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

Advanta monograph

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TSER Programme
European Commission – DG XII
Project No. PL 97/1280
Contract No. SOE1-CT97-1068

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December 2000

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.

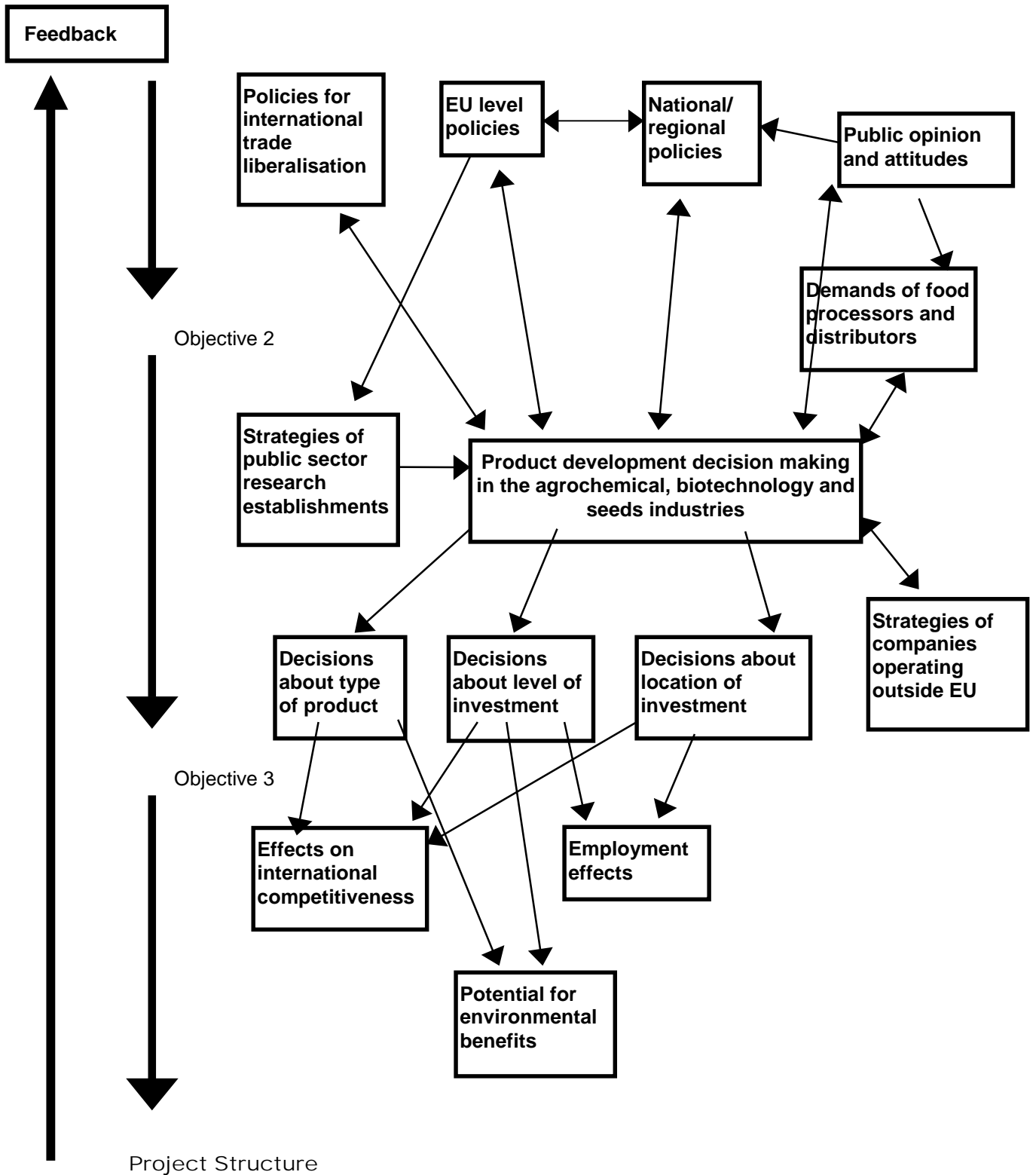
The range of policies and other influences studied includes:

- 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

This monograph reports on the innovation strategy of Advanta, a globally operating seed company with its headquarters in the Netherlands. Advanta is specialised in field crops like sugar beet, maize, grasses, and oil seeds.

This report has been written on the basis of two kinds of sources: (1) material published by the company itself (annual reports, news releases, web site) and material published by others (in research reports, newspapers, trade journals); (2) interviews with several Advanta managers. We would like to thank these managers for their collaboration and for the information supplied. The information from company sources, either from interviews or from documents, is integrated in the text with due reference. It was agreed that no direct quotes from the interviews would be presented.

Although this report is on Advanta's innovation strategy, it has a bias towards the development and application of biotechnologies (like genetic markers and genetic modification). Chapter 3 will make clear that these new technologies, while of utmost importance for any seed company, are not the core of the innovation process, but are complementary techniques that help to improve the efficiency and efficacy of the plant breeding process. Still the bias remains, because public policy issues are most controversial and uncertain in the area of biotechnology.

This report is structured as follows. Section 2 gives general background information on Advanta, particularly its strategy on the main crops it has in portfolio. Section 3 describes the innovation strategies of the company. Special attention is given to biotechnology. In section 4 we discuss the Advanta organisation of decision making on innovation. Section 5 presents the impact of public policies and market developments as they are felt by Advanta. The next section presents the internal discourse on environmental and sustainability issues. Finally, in section 7, some conclusions are drawn on innovation strategies and decision making, on impact of public policies on innovation, and on environment issues in relation to innovation.

2. Advanta

2.1 Key figures

Advanta is the world's fifth largest seed company, developing, producing and selling agricultural seeds all over the world. Its headquarters are located at Kapelle, in the south-west of the Netherlands. Advanta's main crops are maize, grasses, sugar beet and sunflower. Other crops in the Advanta portfolio are soybeans, canola, wheat, sorghum, onions, and rice. Maize is by far the most important crop of the Advanta (table 1).

Table 1 Turnover by crop (million Euro)

	1997	1998
maize	123	123
grasses	65	60
sugar beet	61	64
oil seeds	54	52
others	81	75
Total	384	374

source: Advanta Key figures and addresses 1997, 1998

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Total turnover was 374 million Euro, in 1998 (table 2). For turnover, Europe is Advanta's main area of operation, with North America being a good second. Growth of the company is mainly taking place outside of Europe, particularly in North America.

Table 2 Turnover by region (million Euro)

	1997	1998
Europe	177	168
North America	146	150
South America	31	30
Australia, Asia, Africa	30	26
Total	384	374

source: Advanta Key figures and addresses 1997, 1998

The growth of Advanta's North American activities become particularly visible if we look at the employment figures (table 3). The total number of employees in 1998 (year end) was 2299, up from 2121 in 1997. While in 1997 Europe accounted for the largest part of employees (46%), with North America only 30%, in 1998 both regions accounted for 37% of total employment. This change in employment was mainly the result of reorganisations in Europe (necessary after the 1996 merger) and acquisitions in North America.

Table 3 Employment by region

	1997	1998
Europe	46%	37%
North America	30%	37%
South America	12%	10%
Australia, Asia, Africa	12%	16%
Total number of employees	2121	2299

source: Advanta Key figures and addresses 1997, 1998

2.2 The formation of Advanta

Advanta was formed in 1996 with the merger of the Dutch company Royal VanderHave Group and the British company Zeneca Seeds. Advanta is a joint venture, 50 percent owned by Dutch farmer-owned co-operative Cosun U.A. and 50% by Swedish/British AstraZeneca Ltd. Cosun is a farmer co-operative with a strong position in sugar production (60% of the Dutch sugar market). AstraZeneca, an investor-owned firm, was formed in 1999 by the merger of Zeneca, a producer of seeds, agrochemicals and pharmaceuticals based in the UK, and Astra, a Swedish pharmaceuticals company.

