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

Seminis Vegetable Seeds monograph

Annex C15

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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.

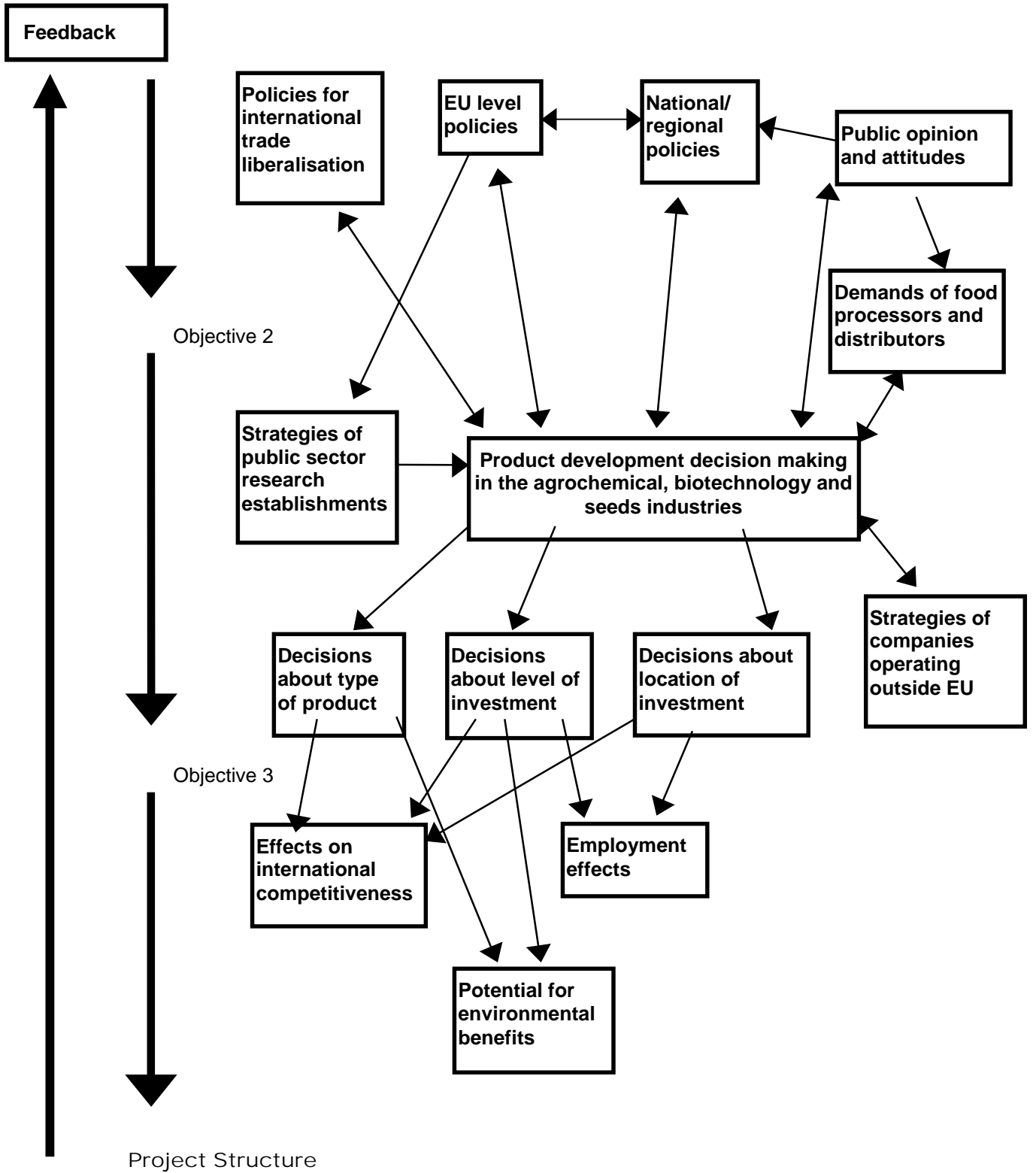
The range of policies and other influences studied includes:

- 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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1. Introduction

1.1 History

SEMINIS VEGETABLE SEEDS (SVS) is a public company¹ whose main activity is the production of hybrid vegetable and fruit seeds. Its administrative headquarters are in Saticoy (California, USA) and its R&D headquarters are in Woodland (California, USA).

SAVIA² is the major shareholder of SVS (Savia owns approximately 67.9% of the SVS' outstanding common stock and controls 80.2% of the vote of SVS common stock, (Seminis, 2000a)). Savia has been a member of the PULSAR INTERNACIONAL Group of companies since 1985 (see figure 1). Pulsar Internacional was formed in 1981 and has its headquarters in Monterrey (Mexico). Pulsar participates in the agro-technology, insurance, packaging, distribution, construction and real estate, information technology and health-care industries, as well as the non-banking financial services sector. Pulsar's web-page tells that two of its driving forces are the application of state of the art technology and strategic acquisitions and alliances with small producers and businesses (Pulsar web page).

The main activity of Savia was tobacco production, cigarette manufacturing and packaging, but between 1994 and 1995 Savia changed its main activity so that vegetable seeds and fresh produce became more important. During 1997 Savia disposed its investments in Cigarrera La Moderna SA and its subsidiaries (Wright, 1999).

Savia is a public company with sales exceeding 2 billion \$US a year. Savia is now a conglomerate with strong interests in insurance, global agro-technology and packaging. In 1997, agro-biotechnology accounted for 78% of revenues, packaging for 19% and other business for 3%. Its agro-technology division is active in 123 countries on five continents (Seminis, several years) and has two elements (see Chart 1): SVS (seed production) and BIONOVA (fruits and vegetable production and distribution and R&D). So, Savia has interests along the whole food chain and says it is the only agrobiotechnology company reaching the final consumer (Seminis, several years).

SVS was born in 1995 from the merger of the vegetable division of the seed company Asgrow (USA), Petoseed (USA) and Royal Sluis (The Netherlands). SVS is today the world leader in hybrid seeds for fruit and vegetable, with production capabilities in 32 countries and 70 R&D stations around the world.

In 1996 Savia acquired 70% of DNA Plant Technology, a biotechnology and fresh produce company; DNAP and Savia's Bionova subsequently merged to form BIONOVA Holding Corp³. Bionova is a leading company in the research, development, production and distribution of fruits and vegetables, with annual sales reaching almost 300 million \$US. The acquisition of Royal Van Namen in 1996 provided Bionova access to fresh produce markets in Europe, the Middle East and Asia, and completed its network in USA, Canada, Mexico and South America. The recent sale of Royal Van Namen indicates the intention of Bionova to concentrate its activities on its North American fresh produce farming and distribution business. DNA Plant Technology and VPP Corp. are the research divisions of Bionova. AGROBIONOVA is the farming division of Bionova. The majority of its production is tomatoes

¹ Seminis was going public in summer of 1999, so most of the information on the company was confidential until then. In June 2000, Seminis announced a "global restructuring and optimisation plan" to cut costs and to increase cash flow. This plan will mean important changes of Seminis organisation and decision making process (reduction of brands, production facilities, products and plantings, strategic management changes, etc.). So this report shows what has been Seminis before this plan.

² In March 1999 EMPRESAS LA MODERNA (ELM) merged with Seguros Comercial America SA de CV, officially changing its name to SAVIA.

³ The merger of DNA Plant Technology with Bionova instead with SVS could be interpreted as a way to keep biotechnology in USA markets and to focus SVS in traditional breeding.

and peppers, although is growing their production of other fruits and vegetables, including melons, cucumber and grapes. The distribution companies of Bionova are: i) BIONOVA PRODUCE and RB PACKING OF CALIFORNIA, at United States level; ii) INTERFRUVER, in Mexico; iii) TANIMURA DISTRIBUTING (Los Angeles), PREMIER FRUITS AND VEGETABLES BBL (Montreal) and PREMIER FRUITS AND VEGETABLES USA (Philadelphia) at regional level. The main commercial brands of distributing activities of Bionova are Master's Touch and Fresh World Farms.

