Policy Analysis Exercise
John F. Kennedy School of Government
Harvard University

Sustainable Forest Development: Long-term Research Funding in Chile

Prepared for
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I have been over the final version of Ms. Loewe's PAE, *Sustainable Forest Development: Long-term Research Funding in Chile*, and find it to be a highly commendable and well-written treatment of the subject. The analysis is thorough, thoughtful, and oriented toward the practical answers any program administrator would be seeking. FIA director Margarita D'Etigny should be very pleased with the results.

In the course of the PAE project, and my fall term course (ENR 522), I have come to know Ms. Loewe quite well and have been impressed by her diligence, commitment, and ability to assess a situation accurately. The written PAE reflects those qualities. As an example, the comparative analysis of the European, American, and Chilean approaches is quite revealing, and the method of displaying the results is most helpful to the reader. The footnoted references indicate a wealth of sources consulted. From firsthand knowledge of the forestry field, I can attest to the difficulty of obtaining accurate and timely data on long-term research investments.

As a former agency administrator, I especially liked Ms. Lowe's recommendations. They reflected an insider's acquaintanceship with various funding sources and a political sensitivity to what would work best in the Chilean administrative environment. In addition, having the findings and recommendations derive from an individual with extensive professional credentials of her own gives the PAE results particular credibility and should materially advance their prospects for utilization.

In my review of the draft paper, I suggested that Ms. Loewe obtain a measure of editorial assistance just because English is not her first language. She seems to have done just that, for the final paper both reflects those inputs and underscores how responsive the author has been to any and all suggestions throughout the course of this project. I have felt for some time that the Kennedy School should provide such services routinely for its foreign students.

Finally, these comments would not be complete without some measure of the individual herself. Ms. Loewe is certainly at the top of the long list of students I have been privileged to know during my thirteen years at the Kennedy School. She has been a pleasure to work with and, in my judgement, is on the threshold of taking her already-substantial accomplishments to another level. She has earned and merits our very best wishes for what is certain to be a continuing, fine, professional career.

Charles H.W. Foster

"It should be salutary, now and then, to remove our workday blinders and look at our approach, the problems on our research agenda, the tools we use, and the way we are organized".

T.W. Schultz

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Executive Summary

Chilean forest research is facing problems of continuity because the biological cycles of forests are much longer than the available funding for research.

Currently, Chilean forest research and development (R&D) policy is supported by a few funds that work on the basis of open-competition, peer review, short-term and cost-sharing project basis. There are no government funds allocated to long-term research (LTR). On the other hand, the private sector by tradition and culture allocates very few resources for R&D, representing less than 20% of the national expenditure. In forestry this situation is still more marked.

This policy based only on short-term projects has had adverse effects on the whole research system, including the deterioration of facilities and the reduction of advanced training.

The author has found that both the European and the American models of R&D forest fund-policy feature components of long-term allocations, although they have different emphases and modalities.

These long-term allocations are important for several reasons. They yield information and predictive models that are of use to policymakers and regulators. Long-term research is also needed to solve scientific and production uncertainties, to establish baseline parameters, to overcome lack of understanding of short-term variations in natural systems, and to identify long-term trends and relate them to their causes.

Therefore, a portfolio approach can be useful, because it is a way of managing risk through diversification of research topics and mechanisms. The portfolios should be evaluated for the balance between short-term research related to their missions and longer-term investments that would be important in future years.

Public funding of forestry research is also justified on the grounds of sustainability, particularly in fields of research where projects are of long duration. In a survey of forestry R&D institutions in developed countries it was found that the stability of funding from year to year was nearly as important for the research performance as the actual level of funding.

Only with research that is continued over many years will the country be able to develop the credibility and necessary expertise to better implement environmental management policies and identify sustainable production models. Both of them are goals under increasing pressure at national and international levels.

In this context, I recommend the following actions:

- Incorporate LTR within the current R&D Chilean fund system to meet the demand for future knowledge and the need for export-oriented applied R&D. This is particularly important for the forestry sector, which works over long-term cycles.

- Base LTR on a peer review and merit based strategy, in order to guarantee quality and innovation.

- Guarantee continuity through funding cycles to promote technical and administrative efficiency. LTR project duration could initially be fixed at six years, renewable, which is a period acceptable to both technicians and politicians.

- Allocate the proposed fund to the FIA (Innovation Agricultural Foundation), which has the experience, political ability and willingness to manage it, and for whom it would represent also a solution to the current problems found in forestry research.

- Promote private participation in R&D funding. Analysis should be done in order to identify some ways of getting higher involvement of this important actor in the sector's economic growth and sustainability.

Benefits of the proposal implementation are:

✓ Deals with environmental issues that are receiving global attention

✓ Yields information and predictive models useful to policymakers and regulators

✓ Solves both scientific and productive uncertainties related to forestry. It would overcome the current problem of forest research continuity

✓ Permits to join international networks of long-term ecological research, giving the country a presence in one of the most important environmental issues

✓ Represents a way of using information derived from short-term research projects and generating questions that should be answered through them. This feedback cycle is important to a more efficient use of the limited resources available to Chilean R&D

✓ Generates benefits of considerable magnitude to the national economy

The Client

The Agriculture Innovation Foundation (FIA) oversees the promotion of the agricultural sector and the transformation of the rural economy in Chile, through the adoption of innovations that can help to develop competitiveness in the entire productive agricultural cycle.

This foundation belongs to the Ministry of Agriculture, and has a leading role in the agricultural sector, through the allocation of important resources in innovation and research projects. It is the only fund specific to the sector, a situation that confers on it an important role for the future evolution of agriculture in the country.

In terms of public policy, FIA considers that applied research should be oriented to find practical and economical solutions for the less developed sectors of the society. In terms of results, the applied forestry research should identify products and production processes that would be highly profitable and easily commercialized. In addition this should be adaptable to the silviculture[1] of small and medium owners, as well as to the production of small and medium size industry.

FIA considers it appropriate[2] to have a research support system oriented to the maintenance of a network of forest technology information; of a system of field trials; and of an adoption system of high technologies related to the production and transformation of raw materials at the "Pequena y Mediana Empresa" (PYME)[3]'s level.

This is because the main problem related to the applied forestry research especially dealing with species and products, is the high cost of[4]:

- Maintaining a permanent, global and updated information system about species and products, genetic breeding and biotechnology.
- Establishing the amount of field trials required by the country's geography due to high diversity of sites and environments.
- Continuing such field trials.

Research on forest products and productive processes is conditioned by actual and future demand, both national and international. Major limitations to it are the requirement for methodologies and networks to develop accurate market studies, including demand in specific niches and studies on technical and economical feasibility; cost of identification, buying and setting hard and soft technologies (to reduce the technological gap between big enterprises and PYME); and high cost of training the PYME on new technologies and products.

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[1] Silviculture: The theory and practice of controlling the establishment, composition and growth of the tree component of forests.
[2] Neuenchswander A. 1998. Personal com.
[3] PYME: Small and medium size enterprise
[4] Neuenchswander A. 1998. Personal com.

The Issue

During the last two decades there has been a shift in the financial-support base for research that basically is done by academics and researchers from technological institutes, from regular budgetary allotments to competitive grants financed through publicly sponsored technology funds[4]. The private sector had and still now has a limited role in agricultural and forestry research.

At the same time the Chilean government has been increasing the resources for R&D, growing from $ 107.6 mill in 1980 (0.39% of GDP) to $ 455.0 mill in 1996 (0.66% of GDP), representing a four-fold increase in dollar equivalents.

However, government support for R&D has been decreasing in relative terms. In 1980 the government was funding 97.7% of academic R&D, 92.0% of technological institutes R&D and 88.3% of R&D driven by others. In 1996 the situation was 89.5% of academic R&D, 71.2 % of institutes and 65.2% of other R&D.

Since then, forest research is facing problems related mainly to the continuity of the studies, because of the duration of biological cycles. Some species have rotations[5] of 20 years, others of 40, 80, 120 years or even more, giving an additional complexity to the situation. In order to collect reliable statistical information[6], it is necessary to make a series of measurements for half of the rotation, in order to extrapolate to valid harvest parameters[7].

The competitive research funds share two basic features: they require private sector involvement through counterpart funding or collaborative research, and they are open to all research institutions/individuals on a nationwide competitive basis, directed at securing technologies for new export markets.

All of these funds are short-term, following the definition given by Mansfield[8] to be those taking five years or fewer. Features of these funds are shown in Table 1.

On the other hand, the private sector by tradition and culture allocates very few resources for R&D, representing less than 20% of the national expenditure. In forestry, this situation is still more accentuated. Private firms focus their research efforts according to short-term, market-driven priorities, motives that often contradict long-term sustainable

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[5] Rotation: Duration of the productive cycle (from establishment to harvest in plantations; or the period comprised between one harvest cycle and the next in the case of natural uneven-aged forests).
[6] CSIR. 1994. Short Course on Breeding Techniques. Vol. 1, Chapter 12. Forestek. Nelspruit, South Africa.
[7] Important parameters are DBH (diameter at breast high), high and others.
[8] Mansfield E. 1968. Allocation, characteristics and outcome of the firm's research and development. Industrial research and technological innovation. W.W. Norton & Company, Inc. Pp. 44-64.

development and economic growth[9]. Besides, the major problem with trying to encourage private research is that there is no certain formula for strengthening it[10].
There are no government funds allocated for long-term research (LTR).

Table 1. Features of Public Funds Available to Forestry Research in Chile

NAME	DEPENDENCY	MAXIMUM PROJECT DURATION	MAXIMUM AMOUNTS	REQUIRE-MENTS
FONDEF (Fondo de Fomento al Desarrollo Cientifico y Tecnologico)[11]	CONICYT (National Commission of Scientific and Technological Research) Ministry of Education	3 years	>$160,000 /year	Oriented to innovation. From the total cost, 20% must be self-funded and 20% private funded. For institutions
FONDECYT (Fondo Nacional Desarrollo Cientifico Tecnologico)[12]	CONICYT	1-3 years	$ 100,000/year	Oriented to basic research. For researchers.
FIA (Fundacion para la Innovacion Agraria) [13]	Ministry of Agriculture	3 years (4 extraordinarily)	$ 53,000/year	Innovation fund For individuals and organizations. Requires 30 % of private funding and high rate of return.
FDI (Fondo de Desarrollo e Innovacion)[14]	CORFO (Chilean Development Corporation). Ministry of Economics	3 years	No limits. Requires at least 18% private counterpart and production impact.	Oriented to innovative production. Public contests or bids.
FONTEC (Fondo Nacional Desarro-llo Tecnologico y Productivo)[15]	CORFO	No limits	50% of total costs	For companies, in order to increase innovative production.