The merger between VanderHave and Zeneca Seeds was inspired to obtain economies of scale both in marketing and in R&D. Critical mass in production and sales was needed to be able to continue substantial R&D investment, particularly in plant biotechnology. Although both companies had invested in biotechnology research, they considered themselves too small to successfully compete in the long run. Global presence has become very important in the seed market for the main field crops like maize, sunflower, sugar beet and oilseed rape. The crops and geographical presence of VanderHave and Zeneca Seeds were complementary, Zeneca Seeds being more international, with a strong position in North America and Australia, and VanderHave being a more European company.

According to Noome (interview 1997), a good base in germplasm combined with a marketing position in many countries around the world provides a strong negotiation position in acquiring access to genes and techniques patented by other seed and biotech companies. For VanderHave, with its commitment to biotechnology research, it was important to obtain a stronger base in the North American market, the most important market for transgenic varieties. Another reason for seed companies to expand geographically is the need to be present in both the northern and southern hemisphere, in order to take advantage of the difference in seasons. This can guarantee a sufficient supply of seeds even in case of disaster in one part of the world.

Since the merger, two subsidiaries have been divested, and further acquisitions have been made. Two vegetable seed companies, Leen de Mos in the Netherlands and Shamrock in the USA, were sold. Leen de Mos was acquired by AgrEvo (and integrated with Nunhems Seeds). These divestments emphasise Advanta's strategic focus on field crops. According to Noome (interview 1999), Leen de Mos lacked sufficient scale for successful competition in the European vegetables seed market. Thus, the choice for Advanta was to acquire another vegetable seed company or to sell Leen de Mos.

In 1998, further acquisitions were made in the USA. AgriPro Seeds, of Shawnee Mission, Kansas, was acquired to strengthen Advanta's position in maize, wheat, sorghum and soybeans. AgriPro will be integrated with Garst, Advanta's main subsidiary in the USA. In addition, the sunflower breeding programme of Eureka Seeds, of Woodland, California, was bought. The latter shows Advanta's strategy to strengthen its leading position in the world sunflower seed market.

2.3 Main subsidiaries

Advanta has subsidiaries (or operating units) in every part of the world. Table 4 presents the main subsidiaries that have their own crop breeding programmes (subsidiaries that are only sales offices are not presented). These subsidiaries are operating as stand alone companies (Bridges, interview 2000). This means their own financial responsibilities, they their own breeding programmes for particular crops, and their own marketing programmes. Innovation decisions however, both on conventional breeding and on biotechnology, are co-ordinated with other subsidiaries (see Chapter 3).

Table 4 Advanta's major subsidiaries and crops

Subsidiary	Location	(Main) Crops
Advanta VanderHave	Kapelle, NL	maize, sugar beet, grasses, onions
SES Europe	Tienen, Belgium	sugar beet
Advanta Seeds UK	Lincolnshire, UK	maize, cereals, oil seed rape, peas and grasses
Garst Seed Company (incl. AgriPro and Interstate)	Slater, Iowa, USA	maize, soybeans, sorghum, wheat, alfalfa
Advanta Seeds (formerly Zeneca Seeds)	Winnipeg, Canada	canola, maize, sunflower
Advanta Seeds Pacific	Albany, Oregon, USA	grasses
Pacific Seeds	Toowoomba, Australia	sorghum, sunflower, maize, soybeans, canola

Advanta VanderHave, at Kapelle, Netherlands, is the continuation of VanderHave Nederland. It is now Advanta's European centre for maize and oilseeds. Royal VanderHave, founded in 1879, was the largest seed company in the Netherlands, and was originally family-owned. It was acquired by sugar co-operative Suiker Unie in 1970, as part of the latter's diversification strategy. VanderHave started its plant breeding research in Rilland-Bath in the 1940s. Originally it focussed on grasses, grains and sugar beet. Later other crops like maize, oilseed rape and onions were added to the breeding activities. Advanta VanderHave has recently united its European grass seed business. Until recently VanderHave and Mommersteeg were two relatively independent grass seed businesses within Advanta. In 1998 the decision was taken to integrate both subsidiaries, but to maintain the brand names *VanderHave* and *Mommersteeg*. Originally, Mommersteeg was a seed trading firm, established in 1923. It started a breeding programme in the 1950s. It was acquired by Suiker Unie in 1972, and became part of the VanderHave Group in 1980.

SES Europe was the sugar beet subsidiary of Zeneca Seeds. SES was established in 1948. It was first mainly a Belgian company, later a European, and with the acquisition by ICI/Zeneca, it became a globally operating company. SES and Advanta VanderHave both have sugar beet breeding programmes.

Advanta Seeds UK is the newly formed combination of the UK subsidiaries of VanderHave – Sharpes (peas), Mommersteeg (grasses) and Sinclair (cereals) – and UK subsidiaries of Zeneca Seeds (maize and cereals).

Garst Seeds is Advanta's main subsidiary in the USA. It has breeding programmes for the main mid-western crops like maize, soybeans and wheat. Garst started in 1927, as a family owned seed distributor. In 1985, Garst started a research and breeding programme for maize. Soon after this investment, Garst was acquired by ICI America (later Zeneca).

Advanta Seeds in Canada was formerly know as Zeneca Seeds Canada. Its main crop is canola, but it also has breeding and commercial activities in maize and sunflower. When ICI decided to start a seed subsidiary, Winnipeg became the newly established headquarters.

Pacific Seeds was also part of Zeneca Seeds. It was acquired from Continental Grain. Pacific Seeds started in 1962 with operations in Canada and Australia. Its main crop is sorghum, but it also has breeding programmes for sunflower, maize, soybeans and canola. Pacific Seeds has a subsidiary in Thailand, working on tropical varieties of sorghum.

Advanta Seeds Pacific is Advanta's North American grasses business. In 1977 VanderHave acquired Advanta Seeds West, a grass seed breeder in the state of Oregon. This local seed company is the origin of the name *Advanta*.

3. Innovation Strategy

3.1 Introduction

Under the heading "Modern Science, Traditional Values", Advanta presents the following mission statement:

Our mission is to be a leading supplier of seeds and seed technologies to major global and regional markets, providing added value to farmers, downstream industries and consumers by combining superior genetics with essential technologies and techniques. Through our commitment to excellence in seeds, we want to achieve high quality, sustainable rewards for our shareholders, employees and other stakeholders. We have respect for ethical market standards and the environment and have a commitment to contribute to the development and maintenance of sustainable agricultural systems.

(Advanta, "Make your future grow", our translation, JB/MJB)

Seed companies take a long term perspective in their innovation strategy, as the development of a new crop variety takes 10 to 15 years from the first crossing to commercial seed. Noome (interview 1999) emphasises that plant breeding still is a very personal activity, as the breeder determines the choices in the crossing and selection processes. Once selection choices have been made, it is not easy to change the goals of the breeding programme. Thus, long term commitment (to the crop, to the breeding goals and to the company) is a basic element of the corporate culture of any seed company. Another major feature of seed companies is the high R&D budget. A main part of the activities of the seed company consist of the breeding programmes and the supporting research.

Advanta spends about 55 million Euro per year on R&D (Cosun Magazine, August 1999). This is 15% of turnover, which is the average among agricultural seed companies. About one quarter of the R&D budget is spent in the Netherlands, at the Rilland-Bath research station of Advanta. The total employment in R&D is about 600 people.

