Overview of the French system of agricultural and agro-food research

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Describing in a few pages the large and diversified French system of agricultural and agro-food research is no easy task. At the risk of oversimplifying, if not overlooking some areas, we concentrate here on the structural and organizational aspects. After a very quick look at the overall size of the system (Chapter II), we briefly describe the main scientific and technical institutions, whether public, "professional" or private and the contacts that they maintain between themselves (Chapter III). After pointing out the important role played by the Ministry of Higher Education and Research (Chapter IV), some conclusions are drawn on the structure and efficiency of French agricultural research. In an introductory chapter, we give some background information on the agricultural and agro-food sector in France.

I - Background information on the agricultural and agro-food sector

This sector covers the vast field that links agricultural production with the transformation and distribution of agro- food products.

Agricultural production in France comes from 1,166,000 farms that represent one-third of the agricultural land of the EEC. The French agro-food industry, with its 600,000 salaried and artisanal workers, ranks second only after the construction and public works sector, representing about 13% of the country's industrialized strength.

At the global level, France is the second largest exporter of agro-food products resulting in a trade surplus of 34.4 billion francs in 1985 (see **Annex 1**). But such positive results should not be allowed to overshadow some serious problems. To begin with, there is a large deficit for certain products (not including, of course, tropical products), particularly oil plants for livestock feed, forest products, meat and tobacco. There is also a lack of dynamism in the transformation sector: private research efforts are lower than those in major European trading countries and 50% of exports are still unprocessed with little value added.

The regions of southern France produced 20.3% of the total value of agricultural production in 1985. They are faced with special problems related to their natural handicaps (highly irregular climate and harvests, water shortages, relatively poor soils), the small size of most of their farms, and the high cost of land. In reality, they must bear (like the rest of France) higher labour costs than southern Mediterranean countries whose harvests

are earlier, thus adding to the handicaps that exist between northern and southern Europe.

II - Introduction to the French system of agricultural research

The table and diagram in **Annex 2** give the list of the main public and professional institutions that contribute to the national agricultural research effort, including their responsible ministry, their basic mandate and their human and financial resources for 1986. When combined, these institutions account for:

- 4,900 research years (or the equivalent of full-time researchers) and a total budget of nearly 4 billion francs ($660 million) considering only those institutions working primarily on the domestic agro-food sector (including that in France's overseas *départements* and territories - DOM-TOMs);

- more than 5,700 research years and 5 billion francs ($840 million) if one includes those scientific institutions working on "overseas" issues, specialized in development programs with the Third World (with some presence in the DOM-TOMs).

As such, the agricultural research investments of simply the domestic public and professional institutions in 1986 reached 3.2% of the gross domestic agricultural product and 1.55% of the gross domestic agricultural/agro-food product, which puts France among the world's top public investors in agricultural research (1). We must emphasize that this effort has been particularly strong since 1980. As an example, the National Institute of Agricultural Research (INRA), whose fundamental importance in the national agricultural research system is described below, saw its budget go from 0.90 to 2.23 billion francs from 1980 to 1986, or an increase of 52% in constant francs.

At the same time, private agro-industry and agro-food interests (both national and multinational) as well as cooperatives also made significant increases in their investments in agricultural research, bringing them in 1986 to more than one third of those of the total public and professional sector (see Chapter III.3).

As far as "overseas" agricultural research is concerned, if we add the budgets of CIRAD and ORSTOM to those of public institutions (INRA, CEMAGREF, CNRS, etc) dedicated to Third World and DOM-TOM research, they total 1.3 billion francs ($220 million). This means that France invests as much in development with tropical or subtropical countries as the entire 13 centres of the Consultative Group on International Agricultural Research (CGIAR).

III - Brief description of the main institutions of the agricultural research system

We describe here the main public and professional organizations working primarily on domestic agricultural research. Among them, INRA, CEMAGREF, higher education institutions in agronomy, agro-food and veterinary studies, and professional technical institutes, are concerned only with problems linked to the agricultural and agro-food sectors. On the other hand, the universities and the CNRS, for example, have a much wider research scope. After a short description of the public scientific organizations working on "overseas" issues (CIRAD and ORSTOM) and of private agricultural research, attention is paid to the multiplication and intensification of the relations between all of these parts of the national agricultural research system.

1. Public and professional institutions working on domestic issues

A. National Institute of Agricultural Research (INRA)

With 2,750 scientists and engineers (out of a total of 8,200 employees), a budget of 2.3 billion francs or $370 million (89% from the State and 11% from its own sources) INRA's 1986 resources made it France's main agricultural research institution, if not the largest in Western Europe. It includes 55 experimental farms totalling 11,000 ha and 303 other sites.

Its mandate (outlined in the December 14, 1984 law) is very broad, including the inventory of physical resources; the improvement of agricultural products; the protection and conservation of natural resources and the rural environment; the socio-economy of farms; the economics of agro-food chains; and the study of

Agricultural research in Italy

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Italy is a country that is marked by a very big deficit in the agricultural products and foodstuffs sector – one that is constantly growing and is now in the range of 10,000 billion lira – in second place after the crude oil trade deficit. Cereals, cattle, meat, wood and cellulose pulp make up the bulk of its imports.

Among the few trade surplus sectors are wine, pasta, as well as fruit and vegetable produce.

In order to have a better understanding of the problems involved in the present agricultural situation in Italy, one must take into account the following factors:

- the number of people employed in the agricultural sector, after the exodus during the period 1960-1970, has tended to remain stationary, but the added value of agricultural workers represents about half that of the industrial sector, whereas in the more developed countries the added values of the two sectors differ very little;

- only 1.2% of those working in the agricultural sector have any qualifications;

- even today there are still a large number of farming concerns that are less than one hectare in size, and this fact – which is absurd from an economic point of view – is one of the main obstacles to modernization both in the technical and management fields; and

- the progressive neglect of hilly or mountainous regions has led to a worsening of the hydro-geological situation, which in turn has had negative results on the soil.

On the other hand, the pedo-climatic conditions of a country such as Italy, which spreads over a latitude of around 1,500 km, provides for different, though complementary, types of production and cultivation.

The primary objectives of agriculture in Italy are to keep costs down, prices stable and to diversify production so as to optimize the use of resources.

Within the framework of this policy, a decisive role can be played in the future by the southern regions where, it should be remembered, one million hectares of land, which today are dry, will become irrigable over the next six to eight years.

Agricultural research will play a fundamental role in reaching the objectives fixed by the Italian government, and which are also shared by the European Economic Community.

I - Agricultural research in Italy in relation to scientific research as a whole

Expenditures devoted to research in Italy amount to more than 8,000 million lira (**Table 1**) and are

shared in equal proportions between public bodies and the private sector.

In the public service field, two research centres – the CNR (*Consiglio Nazionale delle Richerche*) and the ENEA (*Ente Nazionale Energie Alternative*) – are the biggest contributors, followed by the State Civil Service and universities.