Thus SAVIA has created a group of companies that control vegetable seed and its distribution channels on a global scale. (Chart 1 explains ownership structure of SAVIA and provides a guide of companies under its control. Shadow is used to show that we are focused on Seminis in our study).

1.2 Subsidiaries and products

SVS has the following brands: Asgrow, Petoseed, Royal Sluis, Bruinsma, California, Genecorp, Hungnong, ChoongAng, Horticerres, DiVine Ripe and Nath Sluis. Other companies operating under SVS are Barham, Incotec and LSL.

Asgrow, Petoseed and Royal Sluis are full-line brands (with a broad catalogue of products and operating at a global scale); the rest are regional or speciality brands. Asgrow Vegetable Seeds markets more than 550 varieties around the world (Asgrow, 1998). Bruinsma is the Seminis specialist in vegetables produced in houses green, such as cucumber and tomato (Massieu, 1998).

Table 1. Main products and primary markets of SVS' brands

Brand	Main products	Primary markets
Asgrow	Tomato, carrot, onion, pepper, bean, pea, corn, melon, cucumber, brassica	Worldwide
Petoseed	Tomato, pepper, eggplant, brassica, onion, melon, cucumber	Worldwide
Royal Sluis	Brassica, bean, tomato, lettuce	Europe, Asia
Bruinsma	Greenhouse tomato, pepper, cucumber	Europe

Source: Massieu, 1998

California provides fruit crop seeds for highly specialised regional markets. Genecorp is the lettuce seed specialist; its main market is Western United States.

INCOTEC was born in 1989, when the seed and coating technology activities of Royal Sluis were consolidated into a separate division. After the creation of SVS, seed and coating technologies were all placed under the INCOTEC name. Incotec (Integrated Coating and Seed Technology) provides other brands with enhancement technology. Key projects of Seed Technology research cover innovative upgrading, priming and disinfection techniques; key projects of Coating Technology Research cover: development of new seed encapsulation technology, innovative formulation technology, and the incorporation of both biological agents and new highly effective molecules for pest and disease control in seed coatings. The majority of the more fundamental research takes place in The Netherlands, although "*the research support function has been well established at each production location in the world*". (Incotec, 2000a).

Incotec provides the connection between SVS and pesticide industry, because one of the technologies it uses is to incorporate pesticides in seeds coatings. In Incotec's web page we can read:

Seed enhancement and seed coating technology offer excellent opportunities for **Disease and Pest Control** throughout the seed industry. The incorporation of pesticides in seed coatings are a well established and generally known way for a safe and accurate application of fungicides and insecticides. Furthermore this

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application technology greatly contributes to a strong reduction in the use of chemicals and thus to a more environmental friendly pest and disease management.

Incotec has developed special film coating and pelleting processes as well as coating formulations for application of a broad variety of pesticides suitable for a large number of seed species.

By cooperating with chemical companies, Incotec seeks an early involvement in the seed registration process. This enables early evaluation and development of proper application technology for new molecules.

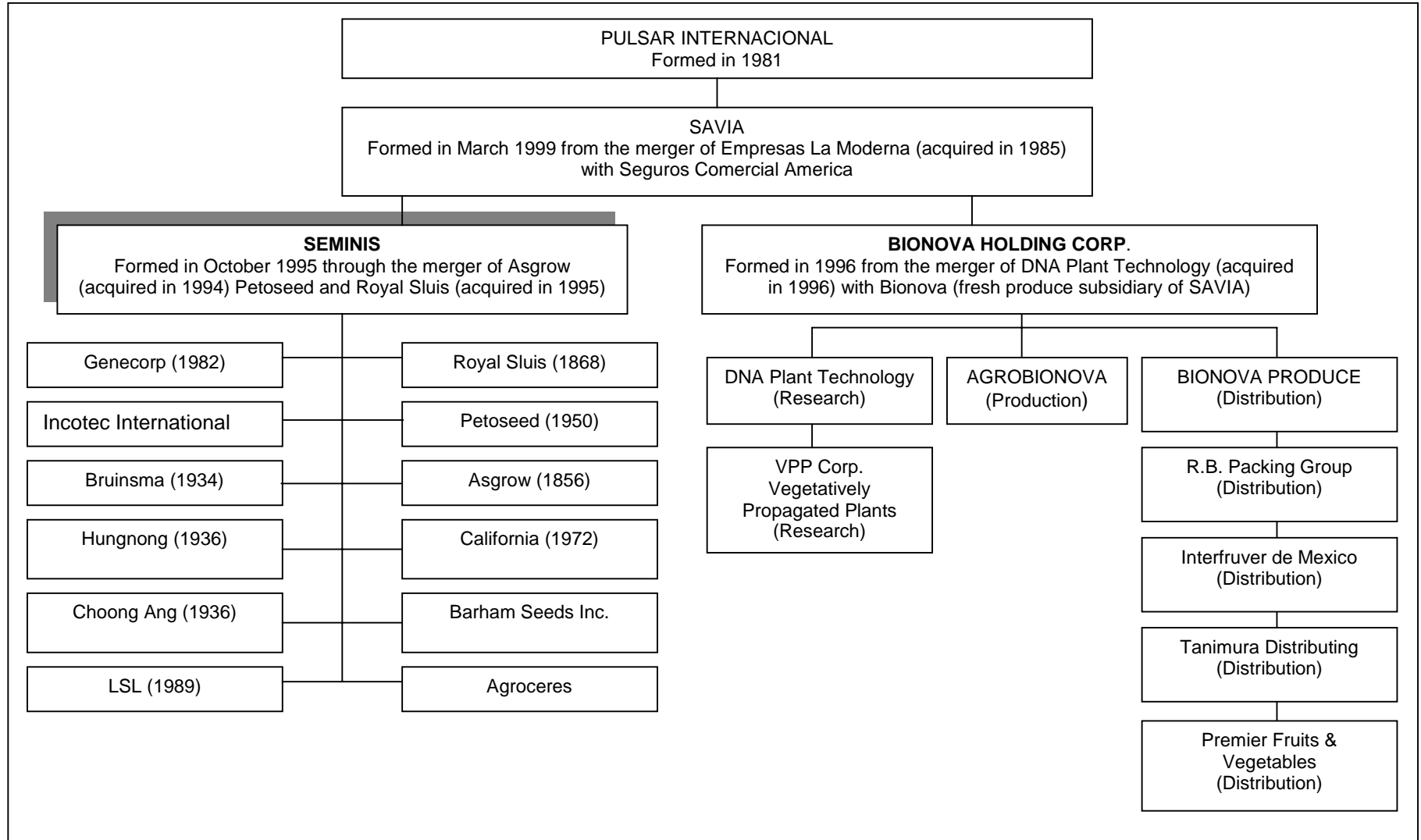
Both in product development and production, special attention is given to the optimal incorporation of the active ingredient into the coated seeds. Formulations have been developed to enable pesticides application with a minimum impact on the seed vitality.

Special analytical tests are used to ensure the best possible recovery, the seed-to-seed distribution, release and shelf life characteristics and thus the best system for the desired biological efficacy of the pesticides used.

Incotec, 2000b

In July 1998 SVS acquired 70% of Hungnong Seed, Korea's largest seed and vegetable firm, for \$US 100 million and ChoongAng Seed for \$US 18 million (AGROW, 1999). Hungnong and ChoongAng are lead companies in the Oriental vegetable market. In November 1998 Seminis purchased the vegetable division of Sementes Agroceres, S.A., a Brazilian company that produces and distributes vegetable seeds throughout Brazil. In 1998 Seminis acquired the distribution rights to LSL Plant Science LLC tomato varieties. LSL is a world market leader in tomatoes developed for long shelf life. In September 14th 1999, SVS acquired Barham Seeds Inc. (BSI), a company dedicated to the research and development of top seedless watermelon varieties.