Although Advanta is committed to biotechnology, most of the R&D budget is still spent on conventional breeding. Out of the R&D budget of Advanta VanderHave, about 80% is spent on classical plant breeding, 10% on genetic marker technology and 10% on transformation technology (Cosun Magazine, August 1999). While genetic engineering is the most spectacular (and most controversial) application of biotechnology, the company sees real growth in applying biotechnology techniques in marker assisted selection.

Advanta managers emphasise that the company's biotechnology research effort is rather small compared to what companies like Novartis and Monsanto have been investing in developing this type of technologies. Also, the biotechnology R&D at the old VanderHave may have been large in Dutch perspective, it was quite small compared to the sums that global agrochemical companies have invested in plant biotechnology.

According to Advanta, classical breeding is still the starting point in developing new crop varieties. If there is a demand from a customer that cannot be met by classical breeding methods, the biotechnology experts are asked to find a solution. This solution can be a license from another company to apply a certain technique or to insert a gene, or it can be in house biotechnology research to find the proper solution. The commercial prospect of a new variety with the desired trait determines whether and how much investments in biotechnology research will be done. Thus, biotechnology is considered as a set of enabling tools for plant breeding. "Plant breeders, and other employees who have direct contact with clients and food processors, are directing those engaged in biotechnology" (Cosun Magazine, Sept. 1998; our translation, JB/MJB).

Advanta has four major research and breeding stations (in order of magnitude):

- at Garst, in Slater, Iowa, USA: focus on maize;
- at Advanta VanderHave, in Rilland-Bath, Netherlands; focus on sugar beet, canola, maize, onion, grasses, sunflower; in June 1999 a new 7 million Euro research and plant breeding station was opened;
- at Advanta Semillas SAIC, in Balcarce, Argentina; focus on sunflower;
- at SES, in Tienen, Belgium; focus on sugar beet.

All four stations carry out both classical breeding and reproduction research as well as biotechnology research. Other research stations are located in France (sunflower, sugar beet, maize), Canada (canola, maize), Australia (maize, sorghum, sunflower), Thailand (sweet maize and sorghum) and the UK (peas).

3.2 Biotechnology research

VanderHave has been engaged in biotechnology research ever since 1985. It was one of the first Dutch agricultural seed companies with its own biotechnology laboratory. VanderHave has always had a strong dedication to research and to applying the most advanced breeding and selection techniques (De Laat and Van Dun, 1994). According to Noome (interview

1999), investment in biotechnology was a natural choice for many years, as it was considered the technology of the future and each major seed company felt the need to invest in biotechnology research and breeding.

Also at Zeneca Seeds, biotechnology was considered an important technology for the future of plant breeding. As part of their (biological) research on the development and working of plant protection products, ICI and later Zeneca have since long been investing in biotechnology expertise. The acquisition of SES and Garst by ICI/Zeneca resulted in the strengthening of the research activities of these companies, and particularly the start of biotechnology research, both in Tienen (Belgium) and Slater, Iowa (USA). Thus, it was the influence of the chemical/pharmaceutical parent company that stimulated these seed companies to enhance their research effort and to engage in biotechnology research.

In the 1980s and early 1990s, biotechnology was considered such an important technology for plant breeding, that biotechnology research projects at VanderHave and Zeneca were initiated on the basis of quite optimistic expectations about commercialising research results. Investments in biotechnology were meant to serve two goals: first, to help develop new (transgenic) varieties; and second, to help develop a patentable technology, which could then be traded with other companies if access to proprietary knowledge was required (Noome, interview 1997). Nowadays, Advanta's investments in biotechnology research are more scrutinised by the board of directors. Each R&D project is fully evaluated *ex ante* on its financial potential.

Biotechnology research for sugar beet breeding is done in Belgium (at SES) and in the Netherlands (at Advanta VanderHave). The biotechnology research in Rilland (NL) is more exploratory, while the biotech research in Tienen takes care of the actual development of transgenic varieties. Still, there is only one biotechnology co-ordinator and the biotechnology research of the two locations may be integrated (see chapter 3). Besides in-house biotechnology research, Advanta also contracts research at universities and research institutes. In addition, Advanta VanderHave is one of the five shareholders of Keygene, a Dutch dedicated biotechnology firm (see also section 3.6).

Garst, in the USA, also has a strong biotechnology research department. Through in-house research as well as strategic alliances, it has developed transgenic maize varieties with herbicide-resistance, insect-resistance, soybean varieties with herbicide-resistance, and maize with a higher oil content. Garst scientists have discovered and patented a proprietary process used to insert genes into plants (the so-called WHISKERS technology). Using this technology, Garst has developed G-STAC hybrids, which stack several traits together in one hybrid seed product. As Garst has a research facility in Hawaii, it is able to study crops in a year-round growing environment. Garst also has much experience with RFLP genetic marker technology.

Advanta considers genetic marker technology as very important for its plant breeding activities. Even when genetically modified crop varieties continue to meet considerable opposition in Europe, DNA fingerprinting techniques will be used, and will help speed up the breeding process. According to Ad Huige, Advanta's CEO, speaking at the opening of the new research laboratories in Rilland-Bath in June 1999:

If under increasing public pressure use of recombinant DNA techniques or GMOs is to be banned or at least temporarily stopped, even though we would regret that very much, I can assure you that the broad basis of our breeding work will continue as before and even improved on the basis of the further development of the DNA fingerprinting techniques.

(Reuters News Service, 23/6/99)

3.3 Crops and traits

Maize

Maize is Advanta's most import crop (approximately one third of global turnover). Advanta's maize varieties are for animal feed (fodder maize and grain maize) and for processing into starch products (grain maize). In the Netherlands, Advanta VanderHave is market leader, with 27% market share (AgD, 10/8/99). The main competitors in the Netherlands are Cebeco (20%), Limagrain (18%) and Zelder (14%).

Maize breeding and research takes place in the Netherlands, USA, Brasil, France, Chile, Thailand, and Germany. The breeding programmes at Rilland (NL) are focussed on agronomic traits like early maturing, herbicide resistance and improved nutrient efficiency (i.e. lower nitrogen demand and better phosphate absorption). The latter trait is a reaction to environmental policies in the Netherlands that are becoming ever more strict (Cosun Magazine, March/April 1998). Production of maize seed is done in France, Hungary, Chili, Brasil and United States. Developing genetic markers is an important part of biotechnology research on maize. Garst (USA) has a strong position in using RFLP's in maize research, while Advanta VanderHave uses the AFLP technology of Keygene.

In 1998, Garst has commercially introduced transgenic maize varieties in the US market. One of these varieties is a *Liberty Link* (LL) herbicide resistant variety. Another is insect-resistant maize (Bt-maize). For Europe, Advanta VanderHave has developed herbicide resistant maize varieties, but has not yet been able to commercialise them. One the herbicide resistant variety was Chardon LL, resistant to the broad spectrum herbicide Liberty. Aventis (formerly AgrEvo) is the producer of Liberty (active ingredient: glufosinate), and the patent holder for the gene that is responsible for the glufosinate-resistance. Chardon LL was the first transgenic maize variety in the Dutch national list of field crop varieties; it has entered the list by January 2000.

In May 2000, Advanta VanderHave, has sold the breeders rights of its Chardon LL (Liberty Link) maize variety to Aventis. Advanta's reason for selling this transgenic herbicide-tolerant variety was the low prospect for commercial success, as the variety in which the herbicide-resistance was inserted, was no longer the top of the market. At the time of sale, an additional problem for the transgenic variety was the lack of approval for using the herbicide with the variety in over the top application (but that problem was solved later).