[9] Levine C.S. 1998. Reorienting for sustainable development: support for a national science and technology policy. Journal of International Affairs vol. 51 (2), 675-688
[10] Pray C.E. and Ruttan V.W. 1990. Science and Technology policy: lessons from the agricultural sector in South and Southeast Asia. In: Science and Technology, lessons for development policy. Ed. Evenson R.E. and Ranis G. Pp. 179-207
[11] Fondo de Fomento al Desarrollo Cientifico y Tecnologico (FONDEF) www.conicyt.cl/conicyt/fondef (Cited 09/29/1998)
[12] Fondo Nacional de Desarrollo Cientifico y Tecnologico (FONDECYT). www.conicyt.cl/conicyt/fondecyt (Cited 09/29/1998)
[13] Fundacion para la Innovacion Agraria FIA. Ministry of Agriculture, Chile www.fia.cl (Cited 09/29/1998)
[14] Fondo de Desarrollo e Innovacion FDI (Online Database). www.conicyt.cl/sistema/financiamiento.html (cited 10/21/98)
[15] Ibid. (14).

The research system has been subject to strong and opposing forces:

- By stimulating the agricultural sector growth, a demand for new knowledge and technology has been created;
- The restriction on R&D public sector funding has forced the system to seek for new sources of resources.

Then it has become more open, competitive and responsive to market forces; it no longer has guaranteed government funding; and there is continuing pressure to improve the productivity of publicly supported agriculture and forestry research.

These policies also have had adverse effects on the research system, including the deterioration of important facilities and a decline in support for advanced training. This is extremely delicate because the development of new knowledge production capacity that leads to technical and institutional change is itself a product[16].

One factor often stressed by policymakers in R&D activities is the critical mass of researchers and equipment, which often are regarded as necessary to achieve high productivity in particular aspects of research[17]. And Chilean forestry sector is far away from reaching this stock of human and capital resources.

In fact, the World Competitive Report of 1996 classifies Chile in the 18th place in general behavior, but it fell to the 38th regarding the scientific-technological capability[18].

The increasing reliance on project-based funding has consequently led to neglect long-term research activities.

The system of public contests currently implemented in Chile does not allow for the solution of the problems identified by the client. This study then looks for ways to provide administrative and technical improvements. Solution promises too much.

Long-term Research: a Good Idea for Chile's Future?

Current incentives for private sector and government investment in most countries favor short-term research planning horizons. As an extreme position, C.P. Snow[19] states that administrators are masters of short-term solutions, for practical reasons, but with non-desirable effects, overall, dealing with biological cycles so different from the human one. Such is the case of forest resources.

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[16] Ruttan VW; Binswanger HP; Hayami Y. 1978. Induced innovation in agriculture. Economic growth and resources, Vol. III. Pp. 162-189.

[17] Mansfield E. 1995. Academic research underlying industrial innovations: sources, characteristics and financing. The review of economics and statistics. Elsevier Science Publishers, vol. LXXVII, Pp. 55-65.

[18] Ministry of Economy. 1998. Programa de Innovacion tecnologica 1996-2000. La innovacion tecnologica en el Chile de los noventa. (Online Database). www.innovacion.cl/documentos/docs/memoria1/doc2.htm (Cited 1/26/99). Page 3.

[19] Snow C.P. 1961. Science and Government. Harvard University Press. Cambridge, MA.

Current government and public concern over problems such as climatic change, acid rain and others illustrates the fallacy in continued reliance on short-term research.

Long-term research yields information and predictive models useful to policymakers and regulators. Accurate long-term monitoring data are necessary to achieve greater resource commitment, good direction, coordination and interdisciplinary integration.

LTR is needed to solve scientific uncertainties, to establish baseline parameters, to overcome the lack of understanding of short-term variations in natural systems, and to identify long-term trends and relate them to their causes. As an example, long-term ecological research seems to have wide applications, including the relationships between environment and human health[20].

Only with research continued over many years will the country be able to develop the credibility and necessary expertise to better implement environmental management policies and identify sustainable production models. Both of these goals are under increasing pressure at national and international levels (Op cit.).

The problem, then, is how to get adequate funding, in a multiyear basis, for assuring that LTR projects can be started, continued and completed.

Within the context of limited government research budgets, peer reviewers and agencies tend to shy away from funding LT studies. However, given their characteristics, they are often the most likely to yield outcomes of a relevant nature, both in ecological and economical areas. Because such studies have the possibility of providing a large return on investment, they should not be discriminated against in the funding process.

One assessment has shown that U.S. forestry research generates economic benefits of considerable magnitude[21]. It concludes that public research performance in the four industries considered -softwood plywood, forest products, softwood forestry and pine industry- for the period 1950-1980, ranged from good to superior. It brought social gains greater than usually anticipated for private investments, comparable to public agricultural research investments. Griliches (1992) estimated that for each dollar of public investment in agriculture research the rate of social return was $13 (considered rather high)[22].

In the same way, other assessment done in Asia concludes that public sector research in the agriculture sector can be a high payoff investment[23].

Consequently, it should seem a good element for Chile to supplement its R&D funds with LT allocations in order to achieve many of the important challenges the forest sector faces, some of which are mentioned in Appendix 1.

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[20] United States. Executive Office of the President. 1985. Report on long-term environmental R&D.
[21] Hyde WF; Newman DH; Seldon BJ. 1992. The economic benefits of forestry research. Iowa State University Press/Ames. 249 p.
[22] Griliches (1992). The search for R&D spillovers. Scand. J. of Economics, supplement, pp29-47.
[23] Ibid. (10)

Forest Research Funding Systems: an overview of the American and European experience

In order to do a comparative analysis, I examined two of the most influential and representative systems in Europe and North America, the cases of France and the United States.

1. The European Model

1.1 An overview of the European Situation

Most European countries present centralized decision-making processes related to R&D. However, currently there is a discussion about which research should be done for Europe as a union.

Growing pressures for savings in public spending has made research funding a current problem in most Western countries. Private involvement in forest research is generally low, being still predominantly publicly funded. This means that pressures for cutting down public R&D funding may have vital effects on the sector[24].

According to the European survey conducted at the European Forest Institute (EFI) in 1995, France and Germany followed by Sweden and Finland have the largest amount of research personnel in the forest sector.

Nearly half (49%) of the European forest sector research is conducted at universities, 40% at public research institutes, with only 9% at private research institutes. Even in Western Europe, the share of forest sector research conducted at private institutes remained low (15%)(Op cit.).

The same author identified that both in Norway and Finland, two important forest countries, there is a clear trend towards an increasing share of public funding through research grants at the expense of direct budget funding. This is a pattern rather common during the 90's in many countries.

In 1997 the European Commission adopted the Fifth Framework R&D Program, with the statement that "the European R&D outlay should tend toward that of the EU's major competitors (Japan and US) "[25]. The program for the period 1998-2002 is based on three fundamental principles: scientific and technological excellence, relevance with respect to the EU's major policies, and European value added. Also a higher degree of flexibility have been proposed in order to face emergencies.

[24] Hellstrom E. 1995. Patterns and policies of research funding in the forest sector. EFI. Research Report 4. 189 p.

[25] Anonymous. 1997. France: Fifth framework R&D program adopted. Paris AFP Sciences. 04/17/97.

This framework, that represents a Parliament's opinion, address five thematic programs: life sciences, environment, information society, production & transport and energy; sustainable forest management is included among them[26].

However this unitarian view, there are internal discussions. France, Germany and the UK wanted a lower budget; the French Research Minister arrived to say " I prefer to give money in France where I know that it is well managed, rather than to the Community, where it is sometimes wasted"[27]. This demonstrates the debate among the larger countries, which do not rely on Europe to finance their research and the smaller countries that want to have what they do not have at the national level financed by the union. For the "larger countries", and in particular for France, European research should not replace national programs, but it should support other priorities: researchers' mobility and exchanges, communications, assistance for innovative transnational small and medium-size companies, or the coordination of national activities and cooperation in certain areas.

Individually, most countries have reported notorious decreases in the budget allocated to R&D in the last decade.

In Italy it was reported in 1995, that there had been a 4.5% drop in investments in R&D over 4 years, with a corresponding loss of more than 4,000 jobs[28].

In this environment, Antonio Ruberti, former Minister and European Commissioner of Research blamed the entire European Union "for the fragmented projects of innovation that condemn us to play a marginal role with respect to international competition". In Europe "the percentage of workers in research are about 4.5% against 7 and 8% in the US and Japan" (Op cit.).

Also Germany suffered the same process. Research's share in the total budget has fallen from 4.7 to 3.4% since 1982 and 1996. This despite the fact that an increase in that share would be necessary to avoid being left behind the United States and Japan[29]. The situation imposed a new focus, and the Research Minister was trying to save money on material costs and supporting focal areas with a promising future, such as multimedia and biotechnology. He also called for greater cooperation between business and science.

Chancellor Kohl[30] in 1994 stated that he would firmly continue on an austerity course, but that "despite the limited resources, we have to consider on behalf of the state and the economy, how we can considerably advance research to the 21st century".

In spite of this, in 1998 the Minister of Research declared that "we will not be satisfied with merely increasing the education and research budget after years of stagnation. What

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[26] CORDIS. 1998. Research Council 11/1997. (Online Database) <apollo.cordis.lu/cordis-cgi> (Cited 2/16/99)
[27] Docquiert J. 1998. France's Allegre questions EU research policy's aims. Paris Les Echos 02/13/98.
[28] Martin F. 1995. Problems with R&D development studied. Corriere della Sera 02/22/95.
[29] Ummen R. 1996. Germany: Research budget cutbacks, refocus assessed. Berlin Die Welt, 11/28/96.
[30] Kohl H. 1994. Address Bundestag on Budget. Mainz ZDF Television Network. 09/07/94

is even more important is that we establish a framework for increasing the efficiency of the entire innovation process, from idea to product".

These cases are representative of the type and characteristics of the changes that have occurred in the last decade in European countries. France experience had been similar, as indicated in the next section.

1.2 The case of France

Institutions. The main public agencies involved with forest R&D in France are:

a) The French Scientific Research Institute for Development in Cooperation (ORSTOM).

ORSTOM is a state-owned, public agency under the joint authority of the Research and Overseas Development ministries. For fifty years it has been conducting research on inter-tropical environments and earning international recognition. It works in cooperation with other scientific institutes in France, Europe and developing countries. It has two multidisciplinary departments (Life conditions for development and Resources, environment and development); and seven scientific committees that regularly assess the careers of researchers careers and the progress of programs[31].

Major research topics for the period 1996-2000 are: conditions for development; dynamics of the major oceanic, aquatic and terrestrial ecosystems; utilization of natural resources; towns and development; and health and development.

Research findings are transferred to the productive economy through various ways (training, teaching, financial negotiation of rights to industrial property, and intellectual property).

b) **National Institute for Agronomic Research (INRA)**

INRA is a public scientific and technological agency that works in the areas of agricultural production and transformation, natural resources and rural environment management, and human alimentation under the supervision of the Ministries of Research and Agriculture[32]. It is one of the agencies in charge of developing the public research in France, spreading the scientific collaboration with the partners, being part of the interagency programs of the National Plan.

Among its main partners are the CNRS (National Scientific Research Center), INSERM (French Institute of Health and Medical R&D), CEMAGREF (National Center for Agricultural and Engineering for Water and Forests), ORSTOM, CIRAD (International Center for the applied tropical agricultural R&D), and others.

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[31] ORSTOM. 1999 An introduction to Orstom. (Online Database). www.orstom.fr/presentation/orstom/presentation_ang.htm (Cited 2/22/99).

