

Priority Technologies and Measures to Encourage Biotechnology in the Canary Islands



Genoma España

Biotechnology in the Canary Islands

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1. Background and Objectives of the Study

The Consortium of the Canary Islands Special Zone (ZEC), in its aim to contribute to the economic development of the Islands, is undertaking a number of activities with the common purpose of promoting biotechnology in the Canary Islands. All the promotion activities will result in the drawing up of a Strategic Plan for Biotechnology in the Canary Islands.

In view of this, the State Monitoring Centre for Industrial Technology Forecasting (OPTI Foundation) and the State Foundation Genoma España have signed an agreement with the ZEC in order to draw up a series of recommendations which will serve as a basis for designing the Strategic Plan. The present study has been designed and compiled with this purpose in mind, and with the aim of integrating and co-ordinating activities and interests. On the one hand, the study has had the assistance of a number of participants in the RDI system in biotechnology in the Canary Islands; and, on the other hand, it has integrated major studies recently carried out by the OPTI Foundation and Genoma España outlining the Spanish biotechnology situation and the principal technology trends in this field¹.

Presented in the following pages, the study undertaken aims to help to identify the lines of research and priority action measures for developing biotechnology in the Canary Islands. Logically, these are in accordance with the capacities of the Islands and the opportunities they have to offer. In this way, the study will help to define the lines of the future Strategic Plan for Biotechnology in the Canary Islands Autonomous Community.

¹ The Technology Foresight Reports on the Impact of Biotechnology on Health, Agriculture and Industry can be downloaded from the web page of the OPTI Foundation (www.opti.org) or Genoma España (www.gen-es.org)

2. The Situation of Biotechnology in the Canary Islands Autonomous Community

What follows is an analysis of the situation of biotechnology in the Canary Islands, taking as a reference the reports published by Genoma España, *Advance of the Strategic Study of Biotechnology in Spain: Description and Indicators*; and *Spanish Biotechnology: Economic Impact, Evolution and Perspectives*; and the report compiled by the Canary Islands Government Science, Technology and Innovation Office, *Biotechnology Perspectives in the Canary Islands Autonomous Community*.

The distribution by Autonomous Community of the Public Grants for R&D and Biotechnology Infrastructure shows that the Canary Islands Autonomous Community received 1.6% of the total Spanish public grants (reference based on the period 2000-2003).

The principal drive is being produced in two areas: firstly, in aid to R&D projects from the National Biomedicine Programme and the thematic networks of the Health Research Fund, and secondly, in aid for the acquisition of science infrastructure, more specifically at the University of La Laguna Biomedical Research Institute.

On breaking down the amounts received for R&D projects by research groups at a national level, **R&D aid to the Canary Islands has undergone a spectacular increase**: in 2000 the Islands received €224,718 in state aid for R&D, while in 2005 this figure stood at €1,794,007. The point of inflexion which marked this increase occurred at the end of 2002 with the appearance of the Health Research Fund's co-operative research thematic networks.

As regards aid for the acquisition of scientific infrastructure, there has also been a considerable increase in this period, primarily due to the 2003-2004 call for grant applications for science and technology infrastructure made by the former Ministry of Science and Technology. This increase has been seen more specifically at the University of La Laguna Biomedical Research Institute.

ANNUAL BREAKDOWN OF PUBLIC GRANTS IN RDI FOR BIOTECHNOLOGY IN THE CANARY ISLANDS PERIOD 2000-2005 (Estimate based on data available) ²						
	2000	2001	2002	2003	2004	2005
R&D EFFORT						
STATE AID	€224,718	€710,726	€342,800	€1,117,050	€1,706,941	€1,794,007
REGIONAL AID	€346,557	€433,870	€492,562	€562,192	€625,169	€692,878
INNOVATION EFFORT						
STATE AID	-	€131,020	€102,235	€99,755	€79,520	-
REGIONAL AID	-	-	-	€130,160	-	-
INFRASTRUCTURE EFFORT						
STATE AID	€781,516	€781,516	€781,516	€1,696,538	€1,696,538	€939,073
REGIONAL AID	-	€108,182	€363,971	€146,937	€379,798	€225,196
RDI INFRA-STRUCTURE TOTALS	€1,352,792	€2,165,316	€2,083,085	€3,994,047	€4,483,966	€3,651,154

² Projects approved for grants by the Health Research Fund for 2004 have been estimated.

For the period 2000-2005, the regional contribution to the total amount of aid granted represents 35% of all R&D aid granted, 24% of innovation aid and 15% of infrastructure aid.

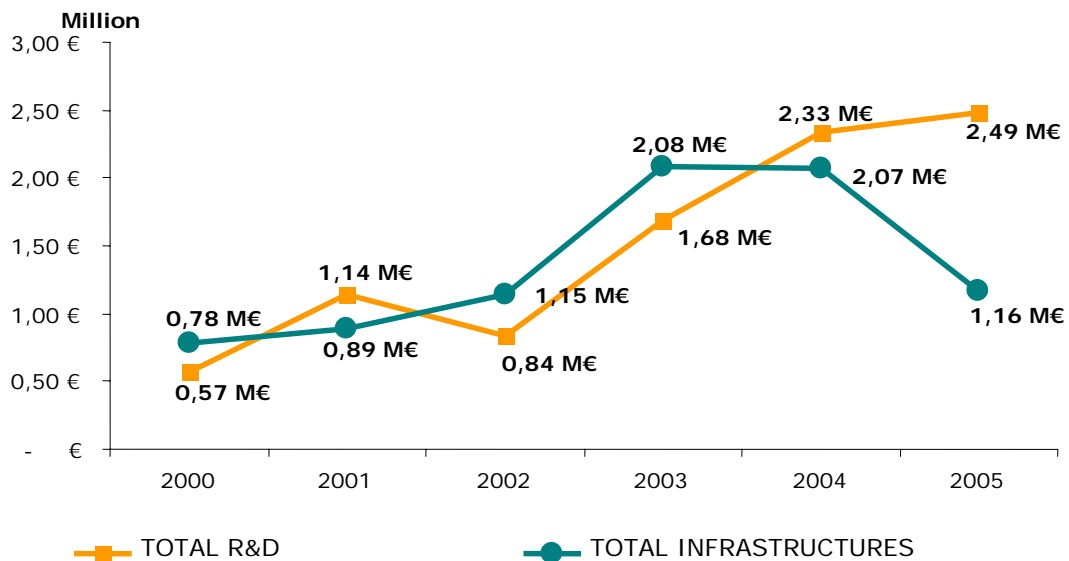
The Canary Islands Government has granted a total of 3,363,412 million euros through the Directorate General for Universities and Research and the Canary Islands Foundation for Research and Health, whose activity is primarily centred on health.