In the private sector, allocations for research come mainly from private firms, followed by those that benefit from state subsidies.

From **Table 2,** which includes the percentage of expenditure for Research and Development (R & D) of the Gross Domestic Product (GDP) in OECD countries, it can clearly be seen how far behind the other more developed Western countries Italy is as far as her commitment to scientific research is concerned. The situation in Italy is slowly tending to improve, as the percentage increase in expenditure on R & D in relation to GDP, between 1965 and 1983, increased from 0.7% to 1.2%.

In the agricultural sector, Italy has made a special effort so that, among the various EEC countries (before the entry of Greece, Spain and Portugal), it had the highest increase in the annual percentage of funds for agricultural productivity during the 1975-1983 period (**Table 3**). Over these eight years, average annual growth in the allocation of funds in Italy was over 10%, in comparison with an EEC average of 2%.

In relation to overall expenditure on R & D, Italy devotes 4.1% to agricultural research (**Table 3**); this percentage is higher than that of West Germany, Belgium and France, equal to that of the United Kingdom and below that of Holland, Denmark and Ireland. However, in terms of GDP, Italy's percentage contribution to agricultural research is the lowest in the European Community (1%).

In global terms, Italy spent slightly less than 300 billion lira in 1983 on R & D in the agricultural sector (**Table 4**). The most substantial contributions came from the Ministry of State Education (30.8%), the Ministry of Agriculture (20.4%) and the CNR (13.9%). More modest, though still substantial contributions, come from regions and municipal governments (11.2%), from the Mezzogiorno Fund (8.4%) and from ENEA (5.9%).

The growing interest shown by the Italian Administration in the agricultural research sector emerges clearly in **Figure 1**.

Table 5 shows the importance of the role played by the State in agricultural research (70.9%), in comparison with that played by companies (29.1%), as well as the impact of applied research (69.5%), in comparison with that of development (25.6%) and pure research (4.9%).

II - National organization of agricultural research and institutions

The public system for agro-food research in Italy stands out for the remarkable multiplicity of its administrations and institutions.

Figure 2 is a schematic presentation of the "politico-managerial organs of research" and the "research structures" themselves.

The Parliament and the Government are responsible for determining the financing; the CIPE and its sub-committee work on agricultural problems; the CIPAA supplies general addresses and authorizes programmes; and the Ministry of Scientific Research carries out general monitoring.

The main body of research and experimentation is carried out through the three national networks which consist of university institutes, the Ministry of Agriculture's Experimentation Centres and the related peripheral sections, as well as the CNR Institutes and Research Centres.

CNR Institutes and Centres can be distinguished from each other in that the Institutes have an autonomous management, personnel and structures, while the Centres depend on the University, and are directed by university professors and make use of university structures.

Each of these three networks is run by politico-scientific bodies which are present in an advisory capacity and are responsible for such tasks as programming: the Ministry of Education's Consultative Committee for Agrarian Sciences, the Ministry of Agriculture's National Committee on Experimentation, and the CNR's Advisory Committee on Agrarian Sciences.

These three committees are for the most part made up of representatives of the scientific world (University and CNR) or the administrative-scientific world (Ministry of Agriculture).

Despite the presence of representatives of three different institutions and of the Ministry of Scientific Research, the following points should be noted:

- the lack of any real coordination between the different research bodies;

- the absence of representatives of the various social bodies concerned with innovation and research (regions, producers' associations, the agricultural food processing industry, etc.),

- in committees and research centres alike, the structures are ill adapted to the realization of projects and the communication of the results obtained.

At the management level, there are big differences between the University, the Ministry of Agriculture institutes (MAF) and the CNR.

The 18 agriculture faculties and the 23 MAF institutes are all administratively independent (Chairman and Administrative Board), while the institutes and the CNR centres are administered by a centralized system.

In spite of their shortcomings – mainly due to the fact that they only became involved in 1977 in the field of "research and experimentation of regional interest" – the regions play an important role, one that is constantly evolving and growing. This is the case for both applied and demonstrative experimentation and in the organization of research financed by them and commissioned from national bodies present in the region (universities, MAF institutes, CNR institutes), and finally service activities (zooprophylactic institutes, observatories for plant diseases, analysis laboratories, etc.), and extension services (regional agencies for agricultural development, mountain communities) activities that are closely linked to research.

Figure 3 gives an idea in graph form of the Regions' contributions to the budget for the agricultural sector (vertical axis) and for agricultural research (horizontal axis).

Proportionately, the regions that are most committed to the agricultural sector are: Basilicata, Sardinia, Marches, Trentino-Upper Adige and Sicily.

The Map shows the geographical distribution of university, Ministry of Agriculture, CNR and regional research structures.

In spite of a certain imbalance in some southern regions (Abruzzi, Basilicata, Calabria), the research structures – leaving aside their functional capacity – are relatively uniformly distributed over the country as a whole.

Tables 6, 7, 8, 9 and 10 classify existing structures in Italy according to the institutions to which they belong.

III - Relations between the national system and neighbouring activities

As has been noted above, a large amount of research, both pure and applied, is being carried out in Italy in faculties of agronomy and veterinary medicine – as in the United States – independently of the Ministry of Agriculture institutes, but sufficiently integrated into the activities of the CNR.

The close connection between universities and the CNR, which was still very strong some years ago, is now tending to loosen thanks to the policies implemented over the last five or six years by the CNR, a policy that tends to create separate institutes that differ from the centres that exist within the universities and which are directed by university professors.

It may generally be said that in Italy there are frequent and positive contacts between research institutions and farmers, outside the institutional context of such collaboration.

The world of Italian research is decidedly open to the practical world, both to supply information, and to receive stimuli and suggestions on the research directions that should take priority.

In the fruit, vegetables and flowers sector, which is of primary importance to Italy's agricultural economy, the Societa Orticola Italiana (SOI) continues to play a very important role in communicating science by encouraging meetings,

exhibitions, open days and guided visits; by taking responsibility for publishing technical articles with a very serious experimental content but written in simple language; and by coordinating the different regional activities in order to integrate them into the national context.

Within the context of collaboration between research and farmers, numerous experiments have been carried out in private companies, especially in the case of university institutes which often lack access to experimental farming concerns.

Many regions have a regional Committee for Experimentation, in charge of the programming and coordination of research carried out in a regional context. Representatives of research institutes (university, MAF, CNR) are asked to sit on such committees.

Regional representatives and farmers are found among the members of the Administrative Board of the MAF experimental institutes.

Relations with the agricultural industry (phytoremedies, fertilizers, agricultural machinery, transformation, etc.) are less widespread and occur less frequently, but are overall positive.

Collaboration between the agricultural research sector and other institutions, whose sphere of interest is not strictly agricultural, but with whom it would be useful to establish contact (chemistry, physiology, microbiology, etc.) is fairly rare and limited.