[32] INRA. 1998. L'INRA, presentation generale. (Online Database). www.inra.fr/presentation_INRA/index.htm (Cited 2/22/99)

Areas of emphasis of this organization are knowledge production with short and long-term visions, innovation, and assistance of public agencies, and diffusion of results and development of techniques and scientific culture.

L'INRA works in close relationship with the regions, agribusiness and industries, professional associations and technological centers, making a contribution to a fast technology transfer, but also to a good sensitivity about socioeconomic demand. It has an active policy of cooperation and exchange with the international scientific community.

Its budget (1996) was 3,230 mill francs; it has 8,570 employees, 21 research centers, 260 research units (50 of them in association with other institutions), 80 experimental units and 100 service units. Signs around 1,200 contracts with both private and public entities every year; produces 6,000 publications per year, 144 patents in France and 1,495 abroad, and 181 licenses.

c) National Scientific Research Center (CNRS)

CNRS is a public agency under the Research Ministry, with scientific and technological characteristics (the so-called EPST). Its mission looks at research (it must evaluate, do or make others do all researches important for the advancement of sciences and for the economic, social and cultural development); at the analysis of scientific situation; at the valorization of results and at the training for and to the research[33]. A high amount of its budget goes to salaries (75%, equivalent to 11.2 mill francs in 1998).

CNRS develops partnerships with the private sector with the idea of developing research with shared goals, technology transfer (mainly to the PME), results valorization (patents, licenses), and company creation from the labs.

One of its main orientations is the enhancement of creativity and innovation. The CNRS has developed a policy preferring young researchers. Currently more than 18,000 Ph.D. candidates are preparing their theses at CNRS's labs.

It also analyzes the state of science, its perspectives in a national and international context and coordinates the research activity among all agencies involved through the action of the National Committee of Scientific Research, which is the advisory body for basic research evaluation. It evaluates the 12,000 researchers and the 1,200 labs through a peer review organization with an extremely large voting base, consisting of all the French public research community, as well the researchers working in private companies in close collaboration with CNRS.

Recently the institution has been trying to increase the autonomy of research units and to decrease the centralized planning by working around defined scientific themes (life sciences, environment, society dynamic, telecommunications and technologies).

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[33] CNRS. 1998. Presentation de l'organisme. (Online Database) www.education.gouv.fr/recherche/orgarech/jcnrs.htm (Cited 2/2/99)

d) National Center for Agricultural and Engineering for Water and Forests (CEMAGREF).

In the area of forest resources, the CEMAGREF focuses on landscape management and detection and prevention of natural risks. Its role is of contribution to the public decision authority and to the private sector with knowledge useful for the development of collective management, machinery creation and maintenance in order to improves the quality, safety and competitiveness of companies[34]. It is an entity that connects research, public decision and socioeconomic reality.

CEMAGREF looks for the development of forest and agriculture activities that will bring rural development without compromising the environment. Ecology, human and social sciences, agricultural and forest sciences are the base disciplines.

This agency considers that public research must help to express societal problems by building scientific answers for the potential users.

Four scientific departments develop research projects, organized into 32 research units. Its main focus on research is knowledge generation, results valorization, diffusion, training and research development.

It has multiple collaboration and coordination activities with other French research institutes as well as with partners from the whole European Community, putting in practice the expression "think globally, act locally". Actually, it has five laboratories with other French institutions, among them ENGREF and CNRS; more than 200 contracts with partners from the private sector, water industry and machinery for agriculture.

CEMAGREF's consolidated budget is 366 mill francs. It has 1,000 employees. About 100 Ph.D. students and 500 long-term trainees are present at the institute at any time. It publishes 670 articles per year; sends 350 papers to symposia and congresses, and has 21 patents.

e) French Institute of Forestry, Agricultural and Environmental Engineering (ENGREF)

The ENGREF is a public institution under the supervision of the Ministry of Agriculture with its own administrative and scientific board. Its budget is 79 mill. Francs and has a permanent staff of 160. Is main vocation is the training of forestry engineers, but also has a strong mission of research around forests and water.

It has strong collaboration with other important research centers, such as CEMAGREF, CIRAD, CNRS, INRA and ORSTOM. Its Research Forest Lab works on six main topics: forest ecosystems, genetics, silviculture, forest dynamic, forest products and forest economy[35].

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[34] Cemagref. 1998. Quelques mots sur le Cemagref. (Online Database). www.rouge.cemagref.fr/Informations/Presentation/Presentation.htm (Cited 2/22/1999).

[35] Engref. 1998. Laboratoire de recherches en sciences forestieres. (Online Database) www.engref.fr/lrsf.htm (Cited 3/12/99)

f) Other Organizations

*** National Agency for the Valorization of Research (ANVAR)**

Is the public body responsible for supporting technological innovation in small business. Placed under the supervision of three ministries (Industry, Telecommunications and Research), it is a publicly owned industrial and commercial bureau that manages an annual budget of around 1.4 bill francs aimed at financing innovative projects in business[36].

An example of shared R&D by the private and public sector, is the Bio Avenir program started in 1991 and finished in 1998. The goal of this joint venture was to improve the transfer of knowledge between public and industry research in the life sciences area. The budget was 1.6 bill French francs, funded 33% by the government and 67% by the industry. This cooperation of more than 500 scientists of both sectors has resulted in extraordinarily fruitful synergies[37].

* **The Science Academy** is also very important in the French system. It is a learned society focusing constantly on science, its applications and implications empowered by the public powers that consult it regularly with national and international roles. It brings together distinguished specialists scientists of international repute, from different fields[38].

Trends.

The forest sector is relatively important for France. There are more than 1,850 companies involved, being a sector that represents more than 3% of the GDP and more than 500,000 jobs[39].

France is a good example of centralized government direction in R&D because of the centralized system of public research institutes. There is an established practice of ministerial and inter-ministerial committees that are responsible for recommending priorities for public research, as well as calls for proposals[40].

An inter-ministerial committee in 1996 designated new research policy orientations proposing measures to promote innovation. Interestingly, a 10% of operating funds would be used for multi-annual programs focusing in those designated priorities in order to galvanize researchers around them. For 1998 the amount to these allocations should be raised to 20%[41]. Key activities cover a range extending from basic research to demonstration.

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[36] Perez A. 1996. France: Jurgensen appointed head of ANVAR research agency. Paris Les Echos 10/08/96.

[37] Froboese G. 1998. France: Biotechnology Research Program Bio Avenir. Frankfurt/Main Frankfurter Zeitug. 01/08/98

[38] Academie des Sciences. 1997. Missions of the Academy. (Online Database) www.acad-sciences.institut-de-france.fr/mission/index.htm (Cited 2/16/99)

[39] Federation Nationale du Bois. 1998. Presentation. (Online Database) www.fnbois.com/presentation.htm (Cited 2/16/99)

[40] Anonymous. France: 1.3 billion francs for research restructuring. Paris AFP Sciences 8/18/97.

[41] Girault D. Government sets new research policy orientations. Paris Electronique International Hebdomadaire. 10/10/1996

In 1997 the Minister of Education, Research and Technology, Mr. Claude Allegre, declared that "research remains national priority", and then emphasized that research should "fuel all education...in such a way as to prepare citizens to understand the world"[42]. He also expressed the hope that "the number of scientific committees would be divided by four and the number of their members by half, so that researchers would not be constantly filling out administrative documents or sitting in airplanes"; a higher focus on the links between research and industry, and the importance of technology and innovation. In his view "the basic unit for research is the laboratory" and he proposed that the evaluation of researchers and laboratories should no longer be done in-house.

Later, in 1998 the creation of a new scientific institution was announced, a National Center for Technological Research, to coordinate and guide public research for technological purposes. Its main role would be to review innovative projects, evaluate them in terms of their commercial potential and, on that basis, promote the creation of innovative enterprises. The main goal behind this idea is to ensure "the penetration of the research spirit everywhere, from major public research institutes to the lycees, including small and medium-sized enterprises, cities and so on" [43], as well as an improved coordination among research institutes. This is a concrete action that reinforces the ideas raised previously.

Problems

One of the main problems facing French research is an aging scientific work force. Because of this many young professionals holding doctoral degrees cannot find employment commensurate with their training. To improve the situation, more than 6,500 posts would be offered to holders of doctorates in sciences in 1998[44]. Also researcher mobility would be encouraged, in order to achieve the orientation proposed.

A recent study shows that out of 11 sectors analyzed by the Science and Technology Observatory (OST), France's position has worsened in eight of them, improved in two cases (transport and biotechnology) and remained stable only in one. In spite of the crisis of 1990 to 1996, French companies did not disinvest in R&D during this period. However, considering all technologies together, France has lost 1% in the world ranking, falling from 8.4 to 7.2%.

On the other hand, France's scientific positions are advancing overall (this measured by the number of scientific publications). French science's share in the sphere of life sciences rose from 5.1 to 5.6%, food industries from 3.6 to 4.0%, and environment and ecology from 3.5 to 3.8%. This progress in academic research confirms the weakness of transfers between the laboratories and the world of industry. This "French paradox" shows that everything is happening "as if the economic sectors were not managing to take advantage of the good positions achieved by French public research"[45].

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[42] Anonymous. France: National R&D Policy Supported. Paris AFP Sciences 08/21/1997.
[43] Anonymous. New Center for Technology Research in France. Paris AFP Sciences 4/09/1998
[44] Anonymous. France: National R&D Policy Supported. Paris AFP Sciences 08/21/1997.
[45] Anonymous. France: Study shows France losing ground in key technologies. Paris Les Echos 05/12/1998.

France was also in line with most western countries. The budget was cut in 1996, when the total amount of civilian R&D significantly fell (down 5.5%). However, 527 job losses were designed to "restore investment capacities and retain a recruitment level of new research workers of 2.5%"[46].

This reduction would seem over now. In fact in 1998 the research budget was up 6.2%, totaling 53.1 bill francs[47] and operating funds for the state research agencies are also experiencing a rise. A specific provision for the employment of post-doctoral researchers in firms and research organizations should be implemented soon.

Another interesting fact is the attention given to the economic intelligence, that consists of collecting, analyzing and understanding all the information an enterprise needs to make strategic decisions, being a tool of product competitiveness especially for the PME-PMI[48]'s which rely in different government agencies for it[49].

2. The U.S. Model

There are various federal programs and policies in place that further technology advancement in the United States.

Traditionally, the government has funded R&D to meet the mission requirements of the federal departments and agencies. It also supports work in areas where the government is the primary user of the results or where there is an identified need for R&D not being performed in the private sector. It is interesting to note that private sector funds around 50% of the R&D performed in the country[50].

In other words, the American system is characterized by[51]:

- Existence of multiple federal and private sources, including in-house technical staff and laboratories, plus outside grants or contracts at a significant scale of competitively selected projects
- Each federal agency acts pursuing its operating missions; so they carry out a substantial program of in-house basic work (ea. Agriculture through Agriculture Research Service)
- From the investigator point of view, there are several opportunities to gain independent reviews of a novel idea; in this sense, a negative decision doesn't eliminate the possibility of another open competition
- The system is important as a source of diversity: availability of multiple governmental and private sponsors

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[46] Anonymous. 1996. France: R&D budget for 97 to decline 5.5%. Paris Les Echos 09/19/96.
[47] Anonymous. 1997. French 1998 research budget increased. Paris AFP Sciences, 10/27/97.
[48] Small and medium sized companies and industries
[49] Anonymous. 1997. France: Economic Intelligence gains supporters. Paris Les Echos, 04/28/97.
50 Malana D. 1993. Critical technologies and economic competitiveness. Nova Science Pub. Inc. 204p.
[51] Nichols R W. 1986. Pluralism in science and technology: arguments for organizing federal support. Technology in Society, Vol. 8, pp. 33-63

- Private and non-profit support gives independence and the flexibility required for first-rank research during the frequent periods of changing priorities among federal agencies and corporations.

