124.2
Herbicides	106.9	131.5	122.1	160.8	172.0	187.8	178.3
Other	44.8	47.8	51.4	60.4	63.6	67.7	69.3
Total	356.2	416.4	433.4	505.0	543.9	599.4	578.6

Source: AEPLA, 2000

On characteristic of the Spanish agrochemical market is the important presence of multinational companies, which account for almost the whole market. On the other hand, it is a very diversified market with a wide range of crops and agro-climatic conditions. This leads to the existence of local markets that demand very specific products.

This feature is very important to understand the role of SMEs in Spain. The high presence of multinational companies has reduced greatly their action capacity and limited them to local markets and specific crops. This focus on local markets, which are of little interest for multinationals due to their small size, was frequently mentioned in our interviews:

"The opportunities for the SMEs are in the marginal markets that have not been entered by the multinational companies yet" (AEPLA interview, 1999).

"SMEs are very important in the national market because they fill gaps not covered by the multinational companies" (interview 4).

"If the SMEs disappeared, a great number of products would be lost because for multinationals it is not cost-effective to sell them, though they are very necessary for farmers" (interview 2).

The main activities of SMEs in the sector in Spain is the formulation and generic production of products based on active substances whose patent has ended or ceded by multinational companies, bottling and distribution. Only very few companies synthesise their own molecules to produce new PPPs. Some companies also develop products on demand for other SMEs or multinational companies.

The SMEs interviewed declared that their main competitors are other SMEs, because they operate in the generic products market. There are two types of markets: the *"generic products"* market, with products based on molecules without patent used by the SMEs for their different formulas; and the *"specific products"* market, based on new molecules developed by the multinational companies, to which SMEs do not have any access. In the generic products markets competition among the SMEs is intense and price-based: *"we could say that there are two markets: one of generic products and another one of new and more specific products. The specific products market is a monopoly of the multinational companies and the SMEs do not enter it. The generic products market includes all types of companies and it is a very competitive one in which product price plays a very important role"* (interview 2).

Spanish agrochemical manufacturers are in general small family businesses that have been operating for more than twenty years. They have survived the concentration process occurred in recent years by which the multinational companies have acquired the companies with the highest potential. Other companies have focused their activities on the pharmaceutical sector attracted by the higher profit expectations and the improvement of their corporate image.

"The market evolution is quite uncertain. Some companies with good distribution networks or a larger market share can be acquired by multinational companies. However, most companies have appeared after them, by using products that were losing their patent, without

research or marketing costs, and approaching farmers with much cheaper products; this has enabled them to stay in the market" (interview 4).

Innovation strategies

The main feature in the strategies of the most relevant Spanish SMEs is their specialisation in market segments (small crops, mainly) with an essentially local character and with generic products. This strategy has resulted from characteristics of the world agrochemical market -- a mature one with a high concentration rate. Moreover, most of the relevant SMEs are adding to their portfolios biopesticides or products for Integrated Pest Management systems (IPMs).

All the SMEs interviewed underline the importance of research activities for them: "Nowadays research is gaining importance and investments in product development are growing. In the past years we have doubled our research efforts and the process is not finished yet" (interview 3).

Over the next years the objective of the SMEs is to reinforce their research activities, not in order to compete with multinational companies, but rather as an essential element to consolidate their competitive position in the domestic market: "*more and more SMEs will have to devote more resources to research and to adapt research to the company's possibilities*" (interview 4).

Research conducted by SMEs consists basically of the development of new formulas from molecules without patent. Luis Roy, AEPLA director, declares that "*the large multinational companies are the ones that really conduct research, but their research centres are abroad and what we do here [in Spain] is applied research to design new formulas and presentations*". The research on new molecules is generally out of their reach due to their insufficient financial resources, therefore this field is restricted to multinational companies. "*So far we do not have the capacity of creating new molecules because this is a very costly process. At this moment no Spanish company can do it*" (interview 2).

As far as public research centres are concerned, their relations with SMEs are not very close: "*the collaboration initiatives are generally made by the research centres and they are very personal projects that depend from the researcher that starts them up*" (interview 2). In general it is the research centres who look for collaboration from the companies, but only sporadically and not by means of long term collaboration agreements. Furthermore, the collaborations that take place originate in personal initiatives of some researchers in the public sector, they do not lie within the framework of any joint research programmes between a research centre and a company.