At the national level, the lack of effective coordination of all scientific research has a negative influence on the relations between structures that are not directly linked to each other.

The Ministry of Scientific Research and Technology was created with the express aim of compensating for this lack of organization. Until now, however, its concrete action has had little influence on the situation that existed previously which was characterized by the existence of several centres of power and scientific decision.

IV- Human resources

1. Scientists

Table 11 shows the number of Italian researchers – as full-time units – in the whole research and development sector. In all, there are 50,000, of whom 30,000 belong to the public sector (60%) and 20,000 to the private sector (40%).

In 1984 there were just under 2,000 researchers employed in agricultural research (**Table 12**), of whom 66% belonged to the State administration sector, and 34% to companies.

Table 13, on the distribution of expenditure on agricultural research per economic category, shows that personnel account for 60 % of the total.

Both university professors and Ministry of Agriculture researchers are on the same salary scale, while CNR scientific personnel and research centres that depend on the other Ministries have a less advantageous salary scale. This tends to lead to a migration of the best people towards the Universities and the MAF institutes.

State administration researchers are employed through a public competitive examinations, with a few exceptions.

Training of researchers, which in the past took place before the examination through study grants, now occurs only after the examination, and this has led to a deterioration of the situation.

The recent implementation of a "Research Doctorate" which resembles the anglo-saxon Ph.D., should allow for better selection of researchers in the future.

One way of training researchers that is relatively common is to spend some time in a foreign research institute. In this respect, the United States is the most sought after country.

2. Other Personnel

Technicians and other staff are shown in **Tables 11 and 12.**

international markets. In other words, all areas possibly related to agricultural research except for mechanization and irrigation.

INRA is organized into departments and research centres (see **Annex 3**). Each of its 25 departments corresponds to one or several disciplines; it is through them that most scientific programs are developed and implemented under the direction of departmental chiefs assisted by a scientific council (including outside members) and a management body. Each of its 22 regional centres (including one in Guadeloupe for the Caribbean and Guyana) bring together on the same site laboratories of the research stations that serve the different departments. Since 1986, they are administered by a centre president who, according to the programs developed by the department chiefs, plays the role of scientific coordinator, promotes INRA, and in particular, tries to improve relations between INRA and outside sectors, notably in each region.

In addition, special commissions bringing together outside researchers (from both the public and private sector) and socio-economic partners, have been created to animate and coordinate research on products (cereals, wine, ovins, etc) or on scientific themes (microbiology, energy and biomass, biotechnology, etc).

INRA does "finalized" research, both applied and basic (about 20% of its researchers). Its contacts with the scientific and socio-economic environment are very numerous as witnessed by the high number (currently 450) of research contracts signed with outside people or agencies. As is shown below, these relations are particularly well developed with agricultural and veterinarian higher education institutions.

B. National Centre of Agricultural Machinery, Rural Engineering, and Forest and Water Resources (CEMAGREF)

This organization is in charge of public research on equipment used in agricultural machinery and the agro-food industry (automation, computerization, etc.) and irrigation and water resources. It is also involved in mountainous and marginal areas, rural development (including tourism) and forest management with a generally complementary approach that is more applied than that of INRA.

It includes 410 senior officials (out of a total staff of 935), two-thirds of whom work on research involving 70% of the budget (243 million francs), 195 million from government and 48 million from its own sources.

CEMAGREF is organized into thematic departments and has ten "groups" or research centres located throughout France, including one in Martinique (see **Annex 4**).

C. Higher education establishments in agronomy, agro-food and veterinary medicine (Annex 5)

The agricultural research activities in these establishments (2) have mostly been developed through their relations with INRA and have taken the form of:

- teaching/research associated laboratories which are particularly common at INA and in the ENSAs established in INRA research centres (Paris-Grignon, Dijon, Montpellier, Nancy, Rennes):

- the nomination of researchers to senior positions within INRA (presidents of centres, commissions, directors of departments and research laboratories, etc) and the promotion of numerous researchers to teaching posts;

- granting of INRA research credits to teachers (for each 0.5 researcher) which are complemented by other smaller sources of funding (about 30%).

These relations have been quite profitable to both parties. INRA gains by the mobilization of teachers' skills, a better selection of a large part of its young researchers, and the diffusion of its methodological results. Higher education gains by an improvement of its scientific potential and of the training of its students (participation of researchers in teaching, supervision of reports and theses).

D. "Professional" technical institutes for agriculture and agro-food

These are applied research institutes, halfway between the above institutions and those involved in development, financed primarily by the government (Ministries of Higher Education and Research, and of Agriculture) and by certain taxes on the sales of agricultural products. Seventeen of them (see **Annex 6**) are specialized in plant and animal production and are coordinated by the

Technical Agricultural Coordination Association (ACTA). Sixteen others (see **Annex 7**), specialized in agro-food industries, are coordinated by the Agro-Industrial Technical Coordination Association (ACTIA).

E. Scientific institutions with general mandates: CNRS, universities, etc.

Among the 12,500 researchers and engineers of the National Scientific Research Centre (CNRS) there are an estimated 300 who work in agricultural and agro-food areas, particularly in the following departments:

- Life Sciences: plant and animal molecular biology, genetics, molecular genetics and endocrinology;

- Chemistry, with its interdisciplinary teams (basic and applied enzymology, valorization of biotechnologies, chemical agents, wood chemistry);

- Engineering physics (programming, artificial intelligence, captors, automation);

- Universe Sciences, with research in remote sensing;

- Social Sciences, in rural economics and sociology.

The same is true in universities which have agriculture related activities, most often through laboratories associated with the CNRS. This includes, for example, the following fields:

- animal and plant physiology: Universities of Clermont- Ferrand, and Montpellier;

- applied botany and ecology: Marseille, Montpellier, Nice, Toulouse;

- plant improvement and pathology; Orsay, Strasbourg;

- rural sociology and economics: Paris-Nanterre, Montpellier, Rennes.

These university resources (like those of the CNRS) engaged in basic research represent about 250 research years, about one quarter of which deal with agro-food or human nutrition.

Finally, apart from the CNRS and the universities among the other scientific institutions with general mandates that get involved in agricultural research, one must mention the Pasteur Institute (that has some joint work with INRA) and the Atomic Energy Commission (CEA) with 27 researchers (and a 30 million franc budget) specialized primarily in radio- agronomy.

2. Public scientific institutions working overseas

France is the only developed country that has preserved large research institutions specialized in development with the Third World: the Centre for International Cooperation in Agricultural Research for Development (CIRAD) and the French Institute of Scientific Research for Development (ORSTOM).

CIRAD was formed in 1984 by combining eight agricultural research institutes specialized in tropical plant and animal production (they were previously coordinated by GERDAT). Its 560 researchers work in more than 50 countries, with a stronger involvement in sub-Saharan francophone countries. Its 1986 budget was 850 million francs, 530 from government grants and 320 from its own resources.