Chart 1. Ownership structure



1.3 Main Figures

In 1998, SVS had the following share of the vegetable seed market: 26% of the global market, 39% of the US market, 24% of the European market (Seminis, several years), and 15% of the Asian market (Nho Joon-hun, 1998). In 1999, its annual sales exceeded 530 million \$US. On 14th September 1999 SVS announced some changes in its structure. These changes reflect its new situation as a public company and the adoption of a more global strategy. Now SVS is completing a strategy of industry consolidation and internal investment. Since its formation in 1994 Seminis has completed nine acquisitions.

Seminis Inc. had 3,000 employees in 1998. Of these, 862 employees worked on R&D activities. Financial data of SVS are shown in Table 2.

Table 2. Financial information on Seminis Inc. (in \$ thousands)

	1996	1997	1998	1999
Sales	381,398	379,544	428,423	530,633
Income from Operations	61,508	33,366	34,691	44,989
Gross Profit	167,267	229,437	265,617	328,284
R&D expenses	42,3	41,039	49,416	62,421

Source: Seminis, 2000

Some useful comments to these data, made in the Annual Report, are:

- Net sales increased 23.9% to \$530.6 million for the year ended September 30, 1999 from \$428.4 million for the year ended 1998. Excluding the effect of acquisitions, net sales increased 12.5% or \$51.2 million. This increase was primarily due to increased sales in North America, the Middle East and South America. Seminis has also increased sales for each of its three major brands: Petoseed, Asgrow and Royal Sluis. The Petoseed brand has shown the strongest increase due to improved sales in several product classes, especially tomato seeds. Since July 1998, Seminis has made several acquisitions including two South Korean companies, Hungnong Seed Co., Ltd. and Choong Ang Seed Co., Ltd., the vegetable division of Sementes Agroceres S.A. (a Brazilian company) and the distribution rights to LSL PlantScience LLC tomato varieties. These newly acquired businesses have generated sales of \$68.2 million and \$17.2 million during fiscal 1999 and 1998, respectively.
- Gross profit increased 23.6% to \$328.3 million for the year ended September 30, 1999 from \$265.6 million for the year ended 1998. Gross margin slightly decreased to 61.9% for the year ended September 30, 1999 from 62.0% for the year ended September 30, 1998. During fiscal 1999 gross margin was positively impacted due to an increase in sales of higher margin, long shelf life tomato seeds and a decrease in sales of lower margin varieties to food processors in North America, while gross margin was negatively impacted due to an increase in lower margin European wholesale sales.
- Research and development expenses increased 26.3% to \$62.4 million for the year ended September 30, 1999 from \$49.4 million for the year ended September 30, 1998. This increase was primarily due to \$6.0 million of expenses incurred by the newly acquired South Korean subsidiaries and a special \$5.0 million charge related to Seminis' research incentive program.

This incentive program is a part of Seminis' continuing efforts to attract and retain industry leading breeders and research personnel.

- Seminis Annual Report, page 14

SVS' main markets are North America and Europe. 38% of SVS sales stem from North America, 32% from Europe, 8% from South America, 8% from Middle East and 14% from Far East. SVS is very diversified in its products, customers and regions in which it operates: *"no one customer or product represents more than 2 percent of our sales"* (Seminis, 2000a).

2. Decision making structure and innovation strategy

2.1 R&D priorities

SVS is a global company that uses a multibrand strategy. Each brand within SVS has autonomy to organise its own activities, but basic research is conducted by SVS for all brands: *"Breeders for each brand have direct access to research facilities of Seminis, but each maintains clear focus on the growers they serve"* (Seminis, several years).

For its main products, the long-term research goals of SVS, pointed out in company information, include:

- Developing disease-resistant varieties that will reduce grower dependence on costly chemicals and will decrease the environmental impacts of these pesticides.
- Increasing vegetable quality by improving colour, flavour, shape, size, texture and nutritional value of all classes of vegetables.
- Increasing yields in all classes of vegetables to improve grower profitability, reduce consumer costs and keep pace with population increases.

SVS and Bionova has a long term research agreement focused on developing varieties resistant to: fungal pathogens, viruses, nematodes (*Meloidogyne incognita*), and Roundup resistant varieties by over expression of a tolerant form of bacterial EPSP synthase (Bionova, web page).

Breeding is a key tool used in research activities, as is biotechnology. Recent GMO field tests carry out by SVS in the US have been made on different species showed in Table 3.

Table 3. Seminis field test in US

Specie	Research
Brassica oleracea	IR - Lepidopteran resistant
Carrot	FR - <i>Alternaria daucii</i> resistant
Cucumber	HT - Glyphosate tolerant VR - CMV resistant VR - PRSV resistant VR - WMV2 resistant VR - ZYMV resistant
Lettuce	FR - Rust resistant HT - Glyphosate tolerant IR - Lepidopteran resistant PQ - Brown spot resistant

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Melon	VR - PRSV resistant VR - ZYMV resistant VR - CMV resistant VR - WMV2 resistant
Onion	MG - Visual marker
Pea	HT - Glyphosate tolerant
Pepper	VR - CMV resistant
Squash	VR - CMV resistant VR - PRSV resistant VR - SqMV resistant VR - WMV2 resistant VR - ZYMV resistant
Tomato	FR - Alternaria resistant FR - Fusarium resistant FR - Verticillium dahliae resistant HT - Glyphosate tolerant IR - Lepidopteran resistant PQ - Fruit ripening altered PQ - Pigment metabolism altered VR - CMV resistant VR - TSWV resistant

FR - fungal resistance **HT** - herbicide tolerance **IR** - insect resistance **MG** - marker gene **PQ** - product quality **VR** - virus resistance

Source: APHIS, USDA, 2000.

In Europe (Italy, Spain, France and The Netherlands), SVS has been testing with GMO. The most important and recent ones are shown in Table 4.

Table 4. Seminis field test in Europe

Specie	Research
Cantaloupe	VR - CMV resistant; VR - WMV resistant, VR - ZYMV resistant
Squash	VR - CMV resistant; VR - WMV resistant, VR - ZYMV resistant
Tomato	PQ - Alteration of ripening characteristics; PQ - Improvement of processing quality; GC - Polygalacturonase synthesis; PQ - Downregulation of pectin esterase, VR - CMV resistant; GC - Chitinase synthesis; FR - Fungal resistance; GC - Glucanase synthesis; OO - Pathogenesis-related protein synthesis

FR - fungal resistance **GC** - genetic containment **OO** - other **PQ** - product quality **VR** - virus resistance

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Source: Joint Research Centre, 2000

Bionova research activities are currently focused on:

- Developing strawberries varieties with improved agronomic traits, including resistance to fungal disease and herbicides.
- Developing "*fruits and vegetables which retain freshness longer through genetic engineering focused on ripening or softening control*" and "*retention of freshness and colour in cut leafy vegetables*" (Bionova, web page).

2.2 Patents

SVS has registered over 360 plant varieties under plant protection laws (Massey, 1999) and owns 75 patents (Semini, 2000b). SVS is currently seeking protection for beans, bean sprout, broccoli, cauliflower, celery, corn, cucumber, dew, eggplant, endive, leek, lettuce, melon, muskmelon, onion, peas, pumpkin, radish, red cabbage, spinach, squash, sweet pepper, tomato, watermelon and white cabbage. Last patents issued by SVS in US and Australia are shown in table 5:

Table 5. Last patents issued by SVS

Patent	US Patent Number	Invention Relates to
Potyvirus Coat Protein Genes and Plants Transformed Therewith	5,998,699	Disease resistance
Lactuca Sativa Cultivar Exhibiting Resistance to Downy Mildew and Corky Root Rot	5,973,232	A lettuce cultivar sold as iSharpshooteri
Brassica oleracea ACC Synthase Gene	5,998,702	Controls maturing and aging
Papaya Ringspot Virus Coat Protein Gene	6,002,072	Disease resistance
Papaya Ringspot Virus Replicase Gene	6,005,166	Disease resistance
Patent	Australian Patent Number	Invention Relates to
Brassica oleracea ACC Synthase Gene	709862	Controls maturing and ageing
Transgenic Plants Expressing DNA Construct Containing a Plurality of Genes to Impart Virus Resistance	708035	Disease resistance
Papaya Ringspot Virus Protease Gene	707753	Disease resistance
Plants Resistant to C Strains of Cucumber Mosaic Virus	706875	Disease resistance
Transgenic Plants Exhibiting Heterologous Virus Resistance	707935	Disease resistance

Source: Semini, 2000b

Other examples of patents held by SVS are: squash resistant to WMV2 and ZYMV (Asgrow, 1998), approved in USA. In 1997 Asgrow announced that it will add papaya resistance to ringspot virus; broccoli with long shelf life (Asgrow); tomatoes with long shelf life (Asgrow); hybrid broccoli for both fresh and processing markets (Asgrow) (Massieu, 1998).