Under this point the start of two large biotechnology support programmes is also noteworthy:

- The BIOPOLIS Project, aimed at creating research networks in biotechnology and biomedicine, strengthening scientific and technological capacities, and promoting the use of biomedical and biotechnology knowledge in Macaronesia.

- The BIOREGION Project, aimed at developing and promoting actions to boost the development of the sector and take advantage of the opportunities offered by biotechnology.

One aspect still pending in relation to public regional programmes is undoubtedly innovation aid, in companies as well as at Universities and Centres, aimed at the development of biotechnology products, processes and services. Nonetheless, some Autonomous Communities such as Galicia and the Basque Country have a differentiated strategy in relation to the state aid they receive. Galicia, for example, invests seven times more in innovation than the amount it receives from the state programmes, and the Basque Country assists regional biotechnology R&D with an amount four times greater than what it receives from state programmes.



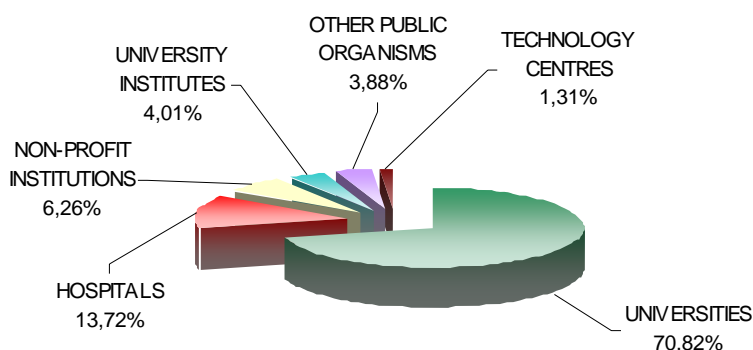
The decrease observed in funds for scientific infrastructures in 2005 is due to the fact that the 2003 call for grant applications was biannual, while in 2005 it was tri-annual.

As regards R&D aid, although a slight decrease is seen in the 2005 growth rates, it is important to note the quantitative and qualitative leap currently occurring with the implementation of the INGENIO 2010 Programme in 2006.

It is also worth highlighting the fact that the Canary Islands Autonomous Community participates in three of the seven Networked Biomedical Research Centres (CIBER) conceded to date (Neurodegenerative Diseases,

Respiratory Diseases and Rare Diseases: Hyperoxaluria), which shows the competitiveness of the Canary Islands research groups.

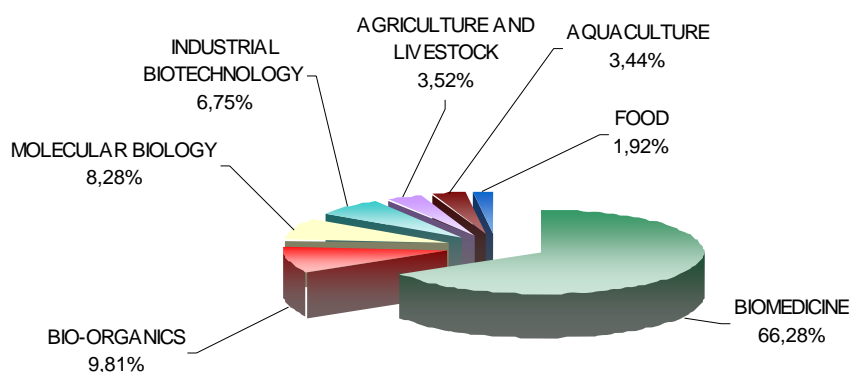
DISTRIBUTION OF PUBLIC GRANTS FOR RDI AND BIOTECHNOLOGY INFRASTRUCTURES IN THE CANARY ISLANDS BY TYPE OF CENTRE PERIOD 2000-2005



The breakdown of total public grants by aid recipient shows that most of the grants awarded for work in RDI and infrastructures go to the universities, which receive more than 70% of the funds. After the universities, a high level of importance is placed on the clinical research undertaken at the Islands' hospitals, with a major increase in the number of projects; these receive almost 15% of the public R&D aid in the Canary Islands.

In this section it is important to note that after screening the databases of the state and regional organisations and institutions there is little record of public aid to Canary Islands biotech companies. This is primarily due to two factors: firstly, that there are very few companies of this type in the Islands, and secondly, that there are very limited regional funds available for encouraging business-based research.

SECTORIAL DISTRIBUTION OF PUBLIC R&D GRANTS FOR BIOTECHNOLOGY IN THE CANARY ISLANDS PERIOD 2000-2005



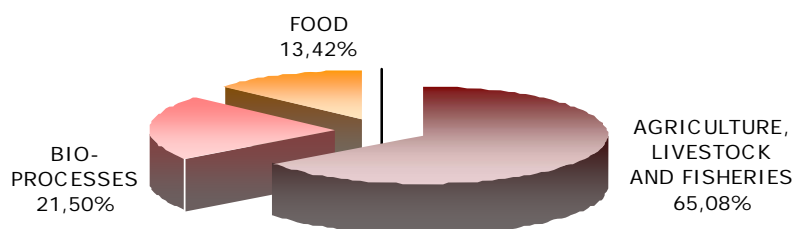
The breakdown of public grants by sectors of application shows that Canary Islands research centres primarily direct their activity towards research in the field of biomedicine, which receives 66.28% of the funds granted. The areas of biotechnology research applied to agriculture, aquaculture, food, and industrial processes receive little attention from public funds, although it should be noted that there is specific activity in the Islands on the search for new molecular entities of an organic nature

with interest for industry, using natural products, which has received almost a million euros in R&D aid.

Returning to the field of biomedicine, and as seen in the following table showing the lines of biomedical research financed in the Islands, the most competitive areas in attracting funds are oncology, neurology, and metabolic, respiratory and infectious diseases.