ORSTOM, which is almost entirely financed by government sources (720 million francs), has a mandate that goes far beyond agricultural research which only occupies about one third of its 750 researchers working in basic fields such as plant production (soil science, plant improvement, phytopathology) and rural economics and sociology (3).

These two institutions have two main research and support bases – Montpellier and Paris – that are available to outside researchers.

3. Agricultural research in the private sector

Agricultural research activities undertaken by private and cooperative agro-industry and agro-food concerns are relatively substantial, amounting in 1985 to an estimated 1.62 billion francs or $270 million ($100 million from government sources) (4). We calculated this to be 41% from public and professional scientific institutions working on domestic issues (32% of the total of both domestic and overseas institutions).

In the agricultural sector itself, this research is particularly active in seeds (a hundred or so seed

companies are involved, including Limagrain, Desprz, CAL, Lafarge-Coppée, Elf, Rhône-Poulenc), fertilizers, pesticides (AZF, Rhône-Poulenc, Roussel-UCLAF, etc). In 1985, they spent about 730 million francs, including 78 million from public sources. As for the agro-food industries, 103 companies (2.7% of the total) do research in this field with a budget of 890 million francs (26 million from government sources) and a growth of 5.6% in constant francs between 1980 and 1986. This only represents, however, 0.12% of this sector's turnover and 0.3% of its added value, a rate that is ten times less than the average for French industry (3%).

4. Synergies between agricultural research institutions

Synergies in this field take place at different levels. First of all, there are many institutional interconnections at the administrative and evaluation levels: boards of directors and scientific advisory bodies for departments and research centres, juries for scientific competitions, etc. As an example, the President/Director General of INRA is also the Chairman of CIRAD's Board of Directors, and a director of CEMAGREF, Rhône-Poulenc, etc. INRA researchers also chair or participate in scientific committees of other institutes. All administrative bodies of INRA (boards of directors, scientific advisory bodies, specialized scientific commissions, etc) include outside representatives from the professions and the private sector. All of these forms of cross-fertilization facilitate the flow of information, complementarities and collaboration, even if they are not always capable of eliminating overlapping of programs (but isn't a little competition both stimulating and desirable?).

Formal and informal collaboration through pluri-disciplinary programs is quite common. We have already mentioned the close links between INRA and higher education in agronomy and veterinary medicine, and between the CNRS and the universities. Such connections have tended to strengthen over the last few years with the creation of "Scientific Interest Groups" (GIS) that associate two or more research institutions on specific projects using common resources: the Moulon GIS has brought together the Université de Paris- Sud, the CNRS and INRA to work on new methods of selecting wheat and corn strains; the INRA-Institute Pasteur-CEA GIS is working on sex typing of bovin embryos, etc.

At times, these groups bring together both public and private partners. In the plant selection field, for example, INRA is working with several private companies (Clause, Limagrain, Rhône-Poulenc) in an "Economic Interest Group" (GIE) on wheat, beetroots and potatoes with the financial support of the Ministry of Agriculture. Other agreements or GISs associate INRA with industrial concerns (Rhône-Poulenc, Mérieux, Sanofi, Roussel-UCLAF) on advanced animal research: gene transfer in embryos, cellular cryo behaviour, development of vaccines for viruses. This sometimes consists of collaboration, specific projects with technical institutes, development services of the Ministry of Agriculture: for example, fruitful collaboration occurs between INRA and ACTA, the Plant Protection Service of the Ministry of Agriculture in the area of integrated pest management and epidemic forecasting for agricultural warnings.

IV - The main role of the Ministry of Higher Education and Research in agricultural research

For many years, government financing of agricultural research was included in the budget of the Ministry of Agriculture. The new governmental and administrative structure of the Fifth *République* (1959) resulted in fundamental changes: the budgets of scientific institutions were established by an interministerial board on research, included in a research "envelope" and then distributed to the different ministries concerned, including agriculture for agricultural research. The Ministry of Research and Technology was created in 1981. Its subsequent attachment to the Ministry of Industry and then to Higher Education reinforced the principle of a basic ministerial responsibility for all of this activity at the national level.

From now on, a single ministry directly manages the largest research budgets of public agencies and grants to the professional and private sectors, but does so in cooperation with the other ministries involved (basically Agriculture but also Development, Environment and Industry) and, of course, Economy and Finance.

The role of the Ministry responsible for research is not limited to that of providing direction for internal priorities of such institutions. For several years now, the Ministry has been trying to

promote directly, in the fields recognized as priorities, demonstration research projects associating several public and private institutions. For this purpose, it has its own research budget - "Research Funds" - managed through specialized scientific committees (wood, diversification of rural development models, product quality, agro-food, biotechnology, etc) that bring together all the social actors involved (researchers, representatives of farmers, industry and consumers). Incentive budgets are relatively small (75 million francs in 1985) but they have made a significant contribution to the inter-institutional synergy mentioned above by improving the exchange of scientific information and promoting the development of certain research directions in these institutions.

Finally, the Ministry of Research (under its different configurations) has been the major motor for change in the status of public research institutions and their personnel.

The creation of Public Institutions on Science and Technology (EPSTs) substituting for Administrative Public Institutions (EPAs) gave a legal status to public research institutions that has much more flexibility insofar as administrative and financial management is concerned, as well as for relations with client groups.

The definition of a senior official position for research personnel enabled the standardization of situations that were very different. This new status conferred greater job security to scientific workers (who were made civil servants) but also implied much greater scrutiny in the selection of researchers before they were tenured or promoted. It also opened (if not imposed) the way for more professional mobility between scientific institutions, both foreign and private, which had been very limited.

V - Conclusions: the relative simplicity and efficiency of the French agricultural research system

1. An agricultural research system at last relatively simple and integrated

The French agricultural research system is relatively simple for two reasons. First of all, there is the privileged role of the Ministry of Higher Education and Research in the financing and functioning of the overall agricultural research system. Second, there is the role played by INRA given its resources (55% of the research years and 59% of the budget in the domestic public and professional sector, and 47% and 42%, respectively, in the public agricultural research sector) (5), its broad dealings with other public, professional and private agencies (special relations with higher education institutions in agronomy, strong collaboration with CNRS, ACTA, CIRAD, etc), and its representation at the many levels of administration of the system (scientific committees of the Ministry of Research, boards of other institutions, etc).

It could be said, in fact, that INRA and the Ministry of Higher Education and Research constitute the "backbone" of the national agricultural research system that also enables the involvement of other institutions whose presence ensures a much greater diversity of approaches (from basic to applied research). This is enriched by a distinctive French touch: notable attention to the problems of developing countries.