Grasses

Advanta sells both fodder grasses and amenity grasses, each account for about 50% of grass turnover. Two third of all research takes place at Advanta VanderHave (NL), and one third at Advanta Pacific Seeds (Oregon, USA). The main breeding goals in the Dutch programme are disease resistance (particularly crown rust) and nitrogen efficiency (Cosun Magazine, May 1997). Improved nitrogen efficiency is important because of Dutch environmental policy to reduce undesirable nitrogen emissions from extensive fertiliser use. Advanta VanderHave is developing fodder grass varieties that have the same yield and disease resistance as other varieties but need less fertilisers (Cosun Magazine, June/July 1998). According to Verburgt, former director of Mommersteeg (a grass seed company that has been integrated into Advanta VanderHave), biotechnology may become important in the near future, for developing tetraploid varieties (with enhanced disease resistance) and varieties with improved digestibility (Cosun Magazine, May 1997).

Sugar beet

Advanta is one of the three largest sugar beet seed companies, with approximately 25% of the world market (in the Netherlands it has a market share of 40%). In the United States, Advanta has a market share of 23 percent. In Europe, the company has two sugar beet breeding programmes, one in the Netherlands (the old VanderHave programme) and one in Belgium (the old SES programme). Advanta has chosen not to integrate these two programmes, because each breeding programme has its own characteristics. Thus, variety in

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the Advanta sugar beet germplasm is maintained, and risk is shared. Marketing of the VanderHave varieties and the SES varieties is done separately. For instance, in the Netherlands SES varieties are sold by Cebeco Seeds, a major competitor of Advanta in maize and other field crops. The processing of sugar beet seed for the Benelux market, i.e. sorting, coating and packaging of seed, has been concentrated in Belgium. The main competitors in Europe are KWS and Hillebrand/Novartis.

Breeding goals for sugar beet continue to be yield, particularly the content of easy recoverable sugar, and pest resistance (Rhizomania resistance, Cercospora resistance and nematode resistance). In recent years, Rhizomania (a virus disease) has become more problematic for sugar beet growers in Europe, which leads to greater attention for resistance in the breeding programmes. As sugar beet cultivation requires substantial amounts of herbicides, and environmental policies press farmers to diminish pesticide use, the development of herbicide-resistant varieties has received a great deal of attention in Advanta's breeding activities. The company could have the first transgenic herbicide resistant (*Liberty Link*) sugar beet varieties in Europe available in 2002, if regulatory approval is obtained.

Sunflower

Advanta is world market leader in sunflower seed. In Argentina, Advanta has approximately 60% of the market. Research is carried out in the Netherlands, Argentina and the USA. Sunflower transformation research is taking place at Rilland-Bath. For sunflower the use of market technology like RFLP and AFLP is important.

Oil seed rape / Canola

Advanta's canola activities are concentrated in Canada. The canola breeding programme is located in the province of Manitoba, while production of canola seed is based in the province of Alberta. The focus of the breeding activities is on developing hybrid canola varieties. Advanta Seeds has introduced transgenic herbicide-resistant canola in Canada.

Wheat

Wheat is more important in the USA than in Europe. With the acquisition of AgriPro, Garst has strengthened its wheat activities. In Europe, Advanta does only the breeding work, and then sells the varieties to other seed companies who multiply them and sell the seed to farmers. Advanta receives royalties from these seed sales. Advanta collaborates with Zeneca Plant Sciences (one of the plant biotechnology units of Syngenta) to develop better wheat varieties. Syngenta and Zeneca Plant Sciences have extensive (basic) knowledge of wheat.

3.4 From agronomic traits to output traits?

When Ad Huige became chairman of the board of directors of Advanta, in June 1997, he stressed that the seed industry will communicate more with the processing industry, in order to find out its interests and demands (Cosun Magazine, November 1997). No longer the farmer is the only client of the seed industry, also the processing industry is client. Huige also expected that there will be more specialty crops, targeted to specific processing purposes. Biotechnology will play a major role in developing those specialty crops. Also Cosun chairman Clevering stated, in March 1998, that future plant breeding and particularly biotechnology will be targeted at special qualities or special ingredients demanded by the food industry (Cosun Magazine, May 1998). Examples of Advanta research on quality traits are the improvement of the quality of sunflower oil, the content of fructanes in sugar beet and inuline in chicory.

Still, Advanta is cautious about the prospects for developing special varieties that will be used in separated agrifood chains (i.e., identity preserved production). These segregated food chains require a new set-up of production, processing and distribution, but also a long-term commitment from companies downstream in the agrifood sector. In fact, all companies in the

segregated food chain have to agree on a contract. These commitments are hard to get, as food processors and food retailers have an interest in reducing raw material costs. Only for a limited number of products can a sustainable competitive advantage be obtained; for most specialty crops a higher price can only be obtained temporarily, and even then it is questionable whether the seed company will really benefit from this. Advanta managers state that companies downstream in the agrifood sector have an interest in turning any specialty crop into a commodity crop as soon as possible, in order to have competing suppliers of their raw material (and thus lowering the price of the raw materials). Given the long-term implications of investing in a separate breeding programme for specialty crops, such investments will not be easily done and will require commitments from customers all through the chain.

Advanta's managers acknowledge that there is a lot of rhetoric in what biotechnology companies say about working on output traits. As agronomic traits do not receive much enthusiasm by the general public, most agrochemical and seed companies working on genetically modified crops now state that they are working on so-called quality traits. This is particularly true for companies listed on the stock market, which have to convince share holders that they have made the right investment.

As Advanta's primary customers are farmers, the company will continue to put most of its plant breeding effort in developing varieties with enhanced agronomic characteristics. Even with more attention to quality (i.e., output) traits, the main focus in the breeding strategy is still on agronomic (i.e., input) traits. Table 5 summarises the main research aims for Advanta crops.

Table 5. Advanta's main research aims

	fungus resistance	virus resistance	insect resistance	flowering /hybrids	herbicide resistance	product quality
maize	x		x	x	x	x
sugar beet	x	x		x	x	x
oil seed rape	x		x	x	x	x
sunflower	x					x
grasses	x		x	x	x	
cereals	x			x	x	x
onion	x		x		x	x

Source: Advanta brochure "Towards a sustainable agriculture".

3.5 Patents and Research Alliances

As far as patents on biotechnology are concerned, Advanta has a limited portfolio (Noome, interview 1999). Most of its biotechnology research is applying existing knowledge to proprietary germplasm, in order to develop enhanced varieties.

As mentioned above, Advanta is one of the five shareholders of Keygene¹. Keygene is a successful small biotechnology company, focussing on DNA-marker technology for molecular selection. It is the world wide patent holder of the AFLP-technique, an enabling technique that can be used for 'finger printing' any kind of genetic information. Keygene also does engineering of novel traits in crop plants and the isolation of novel genes. It is specialised in

¹. The other four current shareholders are Enza Seeds, De Ruiter Seeds, Rijk Zwaan Seeds and Cebeco Seeds, all of them Dutch seed companies. Enza, De Ruiter and Rijk Zwaan are in the vegetable seed business, while Cebeco is a competitor of Advanta in the field crops market.

tracing disease resistance genes in plants. Advanta's position of shareholder gives it preferential access to current and new technologies developed by Keygene.

The merger between VanderHave and Zeneca Seeds has enlarged the opportunities for Advanta to take advantage of the knowledge available in other countries (Bijman et al., 1997). This has been particularly important for VanderHave with most of its research located in the Netherlands. Zeneca Seeds already had an international knowledge network. Moreover, being part of a large agrochemical company, Zeneca Seeds had benefited from other (biotechnology) research carried out within the mother company.

In the Netherlands, Advanta VanderHave continues to collaborate with Wageningen University and Research Centre (including the former DLO-institutes). With the Utrecht University Advanta has a research contract for developing transgenic sugar beet that convert sucrose into fructane, which can be used as a low-calorie (sweetening) food ingredient (Smeekens, 1998).