LINES OF RESEARCH IN BIOMEDICINE		
LINES OF ACTIVITY	NUMBER OF PROJECTS	AMOUNT GRANTED 2000-2005
ONCOLOGY	38	€1,955,681.83
NEUROLOGICAL DISEASES	26	€1,006,711.85
METABOLIC DISEASES	28	€728,595.96
RESPIRATORY DISEASES	16	€563,218.48
INFECTIOUS DISEASES	14	€505,554.32
EPIDEMIOLOGY	13	€317,157.87
GENOMICS	5	€280,126.50
REGENERATIVE MEDICINE	5	€254,724.58
CARDIOVASCULAR DISEASES	8	€246,748.29
MOLECULAR DIAGNOSIS	11	€229,996.81
RARE DISEASES	7	€212,456.74
AGEING	10	€162,917.71
POPULATION GENETICS	5	€125,575.79
BIOMATERIALS	4	€98,667.32
OBESITY	1	€29,200.00
INFLAMMATORY DISEASES	1	€10,000.00

SECTORIAL DISTRIBUTION OF PUBLIC INNOVATION GRANTS FOR BIOTECHNOLOGY IN THE CANARY ISLANDS AUTONOMOUS COMMUNITY PERIOD 2000-2005



The limited innovation aid to biotech companies from public administrations is primarily distributed in the agriculture, livestock, food and bioprocess sectors. The majority of innovation aid is centred on improving the quality of commercial plant varieties. Very little aid has been granted to biomedical innovation, due to the very limited number of either Spanish or international biomedical companies. In light of this, it can be inferred that it is very difficult to convert the results of Canary Islands

biomedical research into industrial applications in the region due to the lack of a Canary Islands industrial base in the field of health and pharmaceuticals, which means that other regions or countries are taking advantage of the excellent results of this research.

Below is a list of centres, universities and companies which have received public aid, with a short description of their activities.

CANARY ISLANDS RESEARCH CENTRES RECEIVING FINANCE IN RDI ACTIVITIES IN BIOTECHNOLOGY	
UNIVERSITIES	
UNIVERSITY OF LA LAGUNA	With a total of 80 projects financed, 54 researchers with biotechnology projects have been identified. The research undertaken is transversal, with greater emphasis on neurology, molecular biology and industrial biotechnology. At present there are 152 researchers capable of undertaking research activities in biotechnology.
UNIVERSITY OF LAS PALMAS DE GRAN CANARIAS	With a total of 43 projects financed, 35 researchers with biotechnology projects have been identified. Their research is primarily oriented towards applications in neurology, molecular biology, oncology and aquaculture. At present there are 166 researchers capable of undertaking research activities in biotechnology.
UNIVERSITY INSTITUTES	
UNIVERSITY INSTITUTE OF TROPICAL DISEASES	Attached to the University of La Laguna, the Institute has 42 researchers. The lines of research financed correspond to tropical disease genomics.
UNIVERSITY INSTITUTE OF BIO-ORGANICS	The main activities carried out at the Institute, which belongs to the University of La Laguna, are the selective production of bioactive metabolites and the understanding of biogenesis processes.
INSTITUTE OF APPLIED ALGOLGY	Belonging to the Marine Biotechnology Centre, the activity of the Institute is centred on the cultivation of marine plants and their industrial use (primarily algae and halophytes).

NON-PROFIT INSTITUTES	
CANARY ISLANDS INSTITUTE FOR CANCER RESEARCH	The Canary Islands Institute for Cancer Research is an autonomous organisation which conducts basic and clinical biomedical research on processes related to cancer genomics, with emphasis on possible applications at the diagnostic, prognostic and treatment levels.
HOSPITALS	
CANARY ISLANDS UNIVERSITY HOSPITAL	With 45 projects approved for grants, this is the Canary Islands hospital which has received most money for R&D activities in biotechnology. The main lines of research funded are cancer epidemiology, nephrology and rare diseases such as hyperoxaluria.
GRAN CANARIA DR. NEGRIN HOSPITAL	With a total of 36 research projects approved for grants, the hospital's scientific activity centres on two units (immunology and research), with research on molecular biology, epidemiology and ageing, among other areas.
NUESTRA SEÑORA DE LA CANDELARIA HOSPITAL	With a total of 31 research projects approved for grants, the main lines of research are infectious diseases, pulmonary lesions and neuronal diseases.
HOSPITAL MATERNO-INFANTIL DE LAS PALMAS (Maternity and Children's Hospital)	With 21 research projects, the principle lines of research are cancer genomics, molecular diagnosis and hereditary metabolic diseases.
HOSPITAL INSULAR DE LAS PALMAS (Island Hospital)	Although only one line of research has been recorded, the hospital has very important research groups working on population genetics and disease analysis.
OTHER PUBLIC RESEARCH BODIES	
CANARY ISLANDS INSTITUTE OF AGRARIAN RESEARCH	This autonomous organisation of the Canary Islands Government, with 50 researchers participating in research projects in the areas of animal production, plant production and applied botany, has more than 10 projects in which biotechnology is applied.
CANARY ISLANDS TECHNOLOGICAL INSTITUTE	The Institute includes a biotechnology department with activity centred on introducing innovative technologies for using the biological resources of the Islands. Its main line of research is the synthesis and production of bioactive compounds of industrial interest.
INSTITUTE OF NATURAL PRODUCTS AND AGROBIOLOGY	Attached to the research centre network of the CSIC (Spanish National Research Council), the research activity of the Institute is centred on lines such as the chemistry of bioactive substances of natural or synthetic origin, selective production of bioactive metabolites and the understanding of biogenesis processes.
NATIONAL INSTITUTE OF TOXICOLOGY	With a delegation in La Laguna, the primary biotechnology activity of the Institute is centred on the study of the genetic variability of the Canary Islands population.
CANARIAN INSTITUTE OF MARINE SCIENCES	The main function of the Institute is to support the fishing industry and encourage university studies in marine sciences. At present, the Institute carries out and promotes work in research and technological development in the field of marine sciences. The principal lines of research and development of the Institute are aquaculture, fisheries biology, sustainable development, the coastal environment, oceanography and fisheries resources.