BIONOVA's IPR portfolio comprises more than 40 US patents in biotechnology. This company holds patents for transformation/regeneration technology to regenerate whole

plants from genetically engineered plant cells. Other patents include gene identification techniques that allow the association of genes with specific plant characteristics without the need to understand intermediary biological processes. Other patents include vector systems for gene transfer, an engineered plant selection technology and a gene expression technology. The most valuable technology of BIONOVA is the so-called Transwitch. With this technology the expression of specific genes can be suppressed. This technology has been used to produce varieties with prolonged shelf life. SAVIA took BIONOVA's Transwitch as a guarantee for its 10 year US\$ 30 million loan to BIONOVA. SAVIA negotiated an agreement with BIONOVA giving dome ownership of any new product developed through this technology (Massieu, 1998). Recent field tests of DNA Plant Technology have been carried out with tomato, strawberry, pepper and grape.

2.3 Research Agreements

SVS is involved in a number of joint ventures with biotechnology companies and universities. Research partners include:

- Cornell University
- CPRO-DLO (The Netherlands)
- Del Monte Foods
- Bionova
- Hunt-Wesson
- John Innes Institute (UK)
- Monsanto
- Pillsbury
- Texas A&M University
- Unilever
- University of California at Davis
- University of Wisconsin
- Zeneca Plant Science

SVS has a collaboration agreement with Mogen (Dutch biotechnology company), a subsidiary of Zeneca, on nematode resistant varieties of specific horticultural crops (Massieu, 1998). SVS' brand Petoseed developed a genetically modified tomato for food processing with Zeneca Plant Science (Massieu, 1998). The research collaboration with John Innes Center has the objective to develop vegetables with fungus resistance and "enhanced nutritional and health benefits" (Massey, 1999).

Savia and Monsanto had a dispute on BIONOVA's Transwitch patent. This dispute finalised in 1996 with an agreement that was possible because of a division of market share. In 1996 Savia sold Asgrow Seeds' agronomic division for US\$ 240 million to Monsanto and signed a technological collaboration agreement with Monsanto (Massieu, 1998). Monsanto's interests in vegetables were limited to tomatoes and the vegetable division of Asgrow remained in Savia as part of SVS. The relationship between these two companies (Savia and Monsanto) has intensified since then. In 1997 Monsanto and Savia signed a technological collaboration agreement which gives Savia access to Monsanto's herbicide resistance technology. Other Monsanto technologies of interest to Savia are coat-protein mediated virus-protection and *Bacillus thuringiensis* for the control of lepidopteran pest. SVS is developing Roundup Ready lettuce that could be marketed by 2003 (Massey, 1999). Savia, that has a lettuce seed market share of 55% in the US, expects to sell this altered seed at two times the price of conventional lettuce seed; this premium price will be halved between Savia and Monsanto (Lemaux, 2000).

In November 1997, Savia and Monsanto announced the joint acquisition of a 20 per cent stake in Mendel Biotechnology (USA) for US\$ 30 million. Mendel Biotechnology is a private gene-research company and the 20% stakeholding will allow Savia and Monsanto access to genes for the development of specific traits (Masieu, 1998). As part of the agreement, Monsanto and Savia are funding a research and development programme over a five year period (Monsanto, 1997).

SVS collaborates with some researchers in Europe. Bilateral contacts between the company and the researchers take place on a case-by-case basis, without a fixed guide to formalise them. The conditions of the agreements depend on the characteristics of the researcher, the subject of the research and on what the researcher wants to do it. There are differences between countries. In countries such as The Netherlands, the government is reducing financial support to researchers, forcing researchers to seek other funding to become more market oriented. In countries such as France and Spain, the government still gives a substantial funding to researchers, so allowing researchers to collaborate with industry without imposing high financial conditions. Moreover, in Spain, government subsidies are an important incentive to collaborate. Public research in Spain has traditionally been very basic, but over the last five years, there has been a big improvement, because of the European subsidies (Company interview, 1999).

Bilateral agreements, especially with plant breeders, are very important for SVS for several reasons: these agreements are more flexible than those with larger groups and it's easier to see a return on the investment. In addition, plant breeders have direct contacts with growers and know their needs (Company interview, 1999).

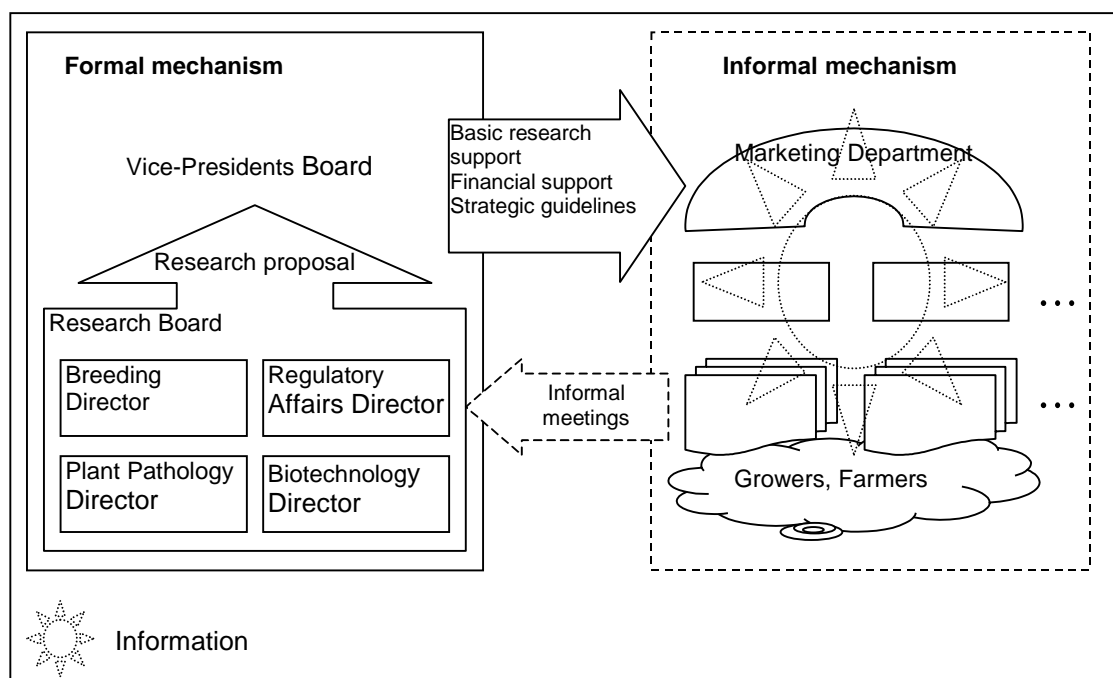
Other important input from public research are students. In the US the impact and the input of research students is higher than in Europe. In the US PhD and masters students are motivated to research within a company and to obtain fast results in weak working conditions (Company interview, 1999).

2.4 Organisation

As we said, SVS provides basic research for the group and concentrates its plant breeding and R&D activities in Woodland, California. In Europe, SVS has 15 research locations and headquarters are in Enkuizen (The Netherlands). Biotechnological activities are localised in The Netherlands, France and California, but there are research stations in other European countries (Spain and Italy are very important too).

We can see two kind of mechanisms in Seminis R&D decision making process: formal and informal mechanisms; and a bottom-up process (see Figure 2).