SMEs consider that research in public centres does not focus on solving business problems, and that general research assistance offered in national research programmes is not very useful. This opinion can be explained by the SMEs' lack of managerial and financial capacity to invest in long term research, though SMEs are very reluctant to admit this. However, they think that public research can be a very important resource for their activity in forthcoming years if joint research programmes are aimed at solving concrete farming problems. An example to be followed is the research project started by the INIA (National Institute for Agriculture and Food Research and Technology of Ministry of Agriculture) to find alternatives for methyl-bromide, whose use is going to be forbidden. This project has brought together the efforts of companies and researchers to solve a specific problem.

Discourse in agriculture and environment; attitudes towards biotechnology

In general, the agrochemical sector feels a strong pressure of the public opinion and the legal regulations to reduce the usage of agrochemicals in farming. In response to environmental pressures, some big chemical companies are separating agrochemical production from their other activities ("*many companies are separating pesticides from the parent company by means of the foundation of new companies that are totally separated from their other activities*" (interview 3); and business organisations are participating in information campaigns aimed at improving the social image of agrochemicals. AEPLA is conducting

communication campaigns on the security parameters, the benefits and the need of their use in agricultural production. Increasingly, the agrochemical sector has incorporated the environmental variable into their discourse.

Agrochemical SMEs in Spain do feel this environmental pressure. Some of them participate in information campaigns, launched through producer organisations, emphasising the need of a more correct use of agrochemicals and on the treatment of the packaging used, as the greatest environmental impacts of agrochemicals result from their improper use. *"Public opinion pressure is very strong in the agrochemical sector and we try to communicate that our products generate little waste and are necessary for agriculture"* (interview 4).

Another effect of environmental pressures has been the development of IPMs. Most of the innovative Spanish SMEs in this sector are developing or planing to develop products to be used within IPMs. Others are exploring the possibilities of the bio-pesticides markets, especially Bt products.

Biotechnology is a controversial issue in the agrochemical sector. In AEPLA's opinion (most of its members are multinational companies), biotechnology is a tool that can render great benefits for the sector: *" biotechnology and plant health products are complementary, biotechnology contributes to ensuring food production for a growing population and to make up for deficiencies caused by single crop farming. It will also contribute to improve the cost-effectiveness of farming units"* (interview to AEPLA, 1999).

However, this advantage is not perceived by some SMEs, especially those that produce their own agrochemicals, which fear that future developments of biotechnology lead to a stronger monopolistic position of multinational companies, which will be able to provide more competitive products linking biotechnological products and new agrochemicals. That means a danger of being cornered out of the market: *"Biotechnology research does not affect our company so far, but in the future multinational companies can take a more monopolistic position with this type of products"* (interview 2); *"biotechnology is a threat to us since we do not have the capacity of creating resistant transgenic seeds [seeds resistant to their products], therefore, we will become mere spectators"* (interview 4).

Most companies are viewing with uncertainty the integration process of biotechnology into the agrochemical sector; they are adopting a "wait and see" strategy. In some cases we find attitudes that are strongly antagonistic towards biotechnology: *"We oppose GMO production and we are collecting information to warn farmers about the damage which these products can cause"* (interview 2).

Impact of public policies

EC Directive 91/414 is the regulation that has a greatest impact on the activities of SMEs. First, because of the uncertainty it has generated about which substances will be finally included in the Single European Register (Annex I of Directive 91/414) and what will be the use that other companies could make of substances registered by another. Second, the high cost the registration process entails makes it inaccessible for many SMEs, which will have to register only their more competitive products. So, some agrochemical products only used in minor crops could disappear because the cost of their inclusion in the Register is much higher than the benefits expected by the market.

"Directive 414 is not clear yet, we do not know how it may affect the sector and the future of small companies depends from it. Neither do we know who will have access to the products registered" (interview 2).

The fact that all active substances must be registered in the Single European register can make it unfeasible for domestic companies to keep the large portfolios they currently have, and so, they would have to compete with multinational companies in a more reduced market in which the latter have more competitive advantages: *"Directive 414 is offering too many opportunities to the large multinational companies because the single register is open only to the companies that have the capacity to register their products"* (interview 4); *"If the Single European Register starts to work, the situation for SMEs will become very difficult, because*

they will have to conduct a series of toxicological studies that are very expensive and this would make them unfeasible (...) many of them will disappear" (interview 4).