The 2000 merger of Novartis Agribusiness and Zeneca Agrochemicals into Syngenta has changed the relationship between Advanta and Zeneca Plant Sciences. Although AstraZeneca is shareholder of both Syngenta and Advanta, the relationship between Advanta and part of Syngenta (particularly Zeneca Plant Sciences) is on a voluntary third party basis. As recent as 1999, the collaboration in the field of biotechnology between Advanta and Zeneca Plant Sciences was intensified (Noome, interview 1999). Zeneca research and Advanta research are complementary, with Advanta doing the applied studies and Zeneca the basic research. In an interview with *Seeds & Crops Digest* (1999), David Buckeridge, while still Zeneca's manager of biotechnology, emphasised the importance of the interaction between Advanta and Zeneca Plant Sciences: "seed (or germplasm) is one of the three foundations of Zeneca's biotech strategy; the other two are research capability and market access". Buckeridge is now Advanta's director for Europe.

3.6 Organic Farming

Advanta is following developments in the organic agriculture closely, but it takes a cautious position with regard to investing in developing seeds for this particular type of agriculture. Currently it has no special research programmes for organic crop varieties. This may change when consumers and governments give clear and unambiguous signals that this is the type of agriculture they want for the future. However, the company has not seen these signals yet. Advanta managers stress that organic agriculture also holds risks for food safety and for the environment. These risks need to be researched much better before a strategic decision towards organic agriculture can be taken.

Developing organic crop varieties is a strategic decision with long-term implications. Just as with conventional varieties, setting up a new breeding programme only yields new varieties after 10 to 15 years. Investing in breeding organic varieties holds great risks for Advanta as the market is still small and as it is not yet clear that it will be the major market of the future. Therefore, such a decision cannot easily be taken, and will depend very much on signals coming from policy and market environment. Advanta managers stress that this is a dilemma all major seed companies are faced with.

Advanta is aware that a growing number of consumers are demanding organic produce. It can see some good things in organic methods, but it is yet to be convinced that organic farming is a panacea for a better environment. It will need to be convinced, in an industry where the up front research costs are so high and technical innovation takes a sustained effort over multiple years, that governments are committed to sustained long term support of this approach to agriculture. Also that sufficient work has been done to look at the effects of this type of farming on the environment. Plant breeding companies have shown themselves very capable of responding to a new technical challenge in the past, but altering the selection screens in a major breeding programme, targeting and incorporating new sources of genetic variation (which would be needed to drive selection towards plant types

that would thrive in organic systems) cannot be achieved overnight. Equally, changing back to the original breeding targets if society changes its mind is also a massive task. Therefore governments need to be sure that the policy changes they make are ones they feel confident to stick with. Then Advanta and other companies like it will have an acceptable risk profile to drive this type of approach forward. Even though the organic sector is growing fast—it is from a small base. Advanta wants sustainable business opportunities which really lead to a more sustainable agricultural system, not just bandwagons.

(Buckeridge, interview 2000)

Advanta VanderHave does sell organically produced seed for fodder maize production. This seed does not come from an organic breeding programme. The seed has been produced on organic farms, and chemical disinfecting of the seed is not applied. Until 2003, seed companies have an exemption under EU legislation from the requirement to use organic cultivation practices in seed breeding and seed production. Advanta manager would not be surprised if this deadline was extended, because there are currently hardly any organic breeding programmes for the major crops.

Cosun has started in 1999 to process organic sugar beets into organic sugar. The seeds used for these organic beets came from KWS and Hillebrand, Advanta's main competitors. These organic varieties have a relatively high Rhizomania resistance, and therefore do not have to be treated with fungicides. Advanta does not yet have Rhizomania-resistant varieties that can be used in organic farming. SES Europe is testing new Rhizomania-resistant varieties and will soon introduce them.

4. Innovation Decision Making Structure and Process

4.1 General decision making structure

Advanta's management board consists of five persons. The names of the members of the board, as of January 2000, and their responsibilities are given in Table 5. Since June 1997, Ad Huige is CEO. He has been a member of the board of directors of Cosun since 1989. Before that he worked at VanderHave for 14 years. Buckeridge is coming from Zeneca Agrochemicals, where he was manager of biotechnology. He is now responsible for all European activities. Also Secombe comes from Zeneca Seeds, has long-time experience in Australia and Asia and is now responsible for North America, Australasia and Africa. Bridges, now responsible for all Research and Development, used to be biotechnology manager at Zeneca Seeds. Decision making in the management board is done by majority.

Table 5 Advanta Management Board (as of 1/12/2000)

Name	Responsibilities
A.J. (Ad) Huige	CEO, Argentina
D.J. (David) Buckeridge	Europe
C.R. (Col) Secombe	North America, Australasia, Africa
G.J. (Graham) Walker	Finance
I.G. (Ian) Bridges	R&D

Advanta has a decentralised organisational structure, which means that the regional organisations have their own financial responsibilities. This decentral organisational structure is taken from Zeneca Seeds, as VanderHave used to have more centralised decision making structure. Thus, Advanta now follows the Anglo-Saxon tradition of relatively independent subsidiaries each with their own financial responsibility. Only for R&D, there is central co-ordination, directly under the responsibility of a member of the board (see below).

The members of Advanta's supervisory board come from the two parent companies, Cosun and AstraZeneca. In 1999, the supervisory board of Advanta consisted of two Cosun managers and two AstraZeneca managers. From Cosun come Menkhorst, CEO and formerly financial director at VanderHave, and Priëst. From AstraZeneca come Hughes and Musker.

An important input for decision making at several levels in the organisation are the yearly forecasts made by the operating units on the prospects for each market/crop combination. This information is not only used by the operating unit itself, for its own innovation and commercial strategic decisions, it is also supplied to the board of directors. The board combines the information coming from all units, and uses it for making the overall company strategic decisions.

Besides pure commercial developments, also changes in agricultural policies in the various regions of the world are closely watched by Advanta. Within the company, policy trends are followed by the crop managers. These crop managers design scenario's about expected developments in the various markets. Each year the scenario's are evaluated and, if needed, adjusted.

4.2 Innovation Decision Making

Advanta is organised as a matrix organisation. On the one hand are the country managers, who directly report to the appropriate member of the management board. On the other hand are the crop managers and senior breeders, who also report to the management board. The crop managers are responsible for world wide crop strategy, particularly the commercial strategy. The senior breeders are responsible for all breeding activities in a particular crop. The senior breeders report to the R&D manager in the board (i.e., Bridges). Each crop also has a biotech co-ordinator, who is responsible for all biotechnology research for the specific crop. Thus, research on a particular crop is divided into a classical breeding part and a biotechnology part.

In decision making on innovation, a major role is being played by the senior breeders (Bridges, interview 2000). Senior breeders call together all breeders of a particular crop quite often. All senior breeders of the various crops convene several times a year, to discuss cross-crop issues like technological advances (e.g., in biotechnology) and financial constraints. Whether crop innovation decisions are made locally or central depends on the importance and geographical scope of the crop. For Advanta's main crops – maize, sugar beet, grasses – strategic decisions are taken with a global perspective in mind.

While production and marketing activities are all decentralised, for R&D there is central steering. This structure of central management of germplasm, technologies and patents is needed to safeguard the long-term perspective in the company's activities. Moreover, investments in R&D are expensive, and duplication would be a waste of funds.

The influence of the parent companies on Advanta decision making is very limited (Bridges, interview 2000). Cosun has stated that Advanta is not part of its core business, and that shareholder value is the main criteria on which Advanta will be directed (Cosun 1999 Annual Report).