Chart 2. R&D organisation and decision making process of SVS



The decision making process starts as an informal mechanism: SVS maintains free alliances with growers; within each brand, breeders are working with growers and farmers and then breeders know market needs. So breeders provide the most important information for R&D decisions. Information from breeders flows through marketing department, that is coordinating the whole process, and through informal meetings to discuss the market situation of products. The groups attending these informal meetings are not very large and are guided by marketing people, with people from research and sometimes from production. The information from these meetings is collected by research directors and is discussed in research board. During planning meetings research activities are reviewed more than planned, and the discussion is focused on products. Innovation strategy is dominated by markets. Market provides the signals for innovation strategy.

Formal mechanisms: There is a world-wide Vice-President of R&D, who coordinates Directors of Breeding, Biotechnology, Pathology and Regulatory Affairs. This structure is reproduced in Europe, where there are a R&D Director and Directors for Biotechnology, Breeding and Pathology (Regulatory Affairs is a world-wide service). Meetings are periodically held to coordinate the work of each research group (biotechnology, pathology, breeding) in different regions and the work in each region (Europe, North America, etc.) of the different research groups. The R&D Vice-President elaborates the research proposal that is discussed by a Research Board (formed by the Vice-President for Research and the worldwide Directors of Breeding, Plant Pathology, Biotechnology and Regulatory Affairs). Then, the R&D Vice-President presents the research proposal to the Vice-President Board. Formally, strategic investment decisions on R&D are taken by the Vice-Presidents Board, at periodically held board meetings. These decisions take Marketing Department Reports into account. The Financial Office finally approves the budget for the proposal (company interview, 1999). Each brand operates with high autonomy; SVS provides each brand with basic research and financial support, and establishes some strategic guidelines. These guidelines are concepts used to draw the public image of SVS, such as the focus on functional foods, the respect to the environment, etc.

Taking into account the information provided by SVS and the discourses of the people interviewed, we can highlight three goals in the Seminis innovation strategy:

- to attend specific needs everywhere. SVS is focused in local markets around the world:

Since fruits and vegetables are largely grown and consumed on a regional level, Seminis has built its business on local research and marketing presence that is supported by worldwide production, quality and operations strength to meet the demands of both segments [developing and developed countries]. We plan to strengthen our leadership position in the global vegetable and fruit seed industry by expanding our existing product lines, enhancing profitability for all parties in the production and distribution chain and continuing to apply a global strategy that addresses local needs.

Seminis Annual Report 1999, page 6

- to capture value from the whole food production chain through the production of functional foods (foods designed to meet specific nutritional needs). For this purpose SVS' affiliation with BIONOVA could provide synergies. SVS has close relations with almost all the big supermarket chains worldwide:

We have very close relations with almost all the big supermarket chains and they lack such partners and also they prefer us as partners because we don't have the other link (with agrochemicals) so they find us as a partner that also see the way they see. They also find interesting that in Seminis they have a partner which has important developing and basic research products and they also learn a lot with this. But in the other hand it's also providing the cover around the world.

Company interview, 1999

This quote shows that SVS does not see a benefit in linking their company with another agrochemical business. SVS considers that agrochemicals and seeds are very different businesses and the size of the seed business is much smaller than agrochemical business. SVS is more interested in connections with food processors and distributors. Its main goal in using biotechnology is to produce functional foods, not seeds resistant to any agrochemical.

Monsanto has developed Roundup resistant seeds because it gives a sales outlet to the Roundup Ready and that is a very interesting thing. (...) we might use this technology also (...) in our varieties just to make use of this new technology, if it's shown that the technology doesn't have any problem and that there is a benefit also from a small market. It is available, but for us in the long term the goal is to get functional foods, food that is helping the quality of life of the people, it's not to have an outlet for other products we have, and I would say that is the basic difference.

Company interview, 1999

- to connect their seeds with the ideas of "a better environment" (to reduce the need for chemicals, limit spoilage, etc) and "more food for more people".

Our innovative seeds, designed to produce larger amounts of hardier and more nutritious fruits and vegetables in a cost-effective manner, help ensure the success of produce growers, processors, distributors and retailers. In addition, they provide healthier products for consumers, while helping to protect the environment by allowing farmers to reduce agrochemicals used in the growing process

Seminis Annual Report 1999, page 4

For these purposes SVS uses three main tools:

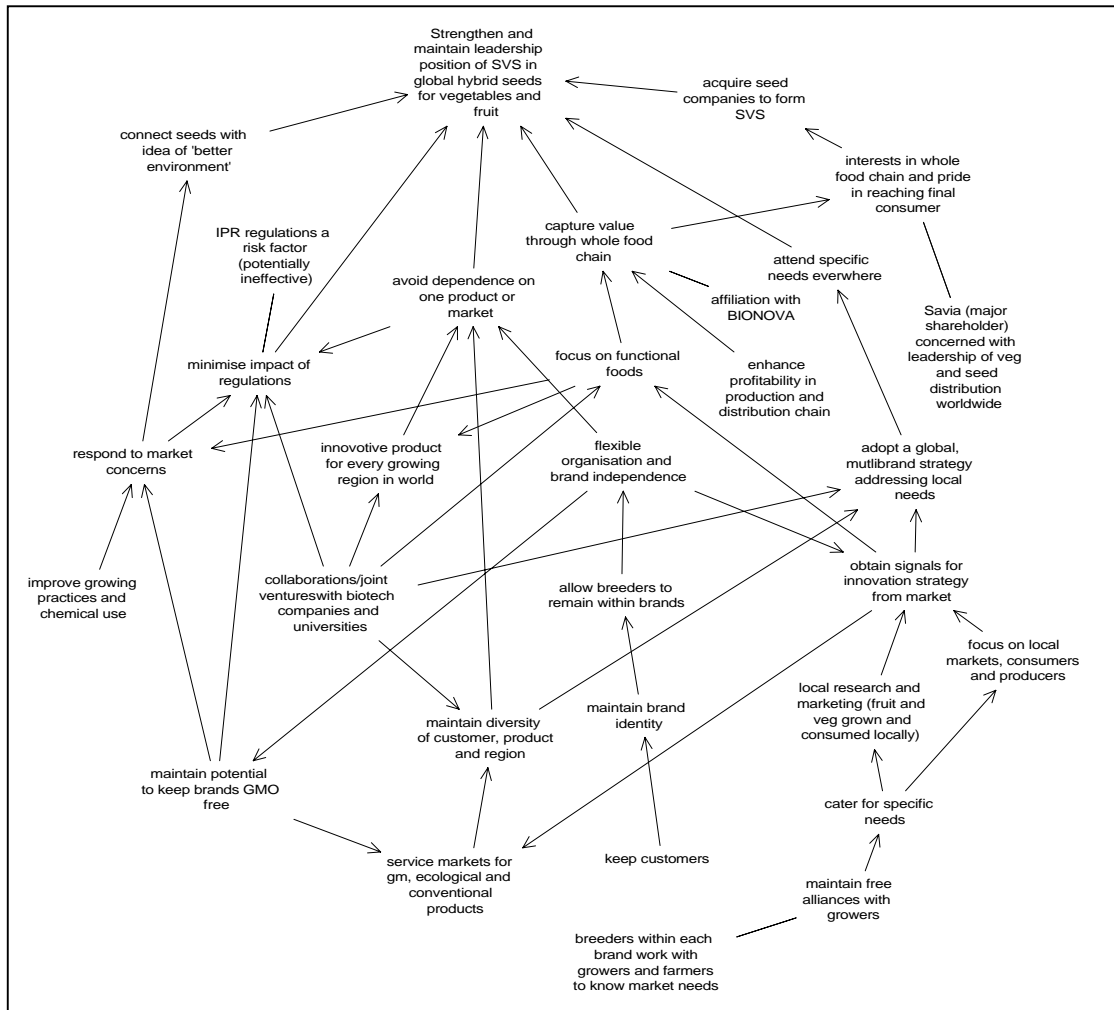
1. a multi-brand strategy and a world wide marketing presence. The brand approach allows the breeding efforts to remain within the brands, so that brand's identity continues to grow and consumer maintain fidelity to each brand. The brand approach is also used to attend specific needs more efficiently. For this reason SVS maintains a flexible organisation: *"it's not a fixed organisation (...) we have our researchers, especially our plant breeders, we have free alliances with growers, with sales people, with product developers and a lot of ideas are sprouting from that"* (Company interview, 1999).
2. A flexible organisation of the decision making process and a division of basic research activities at SVS level (at brands level research activities are focussed on traditional breeding) into three groups: plant pathology, biotechnology and quality groups:
 - Plant Pathology Group (nine laboratories). Plant Pathology's duties fall into two categories: research and quality assurance. In the research category, Plant Pathology develops testing procedures to identify resistance to plant diseases and also keeps breeders informed about disease trends. In the quality assurance category, Plant Pathology oversees an in-house seed health testing programme. Other activities of the Plant Pathology group include: analysing varieties for genetic purity, conducting research into enhanced disease control strategies; helping to compile disease guides for vegetable growers and providing diagnostic services for customers.
 - Biotechnology Group. This group operates in California, France and The Netherlands. The fundamental biotechnology work is done in the US (California) and in France and The Netherlands they explore and research fundamental technology. There is another small laboratory in Italy. This group works on genetic engineering, pollen culture technology and molecular markers. SVS is forging alliances with universities and companies in the US and Europe to access the latest genetic technology, such as the alliance with Zeneca to develop transgenic processing tomatoes, and the alliance with DNA Plant Technology to access to several proprietary genetic traits. Currently SVS has two genetically modified products on the market: genetically modified processing tomatoes in the US, and Asgrow's virus resistant squash in the US. SVS owns the world's largest vegetable gene bank. *Intelligent Seeds™* is the name that SVS has created for seeds capable of controlling diseases, without chemical herbicides and insecticides while using less water and fertilisers.
 - The SVS Vegetable Quality Laboratory in Woodland performs chemical and agronomic analyses for the brands. The laboratory's primary role is to assist breeders in developing new vegetables with traits desired by consumers as well as growers. SVS is more focused on the needs of consumers, such as colour, flavour, etc., than growers', such as high yields, packing and processing qualities, etc.. At least 90 percent of the tests performed in this laboratory are directly related to consumer needs. Some specific examples are: carrots (analyses of sugars as well as levels of alpha and beta carotene, important sources of the eye nutrient retinol and Vitamin A, respectively); tomatoes (standard tests for the processing tomato industry, such as wall thickness, sugar-acid ratio, lycopene and titratable acidity); onions (levels of pyruvate and sugars); peas (sugars and starch levels); hot and sweet peppers (colour, pungency, variability); melons (colour and sugar content); biotech (assists in the testing of genetically modified vegetables); nutrition trends (consumer and medical trends, occasionally conducts tests for substances such as beta carotene and lycopene).
3. an external communication strategy that emphasises traditional breeding efforts and omits references to biotechnology, specially in Europe. In practice, traditional breeding activities are very important in the SVS strategy.

