EVOLUTION OF THE AGRO-FOOD SYSTEM: THE CASE OF THE SEED INDUSTRY

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Abstract

The present paper deals with the ongoing adjustment process of the seed industry within the evolution of the agro-food system.
Given new objective-functions of the above mentioned system, the technological response of the seed industry and of the other inputs related to the agricultural production process is examined.
As far as the seed industry, the paper presents: some estimates about the world market, a stratification of the competitors by market size and by seed technological level, with specification of the increasing R&D investments in the last decade.
On the base of the potential applications of biotechnologies within the agro-food system, a tentative allocation of outstanding seed companies, by typological behaviour, is finally offered taking into account the main multinational groups involved in such activity.

Résumé

Le present rapport il examine les processus d'adaptation de l'industrie semencière dans l'evolution qui trouble le système agro-alimentaire.
A partir des nouvelles fonctions-objectives de ce système, on examine la reponse technologique de l'industrie des semences et des autres «imput» employès dans la production agricole.
Relativement a' l'industrie sementière, on present quelques évaluations du marché mondial, une classification des firmes pour chiffre d'affair et niveau technologique des semences, avec la percentage de investissement dans la richerche, pendant les dix annèes dernières.
Dans le domain des application bio-technologiques possibles, on a partagèes, selon le comportement technologique, des firmes semencières qui sont liées à groupes multinationales engagès dans la production des semences.

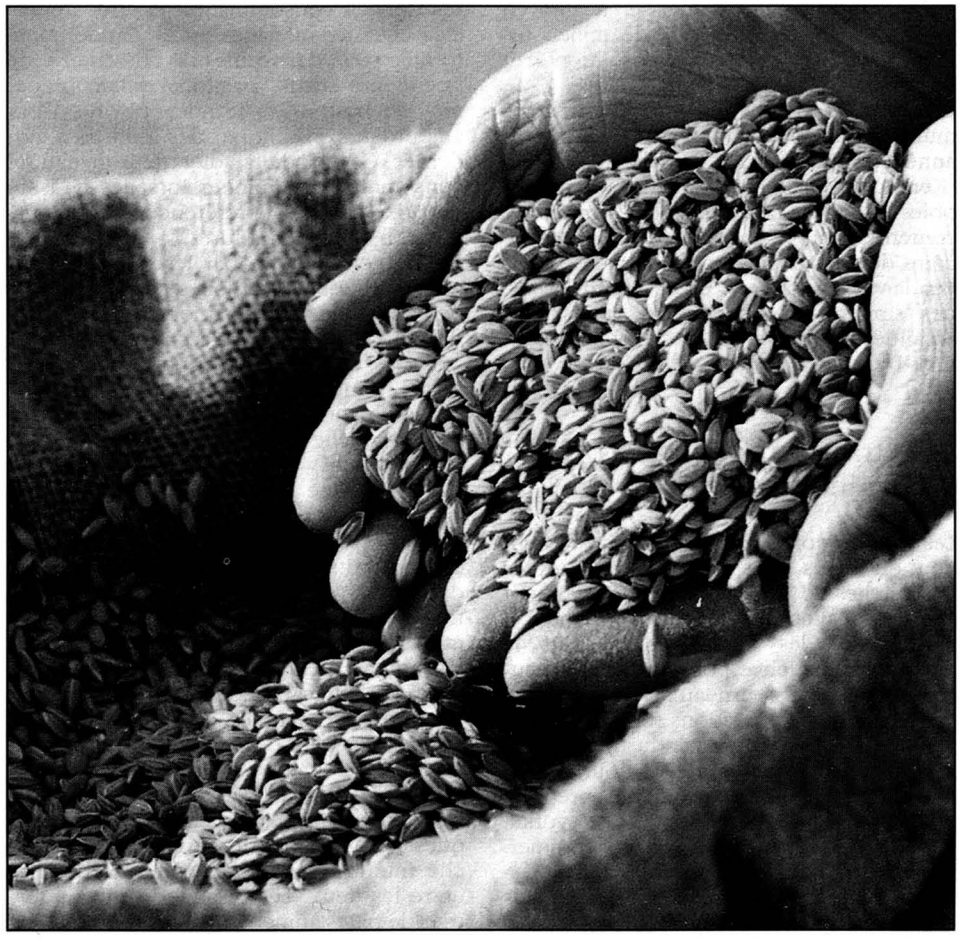
1. New economic targets in a changing agriculture