LIST OF COMPANIES WITH BIOTECHNOLOGY ACTIVITIES		
NAME	ACTIVITY	DESCRIPTION
BIOLÓGICAS CANARIAS S.L.	Agrobiotechnology	Biológicas Canarias is involved in research and development in the field of biotechnology applied to obtaining fertilisers and plant protection products of natural origin. In Spain the company has one office in the Canary Islands and another in Valencia.
SEAWEED CANARIAS S.L.	Agrobiotechnology	The leading <i>blue</i> biotech company in the Canary Islands, Seaweed Canarias works on discovering, extracting, and activating and releasing the active ingredients of micro- and macroalgae for innovative applications in agriculture, cosmetics and human and animal nutrition. Seaweed Canarias integrates and coordinates a wide network attending to the specific needs of theoretically distinct sectors united by the properties of algae.
DRACENA BIORESEARCH	Human health	The leading company in the sector of biomedical research located in the Canary Islands, with activity directed towards covering the large market niche in the Islands in relation to Clinical Trials and Strategic Consultancy.
AYAGUARES MEDIOAMBIENTE S.L.	Agrobiotechnology	Ayaguares is a company whose activity centres on gardening, with an autochthonous and ornamental nursery. It is currently conducting a study on the mycorrhization of the autochthonous plants of the Canary Islands, in conjunction with the Institute of Agriculture and Food Research.
FRAGANCIAS Y AROMAS NATURALES S.L.	Human health	Fragancias y Aromas Naturales S.L. is a biotech company which develops pharmaceutical preparations from Canary Islands endemic plants for medicinal and cosmetic use.
WESTERN SEED ESPAÑA S.A	Agrobiotechnology	The aim of Western Seed is to research, develop, produce and commercialise top quality hybrid seeds, primarily for the production of tomatoes, melons, watermelons, cucumbers, eggplants, pumpkins, courgettes and papayas, and at the same time to achieve maximum satisfaction for producers, growers and markets in general.
LABORATORIOS PEJOSECA S.L.	Human health	Laboratorios Pejoseca S.L. is a pharmaceutical laboratory specialising in the study and extraction of the active ingredients of natural autochthonous species of the Canary Islands which have medicinal, cosmetic and dietary uses. Pejoseca S.L. distributes the beneficial ingredients of plants such as aloe vera, orobal, hypericum, sage, lavender and several types of algae in the European Union. In the European territory, because of their specific features, these plants can only be obtained in excellent conditions within the climate of the Canary Islands.
CULTESA	Agrobiotechnology	Company involved in producing and commercialising plants using micropropagation techniques. Its activity is primarily centred on the characterisation and selection of banana and potato clones.

In view of the results, it can be concluded that the principal biotechnology capacities in the Canary Islands are:

KEY ASPECTS OF CANARY ISLANDS BIOTECHNOLOGY FOR THE PERIOD 2000-2005			
R&D GRANTS		€6.83 Million	
INNOVATION GRANTS		€0.54 Million	
INFRASTRUCTURE GRANTS		€8.13 Million	
HEALTH RESEARCH FUND NETWORKS		€2.21 Million	
NUMBER OF RESEARCHERS		118	
NUMBER OF CENTRES WITH R&D ACTIVITIES IN BIOTECHNOLOGY	16	TECHNOLOGY CENTRES	1
		Nº PUBLIC RESEARCH ORGANISATIONS	3
		NON-PROFIT INSTITUTIONS	1
		UNIVERSITIES	2
		UNIVERSITY INSTITUTES	4
		HOSPITALS	5
BIOTECH COMPANIES		4	
COMPANIES WITH BIOTECH-RELATED ACTIVITIES		4	

3. Priority Scientific and Technical Areas for Canary Islands Biotechnology

In order to outline the technological context in which biotechnology in the Canary Islands Autonomous Community operates, use was made of a variety of Technology Foresight reports compiled by the OPTI Foundation and Genoma España defining the technology trends and the critical technologies currently being developed in Spain and the rest of the world.

The technology trends presented come under three large areas of present-day biotechnology: Health and Pharmacy; Agriculture, Livestock and Aquaculture; and Industry and Energy.

The critical technologies for encouraging the development of the biotechnology sector in the Islands were selected with the assistance of 17 biotechnology researchers and experts of acknowledged scientific and business competence in the Canary Islands from a number of centres (universities, public research organisations, hospitals and companies).

The identification and selection of the critical technologies for each area of biotechnology were carried out by consulting a broad list of technological, scientific and technical topics with a panel of experts who were required to assess the topics on the basis of three fundamental criteria:

- Technological capacity of the Islands.
- Importance of each technology.
- Closeness in time of each technology (time frame 2006-2020).

The value of each of the indices ranges from 1 to 4, from lower to higher importance, with a value of 2.5 indicating “approved”. Taking into consideration the objective of this study, a critical technology is one which is defined as important and which has a moderate degree of competition to enable it to be implemented. Therefore, a graph offsetting capacity and importance leads us to select as critical all the technologies located in or bordering the upper right-hand quadrant.

Cartesian representation of the position in which the technologies are located is as follows: the vertical axis shows the importance, the horizontal axis shows the capacities, and the diameter of the bubbles shows the closeness in time.

For ease of understanding, the analysis was done by biotechnology application sectors. The technologies proposed for the Canary Islands are presented below, broken down into their applications in Health and Pharmacy; Agriculture, Livestock and Food; and Industry and Energy.

3.1. Health and Pharmacy

Continuous progress in the knowledge of biotechnology applications in the field of human health allows enormous advances to be made in biomedical research. The ultimate aim of biomedical research is to provide a quicker and more effective response to a large number of diseases and pathologies affecting us.

The sequencing of the human genome was the catalyst for the rise of a group of highly efficient technologies such as genomics, proteomics and metabolomics, which for the first time have allowed studies to be made of the behaviour of

all the genes (genome), proteins (proteome) and metabolites (metabolome) of a cell or tissue. These technologies allow advances to be made in the understanding of the molecular bases of the “simple” diseases, which depend on alterations in the sequence of a single gene, as well as the “complex” diseases, which depend on alterations in a large number of genes and the interaction of individuals with the environment.

The following technologies were put forward to the panel of experts:

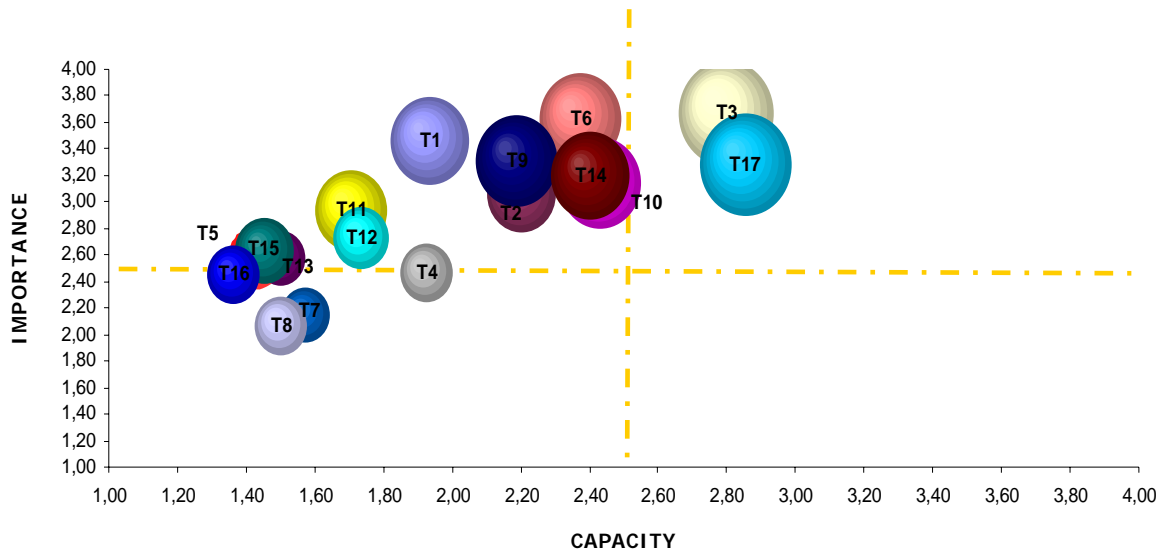


TOPICS AND TECHNOLOGIES PROPOSED IN HUMAN HEALTH

T1	Therapy with pluripotential cells
T2	Automation in the separation and identification of proteins
T3	DNA Microarrays and Biochips for molecular and clinical diagnosis
T4	Analysis of protein-protein interactions or combinatory library
T5	Genomic ultra-sequencing
T6	Pharmacogenetics
T7	Protein tertiary structure prediction and establishment
T8	High throughput in the production of transgenic animal models
T9	Cell and tissue engineering (including grafts and biomaterials)
T10	Chemotherapeutics and monoclonal antibodies (drug discovery)
T11	Bioinformatics for predicting protein activity/functionality
T12	Virtual laboratories for research in genomics and proteomics
T13	Improved gene therapy and gene vaccination vectors
T14	Expert computer systems to support clinical diagnosis
T15	Small Interference RNA
T16	Lab-on-a-chip
T17	Population genetics (disease analysis)



CROSS TABULATED ANALYSIS FOR THE SELECTION OF CRITICAL TECHNOLOGIES IN HEALTH AND PHARMACY



From the results of the survey given to the panel of experts, it can be seen that there is a great deal of awareness among the experts of the use of biotechnology applications in the health field. 47% of these applications have a priority or high level of importance and only four technologies are below the mean. However, the research and development capacities in human health are considered to be very low. **Only two technologies reach the point of mean competitiveness and the Islands lack the necessary technological capacity to deal with 59% of the technologies in the survey.**

As regards the index of closeness in time, there is no technology which the experts consider will be implemented immediately. The technologies closest in time, with availability corresponding to the period 2010-2015, are the use of microarrays as a diagnostic method and the study of the genetic variability of diseases, which in turn is directly related to pharmacogenetics in the search for personalised treatments.

The experts reveal that the most relevant technologies for the Islands are those which allow more accurate diagnoses and personalised treatment of diseases.

CRITICAL TECHNOLOGIES FOR THE DEVELOPMENT OF CANARY ISLANDS BIOTECHNOLOGY: HEALTH AND PHARMACY

T3- DNA MICROARRAYS AND BIOCHIPS FOR MOLECULAR AND CLINICAL DIAGNOSIS

These are key tools in carrying out and generalising more accurate and individualised diagnoses in order to provide patients with the most appropriate treatment for their pathology.

They consist of devices where biological material is immobilised (in the form of oligos or cDNA and proteins or monoclonal antibodies) on a solid surface in order to carry out affinity testing between this material and a sample from a patient. The two main advantages are the very small size of the material and the simultaneity. Their use allows us to determine the expression patterns (genetic profiles of patients) or to perform multiple miniaturised immunoassays.

T17- POPULATION GENETICS

This is the study of the distribution and evolution of genetic variability among individuals of one or several populations.

It is a technique which allows us to obtain haplotype maps or all the nucleotide polymorphisms (SNPs) which make one individual different from another.

These maps enable comparisons to be made between the SNP patterns of persons with a disease and those of healthy individuals in order to identify the genetic variations related to a specific epidemiology.

T6- PHARMACOGENETICS

The study of a patient's response to the administration of a medication due to the changes in his genetic heritage. Its purpose is phenotype and genotype characterisation of the genetic polymorphisms involved in metabolism. Pharmacogenetics allows us to:

- Determine beforehand, for each patient, the safest and most efficient treatment of

those existing through the creation of genetic-based analysis systems.

- Assess the influence of external factors on a patient's metabolism and adjust the most appropriate dose for each medication in accordance with the patient's genetic profile.

T14- EXPERT COMPUTER SYSTEMS TO SUPPORT CLINICAL DIAGNOSIS

Interpretation systems which help a doctor to make a specific diagnosis using the molecular data provided by the patient.

This involves making sense of data from different genetic expressions; that is, the systems make it possible to conduct a study of the different polymorphisms belonging to the patient's genome and to compare these results with the stored data of other individuals.

T10- USE OF LIBRARIES OF NATURAL COMPOUNDS FOR DRUG DISCOVERY AND DEVELOPMENT

Throughout the history of the pharmaceutical industry, organic chemistry has been capable of providing molecules with pharmacological properties which today constitute an important part of the existing pharmacopoeia. These organic compounds have their origin in the study of the chemical and biochemical diversity contained in plant and animal organisms and microorganisms. This diversity has been partially studied and collated in the Canary Islands, although to date it has not been appropriately exploited for drug discovery and development.

For the identification and screening of new pharmacological compounds High Throughput Screening is used. This technique allows a large number of molecules to be studied and determines the molecules which may have pharmacological potential in response to a specific disease.

3.2. Agriculture, Livestock and Aquaculture

Biotechnology allows increases to be made in the productivity of agricultural crops, with significant improvements in the production results of the agri-food industry. It is currently possible to produce crops with agronomic benefits, improvements in organoleptic or nutritional properties and even crops for obtaining compounds of high added value for the pharmaceutical and industrial sectors.

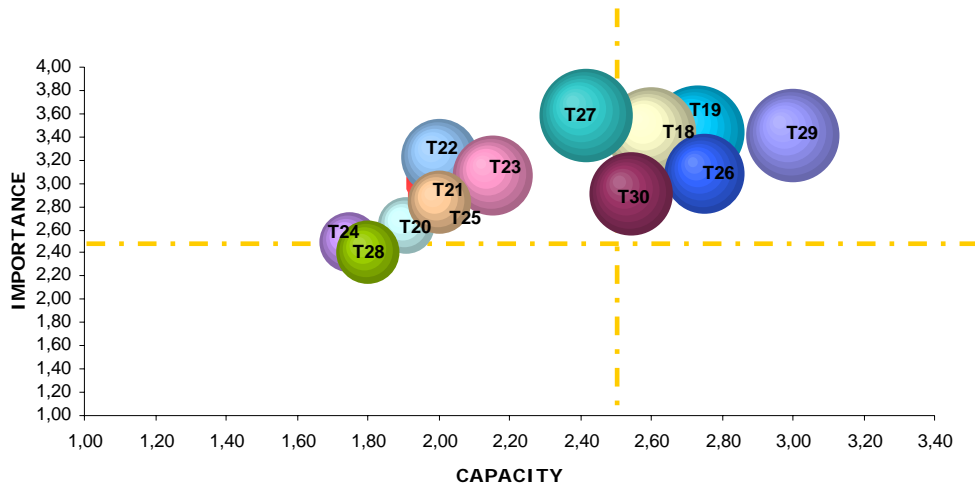
In the same way, biotechnology provides a series of advantages in livestock and aquaculture, including allowing the selection of reproducers with the desired traits and improving the health conditions of agricultural productions.