Chart 3 shows a summary of the main concepts of SVS' discourse on innovation. The main aim of SVS innovation strategy is to strengthen its leadership position in global vegetable seed market. For this purpose, SVS has been acquiring seed companies around the world and now is facing a new stage in its consolidation. The affiliation of SVS with Bionova, both

under the control of Savia, allocate SVS within a broader strategy with interests in the whole food chain. Thus, links with supermarkets chains are very important because they know final consumers' needs and preferences. Nowadays people want a better environment and to improve their quality of life, and functional foods are the best way to cover this market need. There is also a demand for GMO free products and the controversy around GMOs could have a negative influence for the company, so it is still necessary to maintain potential to keep GMOs free products and to serve customers and markets with the products they want. The diversification of products and markets avoid the dependence of the company's success on one product or one market and contribute to minimise the impacts of the differences of regulations between geographical areas and possible future regulations more restrictive. Marketing people know the needs of farmers and market trends, so they coordinate the decision making process to assure that SVS' products met market needs. These needs are very different in vegetable markets because vegetable markets are highly segmented (tomato markets differs from lettuce markets or eggplant markets, etc.); so to know the needs of users is crucial for SVS and flexible organisation is the best way to manage the complexity of vegetable markets. There are also another important sources of information (growers, breeders, sales people, etc.) and free alliances with them allow SVS to get all the relevant information. Breeders are very important for the design of new products because they know growers needs. The flexible organisation allows breeders to work with high independence, that is the best atmosphere of work for breeders. Thus, research agreements are made on a "case-by-case" basis, depending on the characteristics of each breeder.

The last key element of SVS' innovation strategy is the multibrand strategy, that means that each brand operates independently of each other, to strength the identity of each brand and to keep the breeding efforts within the brands. The idea is to keep the confident of customers on each brand and to offer a specialised service that allows SVS to attend specific needs everywhere.

Chart 3. A map of the SVS' discourse on innovation



3. Impact of public policies and market signals on innovation strategy

3.1 Agricultural Policy

The EU's Common Agricultural Policy (CAP) affects SVS activities but not their innovation strategy. SVS doesn't consider the CAP to be a negative influence, and distinguishes two effects: sometimes the effect is a change in their distributing activities, but on the other hand the EU provides a lot of small markets without trade regulations:

"... in some cases what you see is just you are distributing in one area and it could be done in a different area (...) but on the other hand this union [EU] brings, also for companies like Seminis which is very global and is in a bigger global market, a

lot of different and sometimes small markets. Now you get a more global manner with single relations but without trade regulations".

Company interview, 1999

We must interpret this quote keeping in mind that SVS is a vegetable seed company and European vegetable markets are less subject to intervention than big crops. We must also consider that vegetable markets are very specialised and diversified: there is not a vegetable market, but a tomato market, a lettuce market, a melon market, etc., and all of them are different. Then, a change in the European market conditions of one of them doesn't affect the whole innovation strategy of SVS, although it can affect SVS' distribution and marketing activities.

3.2 Science and Technology Policy

The reduction of public support for R&D activities in some countries such as The Netherlands provoked an increase in their own basic research fifteen years ago. Now they keep a balance between research in house and research through cooperation. Government subsidies for research cooperation are important in some countries such as Spain - now SVS has quite bilateral collaborations with Spanish researchers because of the subsidies- but subsidies have a little influence on SVS' R&D decisions because research locations are very difficult to move. SVS has research locations where the market is and where universities have relevant expertise. That's because SVS they have their headquarters in The Netherlands (Company interview, 1999).

3.3 Environment and PPP regulations

Environment is a key element of the institutional discourse of SVS because there is a growing demand for a more environmentally-friendly agriculture. That is because SVS is working on "ecological seeds": seeds that need lower quantity of chemicals inputs to grow. *Intelligent Seeds* is the name for seeds that reduce the need for agrochemicals, and provide healthy and more environmentally friendly food. SVS says that these products are designed to reduce the need for agricultural chemicals, increase crop yield, reduce spoilage, offer longer shelf life, and create better tasting foods and foods with better nutritional content. In the view of SVS, biotechnology allows these characteristics to be achieved (Seminis web page, 2000). However, environmental policies are in a definition process and sometimes there is confusion about what is a clean product or a clean technology. In the next years it will be necessary a clarification of environmental regulations (Company interview, 1999).

Some changes in PPPs regulation forbidding a product have provoked new research projects in order to eliminate the need of such product for the seed growth. In the future there will be more research collaboration with agrochemicals companies on seed treatment, as an option to reduce pesticide use (Company interview, 1999).

3.4 Seeds and Intellectual Property Rights (IPR) regulations

Seeds and IPR regulation are very important for SVS' activities. In the 1999 Annual report, SVS considers that changes in law protecting plant patents in US and the ineffectiveness of the laws in other countries are risk factors for its business.