1.1. Agriculture and the environment

The agricultural/environmental *binomial*, which has for a long time been compatible in both ways, seems to be bound to reconcile the economic and technological development target on the one hand and the environmental protection objective on the other.
The previous conferences held by the University of Minnesota and by the ESAV – University of Padova focused on many aspects of the quantitative and qualitative target – agricultural productivity increase, stable food production, quality food supply and human health, provision of socio-economic services, natural resources protection, which correspond to the general objective defined by the Brundtland Commission in its report on «sustainable development» published in 1987.
This objective is not easy to attain because, in the long term, it aims at gradually balancing a feasible degree of economic growth and technological innovation with a higher level of environmental protection.
As a result of the current rapid succession of events and of modifications in the international context, «the age of change» is likely to modify the conditions which may determine the functioning of our economic systems in general and, in particular, the evolution of the agro-food system (Lombardini, 1991 and Lechi-Grillenzoni, 1991).

1.2. New objective-functions

As a conseguence of these new conditions (GATT, EMS, etc.), the «industrial» countries will confront the following new challenges:
i. The change in the demand for farm and foods products, both in terms of quantity and quality.
ii. The need to adjust the supply of primary products («commodities») to the requirements of the processing industry and to the strategies of the large retail («super and hypermarkets») which influence the consumer's choices and preferences.



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iii. The opportunity to promote genetic research and technological innovation in order to protect both the consumer and the environment (Crosson, 1990 and Kozloff-Runge, 1991).
In this new scenario, the strategies of the firms and the activities of the research institutions involved in the **seed business** will become increasingly important in terms of:
• investments in R&D programmes;
• production of quality seed;
• quality controls and protection of products quality along the agri-food chain.
This paper will try to explore some conceptual issues of the seed industry evolution in a context of growing international competition (Doering, 1992 and Grillenzoni, 1993).

1.3. Technological response

In order to understand the relevance of the choices made in the past and, realistically, to give a tentative evaluation of future opportunities, it is useful to plot down the evolution of the economic targets fixed over the last 30 years (**diagram 1**):

PRODUCTIVITY
⇓
STABILITY
⇓
SUSTAINABILITY

with the corresponding response given by technologists:

GREEN REVOLUTION
⇓
GENETIC AND TECHNICAL INNOVATION
⇓
EVOLUTION TOWARDS AN AGRO-ECO SYSTEM

Recent literature (Altieri, 1987 and Antonietti, Ruttan, Scarascia Mugnozza, 1991, etc.) has shown that the sequential combination of objectives and technologies brings to diversified agri-techniques packages over time, within which the most important achievement of the seed industry concerns the development of:
1) high-yield seed varieties;
2) hybrid seed varieties;
3) environment - friendly quality seeds.
Based on this outline, which is certainly not comprehensive and contains loopholes as regards specific aspects (e.g. the «uniformity» of highly developed varieties vs. the trend towards the protection of «biodiversity») (Mc Neely, 1988), it is easy to see why seeds:
– have acquired a strategic importance for the growth of agriculture and the expansion of companies involved in agri-business;
– have acquired, then, a synergic function with the activities undertaken by agro-chemical and oil companies;