Making a broader analysis, Malana[52] states that legislation shows federal efforts aimed at:

- Encouraging industry to spend more on R&D
- Assisting small high technology business incentives
- Promoting joint research activities between companies
- Fostering cooperative efforts between industry and universities
- Facilitating the technology transfer from federal laboratories to the private sector
- Augmenting math, science and engineering education
- Creating retraining assistance.

Some of the tools used to achieve these goals are tax credits and fostering cooperative research to undertake joint research which is typically LTR, risky and often too expensive for one company to finance.

Environmental problems are receiving global attention, so there is an incremental tendency to develop international research efforts to deal with these topics. An example of this is the International Long Term Ecological Research Network that study tropical forests, coordinated by the Forest Service and funded by National Science Foundation[53].

In U.S. the public funds available to agriculture R&D are distributed through different agencies[54]. Among the most important ones are National Science Foundation (NSF), Department of Commerce (DOC), Environmental Protection Agency (EPA), Department of Energy (DOE), National Aeronautics Space Administration (NASA), Department of Agriculture (USDA)[55], including the Agriculture Research Service (ARS)[56], the Alternative Agricultural Research and Commercialization Corporation (AARC)[57], the Forest Service (FS)[58] and the Natural Resources Conservation Service (NRCS)[59].

Contrary to what was happening in Chile, in the U.S. in the last 20 years there was an increasing concern about LTR. As evidence of that the NSF, the most important fund for short and long-term research in an open-base competition, created in 1979 a long-term

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[52] Ibid. (50)
[53] Long Term Ecological Research Network. (Online Database). www.fs.fed.us/global/iitf (Cited 11/29/98)
[54] O'Hara D. P. 1990. Funding research & development. How to team up with the Federal Government to finance your R&D. The entrepreneur's guide series. Chicago, Ill., 246 p.
[55] U.S. Department of Agriculture. www.usda.gov/agencies (Cited Sep. 29, 1998)
[56] U.S. Department of Agriculture - ARS Agric. Research Service. www.ars.usda.gov (Cited Sep. 29,1998)
[57] U.S. Department of Agriculture - AARC. The Alternative Agricultural Research and Commercialization Corporation. www.usda.gov/aarc/aarcinfo.html (Cited Sep. 29,1998)
[58] U.S. Department of Agriculture - Forest Service. www.fs.fed.us (Cited Sep. 29, 1998)
[59] U.S. Department of Agriculture. - NRCS Natural Resources Conservation Service. <www.nrcs.usda.gov> (Cited Sep. 29, 1998)

ecological research program (LTER)[60] for assessing the ecological phenomena that occur on time scales of decades or centuries and take into consideration the year to year variability in the systems[61]. It operates at a large spatial scale, over long periods of time; is multidisciplinary, comparative, and modeling and networking are key functions. It includes the notion that ecosystems and their components interact in both temporal and spatial dimensions (however, when talking about LTR we're really referring to a comparatively small numbers of years[62]). The system operates through open competition: 17 projects are currently active. LTER fits into part of the budget called "centers" [63].

Also the USDA through the Forest Service initiated a long-term soil productivity program (LTSP)[64] that works nationally as a cooperative study; key points are to evaluate timber management impacts on LTSP, to sustain managed stands and to set calibration and soil monitoring standards[65].

There have also been proposals for long-term data retention and management, considered essential for the development of science[66].

Another interesting sign is the EPA's reinvention activities[67]. Based on a reorganization plan the 12 laboratories are concentrated into only 4, around EPA's major activities rather than individual scientific disciplines[68]. The plan includes strong reductions of supervisory administrative positions and increased partnership with academia. What seems most interesting for this paper, a considerable increase of budget directed to LTR, growing from 30% to 50%, in the hope that it will help wall off the LTR from the problems of the day[69]. Whether EPA will be able to protect funding for LTR when taking the budget to Congress is still unknown.

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[60] Risser P.G. (Ed.). 1991. Long term ecological research: an international perceptive. Chichester, England; New York: Published on behalf of the Scientific Committee on Problems of the Environment (SCOPE) of the International Council of Scientific Unions (ICSU).

[61] Van Cleve K. and Martin S. 1991. Long-term ecological research in the United States: a network of research sites. Washington D.C.

[62] United States. Congress. House. Committee on Science. 1995. Science, environment and technology summit: a long-term national science strategy: hearing before the Subcommittee on Basic Research of the Committee on Science. Washington D.C. 141 p.

[63] Clark M. 1996. Proceedings of the ILTER Conference. (Online Database) www.ilternet.edu/meetings/panama96/notes/notes1.html (Cited 2/9/99).

[64] U.S. Department of Agriculture, Forest Service. 1995. Long-term soil productivity research: a national program in sustaining forest ecosystems. Washington, D.C.

[65] U.S. Department of Agriculture, Forest Service. 1995. Long-term soil productivity research in the South. Washington, D.C. 8p.

[66] National Research Council (U.S.). Steering Committee for the Study on the Long Term Retention of Selected Scientific and Technical Records of the Federal Government. 1995. Preserving scientific data on our physical universe. Washington D.C. 66 p.

[67] Newman A. Reinvention of EPA research office takes shape. Environmental Science & Technology v 29, Jan. 1995, p 16A.

[68] Stone R. 1994. Browner to beef up outside research. Science v. 265, July 29. Pp. 599-600.

[69] Johnson J. EPA to overhaul lab structure, boost competitive grants. Environmental Science & Technology v 28, Sep.1994, p 409-410A.

EPA's change is included in the "Government Performance Project" that is working with 15 federal agencies that have extensive interactions with American citizens in order to improve their effectiveness[70].

Other examples of government institutions that have successfully supported integrated research over a long-term include[71]:

- Establishment of well-funded "centers of excellence" at Universities
- Laboratories owned and operated by Federal Government on contract to Universities;
- Industry-based research organizations.

Given the often-detrimental effects of market forces on the environment, government must be a focused catalyst for research programs that marry ecological and economic concerns, proposing S&T programs for sustainable development. With this purpose it has been proposed a Federal Sustainable Science & Technology (FSS&T) budget, ranking areas of research in terms of importance to sustainable development. This budget should be large, progressive and long-range[72].

Table 4 presents a compilation of available funds for forestry related R&D in 1997. Indeed the amounts are not accurate, but they are useful to have an idea about the short/long term ratio.

Obtaining the amounts invested in long-term studies was difficult, because they are "hidden" under other names and categories, which is not surprising because of the pressure to reduce public expenditures. It can be considered as a strategy to protect allocations that otherwise could be easily cut.

It has also been difficult because the classification by fields is not available. Then data collected represent a judgement call of the managers interviewed in the different agencies. For this reason most of them preferred to remain anonymous.

The fact that more than 20% of the public R&D funds for forestry go to LT studies highlights the importance that the government gives to continuity; and it is a recognition of the importance of forestry biology.

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[70] The Government Performance Project. 1998. (Online Database) www.govexec.com/reinvent/gpp (Cited 11/30/1998)

[71] United States. Executive Office of the President. 1985. Report on long-term environmental research and development

[72] Ibid. (9)

Table 4. Public Funds Available to Forestry Research in the U.S. An estimation of amounts invested in short-term and long-term research in 1997 (million $)

Organization	Kind of fund	Short-term R&D		Long-term R&D		Total Amount	
Department of Agriculture (USDA)	*Forest Service (FS) Forest & Range R&D[73]	144		36		180	
	*Natural Resources Conservation Service (NRCS)	NA (Not available)		NA		NA	
	*Agricultural Research Service (ARS)	NA		NA		NA	
	*Economic Research Service (ERS)	NA		NA		NA	
	*Alternative Agricultural Research & Commercialization Corporation (AARCC)	NA		NA		NA	
	*External sources[74]	90		0		90	
	Sub-total	**234**		**36**		**270**	
Department of Energy (DOE)	*Savannah River Nat. Res. Research Institute	0.997		0.053		1,05	
	*Oak Ridge Nat'l Lab	NA		NA		NA	
	*Agenda 2020[75]	0		7		7	
	Sub-total	**0.997**		**7.053**		**8.05**	
Env. Protection Agency (EPA)	*Office of R&D (ORD)	13,5		1,5		15	
	*Others	0		5		5	
	Sub-total	**13.5**		**6.5**		**20.0**	
National Aeronautics Space Adm. (NASA)[76]	*Earth Sciences: Forest Ecosystem Dynamics (FED) Project	**0.3**		**10**		**10.3**	
National (NSF) Science Foundation	* Long-term ecological research program	**0**		**8.25**		**8.25**	
	* Grants	NA		NA		NA	
Total Govt.		**248.8**	**78.58%**	**67.8**	**21.42%**	**316.6**	**100%**
Private Foundations[77]	*Ford Foundation[78]	0.25		0		0.25	
	*Mellon Foundation[79]	7.479		0		7.479	
	*Rockefeller Foundation	3.65		0		3.65	
	*Pew Trusts	1.770		0		1.770	
	*MacArthur Found.[80]	0.515		0		0.515	
Total NGO's		**13.7**		**0**		**13.7**	

[73] NWOA. 1997. Woodland Report. Vol. 14 No 2.

[74] I assume these external sources come, among others, from the sources from which it was not possible to get information.

[75] Cooper J.S. 1997. The basics of Agenda 2020. TAPPI Journal Vol. 80, pp. 32-35.

[76] Ms. Kristen J. Erickson, NASA Headquarters. Space Flight Office Chief, Space Shuttle Resources and Program Evaluation.

[77] Considered only the major private foundation that supports forest R&D, diffusion and training. The amount shown here however corresponds only to the R&D allocations.

[78] Considering only resources allocated in the US.

[79] Assuming that 50% of the Conservation and Environment grants and contributions are related to forest issues.

[80] Considering only resources allocated in the US.

Policy Options

Specifically there is a discussion in Chile on what to do to overcome the situation that is pressing the institutions that deal with forestry and more widely agricultural research.

Among the possibilities are:

- ✓ Continue with the same system
- ✓ Adopt the Grant & Peer review approach (also called American system). It differs from the current system in the existence of long-term research funding, highly important considering the duration of forest biological cycles.
- ✓ Adopt the Institutional approach (called European system), in which the government finances research institutes, including short-term and long-term programs.

In order to facilitate the analysis of these options, Table 2 presents a summary of their characteristics, and Table 3 their pros and cons considering different criteria.