The Company may have the inability to protect its intellectual property due to the uncertainty of litigation and the ineffectiveness of the laws in some of the countries that the Company currently has operations, which could have a material adverse effect on our business.

A change in United States law protecting plant patents could take away patent protection for our patented seeds, which could have a material adverse effect on our business.

Seminis Annual Report 1999, page 13

This quote shows the obvious importance of the protection of plant varieties for SVS, but also that regulations on this issue are unpredictable for them. SVS manages these risk through a strategy of diversification of products and markets, trying to avoid SVS' dependence on one product or one market: "*We are fully diversified in our products, our customers and the regions in which we operate; no one customer or product represents more than 2 percent of our sales*" (Seminis Annual Report 1999, page 4). This strategy provokes also the low impact of international trade regulations perceived by SVS.

4. Discourse on agriculture and environment. Attitude towards biotechnology

As we mentioned above, environmental concern is often mentioned in the institutional discourse of SVS. SVS considers that concern for the environment has generated a set of demands for improved growing practices and reduced chemical use. That is because they are working on "ecological seeds".

Biodiversity is a concern of the public and plant researcher alike. We have long recognised its importance to the health of the planet as well as maintaining and improving cultivar performance and yield

Al Stevens, Director of World-wide Research. Seminis Brochure, 1997

It gives me real satisfaction to know my research will help reduce chemical disease control, ensuring a safer food supply and environment

Brad Gabor, Pathologist, Seminis brochure, 1997

However, according to a SVS interviewed, environmental issues are sometimes mythical (utopian) and it's quite difficult to distinguish what is a clean product or technology from what is not.

The call is to be as clean as possible, to have clean technology, clean products. The thing is we have a very down way approach. And we say: well, we will try to deliver just clean products but anybody is going to be able to use them. Topics from that are very mythical. For instance, you have the seed treatment on the seed and that is what we would probably take as the clean part of the seed. You don't know why something is very clean or everything is clean. (...) if you don't protect it [the environment] the world will not plant, the world will not get anything out of it, unless technology evolves, ... you need to provide clean products

Company interview, 1999

Chart 4 shows a map of SVS's discourse on environmental issues. It's necessary to protect the environment and public policies and company's strategy need to respond to growing public and government concern. However, there is confusion on some concepts: what is a clean product?, is the objective of no agricultural impacts possible or utopian?, could all farmers adopt clean products, taking into account the current status of technology and economic conditions?. Anyway, environmental issues have an impact on SVS activities because environmental issues have an impact on farmers, but it's an indirect impact.

SVS expects a considerable reduction in agrochemical use as a result of seed treatments, not developed by themselves, but in collaboration with the chemical industry (Company interview, 1999). We can consider the agreement with Monsanto to develop herbicide resistant varieties as an example of these possibilities. Moreover, SVS' subsidiary, INCOTEC, is working on the incorporation of both biological agents and new highly effective molecules for pest and disease control in seed coatings.

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SVS thinks that, in the near future, there will be three types of agricultural products on the market: "traditional" products (produced as nowadays with high quantity of inputs), ecological products (produced without agrochemicals, with a low impact on the environment) and biotechnological products (produced using GMOs). The consumer will choose the products that they want to consume, and GMOs products must be labelled (Company interview, 1999).

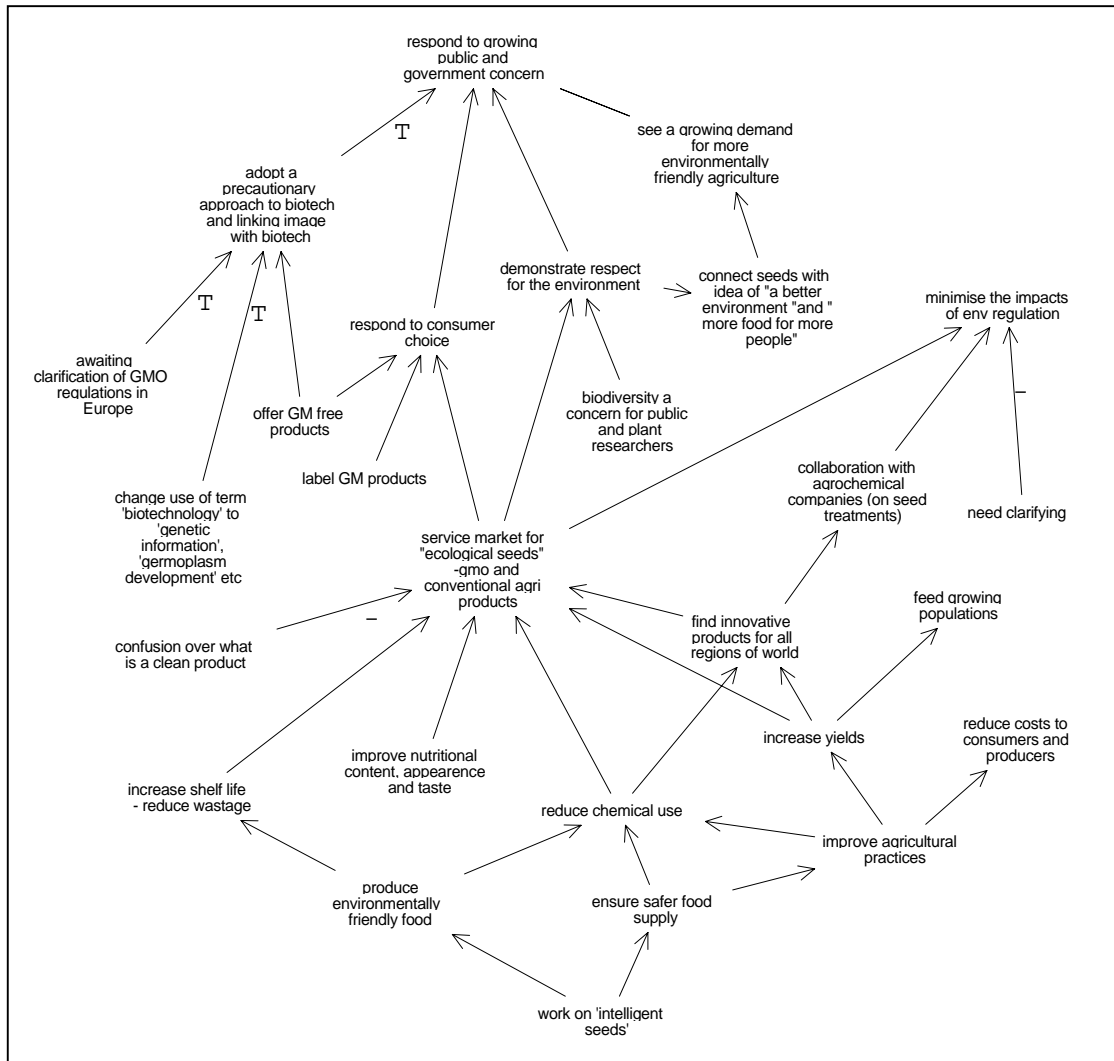
In fact, SVS uses both technologies: traditional breeding and biotechnology, although SVS concentrates its own research in plant breeding and concentrates biotechnology research in the US, through research agreements within Savia Group (agreement with Bionova) or with external research groups and companies (for instance, the agreement with Monsanto to develop herbicide resistant varieties).

In the following quote we can see the importance of both technologies for SVS and the objectives of R&D activities.

Using traditional breeding and advanced plant technologies, we are working on more than 4,500 innovative new products for every growing region in the world. We have also entered more than 100 technological arrangements with leading companies and research institutions around the globe. Through these R&D endeavours, we expect to introduce products that can increase crop yields and uniformity, reduce the growers' dependence on chemicals and fertilisers and improve the appearance, taste and nutritional value of fresh and processed produce. And through premium pricing along the production and distribution chain, we can capture value and enhance profitability.