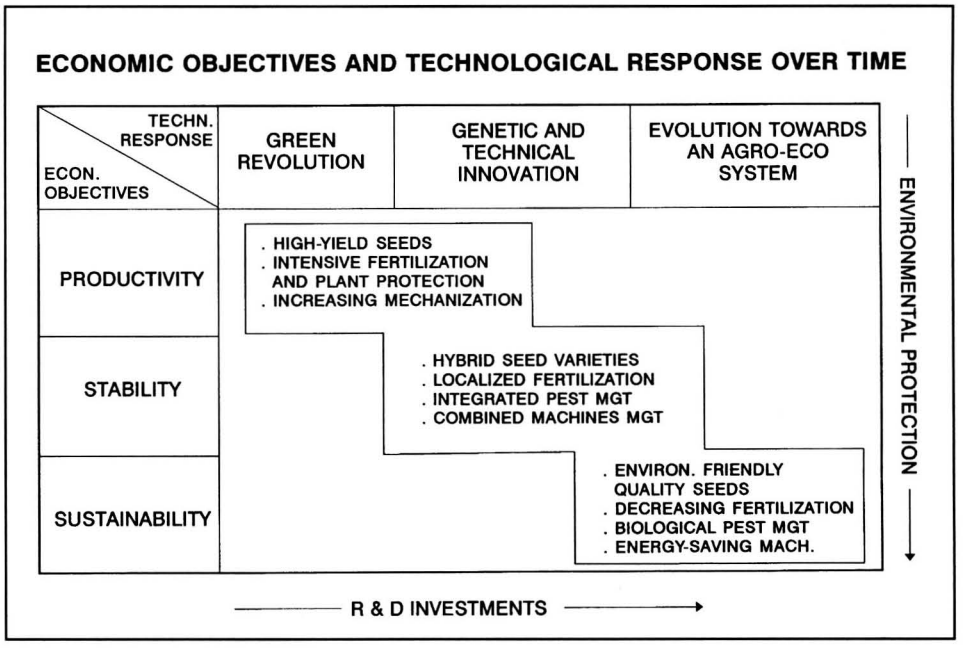


Diagram 1

– have become, more recently, a matter of interest for certain agro-food groups aiming at improving the performace of the agri-food chain.
This basic outline even reveals logical tendency, which might be connected to the industrial «Fordist model» (productivity increase), «Neo-Fordist» (biotechnologies application) and/or «Post-Fordist» (new production models) (Goodman et al., 1987, Byé, 1989 and Junne, 1992).
We shall give more details on this paradigm later on.

2. Evolution of the seed industry

2.1. Some estimates about the world seed market

Data for the world seed market can only be roughly estimated, because of the lack of information concerning a large number of countries, especially Eastern Europe, Africa and Asia.
With respect to the main commercial areas of the world, a tentative valuation may, however, be made in terms of value.
Recent figures have been provided by Precepta, a market research agency. The estimate of about 15 billion dollars seems, in our opinion, fairly prudential, but realistic in 1990, with North America accounting for at least 40% and EC countries for about one third.
Japan and Latin America are the other two major markets.
As far as the EC area is concerned, France is the leading European market with a turnover which Precepta estimated at 1.5 billion dollars (30% of the EC). Germany, Italy and Great Britain account for about 40% of the EC area (5 billion dollars). Among the other countries in this area (30% of the total), Holland is the leader in potato-tubers, flower and some vegetable seeds.
If we take into account the «emerging» countries (China, Indonesia, India, etc.), a more realistic figure of the 16 billion dollars might be estimated in 1992 (Grillenzoni, 1993).
Now, if we consider the main multinational groups, we can observe that about one third is specialized in seeds and agricultural trading; as we said before, several «agro-chemical» groups have made acquisitions of seed companies since the '70s, with an upward trend throughout the '80s.
More recently, some of the larger multinational groups involved in the food sector have made substantial investments in the seed business.
This concentration trend has led to the following situation on 1992 (**table 1**):
– the first 5 groups, distinctly acting all over the world with «mother-house» in the USA, in Western Europe and in Japan, accounted for about 5.340 million dollars of the commercial seeds sales (34,5% of the world total);
– 35 companies controlled more than half of the world seed sales.
Beside these significant concentration ratios, we may note the beginning of a fragmented market: the additional 15 companies (50 as a total) cover less than 5% of the world market.

2.2. Stratification of the seed industry

A few, basic comments can be listed as follows:
i) The leading companies and groups, with the capability of undertaking extensive research efforts, have made continuous investments in various regions of the world with a wide diversification in many crop

Table 1 ***Concentration ratio in the world seed market(a).***

Data for the first	Sales 1922			Total		Ratio
	USA	W. Europe	Japan			
	mill/$	mill/$	mill/$	mill/$	no.	%
3 Companies	1.985	1.474	775	4.234	9	27,32
5 Companies	2.510	1.954	876	5.340	15	34,45
10 Companies	2.874	2.944	–	6.694	25	43,19
20 Companies	–	4.083	–	7.833	35	50,54

(a) Based on an estimate about 15-16 bill/$..