In the short term, the strain on their financial resources due to the high register costs will also reduce the availability of funds to invest in R&D activities.

As far as the **science and technology policies** are concerned, public support is an additional source of resources for SME research activities. And therefore it is an incentive to continue with their research, although they do not influence the determination of their research priorities: *"Research policies that provide funds or soft loans promote research in SMEs. A company conducts research with and without support, but whenever it can have access to support, it will benefit from it"* (interview 4). All the SMEs interviewed participate in some public research support programme; however, their links with public research centres are weak.

Environmental policy is affecting agrochemical companies very much. The ongoing reduction of PPP residues and the pressure of public opinion are pushing the companies to increase their research on new and more environmentally-friendly products and on the reduction of application doses. *"We are researching on the production of Bacillus thuringiensis as an integrated fighting products [IPMs], and afterwards we will start an ecological product line [based on the results of this research] "* (interview 2); *"Other type of research is focusing on the search for formulas with dose reduction and less harmful for the environment, thus increasing product efficiency"* (interview 4).

On the other hand, the stricter maximum limits of PPP residues in the final farming products has forced companies to research new formulas. Environmentally-friendly products are seen as a very important element for the companies' future competitiveness, and the ones not able to produce them will disappear. *"The environmental pressure is very high; this can contribute to improve company competitiveness, since it will force them to be stricter with their products and can cause a selection among SMEs"* (interview 4).

Seed sector

General situation of SMEs in Spain

The Spanish seed market has remained fairly stable since the early 1990s. Table 2 shows the evolution of the sector during these years; the most significant change takes place between 1992 and 1994 and the reason for it is the severe 1990-1994 draught¹ and the resulting economic recession that lead farmers to cut down expenses in order to maintain their margins.

Table 2 Historical evolution of seeds sales (1990-1996, million euro at current prices)

Years	1990	1991	1992	1993	1994	1995	1996
Cereals	108.9	112.8	102.5	70.1	56.9	109.7	101.2
Potato	58.2	56.8	48.4	40.2	51.2	57.0	45.7
Leguminous crops	10.6	11.6	8.1	8.6	13.4	10.0	13.4
Industrial crops	69.0	47.1	44.2	24.7	24.1	23.9	27.7
Vegetables	28.5	27.0	25.4	23.6	25.8	27.8	27.2
Other seeds	18.2	18.1	17.3	17.5	15.8	16.0	22.8
Total	293.5	273.4	245.9	184.7	187.1	244.3	238.0

Source: Own drafting with data from the Ministry of Agriculture, Fisheries and Food (MAPA), 1999

¹ The lack of water affected severely the sector and caused a reduction in the use of farming inputs and especially in the acquisition of quality seeds.

It is difficult to estimate the relative weight of SMEs in the Spanish seed market since not even APROSE knows the sales distribution according to company size or type. Likewise, it is difficult to estimate the number of seed companies existing in Spain, since many of those registered in the official records are just distributors. APROSE includes 90 member companies, and most of them are independent SMEs.

Spanish seed companies are mostly family businesses that have adopted a strategy consisting of specialising in meeting specific needs of local markets. Most of them are just seed multipliers and rarely conduct research or produce new varieties.

According to their characteristics and importance, the three main sub-sectors² of the Spanish seed market are cereals, oilseed and maize, and vegetables. The role of SMEs is very different depending upon the sector they are in.

Spanish companies have a greater market share in the cereal sector than in the oilseed or vegetable sectors³, mainly due to the high seed-reusing rate, which makes this market less attractive for the multinational companies. *"The problem of the Spanish market is not the excessive presence of multinational companies but rather that it is a very small market because the use of certified seeds in cereals in Spain is the lowest in Europe and farmers show a high reuse rate"* (interview 5). The strategy of these companies is to diversify their production and to find local markets to sell their products.

In the vegetable sector, national companies have specialised in few species, first, due to the high competition in this sector where new varieties are launched every year, and the important market share of foreign companies; and second, because of the much greater research capacity of multinational companies, so domestic companies most concentrate their efforts on a couple of species to be competitive. *"The vegetable seed sector is dominated by the large multinational companies that conduct state of the art research; then we have the small companies, like mine, that must specialise"* (interview 2).