Table 2. Main Features of the Models Studied[81]

Characteristics	Chilean Model	Institutional system (European Model)	Grant & Peer Review System (American model)
Funding regimes	Scientists are responsible for raising their own funds through submission of proposals, that are evaluated by peers	Funding comes from the research institutes where they work. In many countries funding is committed for the total project (long-term) at the approval: multiyear budgeting[82].	Scientists are responsible for raising their own funds through submission of proposals that are evaluated by peers. Multiple fund sources.
Research Agenda	There is no clear agenda. Hybrid situation	Agenda is set by the director; exclusion of young researchers	Provides younger persons the opportunity to establish independent agendas
Human Resources	Migration to the private sector of good people	Enhances stratification; early appointments. Encourages migration.	Encourages scientists to remain productive throughout the life cycle. Encourages entrepreneurship and to explore the possibility of technology transfer
Principles	Willingness to develop	Link between science and economic growth	Subsidize the production of the public good knowledge. Desire to win.

[81] Stephan P.E. The Economics of Science. J. Economic Literature Vol. XXXIV, Sep. 1996, Pp. 1199-1235

[82] United States. House. Com. on Science, Space and Technology. Subcom. on Sci. 1992. Setting priorities in science: hearings. Washington D.C. 265 p.

Table 3. Analysis of Three Major Options in Analysis under Several Criteria

Criteria	Chilean Model	Institutional system (European Model)	Grant & Peer Review system (American Model)
Efficiency	Low	Medium	High
Cost	Low	High	Medium
Quality/share of information	Promotes quality and sharing information	All alternatives possible	Promotes quality and sharing information
Reinforcement of technical teams	Medium	Medium	High
Accomplishment of specific forestry requirements	Low	High. It ensures that scientists can follow a research agenda	Medium/High
Accessibility to "new" researchers	Medium	Low	Medium
Accessibility to new ideas	High	Low	High[83]
Equality in the allocation of rewards	Neutral, tendency to inequality	Equality	Inequality
Scientists as "entrepreneurs"	High	Low	High. Fierce competition, high amount of neurosis

R&D Policy Considerations

In order to make decisions about today's research for tomorrow's needs, it is necessary to understand the characteristics of research and its relationship to innovation and economic growth. Because of the increasing comprehensiveness and sophistication of innovation, it is almost certain that the diversity of knowledge required for tomorrow's innovation will be even greater[84].

The link between technological innovations and economic advancement has long been recognized, with R&D seen as a major force behind the emergence of many of the new materials, products, processes and systems that promote economic advancement[85].

To illustrate the problem in a broad way, Scherer[86] identifies three main barriers to the effective utilization of scientific and technical talent for the rapid economic development in the less-developed nations. Most important is the lack of a legal and institutional

[83] However, there is an approximate error of 25% in the peer review process (Scherer F.M., personal com., 1998)

[84] ITT Research. 1968. Technology in retrospect and critical events in science. National Science Foundation, Pp. viii-xiv, 2-26.

[85] Ibid. (9)

[86] Scherer FM. 1997. Conclusions. New perspectives on economic growth and technological innovation (manuscript). Pp. 1-8

framework that encourages vigorously independent risk-taking and dynamic competition. Secondly, he mentions the scarcity of business entrepreneurs willing and able to take advantage of the opportunities for development offered by modern technology. Third, the low real per-capita income makes it difficult to allocate substantial funds to R&D activities. Instances of these three factors can be found in Chile.

The difficulty private enterprises encounter in appropriating the benefits from their innovation investments and the risks associated with those innovations leave a role for governments to intervene, either by enhancing private firms' incentives and/or supporting innovation directly through public funds. The debate focuses on how and to which extent government should intervene[87].

We are living in a time of change. Unfortunately for scientists and policymakers there is no easy answer to uncertainty. Future policy directions will continue to be greatly influenced by annual budget decisions.

Therefore a portfolio approach can be useful, because it is a way of managing risk through diversification of research topics and mechanisms. The portfolios should be evaluated for the balance between short-term research related to their missions and longer-term investments that would be important in future years[88].

A sustainable level of research funding is necessary not only for a stable amount of research, but also for the maintenance of scientific quality and neutrality, and for maintaining and increasing the value of previous investments in long-term research projects.

There is a strong temptation in times of economic restrictions to cut back on long-term research to reduce costs, but without LTR the engine of technological development will run out of fuel, and the loss for the country can be immense[89]. LTR anticipates future needs and fills major gaps in scientific knowledge, and is necessary for the nation to become strong and competitive.

Forestry research has a dual role in public policy. It may be considered both as part of science policy and as part of forest policy.

Public research can increase competition by improving the knowledge of buyers and sellers. In addition, because small and medium sized enterprises generally spend little on research, publicly funded research may be vital for the existence of many small businesses within forestry and forest industry[90]. It is also considered to be worth public support because of their strong positive external effects. In particular, the increase of

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[87] Scherer FM. 1997. Investing in technological innovation. New perspectives on economic growth and technological innovation (manuscript). Pp. 1-32.

[88] Smith PM; McGeary M. 1997. Don't look back: science funding for the future. Issues in Science and Technology, spring. Pp. 33-40

[89] Richter B. The role of science in our society. Physics Today v. 48, Sep.1995, p 43-47.

[90] Hellstrom E; Palo M; Solberg B. 1998. Privatization of forest sector research in Europe. Unasylva 192, vol. 49. Pp. 27-37.

environmental awareness in most countries is reflected in the funding of forestry research because the forest environment is clearly a public good.

Despite a clear need of private forestry research in some well-defined areas, there remains a wide support that favors public funding of most forestry research because (Op cit.):

- Missing markets for research results
- Imperfect juridical infrastructure (e.g. patent system, property markets)
- Positive external effects in the form of innovations
- Forest environment as a public good
- Positive distributive effects in favor of rural areas
- Stabilization of an economy in recession and
- Sustainability of R&D funding-scientific standards.

Scientific R&D supports the country's ability to respond to many of these challenges while promoting sustainable development in various areas, including resource stewardship, forest management and others.

So there are quite important factors conditioning national forest R&D, which must be considered by decision-makers.

Public funding of forestry research is also justified on the grounds of sustainability, particularly in fields of research where projects are of long duration. In a survey of 45 forestry R&D institutions in developed countries it was found that the stability of funding from year to year was nearly as important for the research performance as the actual level of funding[91].

In any event, the goals of national R&D must meet the possibilities and requirements of the country, considering its particular social and economic framework[92].

Chile faces the challenge of regenerating and strengthening both the physical and human capital stocks of its agriculture research system. The nation must also seek to reconcile the demand for a long-term sustained research base with the need for close-to-market research by the exporters. Balancing these requirements and molding the institutional competence needed to respond to these different sorts of demand, will represent an important challenge to policymakers in the decades to come.

[91] Ibid. (90)

[92] Bonnaure P. Une serpente de mer: la politique de recherche. Futuribles, Dec.1994. Pp. 191-193.

The Proposal: Implementation

Previous information and the analysis presented in Table 3, demonstrate how positive for the public interest of the forest sector development is to add a LTR component to the current grant and peer review system as in the American model. This system concentrates a majority of good evaluations through the considered criteria, the most relevant being efficiency, the accomplishment of specific forestry requirements and reinforcement of technical teams.

Part of the European model described above was applied in Chile for several decades, up to the 1980s when the radical shifts in the R&D policies were carried out, the orientation of the system is looking otherwise. The results were pretty low, mainly because of the lack of established criteria and priorities, as well as lack of control mechanisms. I consider there is no room to think that the application of this model can be feasible in Chile again, because of its high cost and medium results obtained through it in there.

In the 1970s, the US offered competitive grants for research, to be assigned to the best proposals presented. The Forest Service encouraged researchers to present proposals in this peer-reviewed environment, seeing this situation as an outstanding opportunity for the best and the brightest to emerge[93].

In Chile the situation should be the contrary. Introducing LTR in a competitive short-term grant environment should be implemented without particular complications because researchers and institutions are already accustomed to high levels of exigency in proposal and report presentation, as well as in developing new ideas and programs. This modification would also constitute a precedent for other areas such as health, climatic change, and others.

As we approach the 21st century, the list and character of the questions that science is being asked to help answer is changing in the world. The issues and questions are geographically broad and multifunctional. Values placed on forests and natural resources are changing and becoming a complex array of often-conflicting expectations; as the interests and needs of citizens vary, and scientific knowledge accumulates, new research needs emerge constantly.

In this environment, priority setting is very important, because is necessary to choose among competing opportunities and requests, within budget constraints. Is also important because today is a time in which the demand for research on natural resources is increasing, the questions faced are large and multifaceted, and so is necessary to anticipate the capability required and to build it.

By setting priorities on research fields, the public sector can affect the distribution of research costs and benefits; this is an important point when looking at the development policies for the rural population or other sector involved.

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[93] Arnold R.K. 1994. View from the top: Forest Service Research. Durham, N.C. Forest Hist. Soc. 365 p.

Priorities then are areas of capability that, at constrained funding levels, the Ministry of Agriculture would want to maintain, strengthen or build in the next years; represent areas where it specifically intends to conduct or support work

More R&D opportunities and challenges exist than the Ministry has funds to address. Then choosing among competing opportunities or requests is inevitable.

Requests for short-term assistance often change faster than significant new information can be generated from them. Although there may be relatively consistent underlying patterns to these requests, responding only to short-term requests rather than to longer-term pattern, would not reserve resources for the research needed on interrelations that are the basis for application to future issues[94]. Hence, the focus cannot be only on short-term needs. An effective balance must be found.

Organization

I propose that the FIA (Agricultural Innovation Foundation) implement the proposal, because it is concerned with innovation in the sector, has high sensitivity to the topic, experience in dealing with fund allocation, and the ability to manage the process.

Currently FIA funds projects of 3 years duration covering all technical topics of the agricultural sector from horticulture to forestry and from cattle to fisheries.

Implementation/Administration

The proposed funds could be administratively allocated within a sub-fund that concentrates all forest R&D activities, because it has some unique common features.

This forest fund should have two components:

- ✓ Short-term research, currently in operation
- ✓ Long-term research, proposed in this document

To concentrate both in one administrative unit will guarantee coordination between the programs and will facilitate the selection process.

I recommend having one forest engineer in charge of this unit; his/her experience in R&D and knowledge of the institutions involved being an important prerequisite.

LTR funds should also be based on an open competition and peer review process, to guarantee quality, innovation and equity in the allocation process. If proposals deal with topics in which there is no enough competence in the country, they could be peer-reviewed by foreign specialists.

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[94] Pacific Northwest (PNW) Research Station. 1997. Research Priority Setting. 17 p.

Competitive grants are increasingly the norm for funding, even in large national research organizations. A study made in Canada shows that the direct costs of grant-seeking behavior in the context of Canada's national forest research organization. The average cost of obtaining additional research dollars from a particular competition is found to be 22 cents per research dollar received[95]. However, this result is heavily contingent on assumptions about the opportunity costs of researchers' time, but is an indicator of the implications that such a system has in economic terms.

Monitoring system

Critical factors in the design of LTR programs are problem definition, design of experiments, selection of sites, monitoring and profile of leaders. Monitoring is an important function often not well done or not done at all.

Requesting the division of LTR projects in sub-periods (2-3 years) and the incorporation of clear performance indicators can be important elements in the monitoring process, giving the opportunity of closing or modifying the project if the quality and/or the expected results are not satisfactory.