Seminis Annual Report 1999, page 9

Chart 4 Map of SVS discourse on environment



However, we can perceive a slightly change in SVS' discourse on biotechnology in recent years. In 1998 company vision mentioned clearly the importance of biotechnology for SVS' innovation strategy. Nowadays, the word biotechnology has been eliminated from their discourse, and replaced by "genetic information", "germplasm developments", and so on. The 1999 Annual Report of the company remarks the low significance of biotechnology for SVS current growth:

As we continue to deliver on our prospects for growth, we are confident that the market will give our stock the inherent value it holds. From the time of our initial public offering to the end of fiscal year 1999, Seminis stock fell 43 percent in price, but not in value. The current debate over the acceptance of biotechnology in some areas of the world has created a reluctance by investors to invest in seed companies. However, even though we are certain of the benefits that advanced genetic techniques offer to all participants in the food production and distribution chain, less than 0.2 percent of our sales for 1999 came from products that were genetically enhanced. Our growth in the short and medium term will not depend on such products.

Seminis Annual Report 1999, page 5

In this quote we can see how SVS is not interested in linking its image to biotechnology, and how SVS has adopted a precautionary strategy towards biotechnology, although it's considered an useful technology. SVS is waiting for a clarification of GMOs regulations in Europe.

5. Conclusions

As a global company, SVS plans its activities on a global scale. The EU is one of its most important markets, but not the only one. However European policies affect the decisions of the brands that are active in Europe (Asgrow, Petoseed, Royal Sluis and Bruisma) and these brands have important interests in Europe. As these companies have high autonomy we could expect an impact of EU policies on their activities. Their independence allows SVS to diversify its activities according to trends in different regions.

Table 6 shows a summary of European policies impacts on SVS' innovation strategy.

Table 6. Policy influences on R&D decisions. Environmental discourse

Policies	Are policies predictable or uncertain?	What is the interaction of the policies and innovation and R&D decisions?	Impacts on the company	Comments Environmental discourse
CAP	Predictable	No impacts	+	Economic impacts: distributing activities may be modified and the EU has provided a lot of small markets for SVS with common rules
STI	Predictable	Public support in some countries like Spain induces new relationship with PSR	+	R&D activities are where markets and best expertise are and is quite difficult to move research locations
Environment and PPP regulation	Policies and regulations need to be clarified in Europe	Growing demand for reducing chemical use and modify farming practices Research on intelligent seeds, with a reduced need of agrochemicals and other qualities New collaboration on seed treatment as an option for reducing pesticide use	++	Environment in the institutional discourse of SVS Some changes in PPPs regulations have provoked new research projects.
Seeds, IPR	Unpredictable Ineffectiveness of the laws in some countries It's possible a change in US law protecting plant patents	To avoid dependence on one product or one market	+++	Changes in law as a risk for SVS business
GMOs	Unpredictable	In-house research is concentrated in plant breeding Biotechnology is concentrated in US and through research agreements (Bionova)	++	Less than 0'2% of SVS sales for 1999 come from products that were genetically enhanced. <i>"Our growth in the short and medium term will not depend on such products"</i>

ANNEX C15

Trade	Predictable	Diversified products, customers and regions	-	No one customer or product represents more than 2% of SVS total sales
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Legend: +++: considered as the most important; ++: important; +: significant but not a priority; =: not referred; -: neglectable

National R&D policies and subsidies have provoked an increase of SVS' own research activities in those countries where public support has diminished (for instance, The Netherlands) and an increase in research collaboration in those countries where there has been money for cooperation (for instance, Spain). However, SVS' decisions about investment in research locations are little influenced by R&D policies, because for SVS is quite difficult to move research locations and these are where markets are. Thus, SVS has kept its main European research location in The Netherlands because that is where the expertise and main markets are, although public support for research activities in the Netherlands has decreased in the recent years.

Agricultural policies and subsidies have only provoked a shift in their distributing activities: sometimes they are concentrated in one area, sometimes in another area, depending on where the subsidies are. But the EU has promoted a lot of small markets for SVS without trade regulations, so it has been quite easy to keep the balance between one area and another within the EU. Trade and agricultural policy has little impact on innovation decisions of SVS because vegetable markets are less subject to intervention in Europe than other crops and because vegetable markets are highly segmented and SVS is very diversified in its products and markets.

Environmental issues are frequently mentioned in the institutional discourse of SVS, although more as a downstream influence (as a marketing factor) than as a direct influence on the decision making process. In practice, SVS doesn't see environmental issues as a problem, but they have to respond to this market concern. Further pressures from consumers on environmental issues could lead SVS to integrate these concerns in their innovation strategy. In fact, some changes in PPP regulations have provoked new research projects to reduce the need of some products.

Seeds and intellectual property rights regulations have an important impact on SVS' activities. SVS tries to avoid the dependence on one product or one market and, then, to minimise the impact of changes in such laws.

Market trends are the most important factors for the innovation strategy of SVS, more than European policies. SVS affiliation with SAVIA (an agri-food company) leads SVS to focus on final consumers as well as on growers. The objective of SVS' innovation strategy is functional foods. Thus, links with food distributors are a key factor for them, more than links with agrochemical industries. Market trends, such as a rejection of GMOs, strongly affect their decisions. Because of SVS' flexible organisation and the high independence of its brands, SVS could keep some brands free of GMOs and supply small markets or specific regions with such products. SVS believes that in future there are going to be three different kinds of agricultural markets: for ecological products, for products from GMOs, and for conventional agricultural products.

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⁴ During our interviews, interviewees provided us with some leaflets that are not formal publications.

Executive Summary

This report analyses the main features of Seminis Vegetable Seeds (SVS), especially those related to its innovation strategy and its environmental behaviour. We have also tried to analyse the influence of policies and market related factors on SVS's decision making process.

SVS has its headquarters in the United States and is the world-wide leader of the vegetable seeds. In 1998 it had the following market share: 26% of the global vegetable seeds market, 39% of the US market, 24% of the European market and 15% of the Asian market.

SVS is majority owned by SAVIA, which is in its turn part of PULSAR (Mexico), a group of companies operating mainly in the agro-technology, insurance and packaging areas. SAVIA is a conglomerate with strong interests along the whole food chain, through two main elements: SVS (seed production) and BIONOVA (fruits and vegetable production and distribution and R&D).

The main aim of SVS' innovation strategy is to strengthen its leadership position in the global vegetable seed market. SVS' affiliation with Bionova locates SVS within a broader strategy with interests in the entire food chain, leading SVS to focus on final consumers' needs and preferences, *more so(?)* than other seeds companies.

A key element of SVS' innovation strategy is a flexible organisation, as the best way to manage the complexity of vegetable markets. Another key element is the multibrand strategy, which means that each brand operates independently of each other to maintain customer confidence in each brand and to offer a specialised service that allows SVS to accommodate specific needs everywhere.

The diversification of products and markets avoid the dependence of the company's success on one product or one market. Diversification also helps to minimise the impacts of different regulations among geographical areas and of future regulations which may be more restrictive.

National R&D policies and subsidies have provoked an increase of SVS' own research activities in those countries where public support has diminished and an increase in research collaboration in those countries where there has been money for cooperation. However, SVS' decisions about investment in research locations are little influenced by R&D policies, because for SVS is quite difficult to move research locations and these are where markets are.

Trade and agricultural policy has little impact on innovation decisions of SVS for several reasons: because vegetable markets are less subject to intervention in Europe than other crops, because vegetable markets are highly segmented, and because SVS is very diversified in its products and markets.

Regulations on seeds and intellectual property rights have an important impact on SVS' activities. SVS tries to avoid dependence on one product or one market, thus minimising the impact of changes in such laws.

Environmental issues are frequently mentioned in the institutional discourse of SVS. But these issues are mainly a downstream influence on marketing decisions -- more than a direct influence on R&D priorities. Further pressures from consumers on environmental issues could lead SVS to integrate these concerns into its innovation strategy.

For the innovation strategy of SVS, market trends are the most important factors -- more important than European policies. Market trends, such as a rejection of GMOs, strongly affect its decisions. Because the company has a flexible organisation and a high independence of brands, SVS could keep some brands free of GMOs and could supply small markets or specific regions with such products.