The competition relations established in the seed sector also depend on the type of seeds marketed. The vegetable market is much more competitive than the cereal market and SMEs compete with multinational companies in the same markets. *"The relationship between SMEs and multinational companies is on an equal basis and quite often we have material exchange agreements, and more frequently small companies buy material from the large ones, which among them exchange varieties"* (interview 1). The cereal and oilseed markets look for the market segments left by the multinational companies, *"MNCs restrict our market very much because we cannot compete with the marketing resources they have; it does not depend as much from seed quality since in many cases our seeds come from licences to grow seeds that belong to MNCs"* (interview 5).

Innovation strategy

As we have seen above, the SMEs in the cereal sector are specialising in local markets with varieties that incorporate little self-developed technology. This can be explained by the long duration of research to obtain a new variety (around 6 years) and by the already-mentioned local character of the market: *"since the national market is small and there are many companies of a very local range R&D investments are low and innovation activities are below the EU average. The evolution of research in this area is low, due to the small market"* (interview 5).

In the vegetable sector SMEs are focusing on a few varieties in which the role of their own technology is greater. In vegetable seeds a new variety can be developed in two years, while in the cereal or oilseed sector it can take up to six years. The research activities of vegetable

² APROSE divides its members into nine groups, according to the species they market: vegetables, fodder crops, maize and sorghum, cereals, sugar beet, oleaginous crops, cotton and other textiles, and potatoes.

³ Only 7 of the 51 cereal seed companies members of APROSE belong to a transnational group; however 11 of the 22 vegetable seed companies are subsidiaries of multinationals.

seed companies are currently focusing on varieties resistant to viruses, *"the most important research activities are focusing on viruses because there are no agrochemicals that can protect from infections by virus; it is also important to introduce resistance to bacteria and fungi, especially for organic farming"* (interview 1). Cereal seed companies are looking for varieties better suited to local environmental conditions, *"we are trying to find more polyvalent seeds⁴ and trying to reach the whole country in order to pay off R&D investments"* (interview 5).

However, few resources are allocated to research in both sectors, since research activities essentially consist of adapting existing varieties to local conditions or developing new varieties by means of traditional breeding techniques. In Spain there are currently no independent companies developing seeds by means of modern biotechnology techniques; these techniques are used only by subsidiaries of multinational companies, though few of them are already using assisted breeding techniques.

Companies give a great importance to research and consider that investments in this field will increase in the forthcoming years, *"research is very important for our company; we have our own R&D department and we conduct research on almost all the varieties we market"* (interview 5).

SMEs consider that the only way of competing in research with the multinational companies is to join other companies in their sector, *"more and more we will have to invest in research. 50% of the research of Spanish companies is done in collaboration with other networks"* (interview 1). This trend towards collaboration can be detected in both sectors. However, there is little tradition or experience in this type of agreements, and they raise some uncertainty: *"In order to be competitive national companies will have to join efforts, and so we will be able to compete with MNCs; however, it is going to be difficult because we lack this collaboration culture"* (interview 5).

The same problems, as in the case of agrochemicals, appear in the relationships with public research centres. All companies assess very positively the basic research conducted in the public sector and the benefits of a closer collaboration, especially in the case of biotechnology, which due to financial reasons is beyond the reach of many SMEs. However, the current cooperation and information exchange levels are not sufficient to establish stable collaboration links in research activities. According to SMEs, the main deficiencies of the public R&D system are its lack of business orientation, its fragmentation and its linkage to a specific individual's initiative and research career: *"research is very fragmented and it focuses on very specific topics. In order to find a suitable research centre we must go to The Netherlands"* (interview 1); *"public research shows severe deficits in the transmission of research outcomes to companies"* (interview 5).

In the case of biotechnological techniques, companies rely more frequently on research groups and universities, due to the high cost of the technology: *"we conduct research in collaboration with different universities, especially on the use of biotechnological tools we cannot afford"* (interview 5). Research with biotechnological means is becoming to gain importance in these companies but the production of genetically modified (GM) varieties is currently out of their reach, *"transgenic products are unachievable for SMEs, though we are already using biotechnological techniques, such as molecular markers"* (interview 1).

Discourse in agriculture and environment. Attitudes towards biotechnology.