Projects should state clearly the goals, outputs and outcomes of the different phases, permitting an easier evaluation, as well as facilitating management and feedback.

The short-term justification of the budget can be shaped by a continuing set of products (publications and others) that can be a valuable input to the current short-term research.

These ideas seem adequate to the current environment of applied and pre-competitive R&D; however, from the public policy prospect, the importance of basic research is high, and in this case the kind of highly perform-based monitoring can be an obstacle to the generation of knowledge. Basic research intrinsically needs high flexibility and freedom in its development, and it can not guarantee results or products *a priori*.

Public funding has being increasingly tied to specific research programs of more of an applied than of a basic nature. A danger with such a policy is the low level of basic funding which is necessary for the maintenance of scientific competence of research institutes through a sufficient amount of basic studies. Major threat to maintaining the present level of activities is a decreased basic funding.

[95] McKenney D.W. 1994. On the cost of chasing research dollars. Canadian Journal of Agricultural Economics. Vol. 42(1)105-112

Priority-setting mechanism

1. What's going on

Setting priorities should be done through a well-defined mechanism, which should be adopted considering the own reality in order to get results that meet possibilities and needs. This process should incorporate a periodic revision of priorities, being flexible enough to achieve the challenges mentioned.

In reviewing other nations' systems, mechanisms used to define priorities vary widely. However some of these priorities established could be used as a reference framework in order to define forest research priorities at the Chilean Ministry of Agriculture.

* *United States*

In the US, sustainability of natural resources has become a focal point for public and private actions. Policy and management actions on sustainability are often vigorously advocated and promptly adopted. This concept encourages strategic thinking about the long-term effects of decisions and guides the design of policies and programs[96]. Greater emphasis on economic and sociology research has also been suggested.

And the global scientific interest in developing LTER programs is expanding very rapidly, reflecting the increased appreciation of their importance in assessing and resolving complex environmental issues. In December 1998, 17 countries had established formal national programs, 13 more were actively pursuing this goal, and many others had expressed interest in the model, including Chile[97].

Somewhat surprising, also the forestry R&D segment of private company research programs is increasingly being directed toward environmental problems, often at the expense of more traditional concerns of forestry research[98]. The American Forest and Paper Association in 1995 ranked the research needs in the following order: forest management, environmental-social-biological interactions, silviculture, and energy utilization and markets[99].

Agenda 2020 is a research partnership between the Department of Energy, pulp and paper research institutions, and leading paper companies that aim to help create "the pulp mill of the future"[100]. They have outlined the research priorities in six key areas: sustainable forest management, environmental performance, energy performance, capital effectiveness, recycling and sensors and control. The alliance seeks to coordinate access to government funding for these six major long-term pre-competitive research areas

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[96] National Research Council. 1998. Forested Landscapes in Perspective. Nat. Ac. Press. 249 p.

[97] U.S. Long Term Ecological Res. Network. 1998. (Online Database). <www.ilternet.edu> (Cited 1/26/99).

[98] Ellefson P.V. 1996. Privately initiated forestry and forest products research and development: current status and future challenges. Forest Products Journal 46(2) 37-43.

[99] Ibid. (96)

[100] Rooks A. 1995. New partnerships propel research projects. Pima Magazine Vol. 77, p. 33-34.

regarded as vital in the American Forest & Paper Association's agenda[101]. They are looking for projects that "provide new ways of handling old problems and research that opens up ways industry manages all aspects of recycling"[102].

This "Agenda 2020" is the pulp and paper industry's long-range research program to promote growth, energy efficiency and international competitiveness while protecting the environment[103].

** Europe*

In Europe there are different focuses. EFI has identified what kind of research are needed in different themes. For example for rural development, in the context of forestry it suggest to provide a sound theoretical basis as well as empirical evidence, and combine both in order to establish fruitful research regarding forestry in this context[104].

The analysis of changes in the markets for round wood and forest industry products is other of the EFI's R&D priority areas, as well as additional projections and sensitivity analysis of the European trend timber study[105]. The former has identified six areas that should be developed over the long term: dynamics of raw material markets; structural change in the European forest sector; product supply issues; product demand issues, and outlook for Eastern Europe[106].

In 1990 the European Union (Strasbourg Resolution S6) agreed that forest ecology needs to be studied more intensively in order to stimulate a protection strategy not limited to conservation. However, it failed to provide the necessary financial means. This is one example of a policy without corresponding funds that can not be implemented. The program was actually implemented some years later[107].

The Research Council of Norway (NFR) wishes to increase research on effective and environmentally sound forest treatment, the promotion of the use of wood as material, and better use of wood raw-material[108]. It also points out the need to produce new information on national forest resources, forest policies and matters of environmental concern, in order to meet the objectives stated at the Congress held in Rio de Janeiro in 1992 (Op cit.).

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[101] Ferris J.L. 1997. Universities play a major role in solving future problems. Pima's North American Papermaker Vol. 79, p. 52.
[102] Anonymous. 1997. "1998 forests products industry research". BioCycle June.
[103] Cooper J.S. 1997. The basics of Agenda 2020. TAPPI Journal Vol. 80, pp. 32-35.
[104] Gluck P. and Weiss G. 1996. Forestry in the context of rural development: future research need. EFI Proceedings No15. Pp. 17-25.
[105] Brooks D.J. 1995. European timber trends: issues and priorities for further research. European Forest Institute, Working paper 6.
[106] Brooks D.J. 1995. European timber trends: issues, priorities for further R&D.EFI Working Paper 6;19 p.
[107] CORDIS. 1998. European Network for Research into Forest Ecosystems. (Online Database) <apollo.cordis.lu/cordis-cgi> (Cited 2/16/99).
[108] Ibid. (24)

* *International Institutions*

IUFRO, organization that serves as a forum for the exchange of knowledge and experiences in the field of forestry research at national and international level has recently placed increased emphasis on problems of global concern including atmospheric pollution, climate change and tropical deforestation[109].

In order to develop methodologies for research priority setting and impact assessment in the international arena, CIFOR proposes to build capacities among partner institutions and to provide access to information, which will lead to improved research planning, design and priority setting[110].

A study done by the Montreal Process Working Group identifies research priorities and issues that need to be addressed, focusing on the Montreal Process Indicators[111]. These topics are fundamental challenges in order to develop useful indicators that can be applied nationally. The same study recommends a commitment to intensive long-term studies, being a multidisciplinary team-based approach required.

2. A mechanism

In the United States the main idea is to support work in areas where the government is the primary user of the results or where there is an identified need for R&D not being performed in the private sector[112].

Government funds are not limitless. Thus, agencies are working to make smarter, better science and technology investments, guided by two fundamental principles[113]:

- First, to focus on potentially high payoff research that could have substantial public benefit, but is too high-risk or long-term for the private sector; then in partnership with other actors the government supports a balanced mix of basic and applied R&D.
- Second, to focus more on the performance and results of science and technology investments, rather than just dollars spent. They are also pursuing improvements in efficiency.

The same principles are present in the Science & Technology discussion in Chile. In fact the Chilean Minister of Agriculture at Expocorma, the main Latin American forest exposition, declared that "to reinforce and focus R&D according to the current and future

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[109] IUFRO. 1998. Forestry Research. (Online Database) www.metla.fi/iufro.htm (Cited 2/12/99)

[110] CIFOR. 1996. Project 9: Research impact, information and capacity building. (Online Database) www.cgiar.org/cifor/research/projects/project9.htm (Cited 1/19/99)

[111] Tickle P. and Hafner S. 1998. Scooping study: final report Fragmentation of forest types, identification of research priorities. (Online Database). www.dpie.gov.au/agfor/forests/montreal/11esummary.htm (Cited 1/10/99)

[112] Ibid. (50)

[113] US Executive Office of the President. Office of Management and Budget. 1999. Budget. 381 p.

forest needs is a determinant element in our competitiveness"[114]. Strategic management and setting priorities are vital parts of the technological development process for a country.

3. Recommendation

There are some Chilean funds in which "forestry" is one priority, but there is not any further desegregation of what topics in this wide area are worthy of being studied.

Based on the rationale presented herein, I recommend organizing a conference with key people, in which ministerial principles are agreed upon. World trends should be considered as a reference frame to identify the national priorities, goals and availability of resources.

Among the considerations for the process of priority setting should be included the importance of the issues, the comparative advantages of the proponent and the capabilities to develop it.

Identified areas that are currently being studied should be continued; others not being developed should be induced (through specific bids), and finally areas being researched but not prioritized should eventually be discontinued.

At the same time it should be enhanced the application of science to policy issues. Available information should be synthesized and transformed into a form most relevant to the policy issues being addressed.

Additionally, as a way of promoting innovative ideas to arise I recommend to allocate part of the funds (10-20%) to new ideas/young researchers, in order to promote innovation.

The proposed conference should meet every three years, to review the main orientations, adding flexibility to face new situations and reassessing national and international trends, as well as to incorporate follow-ups and observations done to the projects and to the process they generate. In this way, the priorities will be revised based on new information.

The group should be formed by people representing the private sector, the research/academic environment, and politicians with a vision of the country's future, because they can represent important points of leverage on the allocation of funds for this new modality proposed. Both public and private sectors should find applicable research from the identified priorities.

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[114] Mladinic C. 1998. Inauguracion Expocorma 1998. (Online Database). www.infor.cl/webinfor/revista/revnov/publnov9.htm (Cited 1/26/99).

Potential resources to be allocated in long-term studies

The question of research funding has become increasingly relevant, especially in countries where public funding of R&D has been cut dramatically in recent years, but also in a wider international context.

However, data on resources allocated to forestry research in either developing or developed countries are not widely available. Especially interesting questions here are the analysis of what is a reasonable/optimal input level for forestry research. There was one attempt to construct an international inventory of spending and scientist man-years devoted to forestry research. The data showed consistently low levels of research investment in developing countries[115].

More recently, a European survey pointed out the profound lack of data on forestry research funding at the European level[116].

The US National Research Council concluded that public funding should be continued and possibly augmented to be commensurate with current or potential benefits. In addition, creative funding mechanisms should be considered, including dedicated public funding, special fees on commodities obtained from forests, a greater role of the private sector via the issuance of bonds and reinvestment of revenues and fees for conducting research activities[117].

The survey done about the US (Table 4) shows that around $248.8 millions are invested in short-term research, while $ 67.8 millions in long-term research, representing 78.58 and 21.42% respectively.

Based on this for the Ministry of Agriculture, I recommend allocating for LTR an initial annual budget equivalent to the 15% of its total R&D resources. Future evaluations of the program could lead to a modification, hopefully increasing the resources allocated, considering both the availability of resources and the results and impacts of the studies but most importantly, following the allocation process based on national priorities.

A less visible way of introducing the reform would be to co-share it; in this way FIA could contribute some of the current budget to it and the Treasury the rest.

[115] Evenson R.E. 1986. Forestry Research: a provisional global inventory. Working Paper, U. of Yale. 42 p.
[116] Ibid. (24)
[117] National Research Council. 1998. Forested Landscapes in Perspective. Nat. Ac. Press. 249 p.