Source: Data taken from «Seed Encyclopedia», O'Mediations, 1993.

sectors (**tables 2** and **3**); this increasing activity may be justified in the following terms:

– to consolidate their image and market share;

– to improve their internal structure (so as to cover overhead costs, optimize the use of technical and research staff, reduce commercial risks, etc).

ii) The multitude of the remaining seed companies, mostly represented by middle-sized firms, seems aimed at competing in peculiar segments of the market. In this context, a useful distinction may be made in terms of:

– market size (small or large);

– technology level (low or high).

Table 2 ***Invest region of the main seed groups.***

US GROUPS	North Central America	South America	West Europe	East Europe	Africa	Asia	Oceania
CARGIL	*	*	*		*	*	*
DEKALB	*	*	*		*		
PIONEER HI-BRED	*	*	*	*	*	*	
UPJOHN	*	*	*		*		

EUROPEAN GROUPS	Country	West Europe	East Europe	Former USSR	North Central America	South Americ a	Africa	Asia	Oceania
CIBA GEIGY	CH	*	*		*	*	*	*	
ZENECA (ex ICI)	GB	*			*	*		*	*
KWS	D	*	*	*	*	*			
LIMAGRAIN	F	*	*		*	*	*	*	*
ORSAN	F	*			*	*	*		
PHONE POULENC	F	*			*	*			
SANDOZ	CH	*	*		*	*	*	*	
SANOFI	F	*	*		*	*			
SUIKERUNIE	NL	*	*		*	*			

Source: «Agritech decision», OCDE, April 1990.
«Seed World», November 1992.
«Seed Encyclopedia», O'Mediations, 1993.

Table 3 ***Seed diversification of the main seed groups.***

US GROUPS	S. grain cereals	Corn and sorghum	Forage crops	Oil seed crops	Rice	Flower and vegetable	Cotton
CARGIL	*	*		*	*		*
DEKALB		*	*	*			
PIONEER HI-BRED		*	*	*			
UPJOHN		*	*	*			

EUROPEAN GROUPS	Country	S. grain cereals	Corn and sorghum	Forage crops	Oil seed crops	Protein crops	Flower and vegetable	Sugar beet
CIBA GEIGY	CH	*	*		*			
ZENECA (ex ICI)	GB	*	*		*			*
KWS	D	*	*		*	*	*	*
LIMAGRAIN	F		*	*	*	*	*	*
ORSAN	F	*	*	*	*	*	*	*
PHONE POULENC	F	*	*	*	*	*	*	*
SANDOZ	CH		*	*	*		*	*
SANOFI	F	*	*		*	*	*	
SUIKERUNIE	NL	*	*	*	*		*	*

Source: See table 2.