Seed companies are of the opinion that seeds will not reduce significantly the environmental impact of agriculture, since the greatest impacts stem from the use of agrochemicals. Therefore, they do not feel involved in improving the environment. However, they think that research on seeds, both by biotechnological methods and by classical genetic improvement, can contribute to obtaining new varieties with a lower need for farming inputs.

⁴ Seeds with multiple characteristics

However, some SMEs see a market opportunity in the development of seeds that require a lower usage of agrochemicals. Research and development of disease, pest and virus resistant varieties is gaining importance for SMEs, since both the environmental regulations and the agro-food industry are establishing more stringent environmental standards of the farming products: *"the environmental regulations requires them [farmers and agro-food industry] greater controls, especially for integrated production, which requires more resistant varieties"* (interview 1). SMEs emphasise the environmental benefits of such seeds and claim for an official certification of this type of seeds as "organic" ones in order to promote their production, *"organic seeds⁵ are already appearing in Europe but in Spain there is no entity to certify them"* (interview 1).

Regarding biotechnology, Spanish seed companies envision an uncertain future for the introduction of GM seeds: *"for some years there will not be any transgenic seeds in Europe and in food products it will be even more difficult"* (interview 1); however, they consider that finally they will be introduced. Therefore, they still consider biotechnological techniques as a useful tool for the time this type of seeds gain approval *"we try to be well positioned for the moment in which these seeds are authorised"* (interview 5).

Despite of the above mentioned uncertainty, APROSE favours the use of these technologies and participates actively in the campaigns for their use (APROSE interview, 1999). Ramón Olarquiaga, Director of APROSE, indicates that when biotechnological products reach public acceptance SMEs will play a minor role *"SMEs will not be able to invest in research and they will become seed multipliers or distributors, but not producers of new varieties"* (APROSE interview, 1999).

Impact of public policies and market signals on the innovation strategy

The reaction of companies to changes in policies or regulations is usually slow, especially in terms of their research activities, because the companies' research programmes have a long-term perspective: *"the response capacity of SMEs to new policies is quite slow, because we cannot change quickly the research programmes, which have a long term perspective. If research is focusing on a variety and the market moves to a different area or country, you do not change the research programme but rather look for a buyer in that other area"* (interview 1).

The impact of policies on seed companies depends very much on the sector the company is in and on the specific features of each crop.

Agricultural policy has a greater influence on extensive crops such as cereals or oilseed plants: *"cereal farming is one of the most sensitive ones to any agricultural policy change, because farmers can change the crop from one year to another; however, this is not possible in woody plants or in other crops requiring greater infrastructures"* (interview 5). The CAP reform has had a great impact on this subsector. Initially it caused a great uncertainty among farmers and led them to reduce their expenditure in farming inputs: *"the CAP initially caused instability, leading farmers to save on the inputs they used and to buy cheap seeds that did not incorporate any technology. After a couple of years the market has stabilised again"* (interview 5). However, the Agenda 2000 is causing a similar effect to the one caused by the CAP reform: *"the Agenda 2000 can be very traumatic because it means a radical change in production systems, because it levels the regulations and conditions for all crops, even though these crops are different. Therefore, it will damage the seed sector more than the CAP reform did some years ago, since it will benefit some crops [oilseed plants] and it will have a negative impact on the seeds produced and marketed by national companies"* (interview 5).

⁵ "Organic seeds" is the term used by some SMEs interviewed to indicate "resistant seeds that require less farming inputs"; they don't use such term meaning seeds to be used only in organic farming.

However, in the vegetable sector the impact of the CAP and the Agenda 2000 on the activity of seed-producing companies is lower. Vegetable markets are more liberalised and the Spanish production is export-oriented, so market factors are more important.

Regulations on seeds markets and Plant Breeders Rights have a great impact on the cereal sector, which is the one with the highest rate of illegal marketing of seeds (i.e. seeds that are not included in the National Register of Commercial Varieties) and seed re-use rate. The greatest disadvantage of the product register is the long time of the procedure required for introducing new products in the register, especially in the European one. This problem is worse in the vegetable subsector, in which companies must react quickly in such a competitive market, *"there is a very serious problem in the variety register; between the approval in Spain and the approval in the EU, it takes between 6 months and one year"* (interview 1).

Policies on agrochemicals also affect seed companies, since the obligation to reduce agrochemical pollution in the final products is reinforcing the research and production of more seeds resistant to virus and diseases.