The following technologies were proposed to the panel of experts:

TOPICS AND TECHNOLOGIES PROPOSED IN AGRICULTURE, LIVESTOCK AND AQUACULTURE

T18	Marker-assisted selection
T19	Genetic maps
T20	Transformation protocols and vectors
T21	Proteomics
T22	Transcriptomics (Microarrays)
T23	Bioinformatics
T24	Automated identification and separation of proteins
T25	Gene libraries and EST collections
T26	Molecular register of varieties
T27	Metabolomics
T28	Directed insertion and deletion/reverse genetics
T29	Germplasm bank
T30	Optimising the obtaining of pure lines (including polyploids)

CROSS TABULATED ANALYSIS FOR THE SELECTION OF CRITICAL TECHNOLOGIES IN AGRICULTURE, LIVESTOCK AND AQUACULTURE



All except on of the technologies under discussion showed a higher than average index of importance, which is undoubtedly indicative of the degree of importance of Agriculture, Livestock and Aquaculture in the Canary Islands Autonomous Community. The technological capacity of the Islands is even slightly higher in this area than in Health and Pharmacy.

The experts were more interested in technologies aimed at producing knowledge at the genetic and molecular level of plant species (as in the case of metabolomics and transcriptomics) and in collecting and making use of the variability of the species in the Islands (for example through germplasm banks and genetic maps). The knowledge generated

by these technologies will facilitate the appearance of applications of commercial interest at a later stage.

As in the case of health technologies, the Canary Islands need to strengthen their capacities in more horizontal technologies aimed at generating molecular knowledge, specifically in all the “-omics” technologies, and also in bioinformatics.

In general it can be said that there are four critical technologies in which to prioritise investment, and of these, only metabolomics presents obvious problems for development at present as it is virtually non-existent in the Islands.

CRITICAL TECHNOLOGIES FOR THE DEVELOPMENT OF CANARY ISLANDS BIOTECHNOLOGY: AGRICULTURE, LIVESTOCK AND AQUACULTURE

T29- GERMLASM BANKS: USE OF NATURAL VARIABILITY TO IMPROVE AND OBTAIN SPECIES, VARIETIES AND RACES.

Germplasm banks are infrastructures aimed at conserving the genetic diversity of species and using this knowledge through sequencing, genomic analysis and the identification of genes and biomarkers of agronomic and/or economic interest. The use of the natural variability held in germplasm banks allows us to enter into two other technologies considered critical: genetic maps and marker-assisted selection.

T19- GENETIC MAPS

Genetic maps are the physical representation of the DNA sequences which make up the chromosomes and contain the hereditary traits of any living being.

The ultimate aim of this technology is to locate and order sequences, genes or regions of interest, as well as specific molecular markers (for example single nucleotide polymorphisms - SNPs), which include phenotypic traits of commercial interest. Among other activities, these maps allow comparative genomics studies to be made and genetic improvement programmes using marker-assisted selection to be developed.

T18- MARKER-ASSISTED SELECTION

Molecular markers are DNA sequences of varying lengths capable of detecting associations between the presence or absence of certain alleles. This technology therefore allows individuals carrying certain markers associated with a trait of interest to be selected.

The main advantage is the speeding up of traditional genetic improvement programmes (both animal and plant), which reduces the development time and the costs involved. Marker-assisted selection is essentially useful in the selection of traits of high environmental influence and phenotypic traits which are expressed late.

T27- METABOLOMICS: IDENTIFICATION OF METABOLITES WITH HIGH ADDED VALUE

Metabolomics studies all the small molecules or metabolites present in one type of cell, tissue, organ or organism at a given stage of development or as a result of environmental stimulus.

The result of this analysis is both the biochemical characterisation of the development and state of productions and their subsequent performance, and the identification of compounds with added value as functional and nutraceutical food ingredients or additives.

3.3. Industry and Energy

Under this point the use of biotechnology applications takes on particular relevance. The competitiveness and positioning of companies depends to a great extent on their ability to develop new scientific and technological tools to allow them to reduce costs and achieve higher production levels and sustainable industrialisation.

Biotechnology applications are being implemented in a wide variety of industrial sectors such as food, chemistry, textiles, plastics and materials, fuels, rubber and mining, among others.

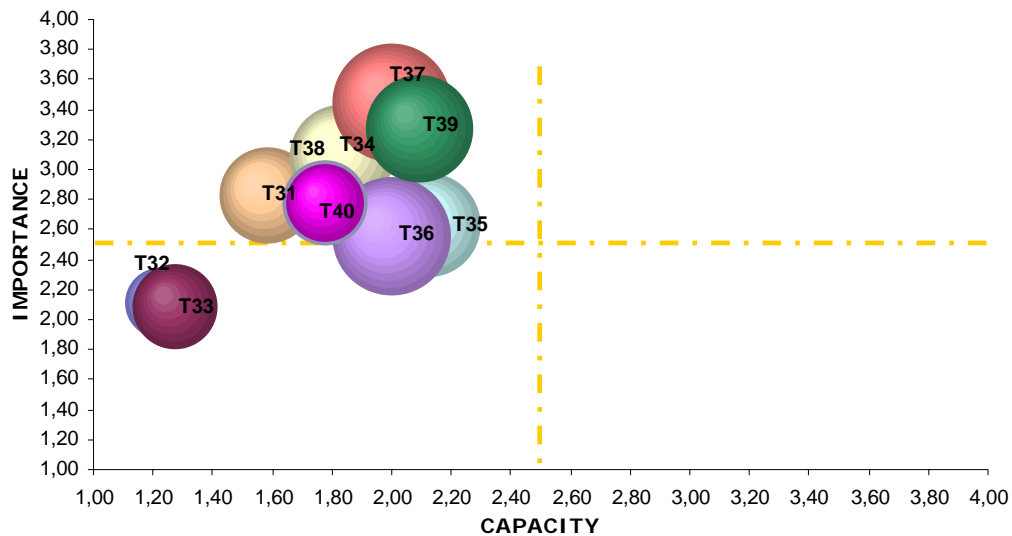
The following technologies were put forward to the panel of experts:

TECHNOLOGIES PROPOSED IN INDUSTRY AND ENERGY

T31	Discovery and development of enzymes with multiple applications
T32	New technological developments for the immobilisation of enzymes and microorganisms
T33	Technological improvements in producing, purifying and stabilising industrial-use enzymes
T34	Biocatalysis for producing pharmaceutical products
T35	Identification, isolation, purification and expression of industrial enzymes by high throughput technologies
T36	Protein expression and purification systems for efficient increase in production and high throughput functional testing
T37	Biological optimisation of bioethanol production from starch
T38	New enzyme technologies for hydrolysis of cellulose and hemicellulose for biofuel production
T39	Development of enzymes and microbial processes for the conversion of waste water and organic waste
T40	Multiple gene expression systems for metabolic engineering and production of complex enzyme systems



CROSS TABULATED ANALYSIS FOR THE SELECTION OF CRITICAL TECHNOLOGIES IN INDUSTRY AND ENERGY



The experts show that 80% of the technologies are of enormous importance for improving industrial and energy processes in the region. Their main concerns are in relation to three technologies of different natures:

- The production of new fuels by the conversion of starch and vegetable oils, which would mean a competitive advantage for the Islands and a reduction in the costs of obtaining energy.
- New processes for converting waste water would facilitate the management

of one of the most highly valued resources in the Canary Islands.

- Biocatalytic processes which would facilitate the process of new drug discovery and development for companies located in the Islands.

However, the Canary Islands Autonomous Community does not have sufficient technological capacity to cope with the entry, application and development of these technologies. This situation is significantly more accentuated than in the previous sections as **none of the technologies is above the mean capacity value.**



4. Socioeconomic Measures to Encourage Canary Islands Biotechnology

Direct mechanisms for encouraging RDI in biotechnology are widely implemented in many countries and regions, including the leading countries in this science and business field and others which are not as advanced as Spain. The mechanisms are also homogeneous in most countries and successful experiences provide sufficient grounds for proposing their implementation in other regions.

In order to outline the possible measures and programmes to encourage biotechnology in the Canary Islands, use was made of a number of reports prepared by Genoma España detailing the main regional and national tools being implemented in Spain and the rest of the world.

In line with this, the measures proposed can be classified as follows:

1) **Regional Science Policy Instruments:** all the tools and actions aimed at encouraging the undertaking of more and better activity in R&D in the public sector.

2) **Science and Technology Policy Instruments:** tools aimed at encouraging co-operative research between the public and private sectors.

3) **Technology Policy Instruments:** all the tools aimed at encouraging the creation and

consolidation of research and technological development in companies.

For each of these paths a wide range of tools, instruments and innovation policies is available. Nonetheless, the preferred choice is always for a combination and simultaneous use of several of these instruments.

The analysis and identification of priority measures are based on two indices:

- The institutional capacity to implement the measure within the current programmes.
- The importance of the measure for the Canary Islands Autonomous Community.

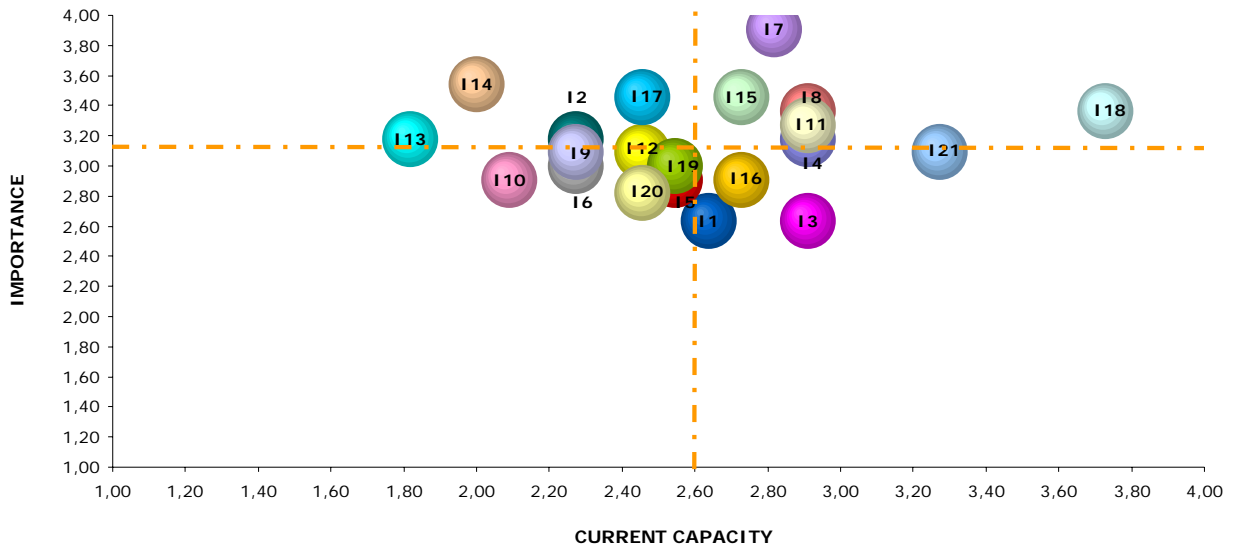
Statistical treatment of the results is carried out in the form of indices; that is, the number of answers received for each valuation is modulated with a factor ranging from 1 to 4, for greater or less importance (capacity and importance, respectively), with the value of 2.5 meaning "approved". Cartesian representation of the position at which the measures are located shows the importance on the vertical axis and the capacity to implement them on the horizontal axis.

The following measures were discussed by the committee:

INSTRUMENTS PROPOSED

I1	Creation of regional R&D centres
I2	Service centres for advanced research
I3	News office and lobby
I4	Regional R&D projects identified as priority
I5	Promotion agency and networking
I6	Investment fund for basic research
I7	Programme for attracting and keeping scientists
I8	Science and technology parks
I9	Co-operative public-private research projects
I10	Research consortiums (own legal entity)
I11	Technology transfer agency
I12	Think tank for services related to R&D and business-based research
I13	Private technology centres
I14	Product development projects aimed at SMEs
I15	Incentives for RDI activities
I16	SME creation and support centres
I17	Mixed fund of public-private capital
I18	Tax incentives to attract investors
I19	Public-private programme to manage projects
I20	Programme to promote a Business Angels network
I21	Actions to promote and internationalise Canary Islands biotechnology

CROSS TABULATED ANALYSIS FOR THE SELECTION OF ENCOURAGEMENT MEASURES



As a result, the panel of experts proposes two types of measures or recommendations aimed at strengthening the strategic position of the Canary Islands in biotechnology:

- Recommendable and feasible encouragement measures: for which

the Canary Islands have sufficient capacity to implement the measures.

- Recommendable but less feasible encouragement measures: where there may not exist sufficient capacities for the measures to be implemented.