Political constituencies

The design of the process leading to the proposal's approval is key for the proposed policy reform. In order to develop a sense of ownership and support of the idea, I recommend going through a validation process in which the main actors involved could express their ideas, comments, suggestions and criticisms. Such a process could enrich the proposal itself and "prepare the soil" for the formal discussion in the legislative branch.

Some of the actors that should participate in the process are:

- Chilean Association of Forest Engineers
- Minister of Agriculture & team
- House Commission of Science and Technology
- Senate Commission of Science and Technology
- House Commission of Agriculture
- Senate Commission of Agriculture
- Presidential Advisory Committee in Science and Technology
- Technological Innovation Program, Ministry of Economics

Additional policy proposals to be assessed

One proposition being made in the US is to develop a flexible program for funding certain studies, in a very short-term frame, for which relatively unique and transient opportunities present themselves and in which the research benefits are potentially high.

In this case the provision of initial funding could help the investigator acquire baseline data, but he/she would then be obligated to submit a full proposal for continued funding of the project. This process would allow the supporting agency to take advantage of a unique circumstance with a modest investment of money, while requiring the investigator to perform in an acceptable and peer-reviewed way for continued support.

This modality could be useful to introduce a new concept of long-term vision in a gradual and progressive way. It represents one additional possibility to analyze.

Secondly, we are in an era where the ideas of a single person alone seldom lead to fruition. Innovative ideas must fit into a matrix of innovation before progress is made. It extends across groups of researchers and, in many cases, across nations and the world. Developments involve progressively larger teams working together. Results came up from the co-ordination of top minds rather than from isolated genius. The scale has increased further and the development of a microchip takes the combined work of hundreds of researchers. For innovation to flourish, enterprises should participate and collaborate with the universities involved[118].

[118] Financial Times. Teamwork puts paid to the power of one: Universities should carry out research alongside industry. 11/12/1998.

So the enhancement of team building work should be considered in the grant development and fund design.

Third, even though science policy in several countries promotes increased involvement of the private sector in traditional forestry research, there is no optimism about getting the private sector activated into financing forestry research.

In order for the private sector to have incentive to invest in R&D, the gains have to cover the R&D expenses, as well as giving a sufficient rate of return. Whether or not producers are willing to invest in research depends not only on profitability but also on the expected period of payoff of the investment. The time scale is a crucial aspect[119].

For this reason an actual question within science policy is the scope for increased private involvement in research activities. As forestry research is predominantly publicly funded, the question has special significance for forestry[120]. Empirical findings strongly support the theoretical framework, in which economic criteria for a rational division of public and private funding is present.

There are some tools useful to enhance private sector participation, being tax policy a familiar one. Studies in the US show that general R&D tax deductions are an efficient tool for stimulating research by firms. The influence of tax policy on general research priorities is less certain due to the time lag inherent in changing research spending priorities and because of measurements problems in analyzing tax effects[121].

This is a topic that merits a deeper analysis considering the national situation, economic and legal parameters, as well as the main goal of the Chilean S&T policy. These debates should be channeled especially in a period of political changes (new government in year 2000).

Implementation feasibility analysis

The project's results strongly indicate that long-term research funding should be added to the current system. This addition would increase efficiency, contribute to the specific requirements needed for forest growth (we must give to trees the time they need to grow!) and strengthen the relevant research teams.

Because researchers and institutions are accustomed to high standards in preparation of proposals and reports, the use of LTR funds could be readily implemented into the current competitive short-term grant environment.

[119] Ibid. (90)
[120] Ibid. (24)
[121] Ibid. (9)

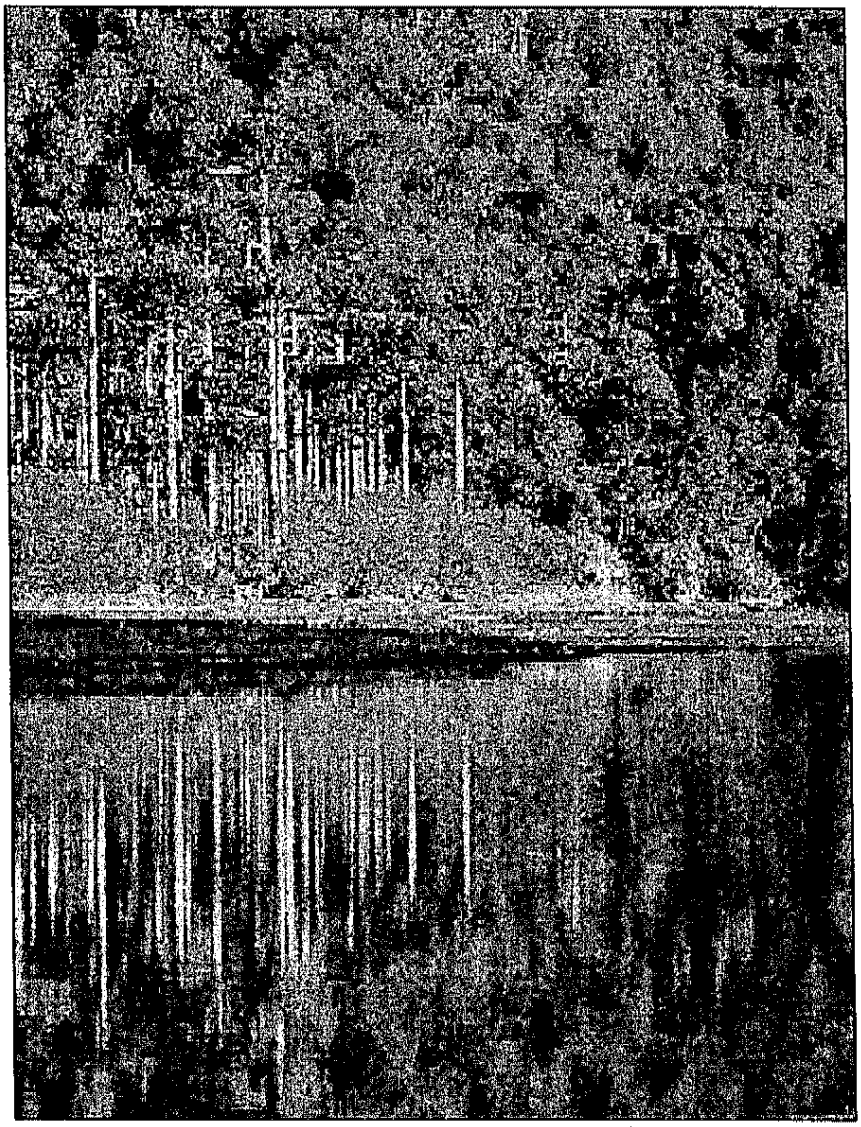
Appendix 2 presents a detailed feasibility analysis of this reform and includes a matrix that is useful for predicting the behavior of those involved in the process. According to the matrix and analysis that follows, one can expect a 75% chance of having the reform implemented.

The main opposition to the reform is likely to be the Minister of the Treasury. His potential objections to the proposal are presented in Appendix 3. However, a positive evolution can be expected.

Problems with the implementation process would certainly exist. Administrators responsible for defending long-term funding to the congress would have a difficult time because long-term funding runs counter to political budgeting on a short-term basis[122]. There is little leadership to manage the LT projects: it requires both technical and administrative capabilities, as well as long-term vision and extensive knowledge of the topic. Nevertheless, this is a step that the country must take, if it wants to continue to be a leader in forestry.

[122] Newman A. Reinvention of EPA research office takes shape. Environmental Science & Technology vol. 29, Jan 1995, p. 16A.

Appendix 1. The Chilean forest sector: data



Forest of *Araucaria araucana* and *Nothofagus sp.* in the 11th region, southern Chile.

Chile is a country of forests, being 45% of it area preferentially forestlands. Forestry exports ($1,829.9 mill in 1997) represent more than 14% of the national amount, being the second important sector in the national economy, after mining. Forest activity generates about 100,000 jobs.

However, the equivalent of less than 0.5% of the forest export value is invested in forestry R&D.

Forest resources are formed by native forests (13,5 mill ha) and plantations (2,18 mill ha), which concentrate the highest production activity[123].

Since 1975 the sector has presented a big change: the industry grew 60 times; the timber harvest grew from 4 mill m3/year to 30 mill m3/year; and plantations grew from 350,000 ha to the actual area[124].

Part of this huge increase was due to a forestation subsidy policy introduced in 1974, which consists in a retribution equivalent to the 75% of the plantation costs one year after the establishment, if at least 90% of the stock is alive; the subsidy also covers some other secondary activities.

During the last two decades a large process of re-conversion of agricultural activities and rural areas has been going on[125], and forest activities are related to both issues, offering some alternatives to traditional crops, not anymore financially attractive.

However its big growth, the sector faces big challenges for its future development, conditioned by important factors such as[126]:

- Competitiveness with other countries that have been pushing very strongly in forestation with fast growing species.
- Lack of a forest policy that includes all the topics. Actually, for more than 10 years the native forest law has been discussed and in legislative process, but the bill still sleep in Congress.
- Asymmetry among private and public sector
- Low timber utilization in the country
- Timber production concentrated in mainly two species, radiata pine (*Pinus radiata*) (83%) and eucalyptus (*Eucalyptus globulus* and *E. nitens*). This brings to a low price of the resource and to a high potential risk of pest and diseases as well as market variations, being the diversification of the sector one of the main issues of the future.
- Concentration of forestry resources in two industrial companies. This fact can limit the forest activity or at least inhibit innovation.
- Future increase in timber offer (about 40 million by year 2005).
- Elimination of rural poverty, which is a *conditio sine qua non* to achieve modernity, and one of the most important government's goals.

[123] Corporacion Nacional Forestal CONAF. 1998, www.conaf.cl. (Cited 10/22/1998)
[124] Gemines. 1997. Sector Forestal en Chile: diagnostico y proyecciones. 153 p.
[125] Hojman D.E. 1995. Neo-liberalism with a human face? The politics and economics of the Chilean model. Institute of Latin American Studies, the University of Liverpool. Monograph Series No 20. 256 p.
[126] Ibid. (124)

Appendix 2. Implementation feasibility analysis

What follows is a matrix useful for analyzing the implementation feasibility of this reform, including the actors relevant to this policy. From the matrix and the analysis that follows a 75% chance of getting the reform implemented can be expected.