2. Significant results

It is impossible to summarize here the results of French agricultural research. Some have been very spectacular, such as the introduction at the world level of tissue culture, embryonic sexing of ovins and bovins, the development of new methods of plant and animal genetic breeding, of biotechnologies, of fertilization, integrated pest management, and farm management, etc.

All of the results have not been so spectacular and it is often more by their accumulative effect that agricultural research institutions, notably INRA, have participated in the promotion of national agriculture. A few numbers show the progress that has been made.

Between 1945 and 1985, average yields of wheat and corn went from 16 to 60 quintals and 16 to 67 quintals, respectively. For sunflower, yields went from 14 to 24 quintals between 1964 and 1985. Areas planted in corn went from 60,000 to 3,000,000 ha; for rape from 60 to 500,000 ha; for sunflower from 15,000 to 600,000 ha. As for animal production, milk production has increased since 1945 by 100 litres per cow per year and by 6 kg of milk per ewe per year. In the accelerated modernization process of French agriculture, very

few sectors have not benefited significantly from agricultural research work.

Notes

1. Among the foreign resources used by French institutions, there is some financing from EEC sources (Agriculture - DG VI, including AGRIMED; Research - DG XII) that is still very limited but expected to grow in the future.

2. Paris-Grignon National Agricultural Institute (INA-PG), National Advanced Schools of Agronomy (ENSAs: Montpellier, Nancy, Rennes, Toulouse) and National Veterinary Schools (ENVs: Paris; Lyon; Nantes, Toulouse) as well as "Applied Schools" (ENGREFs: Paris, Nancy; ENSSAA: Dijon; ENSIA: Douai, etc (see **Annex 5**).

3. The other researchers work in the fields of hydrology, oceanography, human health, and other social sciences, etc.

4. Sources: "Recherche et développement dans les entreprises", Paris, Documentation française, 1985
"La recherche alimentaire publique et privée", APRIA, 1986

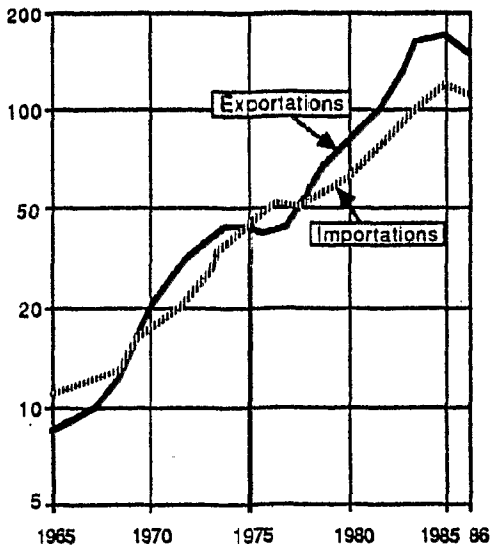
5. Estimates based on data contained in **Annex 1**.

Annex 1: French agro-food trading balances

Source : *Graph Agri 87*.- Paris : Mini. Agri,1987.-157 p.

French agro-food trading balances

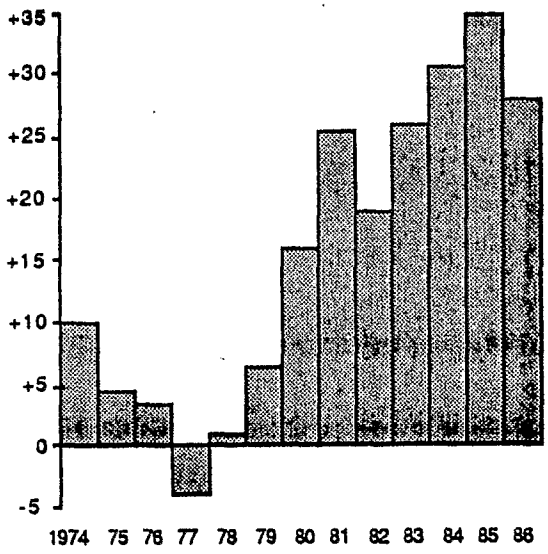
milliard de francs



Ordonnée logarithmique.
Source : Direction Générale des Douanes et Droits Indirects.

French commercial agro-food trading balance

milliard de francs



Source : Direction Générale des Douanes et Droits Indirects.

French agro-food exchanges (1)

	1960	1965	1970	1975	1980	1981	1982	1983	1984	1985	1986
					million de francs						
Exportations	4.750	8.384	15.977	35.431	77.532	98.160	103.139	121.190	137.559	146.712	139.194
dont CEE (2)	///	3.660	10.876	22.134	44.657	51.529	61.549	73.409	83.281	89.036	95.685
(%)	///	(43,7)	(68,1)	(62,5)	(56,7)	(53,6)	(59,7)	(60,6)	(60,5)	(60,7)	(68,7)
Importations	7.938	10.673	16.389	31.151	61.866	71.054	84.509	95.771	107.737	112.277	110.926
dont CEE (2)	///	2.178	5.837	13.970	29.289	35.092	42.954	48.341	55.014	58.556	66.590
(%)	///	(20,4)	(35,6)	(44,8)	(47,5)	(49,4)	(50,8)	(50,5)	(51,1)	(52,2)	(60,0)
Solde	− 3.188	− 2.289	− 412	+ 4.280	+ 15.865	+ 25.106	+ 18.630	+ 25.419	+ 29.822	+ 34.435	+ 28.268
dont CEE	///	+ 1.482	+ 5.039	+ 8.164	+ 15.368	+ 16.437	+ 18.595	+ 25.068	+ 28.255	+ 30.474	+ 29.095

(1) Les importations sont comptabilisées CAF (c'est-à-dire y compris les coûts, assurances et frais d'importation) et les exportations FAB (franco à bord); le total agro-alimentaire correspond aux 24 premiers chapitres de la Nomenclature générale des produits; les produits de la sylviculture, les laines, les textiles tropicaux, le caoutchouc naturel brut... sont donc exclus de ces résultats.
(2) CEE à 6 en 1965, CEE à 9 à partir de 1970, CEE à 10 depuis 1981, CEE à 12 depuis 1986.

Source : Direction Générale des Douanes et Droits Indirects.