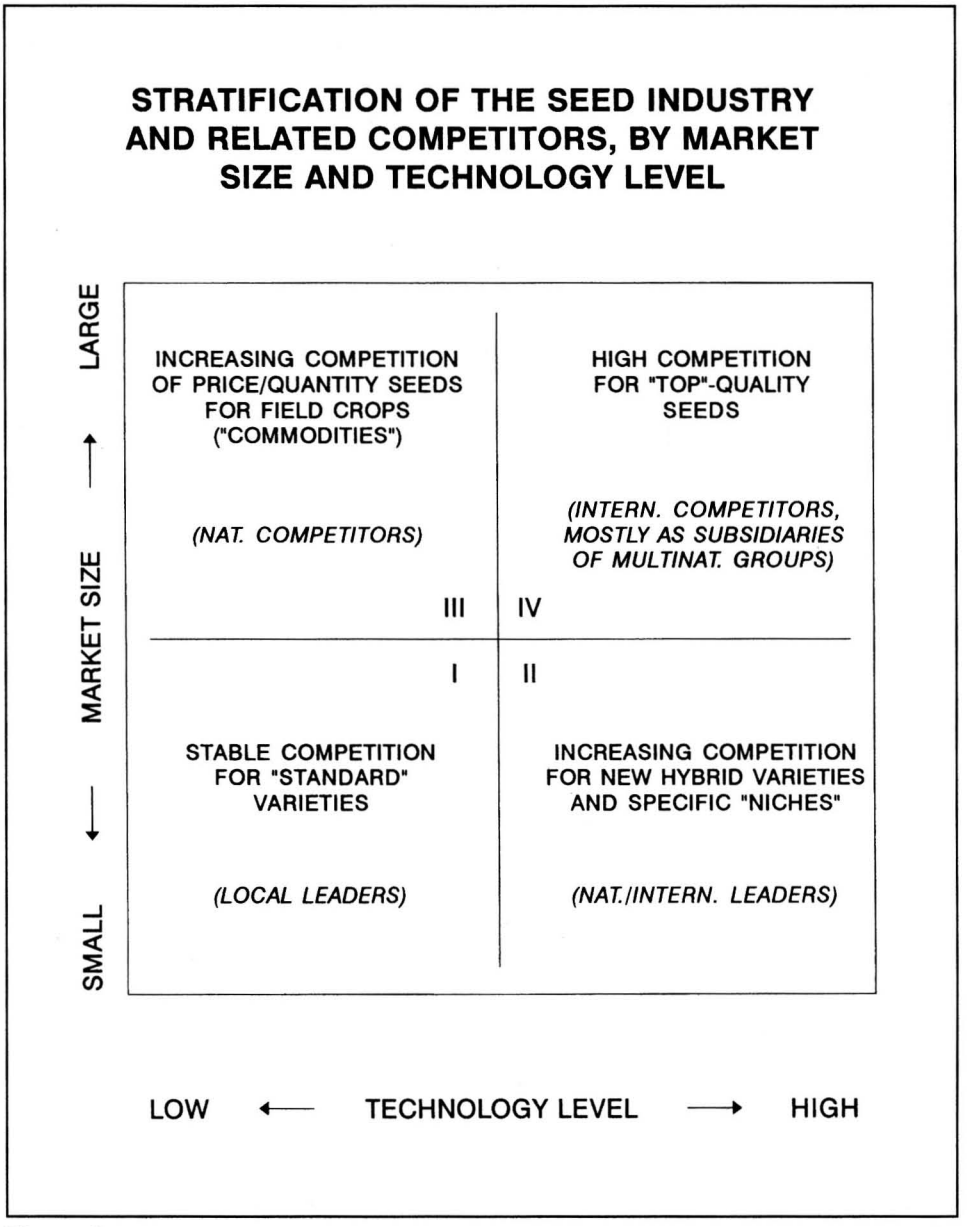


Diagram 2

A comprehensive stratification of the seed industry, with regards to the competitor types, is shown in **diagram 2**.
According to a generally accepted opinion:
– section I includes «standard» or local varieties for traditional vegetable and forage crops;
– section II includes new hybrid varieties and specific «niches» for florist and vegetable specialties;
– section III includes traditional seeds for extensive field crops (small grain cereals, soybean, forage sorghum, etc.);
– section IV includes peculiar «top» quality seeds, like hybrid varieties for corn, selected varieties for sugar beets, flowers and vegetables.
In our opinion, section II and IV seem to offer an interesting insight, because of the significant investments increasingly made by seed companies in R&D programmes.