It may be surprising that Cosun, a sugar beet processing company, does not want direct influence on innovation decisions regarding sugar beet breeding. This can be explained by the strategy of Cosun and by the freedom of choice sugar beet growers have in selecting varieties. Cosun's main strategic goal is to become a preferred supplier of 'customer specific food ingredients'. These are food ingredients supplied to the food industry and developed in co-makship by Cosun and its client. The sugar beet growers that are members of the co-operative Cosun are not obliged to purchase seeds from Advanta. They can choose any variety that is endorsed by Cosun, and the Cosun list of preferred varieties always contains varieties of various seed companies.

The annual research budget (55 million Euro in 1998) is established by the central management and the decentralised R&D centres together. From the decentralised level proposals for R&D spending per crop, per country and per product are presented to the

management board. Decision making is a dynamic process, taking into account profit, turnover, future prospects, etc. Small research projects are dealt with by the local subsidiary, large projects are co-ordinated from Advanta headquarters. Only when a whole new and large R&D project has to be set up, does the supervisory board make the final decision.

5. Influence of Public Policies and Market Development

5.1 Science, Technology and Innovation (STI) Policies

Representatives of Royal VanderHave have always been actively involved in Dutch policy discussions on agricultural biotechnology. The company has also been a beneficiary of Dutch and European funds for the promotion of biotechnology research, both indirectly (research funding going to PSRE's) and directly (subsidies for private biotechnology research). The company has always been very open and informative about their biotechnology activities (e.g., VanderHave, 1991).

Kees Noome, former director of research at VanderHave and now manager Intellectual Property Rights and Regulatory Affairs at Advanta, is a member of the governmental advisory committee for the introduction of genetically modified organism into the environment. He has been sitting on this committee since the early 1990s. He was asked to sit on this committee because VanderHave had the largest agricultural biotechnology research effort in the Netherlands. VanderHave and Advanta have carried out more than one third of all Dutch field trials with genetically modified plants in the period 1999 – 2000.² Dutch field trials of VanderHave and Advanta were done with crop plants like sugar beet, maize, rapeseed, sunflower and potato.

Protection of intellectual property rights is important for a seed company with substantial biotechnology activities. Advanta managers stress that protection of property rights is of utmost importance when substantial investments in R&D have to be made. Without protection, these investments would not be made. For this reason, VanderHave has always been in favour of both strengthening plant breeders rights for new varieties and patent rights for biotechnology inventions. Strengthening of plant breeders rights has been achieved in the 1991 revision of the UPOV convention and the 1995 EU Regulation for community plant breeders rights. The 1991 UPOV agreement has introduced changes in the concepts of "farmers' privilege" and "derived plants breeders rights". The farmers' privilege provision regulates the use of farm saved seeds. The derived plant breeders rights means that if a new variety only has a minor difference compared to the existing (and protected) variety it is based upon, the holder of the rights of the original variety can profit from the commercialisation of the new variety. Both concepts are important for seed companies, as they control the use of (seed of) protected varieties. The 1995 EU Regulation for community plant breeders rights has opened the door for applying for breeders rights in all of Europe with only one application (instead of applying in all member states individually). This saves a lot of administrative costs as well as time. For biotechnology research in Europe, the adoption of the 1998 EU Directive (98/44/EC) on the legal protection of biotechnology inventions has been very important. A proposal for this Directive has been discussed for more than 10 years. VanderHave has always been in favour of strengthening the legal protection of the results of biotechnology research.

Zeneca Seeds, in North America, has always had a strong focus on protection of biotechnology research findings, as the legal protection of intellectual property is stronger in the USA than in Europe (for instance plant patent rights).

². For a list of all approvals for field trials with genetically modified plants in the Netherlands, see: www2.minvrom.nl/ggo.

The world-wide judicial battles for patents and patent claims are still going on. Although some of the key technology patents are now unambiguously awarded and a growing body of jurisprudence on patent litigation is available, the large biotech companies continue to compete in the courtyard. Partly as result of the merger, partly as a result of the growing importance of patents and other forms of intellectual property protection, Advanta now has a full time patent attorney in house (at its headquarters at Kapelle). This person comes from Garst. One first result is that research activities in the Advanta laboratories in the Netherlands are much more precisely documented then before.

5.2 Environment, public health and biodiversity

Advanta VanderHave's herbicide resistant varieties of maize and sugar beet have been developed partly in response to Dutch environmental policies (De Laat and Van Dun, 1994). One of the main goals of Dutch agri-environmental policy is a reduction of the environmental impact of pesticides. This goal has to be reached by (1) limiting emissions into the environment, (2) limiting dependence on agrochemicals and (3) limiting the overall use of pesticides (MLNV, 1990). Before VanderHave decided to develop herbicide-resistant varieties, the company communicated with the Dutch government about this application of biotechnology. It concluded that the government position was cautious but positive if the application would lead to lower environmental impact of maize and sugar beet cultivation. On the basis of own research and information from national and international experts, VanderHave concluded that both maize and sugar beet herbicide-resistant varieties would have environmental benefits compared to conventional weed control in these crops. As a result, VanderHave decided to develop glyphosate (*Roundup*) resistant and glufosinate (*Liberty*) resistant varieties of maize and sugar beet.

In reaction to (Dutch) environmental policy targeted at the reduction of mineral emissions, Advanta VanderHave is developing maize and grass varieties that require less fertilisers and generate a good yield. Since 2000, each animal husbandry farm has to keep a record of all minerals supplied to the farm and leaving the farm. From 2002, crop farmers have to do the same. In case of an on-farm mineral surplus (i.e. more input than output), the farmer will have to pay a levy over the surplus. Thus, all farmers are looking for crop varieties that yield as much as the current varieties (or more) but need less mineral input from manure and fertilisers.

A major policy influence for a seed company developing genetically engineered crop varieties is the current de facto moratorium on the introduction of these varieties in Europe (Bridges, interview 2000). The position taken by the policy makers at the European level has a negative influence on the public attitude towards biotechnology. The influence of European approval policies on Advanta goes beyond the borders of the Union. Because the EU is a major importer of agricultural products, particularly oilseeds and cereals, also seed sales in other parts of the world countries are affected. For instance, Argentina has a public policy that does not allow the cultivation of gm-crops until Europe has given import clearance for gm-soybeans and gm-sunflower (Bridges, interview 2000). The European market situation could also affect the cultivation decisions of farmers in North America. Farmers, seed distributors and others may be reluctant to buy gm-varieties, or delay such purchases till the very last moment, thereby negatively influencing seed prices. For Advanta, the negative public attitude in one part of the world can influence innovation decisions in other parts of the world.

Advanta will be able to supply gm-free seeds if there is a market for it. However, it is currently absolutely unclear what is "gm-free". As zero tolerance is, according to Advanta managers, impossible, workable thresholds for the level of contamination with genetic material from gm-crops have to be established. As there is currently no regulation with such thresholds for seed, it is impossible to claim that seed is gm-free. Moreover, several tests exist, and not all are completely reliable. According to Buckeridge (interview 2000) there is an urgent need for (1) regulation with clear threshold levels for contamination from gm-plants; (2) technical methods to test contamination, and (3) protocols for how and when to analyse for contamination. The (regulatory) uncertainty surrounding these issues has an impact on (the

speed of) innovation decisions by Advanta. Currently the organic farming community demands a zero tolerance for contamination by gm-products (including seed). According to Noome (interview 1999), it would be better if the organic farming community would agree to a threshold that is workable.

5.3 Agriculture and International Trade

Particularly in Europe, most of Advanta's crops fall under some kind of market regulation. The impact of the Common Agricultural Policy (CAP) of the EU, and the changes therein, are substantial. As farmers are driven by financial incentives, and the latter are influenced by policy decisions, changes in price guarantees or subsidies, influences farmer's planting decisions. As most of Advanta's innovation decisions continue to focus on traditional goals of yield and pest resistance, policy changes that influence the profitability of certain crops and certain varieties will also influence the market for Advanta's product. If changing markets require so, Advanta will change its innovation (i.e., breeding) goals.