Annex 2: Main public and professional agricultural research institutions in France

Categories	N°	Responsible ministries	Autonomous institutes	Coordinating institutes	Mandates		Number of prof. staff		Budget (10^6F)	
					Type	Areas	Total	Agric.	Total	Ag.res.
		A	B	C	D	E	F	G	H	I
I. Domestic institutions	1.1	MESR/MINAG	INRA		RA	All except 1.2	2,720	2,720	2,330	2,330
	1.2	MESR/MINAG	CEMAGREF		RA-DA	Irrigation mach., etc.	410	270	240	170
	1.3	MINAG	8 ENSA-ENV		ESA-RA	All	700	350*	-	150*
		"	12 ESA pub.		ESA-RA	All	-			
		MESR	ESA priv.		ESA	All	-			
			2 ENSA		ESA	All	-			
	1.4	MESR/MINAG	33 inst. techn.	ACTA	RAa	Anim, plant Prod.	900	900	600	600
				ACTIA	RAa	Agro-food industry	160	110	150*	150*
II. Other domestic institutions	2.1	MESR	CNRS		R	All	12,400	300*	9 000	300*
	2.2	MESR	Universities		ES-R	All	-	250*	-	250*
III. = I + II	3							4 900*		3,950*
IV. Overseas institutions	4.1	MESR/MINCOOP	CIRAD			Tropical research	560	560	850	850
	4.2	MESR/MINCOOP	ORSTOM				760	250*	720	250*
V. = III + IV	5							5,710*		5,050*

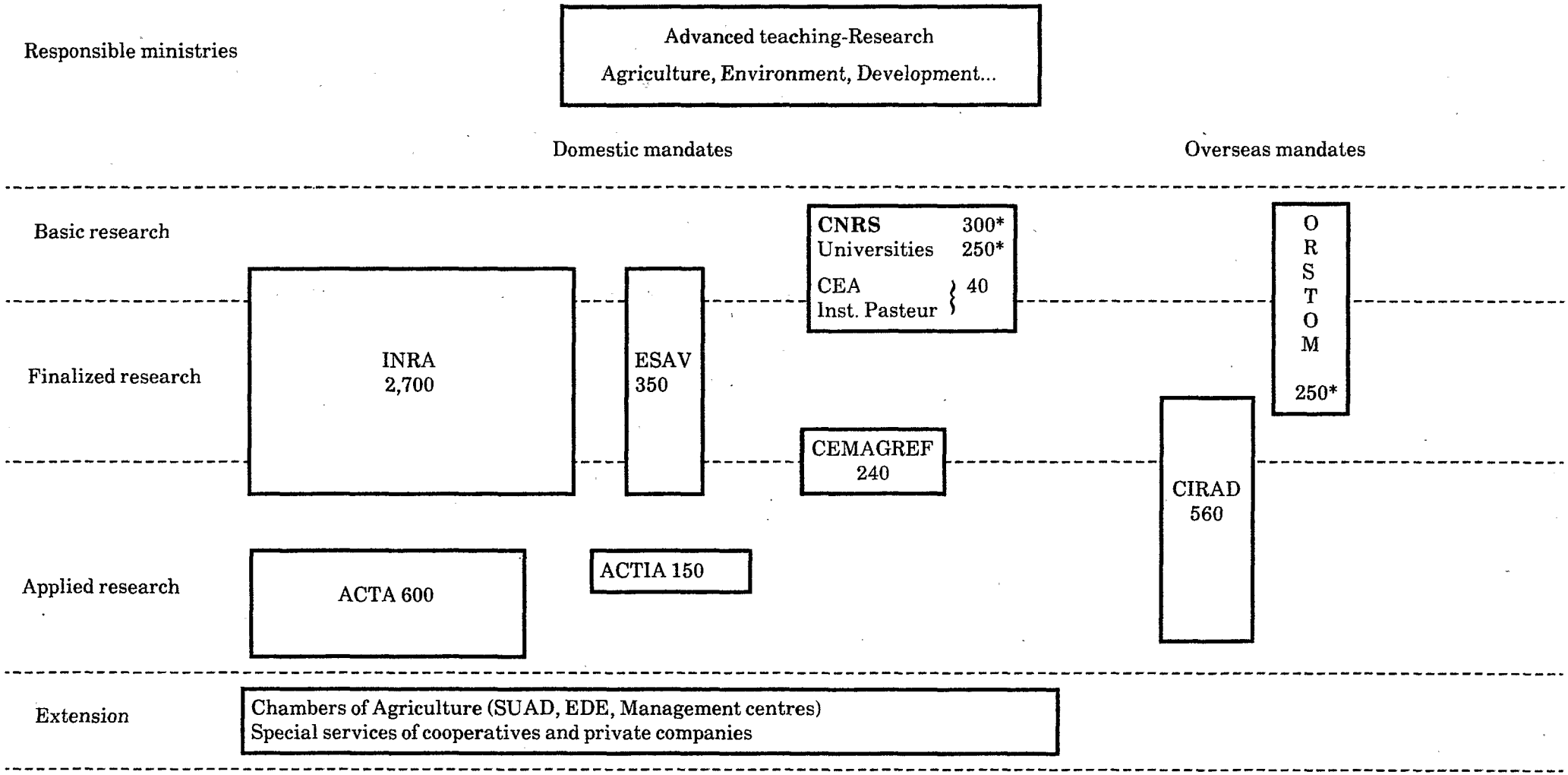
A: MESR = Ministry (M) of Higher Education and Research, MINAG = Ministry of Agriculture, MINCOOP = Ministry of Development

B, C, D, E: see text

D : RA, R: agronomic research or general research ; RAa = applied agronomic research ; ESA-ES = advanced agronomic or general education ; DA: "agricultural" development.

G, H, I: * personal estimates (for teaching establishments we considered the teachers' salaries for the time spent on research).