Research policy, although it could have a direct impact on corporate R&D, is not essential for these companies: *"the influence of research policies is very small and depends more on the initiative of a specific researcher who wants to research"* (interview 1). In the case of European programmes, the access of SMEs is very difficult since they lack the management capacity needed and the multinational companies take more advantage of them: *"the EU funding policy requires them to associate with other foreign companies and therefore it is more difficult to become eligible for those subsidies. It is much easier for multinational companies that can do it through some of their subsidiaries"* (interview 5).

Although SMEs are not developing GM seeds, they closely observe the evolution of **GMOs regulation**. The SMEs interviewed consider that biotechnology will be finally accepted by consumers and markets, probably after three-five years. They need to prepare themselves for such a moment, by increasing their investments in biotechnological techniques. The lack of financial resources is an important problem; they foresee a greater number of collaboration agreements between small companies and a more important role of PSREs.

We must point out that the signals on market evolution stem more from the **agro-food industry** than from farmers, *"we are getting the market signals from the agro-food industries, which tell us which products they need"* (interview 5) *"the agro-food industry is becoming more and more meticulous, and although they normally require the levels established by the regulations in force, sometimes they demand more stringent standards and we have to provide them"* (interview 1). Only few market signals are given by farmers *"The information flows between seed producers and farmers are very scarce because there is no dialogue culture"* (interview 5).

Conclusions

One of the main characteristics of the Spanish agriculture is the great number of plant varieties grown, as well as the great diversity of agro-climatic conditions. Consequently in Spain we can find many small local markets in which the farming inputs are very specific and that are not attractive for multinational companies.

This wide range of local markets allows the survival of family-owned SMEs with slow, small-scale innovative processes. In general, Spanish SMEs have a minor role in agricultural innovation; only a few SMEs are able to launch own new products onto the market. A few SMEs have a more innovative behaviour but have financial difficulties to compete with multinationals, which dominate the Spanish market. Recent developments -- the wave of mergers between MNCs, acquisitions of seed companies by large agrochemical companies, and the incorporation of biotechnology in the technological trajectories of leading companies -- are generating much uncertainty among SMEs about future markets. Perhaps they will not be able to compete with new products, for lack of financial and managerial resources.

Agrochemicals

The Spanish market of agrochemicals is dominated by multinationals which launch the most innovative products onto the market. SMEs' activity is the formulation and production of generic products to supply local markets. Innovation capacity of SMEs is quite low because they lack the financial resources needed to invest in the long-term research required in agrochemical sector.

Within the agrochemical sector there are two policies that have a great impact on Spanish SMEs. First, the implementation of the Directive 91/414/EEC generates uncertainty about what Active Ingredients (AIs) will be finally included in the European Register and what will be the access conditions to registered AIs. This uncertainty and the expected reduction of allowed AIs threaten the survival of many SMEs that base their activity on the use of off-patent active substances for their formulas, because many of such substances may no longer be permitted, and so SMEs will have to obtain new licenses from multinational companies in order to continue the supply to local markets. For SMEs that market products obtained from their own AIs, the high costs of the registration procedure means that they need to use more of their budget for administrative procedures and toxicological tests. This expenditure has two effects: they concentrate their efforts on the most competitive products, while reducing their product catalogue, thus abandoning some products which have a small market; and they have less financial resources available for R&D activities in the short term.

Second, stricter environmental legislation is very important in this sector too. Companies are incorporating environmental criteria in their decision-making process and promoting the adoption of IPMs in farming systems. The environmental pressure is considered a key competitive factor, because companies will have to produce new products with less environmental impact -- as some of them are currently doing. Those companies unable to produce such products will disappear from the market.

Agricultural policy has no direct influence on innovation decisions, though *Agenda 2000* is stimulating lower usage of agrochemicals, thus increasing the pressure for SMEs to produce less environmentally-harmful products.

Science and technology policies are gaining importance for SMEs, especially those oriented to promote collaborations with PSRs (which are not now frequent). Subsidies for R&D activities will increasingly be an important additional source of funding.

Table 3 shows the influences of national and European policies on innovation and R&D decisions of SMEs, the predictability of these policies and their incorporation in environmental discourse.