For instance, the sugar market in Europe is fully regulated with a quota system for the amount of sugar that can be sold against the internal EU price. Thus, Advanta's market for sugar beet seed is directly influenced by the size of the quota, and thus by political decisions about the continuation of the quota system.

Restrictions on international trade in gm-crops, as currently applied by the EU, influence Advanta decisions to commercialise gm-varieties in several parts of the world (see above).

Reform of the CAP towards a set of policies that reward farmers for producing in a sustainable way is welcomed by Advanta. However, governments have to make clear what they consider, now and in the future, to be sustainable agriculture. Only if they take a long term view on which direction European agriculture should go, seed companies like Advanta can take the appropriate innovation decisions. Advanta managers (interview 2000) also stress that there is a clear role for government in directing farmers towards more sustainable production methods, because the consumer is often not prepared to pay a higher price and food processors continue to follow a least cost strategy.

5.4 Impact of food processors and retailers

Advanta considers the farmer as its primary customer (although Advanta does not sell to farmers directly, but to seed wholesalers, co-operatives and agricultural contractors). Advanta competes with other seed companies in supplying the arable farmer with seeds of the best crop varieties. Agronomic traits like disease resistance and yield continue to be the most important breeding goals. Formerly, most of the attention has been on yield. Since the early 1990s, under the influence of stricter environmental policies, more attention has been given to pest resistance, giving farmers the opportunity to reduce the use of pesticides.

All of the crops for which Advanta supplies the seed are being processed before they reach the consumer³. As the farmer is producing agricultural products to be processed by the food and feed industry, we can consider these industries as the secondary customers of Advanta. Requirements from these industries, for instance from the sugar beet processing industry, are also incorporated in the breeding goals. In recent years, the specific demands of firms downstream in the agrifood chain have received more attention in innovation decisions, for several reasons. First, by better co-ordination through the whole agrifood chain, efficiency benefits can be gained. Second, food processors are developing specialty products for which they require specialty raw material. Third, food processors are responding to consumer demands for food produced in a sustainable way.

The influence of sugar beet processors on farmers' choice of varieties is large. In most countries, the sugar company presents the farmer with a list of varieties it can choose from. In the words of Van Loon, Advanta's senior crop breeder for sugar beet: "The processing

³. In contrast to vegetable crops, most of which are consumed fresh.

industry is the client, the farmer is the user [of the seed]. Each company has its own requirements for the varieties it wants its suppliers to grow, depending on climate and soil conditions, on disease incidence, and on technical aspects of processing." (Cosun Magazine, October 1997; our translation, JB/MJB). But the most important trait continues to be sugar content. A high sugar content means low transportation and processing costs per unit of sugar.

Impact of food retailers on Advanta's innovation decisions is only indirect, through choices of food processors and farmers. An important issue for retailers is labelling of gm-products. According to Noome (interview 1999), Advanta's position on labelling gm-products is the following. All of Advanta's seed from transgenic plants is labelled as such. This is the normal procedure for seed companies supplying professional farmers. Advanta is also in favour of labelling gm food products, but is worried whether the consumer can come to a good judgement only on the basis of the label.

According to Advanta managers (interview 2000), the impact of food processors on innovation in the seed industry is neutral. As stated above in section 3.4, most food processors follow a least cost strategy and therefore prefer commodities above specialty products. Where genetically modified crops are concerned, food processors seem to be reluctant to accept products harvested from these varieties. While farmers planting gm varieties are generally positive about them, food companies, even in North America, take a 'wait and see' position. Advanta managers stress that food companies do not give any indication about what kind of output traits they would like to see developed by the seed companies. To overcome this dilemma, as well as to improve the 'education' of food processors on biotechnology, Bridges would favour integration between seed and food companies above integration between seed and agrochemical companies as is now often the case.

5.5 Government and public attitude

The current uncertainty surrounding genetically modified crops in Europe has a major influence on Advanta's innovation strategy. According to Advanta managers (interview 2000), there is a large discrepancy between the long term perspective that seed companies need to take into account when making innovation decisions and the short term view that governments currently take on issue of gm crops and gm foods. Interests groups with their specific interests have a major influence on public opinion and indirectly on the positions that governments and politicians take on biotechnology issues. Some of these pressure groups are radically opposing any application of genetic modification in food crops. Because biotechnology is a politically sensitive issue, policy makers and regulators are reluctant to take firm decisions. But with regulation unclear and politicians not taking decisions, no change in public opinion can be expected. Thus, Advanta finds itself faced with a deadlock in the development of clear biotechnology regulation.

These uncertainties make it very difficult for a science-based company like Advanta to take decisions on innovation, as decisions taken now cannot easily be turned around and thus have long-term economic consequences for the company. Because of the lack of absence of political choices and regulation, Advanta does not know whether it should (further) invest in breeding programmes for gm crops, organic crops or conventional crops. As it is economically impossible for follow all these options (because investments in breeding only pay off in the long run) Advanta managers have stressed that they would like to see a longer-term perspective in policy making and regulation.

6. Company Discourse on Environmental Issues

6.1 Towards a sustainable agriculture

Advanta managers (interview 2000) stress that the company is developing environmentally enhanced products. Every yield increase means a reduction of land and inputs needed per unit of harvestable product, which thus means an improvement of environmental impact per unit of product. Also the large emphasis on pest resistance (virus resistance, fungus resistance, disease resistance) in breeding leads to varieties with improved resistance, which give farmers the opportunity to reduce the use of chemical pesticides.

They argue that the cultivation of herbicide-resistant crops, particularly soybeans, has beneficial effects on the environment, as herbicides with a bad environmental performance can be substituted by more benign herbicides (like Roundup). Herbicide-resistant varieties have additional benefits for the farmer: more flexibility and lower costs in weed control. In general, Advanta strongly believes that modern scientific techniques like biotechnology can generate benefits for the environment. The following are two statements on the importance of biotechnology for sustainable agriculture, taken from Advanta brochures.

Employing biotechnology may result in crops withstanding more diseases and pests, or suitable to apply modern, more sustainable, methods of cultivation.

Advanta firmly believes, that input from modern biotechnology will be required to achieve an economically feasible, sustainable agricultural production, that minimises the use of energy and raw materials.

The range of renewable resources from agriculture can be enlarged by genetic modification thus slowing down the depletion of mineral oil reserves.

(Advanta brochure: Towards a sustainable agriculture)

Modern biotechnology brings forward the ideal of sustainable agriculture. It enlarges the opportunities for the production of renewable resources, produced in an environmentally friendly way. (...) Sustainable agriculture requires plants that need less nitrogen and use nutrients more efficiently. Advanta is developing these plants. There is also a need for plants using available water more efficient. Drought resistance is one of the targets in our plant breeding research. Modern breeding techniques open new options for crop protection and weed control. By introducing disease resistance and herbicide resistance, the use of and dependence on chemical plant protection products can be diminished. Advanta is developing these varieties of the future.

(Advanta brochure, "Make your future grow"; our translation, JB/MJB)

Varieties that need fewer inputs, like fertilisers and agrochemicals, may be good for the environment, but will only be grown by farmers if they generate sufficient income. As there is always a trade off between yield and pest resistance, varieties that require fewer inputs usually have lower yield. Farmers run a commercial business, and they choose those varieties that optimise their income. Only when farmers receive sufficient financial incentives for choosing low input varieties, will they demand them and Advanta will develop and supply them.