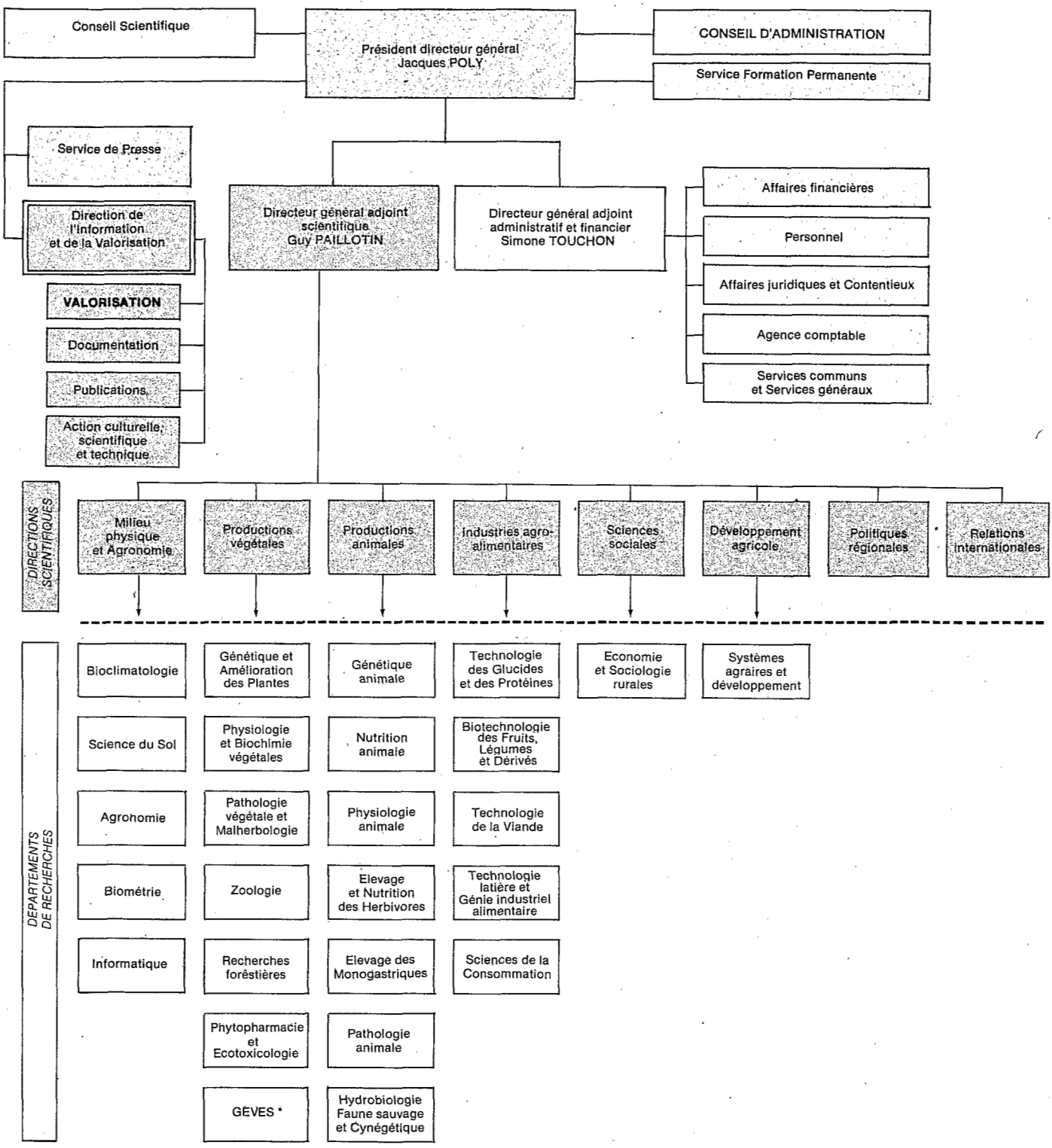
Annex 2: Diagram of the main public and professional agricultural research institutions in France (1)



(1) The numbers are for the quantity of research years (or equivalent full time researchers) exclusively in agronomic and agro-food areas.
CNRS, ORSTOM, etc. : scientific mandate exceeding this field
* : estimates

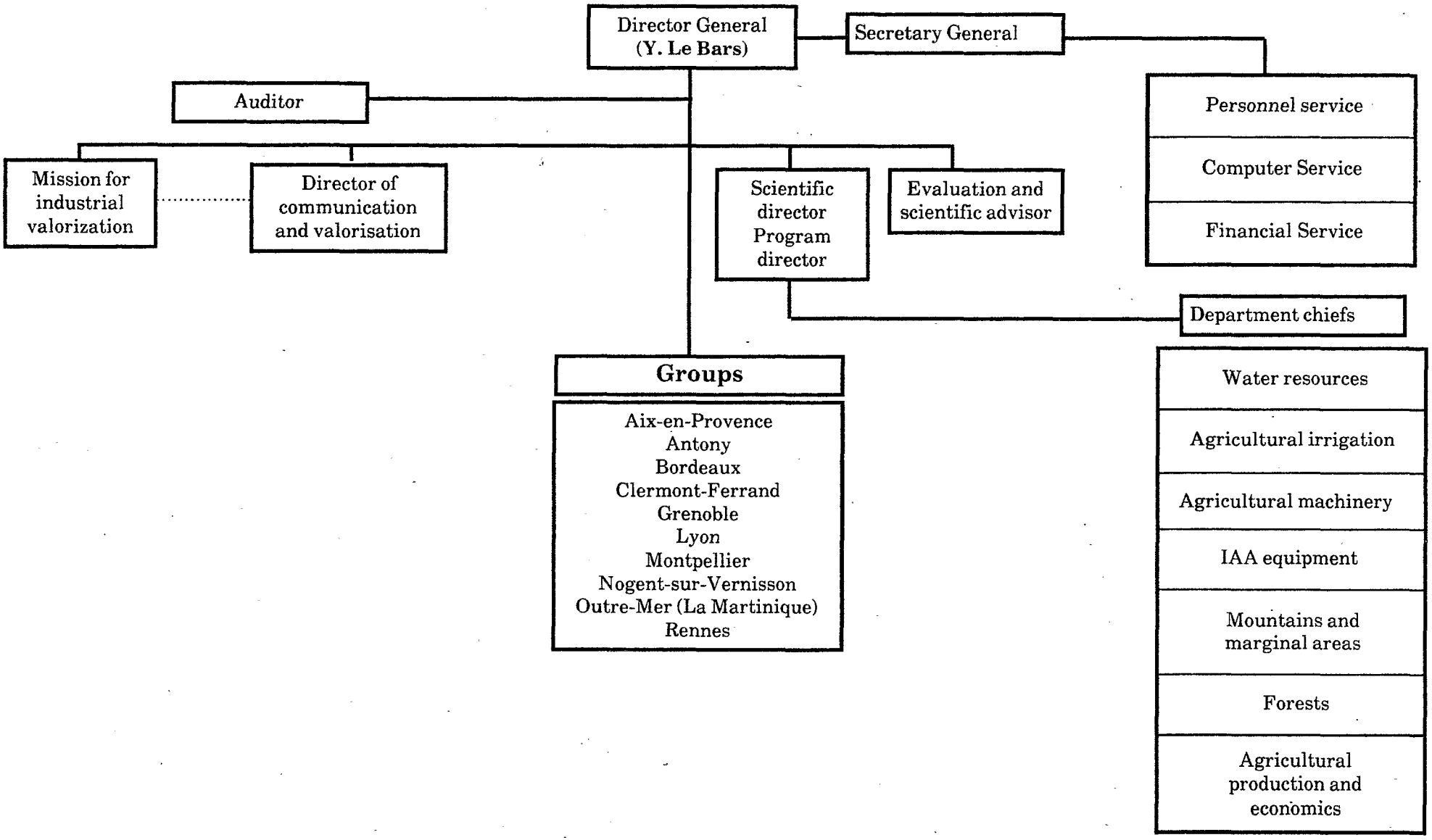
Annex 3: Organizational chart of INRA

Source : *INRA et les entreprises*.-Paris : INRA.-nd.-8 p.