Table 3 Policy impacts on the agrochemical sector

Policies	Are policies predictable or uncertain?	What is the interaction of the policies and innovation and R&D decisions?	Impacts on the sector	Comments Environmental discourse
Directive 91/414/EEC	Uncertainty about the substances that will be included in the Single European Register and about SMEs' use of active substances	SMEs' innovation capacity may be reduced, due to the reduction of their product portfolio and the need to use part of their budget for administrative procedures and toxicological tests.	+++	Disappearance of SMEs Higher awareness of the environmental impacts of their products Promotion of IPMs

ANNEX D6

Policies	Are policies predictable or uncertain?	What is the interaction of the policies and innovation and R&D decisions?	Impacts on the sector	Comments Environmental discourse
CAP	Predictable	No direct influence on innovation decisions	+	The CAP reform has had no direct influence on the companies. However, Agenda 2000 promotes agri-environmental measures which could reduce farmers' use of agrochemicals.
Science and technology	Predictable	Positive interactions, as funding source and as a support instrument for collaboration with PSREs	++	These policies are gaining importance.
Environment	Predictable	The reduction plant protection products will lead to research in more products with a lower environmental impact.	+++	The environmental factor will become a competitiveness factor.

Legend: +++: considered as the most important; ++: important; +: significant but not a priority

Seeds

One of the main characteristics of Spanish seed market is the high fragmentation between different crops. SMEs in the cereal sector supply local market left by multinationals; they specialise in varieties that incorporate little self-developed technology. In the vegetable sector SMEs compete directly with multinationals in the most profitable markets, where they focus on a few varieties in which the role of their own technology is greater. The influences of policies on each sub-sector are different.

The regulations on seeds market and Plant Breeders Rights have the greatest impact on SMEs because they have helped to reduce the use of illegal seeds, especially in larger-scale crops, and they provide a significant incentive to invest in innovation. In general SMEs consider the administrative procedures as excessive, though this policy has more positive impacts than negatives ones.

Agricultural policies have a greater influence on cereal and oilseed crops than on vegetables ones. The shift from price support to direct income support, and the set-aside policy promoted by CAP reform and Agenda 2000, might lead farmers to reduce their expenditures on agricultural inputs, especially on agrochemicals, due to the emphasis on agro-environmental measures. Sales of SMEs in some local markets could be reduced, although there are also incentives to strengthen investment in disease-resistant varieties that need less usage of chemical inputs.

Environmental issues are not seen as very relevant, although in past years Spanish firms have been investing in new seeds that need less quantity of pesticides to grow, because there are market opportunities from the reduction of chemical inputs. In the seed sector there is also great influence from the agro-food industry, which continuously demands new products with specific characteristics.

Science and technological policies have an increasing importance, especially those related to biotechnological research, because it needs high investments that SMEs cannot afford by themselves. SMEs are concerned about the likely approval of GM varieties in the medium term; SMEs lack the capacity to develop such products, which thereby would pose a competitive threat. Their capacity would have to be strengthened through collaboration agreements with other small companies and joint research projects with PSREs.

Table 4 shows impacts of public policies on Spanish SMEs in seed sector.

Table 4 Policies influences on seed sector

Policies	Are policies predictable or uncertain?	What is the interaction of the policies and innovation and R&D decisions?	Impacts on the sector	Comments Environmental discourse
CAP and Agenda 2000	Unpredictable impact on evolution of agricultural Spanish markets	Vegetables: no direct influence is perceived	+	Greater importance of agro-environmental measures in large-scale crops
		Cereals: research on new seeds to met new farmer needs (more resistant to diseases, higher productivity)	++	
Environment, including Directive 414	Predictable	Research and investment in disease-resistant seeds and seeds that reduce the need for agrochemicals Greater effect on vegetable crops	+	No direct relation between seed production and environment, although consumer demands for ecological products could be a new market niche
Science and Technology	Predictable	Positive interactions as an extra financial resource and positive impacts of collaborations with PSREs, especially in biotechnology	+	
Seeds and IPR	Predictable	Vegetables: registration process is slow and delays the marketing of new products	++	
		Cereals: Reduction of illegal seeds and greater benefits could stimulate more resources for innovation	+++	
GMOs	Unpredictable	Need to increase their investments in research for access to biotechnology in future	+	Research on GMOs will have to be conducted in collaboration with PSREs

Legend: +++: considered as the most important; ++: important; +: significant but not a priority

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