2.3. R&D investments

Firstly, let us point out that among the main 35 seed companies R&D activity increased from 4-12% (1982) to 5-17% (1992) of the turnover in the last decade.
Within an observed sample (**table 4**), most of the seed companies (either with «agribusiness» or «agro-chemical» main activity) still operate large investments in traditional breeding; only a minority (Ciba-Geigy, Maribo - Danisco, Agrigenetics) seems to pay more attention to plant biotechnology, which is – viceversa – prevailing in specialized companies (like Calgene) or in those which have more limited experience in plant breeding (Enimont and Du Pont, for example).
At this point, it may be useful to spend a few words to better explain the changing industrial paradigm (fordism ⇒ neo-fordism ⇒ post-fordism) for biotechnologies applied to the agro-food systems.
Since the second half of the '70s neo-fordist applications have been carried out, getting over partially the «fordist model» which, indeed, was smoother and slower in agriculture with respect to the industrial sector.
Many of the neo/post – fordist applications aimed at reducing agriculture season – dependence and to increase its compatibility with the environment, by genetic engineering techniques meant to improve resistence to stresses and diseases. At the same time, biotechnological research made substantial improvements in nutritive contents and time preservability of food products, setting up new-biological processes for the agro-food system.
The post-fordist applications are ongoing right now and might offer further improvement in terms of quality for many food products, starting from low-input agritechniques.
The open list shown in **diagram 3** tries to give a few, significant examples about potential applications of biotechnologies in this context.

Table 4 ***Distribution of R&D funds (mill/$).***

COMPANY OR GROUP	Traditional breeding	Plant biotechnology	Total
PIONEER HI-BRED	46	7	53
SANDOZ	41	16	57
UPJOHN	24	3	27
LIMAGRAN	22	5	27
ZENECA ICI	21	17	38
KWS	18	5	23
DEKALB	16	6	22
CIBA GEIGY	9	17	26
MARIBO-DANISCO	7	12	19
AGRIGENETICS	6	12	18
MONSANTO	1	15	16
CALGENE	1	10	11
DNAP	0	11	11
ENIMONT	0	15	15
DU PONT	0	20	20

Source: Biofutur (1990) and OECD (1991).

POTENTIAL APPLICATIONS OF BIOTECHNOLOGIES FOR THE AGRO-FOOD SYSTEM (OPEN LIST)

NEO-FORDIST APPLICATIONS	NEO/POST-FORDIST APPLICATIONS	POST-FORDIST APPLICATIONS
	AGRICULTURAL INPUTS	
PEST RESISTANT VARIETIES	BIO-PESTICIDES	LOW-INPUT AGRI-TECHNIQUES
	PLANT BIOTECNOLOGIES	
SOMATIC HYBRIDATION	GENETIC RESISTANCE TO STRESSES	BIOLOGICAL NITROGEN FIXATION
DISEASE - FREE PLANT PROPAGATION	IMPROVEMENT OF NUTRITIVE CONTENTS	IN-VITRO GERMPLASM CONSERVATION AND PRODUCTION OF PLANT METABOLITES
	AGRO-FOOD INDUSTRY	
ADAPTATION OF FOOD COMPONENTS TO DIETETIC MODELS	IMPROVEMENT OF TIME PRESERVABILITY OF FOOD PRODUCTS	IMPROVEMENT OF FOOD PRODUCTS QUALITY AND OF REGIONAL SPECIALTIES

SOURCE: ADAPTED FROM BOYER (1991) AND JUNNE (1992).