When Advanta's herbicide-resistant maize variety (Chardon LL) was registered in the national variety list in early 2000, the corresponding herbicide (*Liberty*) was not approved for over the top use in maize. At that time, Advanta was disappointed about this lack of approval, particularly about the original position taken by the Dutch Commission for Approval of Pesticides (CTB) that glufosinate had an adverse environmental impact if leached to surface

water. Noome (interview 1999) viewed this situation as unfortunate because he considered glufosinate better for the environment than other herbicides used in maize. Because the CTB does not make an overall comparison of environmental impacts, but just looks at an individual pesticide and an individual application, no full assessment of environmental impacts is made.

7. Conclusions

7.1 Innovation strategy

Advanta is one of the largest seed companies in the world. It has made the strategic choice to focus on field crops, both food crops like sugar beet, canola, soybeans and sunflower, as well as fodder crops like maize, sorghum and grasses. In Europe it has a particularly strong position in sugar beet and grasses, in Argentina and Australia it is the largest supplier of sunflower seed, in Canada the focus is on canola, and for its American subsidiaries maize and grasses are the main crops. Overall, maize is the most important crop for Advanta.

Advanta has a rather decentralised decision making structure. It is organised as a kind of holding company, with subsidiaries receiving financial targets. Subsidiaries have significant freedom in making their own commercial and innovation decisions. This organisation of stand alone companies was taken from Zeneca Seeds, one of the companies that were merged into Advanta in 1996. Although the headquarters is located in Kapelle, Netherlands, the structure of the company is more Anglo-Saxon than continental European. The current board of directors also mirrors this influence, with four out of five members coming from the former Zeneca organisation.

Advanta seems to have three kind of clients: farmers, seed distributors, and food processors. Farmers use the seed, but do not purchase directly from Advanta. Seed retailers and contractors are the actual clients of Advanta. As the food crops are subsequently processed by food companies, these can also be considered as clients of Advanta. Particularly for sugar beet seed, sugar companies have an important voice in which varieties farmers can grow. Even for fodder crops like maize and grasses, food processors have become important. For instance, in the Netherlands dairy processors have told seed companies, among them Advanta, that gm maize can only be grown by farmers if the dairy companies give their approval (which is not likely to be given with the current negative public attitude towards gm food).

From these three groups of clients, Advanta considers the farmer as the most important. High yield and good disease resistance continue to be the most important targets in variety breeding. Since the early 1990s, relatively more emphasis has been given to pest resistance and less on yield. Pest resistance has become more important because of stricter environmental policies. To comply with environmental policy goals, farmers have to reduce the use of pesticides and fertilisers.

In its marketing strategy Advanta continues to emphasise its role as supplier of first class agricultural seeds. Having a long tradition of plant breeding and seed marketing, Advanta operates at a short (psychological) distance from farmers. Also being partly owned by a farmer-owned co-operative positions Advanta in the centre of the farming community. This has the advantage of being trusted as a seed company that listens to the demands made by farmers.

The impact of food processors on Advanta's innovation decisions seems to be mostly neutral. Communication with food processors about their specific demands is, even with parent company Cosun, not very intensive. Although there is a lot of writing and talking about quality attributes gaining weight relative to yield and pest resistance, Advanta considers much of this as rhetoric and sees limited opportunities for benefiting from this development. This does not mean that Advanta is not doing any research on output traits, but its research effort on improving quality attributes is limited. Moreover, commercialising crops with special quality

traits requires contractual relationships with many others in the food chain (like processors, carriers and retailers). There are serious risks involved in making long-term and costly investments in breeding specialty crops that depend so much on what other companies do (or do not) with these crops.

Both VanderHave and Zeneca Seeds had invested in biotechnology research. Advanta has continued to follow this route. Biotechnology is seen as an important tool in crop breeding, although more than 80 percent of R&D funds are still spent on conventional breeding activities. In the North American market, Advanta's subsidiaries are already selling transgenic varieties of maize and canola (with herbicide resistance and insect resistance). Also for Europe and other parts of the world, Advanta strongly believes in the advantages of applying biotechnology. It is already using genetic marker technology in most its breeding programmes. However, due to the low public acceptance of biotechnology in Europe, it expects that it will take several years before transgenic varieties can be introduced in the European market. For decisions on what varieties to develop and produce, the current legislative and market situation in Europe (and even in other parts of the world) leads to great uncertainty for the company. As R&D decisions in a seed company are taken with a long term perspective, the current uncertain regulatory situation makes innovation decision making extremely difficult.

7.2 Public Policy Impact

Many of the crops for which Advanta supplies the seed encounter government regulation and trade restrictions. Although the protectionist agricultural policies in various regions of the world are slowly but gradually being diminished, the impact of public policies on farmers' crop choices continue to be important. For this reason, Advanta closely watches developments in farm policies. When agricultural policies change from price support to income support, with the latter conditional on environmental performance by the farmer, new challenges arise for seed companies like Advanta. The question is what economic incentives will farmers respond to and how that translates into the demand for specific crop varieties.

As environmental regulation is becoming stricter all over the world, but particularly in regions with intensive agricultural production systems (like Northwest Europe), Advanta is putting more emphasis on breeding resistance into its crop varieties. Developing herbicide-resistant varieties is part of the company strategy to help farmers diminish the use of chemical plant protection products. In reaction to government policies to reduce nutrient emissions, all farmers in the Netherlands have to keep a record of all nutrients entering and leaving the farm. Any remaining surplus will be taxed. Thus, the challenge for the plant breeders is to develop varieties that need less added nutrients (in the form of manure and fertilisers), while still having good yield and good disease resistance.

Current European government policies on approving gm-crops and gm-food products lead to many uncertainties for Advanta. While it continues to do biotechnology research both in Europe and other parts of the world, commercial introduction of gm-varieties in Europe is postponed until public attitudes are more favourable. Advanta believes that public attitudes will become more favourable once policy makers and regulators take decisions with a long-term perspective on innovation and sustainable agriculture (instead of only listening to short term political pressures).

As far as STI policies are concerned, Advanta (and its predecessors VanderHave and Zeneca Seeds) have profited from the subsidies available for biotechnology research. They have received subsidies for their own biotechnology research and they have been beneficiaries of the increased biotechnology expertise at public research institutes and universities. Also public research institutes have benefited from this collaboration. VanderHave has been very active in discussions on policy issues regarding agricultural biotechnology, both in the Netherlands and in Brussels.

7.3 Environmental Discourse

Advanta sees itself as a science-based innovative company, providing farmers with ever better crop varieties. Almost every new variety leads to higher productivity and/or higher pest resistance, which both mean to a lower negative environmental impact per unit of production. Although Advanta continues to spend most of its R&D funds in conventional breeding activities, biotechnology has become more important in recent years. In North America, the company is already selling transgenic varieties, like herbicide-resistant soybeans, which bring environmental benefits. The company firmly believes that biotechnology can make an important contribution to promoting sustainable agriculture, partly by developing varieties with better pest resistance.

Advanta is closely following the developments in the market for organic farm products. So far, the market is rather small. Advanta is not yet convinced that consumers and government want to wholeheartedly follow the organic route. As long as the future prospects are very uncertain, Advanta will wait and see. Setting up a breeding programme for organic varieties not only requires substantial investments now, it also has long-term consequences for the company, as it will take 10 to 15 years before seed is available for commercialisation.

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ANNEX C3

Interviews

Dr. I.G. (Ian) Bridges, research director, (25 February 2000 and 29 November 2000)

Dr. D. (David) Buckeridge, director Europe, Advanta (29 November 2000).

Drs. C. (Kees) Noome, manager intellectual property and public affairs biotechnology, (April 1997, 16 April 1999, and 29 November 2000)