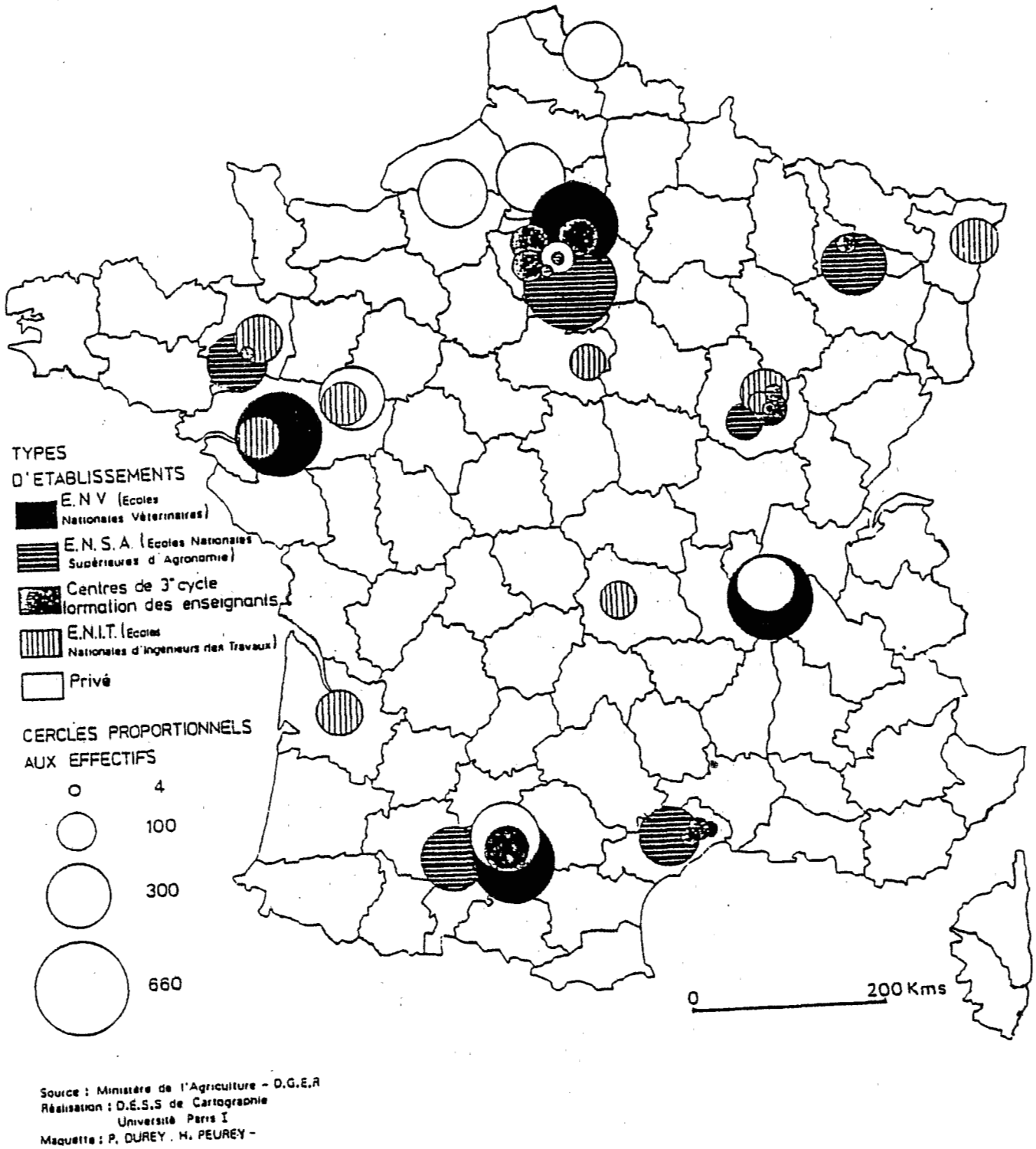


* *Groupe d'Etudes et Contrôle des Variétés et Semences*

Annex 4: General organization of the DG of CEMAGREF



Annex 5: Location and size of French higher education establishments in agriculture, agro-food and veterinary studies



Source : Ministère de l'Agriculture - D.G.E.R
Réalisation : D.É.S.S de Cartographie
Université Paris I
Maquette : P. DUREY . H. PEUREY -

Annex 6: Member institutions of ACTA

AGPM Association Générale des Producteurs de Maïs
CTIFL Centre Technique Interprofessionnel des Fruits et Légumes
CETIOM Centre Technique Interprofessionnel des Oléagineux Métropolitains
IDF Institut pour le Développement Forestier
IGER Institut de Gestion et d'Economie Rurale
ITAVI Institut Technique de l'Aviculture
ITB Institut Technique Français de la Betterave Industrielle
ITCF Institut Technique des Céréales et des Fourrages
ITEB Institut Technique de l'Elevage Bovin
ITL Institut Technique du Lin
ITOVIC Institut Technique de l'Elevage Ovin et Caprin
ITP Institut Technique du Porc
ITPT Institut Technique de la Pomme de Terre
ITV Institut Technique de la Vigne et du Vin
ITEPMAI Institut Technique des Plantes Médicinales, Aromatiques et Industrielles

Annex 7: Member institutions of ACTIA

ADIV Association pour le Développement de l'Institut de la Viande
ADRIA (Normandie) Association pour le Développement de la Recherche appliquée aux Industries Agro-alimentaires
ADRIA (Quimper) Association pour le Développement de la Recherche appliquée aux Industries Agro-alimentaires
ADRIAC (Champagne-Ardennes) Association pour le Développement de la Recherche dans les Industries Agro-alimentaires et de Conditionnement de Champagne-Ardennes
INSTITUT APPERT Institut National de la Conserve
IFBM Institut Français des Boissons de la Brasserie Malterie
ITERG Institut des Corps Gras
ITG Institut Technique du Gruyère
SSHA Société Scientifique d'Hygiène Alimentaire
TECALIMAN Association pour un Centre Technique des Aliments pour Animaux
CTCPA Centre Technique de la Conservation des Produits Agricoles
CNH Centre de Nutrition Humaine
CREDCA Centre de Recherche et d'Etude pour le Développement de la Coopération Agricole
CTSCCV Centre Technique de la Salaison de la Charcuterie et des Conserves de Viande
CTUC Centre Technique de l'Union Intersyndicale de la Biscuiterie, Biscotterie et Industries Céréalières
GTS Groupement Technique de Sucreries (SARL)

Annex 8: Information sources and useful addresses

Apart from some sources of information cited in the text, recent documents published by the main bodies referred to were also used: annual reports, activity reports, reports to boards of Directors, scientific reports, oral presentations, etc.

People interested in more details of the main scientific institutions in France should contact the following:

ACTA : 8, avenue du Président Wilson, 75116 Paris
CEMAGREF : Parc de Tourvoie, 92160 Antony
CIRAD : 42, rue Scheffer, 75116 Paris
Dir. de l'Enseignement Agricole, Ministère de l'Agriculture: 78, rue de Varenne, 75007 Paris
INRA : 145, rue de l'Université, 75345 Paris Cedex 07
ORSTOM : 213, rue Lafayette, 75840 Paris Cedex 10