Diagram 3

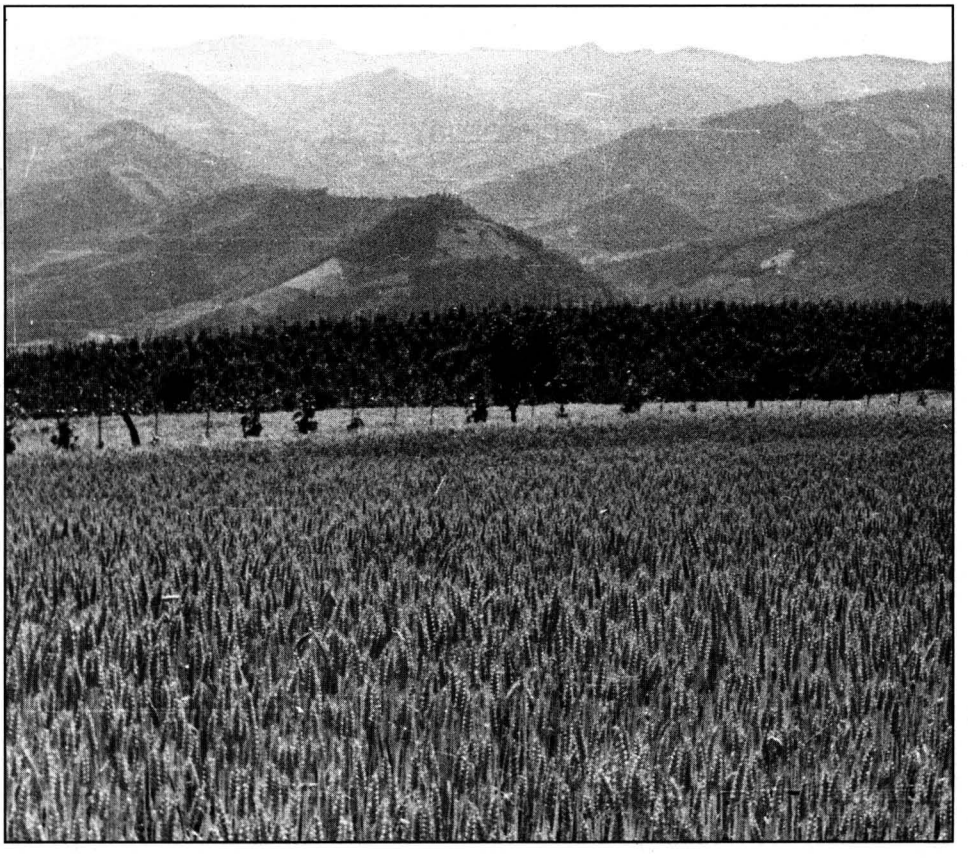
3. Development prospects

3.1. The diversified behaviour of seed companies within the multinational groups

Coming back to the characterization of the seed industry, we do recognize that the acceptance of a given variety by farmers is still strongly and positively related to its performance. This trend has led somewhere to a jump in seed prices, which caused penetration difficulties into the markets of emerging countries.
Research efforts aimed at developing stress/pest-resistant varieties have, therefore, determined an increasing demand for overall cost-effective strategies, so that it can be expected that many companies (mainly belonging to the «agri-business» sector) will continue to concentrate their efforts on the production of such varieties (Leibenluft, 1981 and Desprez, 1994).
Various authors (Goodman et al., 1987, Byé, 1989, and Junne, 1992) have clearly explained how the agro-chemical industry approaches biotechnological development in a way which is different from the agro-food industry.
According to them, the agro-chemical industry is mainly interested in the development of «packages» of seeds and other inputs highly specialized in the plant fertilization and protection.
On the other hand, the agro-food industry is rather in favour of a reduction in the use of agro-chemical products (with related residues in plants and in the environment) to the benefit of genetic engineering techniques, capable of improving the processing conditions, the nutritional value, taste and preservability of food products.
In connection herewith, it should be noted that the agro-chemical industry focuses more intensively on research, whereas the competitive advantage of the agro-food industry lies in its logistic and commercial capacities. Even if a less intensive research policy is pursued, the agro-food industry is closer to the market and, indeed, to consumers.
As a result, we are facing a complex situation in which the priorities of firms with good R&D experience do not correspond to the consumer's preferences, while technological development which could meet these preferences need more time to materialize, as the firms which pursue that approach have less R&D experience (Junne, 1992).
Consequently, the agro-food industry is showing an increasing interest in the seed business as borne out by the capital investments made in the sector as well as by the various joint-ventures undertaken. Such a trend may be explained by the attempt to gain a greater control of the «food chain» by directly developing quality seeds. In other words, the «global quality» issue for many food products requires the direct management of all stages in the «food chain», starting from a selected number of specific seeds.
For example, the Del Monte Co. recently invested in the seed activity in order to obtain quality vegetable crops for its processed products.
But many other similar situations might be considered, so that the tentative allocation of seed companies, by typological behaviour (**diagram 4**), looks like a limiting scheme, being several linkages operating in this context.

3.2. Final considerations

The seed activity may be recognized as a strategic one for the agricultural growth and the connected food sector.