Table 5: Matrix of Feasibility Analysis

Actor 1.Government	Benefit	Impact	What may they do?	Resources they have	Strategy to address it
Minister of Treasury	Loser: needs to allocate additional funds	Low: involves few resources	Lobby with Congress for denying approval	Political and financial	*Present the reform with a justification and an economic impact analysis *Present cases of others countries *Prepare the "soil" with time before presenting the formal proposal
Minister of Agriculture	Winner: can show it as an important innovation for the sector	Medium: concerns only one sub-sector	Defend the proposal	Good relation-ships; technical arguments; he likes reforms	Provide him with the necessary information, in order to get his support
Under Secretary of Agriculture	Winner: same position as his superior	Medium	Defend the proposal	Political networks	Same as above
ODEPA (Oficina de Planificacion) (MINAGRI[127])	Neutral/loser: its role is to propose policies; potential rival	Medium: is not a visible reform	Lobbying for stopping it	Technical capacity	Make them feel participating in the design
CONAF (Chilean Forest Service) (MINAGRI)	Neutral/Winner : understand the forest R&D stakes	Low: they do very little R&D	Support it	Medium technical and political ability	Maintain them informed about the process
CORFO (Chilean Deve-lopment Corporation) (Ministry of Economics)	Neutral/winner : if the reform has positive results, they could apply similar ideas to their funds	Medium: short-term research will continue to be their core	Light support	Lobbying, financial resources	Provide them information

[127] Ministry of Agriculture

Legislative branch	Unclear: there will be different positions. Committee members are not experts on forest and natural resource matters.	Low/medium: not an important topic in the agenda, but eventually can establish a precedent	*Most capital representatives will oppose the reform *Most rural representatives will support it *Part of both groups will be indifferent	*Capacity to approve or not the budget *Bargaining ability	*Lobbying with supportive members *Present a justification and economic impact analysis of the investment *Present cases of others countries
INIA (National Institute of Agricultural Research). (MINAGRI)	Winner: potential beneficiary	High: would represent a change in its fund composition	Public support	Technical capacity	Provide them information
INFOR (Chilean Forestry Institute). Ministry of Economics	Winner: it does most of the forest R&D	High: currently have big problems because of this lack	*Public support *Can try to mobilize other actors in order to support it	Technical capacity	Provide them information
2. Non Government CORMA (Chilean Timber Corporation) Assoc. of medium and big timber companies.	Winners: they could profit of the long-term research results	Medium: not immediate results	Support it	*Political contacts *Financial resources *Public opinion support	*Present the reform with a justification and an impact analysis of the investment *Present other cases
Press	Neutral: not involved directly with the issue	Low	Specialized press would support the reform	*Itself (monopoly) *Contacts with political and economical elites	*Present a justification and an analysis of the impact in economic growth *Present cases of others countries
Universities	Winners: potential beneficiaries	High: currently have problems because of this lack	Support it	*Mobilize public opinion *Connections in Congress (S&T Com-mission)	Provide them information

Problems in the implementation process would certainly exist. The fund's defense when taking the budget to Congress may be hard because of the multiyear budgeting[128]. The leadership to manage LT project doesn't abound in the country: it requires both technical and administrative capabilities, as well as long-term vision and good knowledge of the topic. But this is a step that the country necessarily must take if it wants to continue to be a "forest leader".

Recently, The Minister of Agriculture declared in a public speech that "to enhance the comparative advantages of the Chilean forest sector R&D is one of the topics that deserves attention" and also that "The actions we will take in R&D are determinants in the competitiveness of the sector"[129]. This is a fertile environment to discuss such a proposal.

The high probability of implementation is based on two main points:

1. The actors involved are 6 winners, 2 neutral/winner, 1 neutral, 1 undefined, 1 neutral/loser and 1 loser.

   The first 3 groups represent 75% of the players, and looking at their position I think with information management they can support and advocate for it all through the process.

   Given the important role that legislative staff play in developing and implementing policies and programs[130], the "legislators" (undefined) should be persuaded to take a more positive position through lobbying with key people; the role FIA had played can be a good reference to them.

   The neutral/loser actor is not relevant because of low political power.

2. The real stake for the reform is the Minister of Treasury. His potential objections to the proposal are presented in Appendix 2. But a positive evolution can be achieved because:

   - FIA has been growing its budget considerably in recent years, showing good performance and innovative programs. So this reform can be one more, and not an exception.
   - Technical information can support the proposal.
   - A way of introducing the reform in a less visible way is to co-share it; in this way FIA can contribute some of the current budget to it (50%) and the Treasury the rest.
   - Described features of the proposed-fund are acceptable for him.

[128] Newman A. Reinvention of EPA research office takes shape. Environmental Science & Technology vol. 29, Jan 1995, p. 16A.
[129] Mladinic C. 1998. Inauguracion sede del Instituto Forestal en la X region, Valdivia. (Online Database). www.infor.cl/webinfor/eventos/discMinistro.htm (Cited 1/26/99).
[130] Lewis B.J; Ellefson P.V. 1996. Evaluating information flows to policy committees in State Legislatures. Evaluation Review Vol. 20 (1)29-48

- Requesting the division of projects in short sub-terms (2-3 years) can give the opportunity of stopping it if the quality and/or the expected results are not satisfactory.
- The incorporation of clear performance indicators can act as important elements in the constituency.

In this particular case political and bureaucratic capacity are pretty good; resources can be re-allocated and hopefully allocated specifically; and alliances are not difficult to build.

Because of the bureaucratic nature of the proposal, public opinion won't have a great impact; instead, there is a high probability that the different players of the forest sector and academia and intellectuals will support it.

Appendix 3. Potential objections to the proposal.

Theoretical simulated position of the Minister of Treasury before the Commission of Science and Technology, House of Representatives. Session on Forest R&D Fund Policy Reform.

Thank you Mr. Chairman for inviting me to testify at this hearing about R&D forest fund policies. Both forest and R&D issues are very important to the country's development, so I am very pleased to be here.

As you know, the main objective of the Ministry I am representing is to maintain the macroeconomic equilibrium achieved through this government period, based on an export-oriented policy, to promote the further development of the country[131].

In this context, we understand that R&D is essential to the development of our economy, and for this reason we have increased dramatically the amounts allocated to it, growing from 0.53% of GDP in 1990 to 0.84% of GDP in 1998, and planning to go still further in this increasing trend[132].

Mrs. D'Etigny, Director of the Agricultural Innovation Foundation (FIA), Ministry of Agriculture, had proposed a policy reform that includes -as a complement to the current system- long-term research (LTR) funds for forestry, arguing that this alternative would increase the efficiency, permit the accomplishment on the specific forestry requirements and have a positive effect of reinforcement of teams. FIA is an institution that has been growing its budget considerably in recent years, showing good performance and innovative programs. However, I would like to comment briefly on some of the issues that emerged from her presentation.

1. Research Budget

First, she suggests that the funding choices being made currently are not enough, comprehensive of the whole range of issues expected by the scientific community.

However, I would like to remind you that there will always be more worthwhile research projects than the government, with its limited resources, can possibly fund.

In reality we are funding more projects than ever, and their quality is much higher than it was in the past. The forest sector is no exception: we can show good examples in FONDEF, which had funded outstanding projects related to fire management, genetic improvement of important species -both native and exotics-, models of forest diversification, and others, as well as in FDI and FIA itself.

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[131] Aninat E. 1994. La agenda economica y social 1994-2000: discurso al pais del Ministro de Hacienda E. Aninat. Santiago, Chile, 15 p.

[132] Comision Nacional de Investigacion Cientifica y Tecnologica, CONICYT. Santiago, Chile. (Online Database) www.conicyt.cl/sistema/indicadores/PAG-HTML/t1-16.html (Cited 10/21/98)

2. Priority Setting

Second, we have made considerable progress over the last few years in developing and strengthening mechanisms for setting research priorities, driven by scientific and technology excellence and progress. The need to contribute to industrial competitiveness cannot be successfully addressed merely by increasing R&D budgets. We need to decide within disciplines which goals are more urgent. And we also need to establish a deeper coordination among the agencies and with the Congress.

3. Economic Growth and R&D

It is somewhat unclear to me, still now, the efficacy and effectiveness of developing our own technology and knowledge instead of buying it from more developed countries, since our country is still developing and not so far away from the time when it was called a "Third World" country. I recognize there are some areas we need to develop, but which are they? Is forestry one of them? Which others might have more priority?

And it is good to remember that the higher growth of the forest sector happened in a period of restricted investment in R&D (70s and 80s), as Chile is now recognized in the world for its work with industrial plantations.

On the other hand, research is facing the new century on a decreasing-slope productivity curve, because costs are higher as we go to the very small (for example genes) or very big, and because of the complexity and multidisciplinary characteristics of most areas[133]. So my concern is still greater.

4. Experiences from Other Countries

Fourth, Mrs. D'Etigny talked about the United States example of long-term R&D allocations. There seems to be an implicit assumption that the scientific and technological leadership of this country is due in part to these US allocations. But I ask her, where in the US Budget are the LTR allocations? I have been trying to find them without any success ..... Are they so important?

5. Proposal Technical Constraints

Additional problems I see regarding the reform proposed are described in the following points:

- Can we ***compromise future budgets***, especially now when we are going to face a change in government? How to deal with the multiyear budgeting proposed? Once we

launch a project, should we feel bound to carry it out through to its logical conclusion? What if along the way we determine that our priorities have changed? Science nowadays is a very dynamic universe: new fields of research are being continually created, while mature fields are being combined or refocused, or phased out in favor of new areas. I am concerned about potential compromises in the future.

- Do we have the necessary ***human resources*** to ensure the quality and continuity of the projects proposed? Highly qualified people must lead LTR projects, with both technical and administrative qualifications, as well as long-term vision and good knowledge of the topic.

- Can we believe with the national experience of direct transfer of resources to research institutes, that giving LTR funds again will produce ***beneficial products***? We should remember how many resources have been allocated in this area without results. Perhaps the most difficult element in the R&D enterprise are assessments and evaluations of results of government financed R&D, which usually reach only tentative conclusions[134]. But I hazard to say that in many areas in which the State allocated generous amounts of money for long periods in the past, it produced a zero product, with almost no contribution to the development of the area (arid zones, species introduction and others examples are valid in here).

- A last but not least consideration is the ***effect of this reform in the peer-reviewed merit-based system*** currently in practice, which has many advantages for the scientific community[135]. I think a researcher will develop a significant lack of commitment to the project if he/she knows that he has resources assured for the next 6-10 years. Is this policy going to increase his incentives to do better? What will be the effects of the reform on the competitiveness created with punch effort during the recent years? I see the peer-reviewed process as it is now operating as one of the most important achievements of the reforms of this government, and I tend to refuse anything that can debilitate it.

6. Private Investments

Among the challenges we have in the area there is the need to encourage increased private sector innovation-related activities, because government can not and must not do everything[136]; this is an illusion. Historically, the private sector has invested very little in R&D, and this is also true for the forest sector. Therefore we should develop tools that could induce a modification of this situation, because economic growth cannot rely totally in the government. It is a shared responsibility in any developed country.

7. The importance of Long Term Research

[134] Morehead J. 1984. Federal subventionary activities: policy issues and information sources. Government Information Quarterly, 1:15-26 No 1.
[135] Ibid. (82)
[136] Ibid. (50)

From the above remarks follows that a short-term/long-term R&D portfolio does not make much sense. What we are talking about as LTR in reality is a comparatively small number of years for trees, and I think it won't change significantly the situation we have now.
I think the portfolio of LTR is been built by the allocations in basic research, which results and products will be the basis for future breakthroughs.

8. A vision for the country

We need R&D goals that match our needs and desires, and the social and economic possibilities of the country.
The governments have been discussing the utility of having several R&D funds, some of them for specific sectors of the economy. And the conclusion seems to lead to global funds oriented to innovations, without regard to the specific area. Then, should it make sense to have specific LTR funds for the forest sector?

In the light of the preceding considerations, I cannot react positively with the proposal. Members of this Honorable Commission: I do not recommend it.