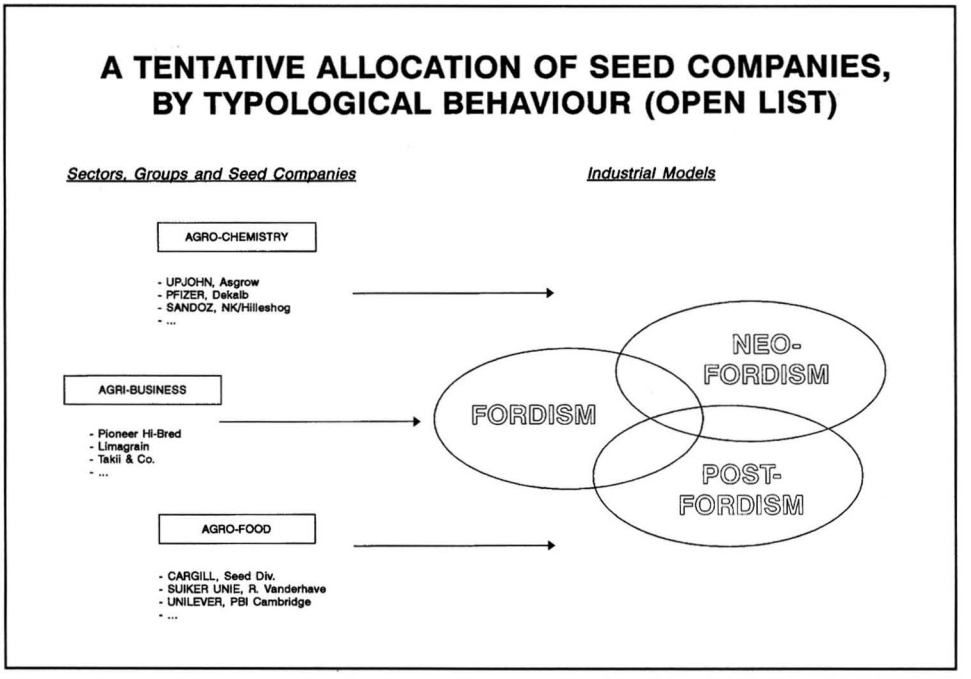


Diagram 4

Its increasing role is not only referred to ensure a fair sustainability of productive activities between agriculture and the environment, but also to improve the «global» quality of food products, through the marketing channels for fresh/processed items.

Technological innovation in agricultural practices as well as biotechnologies applications to plant and food sector are certainly becoming the determinants of diversified strategies pursued by the main seed groups, according to the stratification and allocation previously shown in **diagram 2** and **4**.

But, behind the main seed companies holding «patentes» for their high-tech seeds, for which we need technology assessment studies to evaluate the potential economic impact of these new varieties by the applications of modern biotechnologies (Kalter and Tauer, 1987, Offutt and Kuchler, 1987), there is a «golden pond» of acceptable «quality seeds», which might be managed by public institutions / private companies through equitable agreements and profitable marketing channels. This latter assumption may be confirmed by the increasing number of interprofessional and intersectorial agreements which, on a country-by-country basis, are aimed at setting up innovative technological processes and services (which make added value) consistent with the economic development of agriculture over time and the specific situation in more or less developed countries of the Mediterranean Basin, of East - Europe and of Asia (like those previously mentioned).

Many other considerations might be made about international agreements on IPR - Intellectual Property Rights (Sehgal and Van Rompaey, 1992) and international policies and technical change with respect to distorsions determined by R&D investments in agriculture (Alston et al., 1993, page 50) and related sectors.

One basic consideration is that «agricultural trade liberalization will change the location and intensity of production and that agricultural externalities will decrease in some areas and increase in others» (Antle, 1993, page 784).

If we agree with this assumption we have, finally, to take into account the impressive opinion of a Purdue University economist (Doering, 1992):

«International cooperation in this efforts appears to be drying up and other countries are launching their own efforts. Or, they are turning their cooperative international efforts into national ones. What impact will this have on the pace of scientific discovery and technology development in the 1990s? What will this new approach do to the structure and survival prospects of technology firms, such as those in the seed business?

«Have we been wrong to have large public investments in basic research and technology that was then available to all? These are critical decisions that will have great impact.

«How we respond to the very real internationalization of agriculture depends partially upon how we receive it. We can perceive it as something we can, at least partially, shape through our own actions». ●

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