RECOMMENDABLE AND FEASIBLE ENCOURAGEMENT MEASURES

I7- PROGRAMME FOR ATTRACTING AND KEEPING SCIENTISTS

To promote the scientific activities carried out in the research and development centres in the Canary Islands Autonomous Community, by facilitating incorporation, stabilisation and professional placement through a regional programme to enhance methods for hiring doctors and technologists from the public sector. This would allow an improvement in the scientific and technical skills of research groups, resulting in greater cohesion and continuity in their lines of research as well as an increase in the requisite number and retention of talents. This type of programme could be complementary to national incentives such as the Ramón y Cajal Programme.

I8- SCIENCE AND TECHNOLOGY PARKS

To develop a context of innovation for the location of public-private ventures in relation to scientific research and technological development. This includes science and technology facilities, think tanks and infrastructures capable of catalysing regional economic development and generating both research of excellence and the development of new products and services. All of this would allow easier communication between public research centres and private companies, more effective transfer of high quality knowledge and developments, and the rise of new technology-based companies.

This initiative must centre on priority areas or lines which facilitate the specialisation of the park and make it internationally competitive. Such is the case of the Science Park in Barcelona, located in a zone with a large concentration of science structures and characterised by a high level of specialisation in biotechnology and pharmacy.

I11- TECHNOLOGY TRANSFER AGENCY

To strengthen **Regional Capacities for the Protection and Commercialisation of R&D Results** in order to facilitate the administration and protection of patents, both technically and economically. Although at present few initiatives of this type are found in Spain, at the European level there are very professional organisations of major importance which have enabled the regions where they are located to become positioned as leaders in innovation. This has also helped to attract investments in these regions. One example of this is the Cambridge Enterprise Agency, which administers all relations with entities financing research and also deals with the commercialisation of the university's research results. In 2003 alone, the Agency studied 148 inventions, applied for 66 patents, achieved 32 licence agreements and participated in the generation of three new spin-offs.

I15- INCENTIVES FOR R&D ACTIVITIES

To encourage the generation of scientific and technological knowledge in the region through an **improvement in the tax treatment of research and development** by regularising or decreasing the application of VAT in public and private centres. A good example of this is the incentive programme of the Walloon region in Belgium, consisting of five initiatives aimed at improving the positioning of the biotechnology industry in the area. These initiatives cover a percentage of the costs for basic research, acquisition of science equipment, and the salaries of the researchers, among other items.

I18- TAX INCENTIVES FOR ATTRACTING INVESTORS

To facilitate the establishment of new technology-based companies and the creation of venture capital companies through a regional programme of favourable tax policies, making it possible to attract national and international initiatives and investments. The Canary Islands Autonomous Community has a series of ideal components (natural resources, scientific and technological capacity, quality of life) which would facilitate economic flow into the region. An example of this type of initiative which could be followed is Canada, which with its policy of providing incentives for biotechnology investments is becoming one of the most competitive countries in terms of biotechnology. Quebec has a grants and incentives programme which is capable of returning to entrepreneurs 70% of the investment made.

I21- ACTIVITIES TO PROMOTE AND INTERNATIONALISE CANARY ISLANDS BIOTECHNOLOGY

To improve the competitiveness of the biotechnology industry through **aid programmes to assist in the promotion, commercialisation and international profiling** of the companies in the region. Some of the activities which should be included are: encouraging trade strategies; participation of companies at trade fairs and conventions of a professional and sectorial nature; identification of strategic partners; and the promotion of other foreign trade activities.

RECOMMENDABLE BUT LESS FEASIBLE ENCOURAGEMENT MEASURES (REQUIRING CERTAIN CAPACITIES AND STRUCTURES TO BE PUT IN PLACE FIRST)

I2- SERVICE CENTRES FOR ADVANCED RESEARCH

To create **Co-operative Research Centres with activity centred on specific lines** capable of responding to some of the needs of the Canary Islands scientific and business community. This involves centres designed to increase scientific co-operation and strengthen the scientific and technological capacities of the region by means of infrastructures of priority need, thereby increasing competitiveness and scientific excellence.

As an example of these kinds of measures, we can mention the example of the Bioscience Co-operative Research Centres designed by the Biobask 2010 Programme, whose objectives are to optimise the scientific and technological capacities in strategic areas, reach the minimum requirements and generate economies of scale.

PRIVATE TECHNOLOGY CENTRES

To encourage the development of **infrastructure to support technological innovation** for Canary Islands biotechnology companies and to help improve their competitiveness. This involves research and development centres aimed at satisfying the technology and service demands of industry.

Although biotechnology examples of this type are unknown in Spain, a wide range of initiatives can be found in other industrial sectors. A good example of this is the research and technological development centre of the agri-food sector, AINIA, whose objectives are to increase production quality, improve competitiveness and encourage the modernisation and diversification of industries in this sector.

PRODUCT DEVELOPMENT PROGRAMMES AIMED AT SMEs

To increase the regional budget for **business-based biotechnology innovation as key strategic support for the development of the industrial base**. The objectives must be centred on co-operative applied research projects identified by the needs of the companies in the region.

Examples of regional Spanish initiatives include the Biotechnology, Pharmaceutical and Health Science Programme of the Galician Research Plan. Galicia is the first Autonomous Community in Spain to opt for a sectorial programme specifically based on biotechnology with the aim of boosting the capacities of the region, by taking action on the weak points and endeavouring to optimise the resources available.

MIXED FUND OF PUBLIC–PRIVATE CAPITAL

To increase the investment options on the **basis of the needs** presented by bioentrepreneurs. Biotechnology companies require large investments in the first stages of development, when there is greater uncertainty and less available capital. In this respect, one alternative which could cover the risk threshold of private capital and would provide solidity to the competitiveness of the projects would be the allocation of funds from regional administrations. This would facilitate the administration and assessment of projects both technically and economically.

Other initiatives worth mentioning include the Biobask 2010 Programme for boosting venture capital (with the administration providing 1/3 of the total investment); BioNavarra 2007 (with a capital stake ranging from 5% to 45% of the company capital); and INVERTEC (with investments which can be as much as 300,000 euros per project).

5. Final Thoughts

The Canary Islands are facing a variety of major challenges in their bid to improve the competitiveness and the economy of the region. The geographical location of the Islands (as an outermost region of the European Union) and the limited area of their territory combine to increase the costs of purchasing raw materials, processed products and advanced technologies. This situation conditions and to a certain extent hinders the productivity of Canary Islands companies.

The search for solutions to these types of problems can be undertaken in a variety of ways. One of the most important is innovation, both in terms of technological development and in the improvement of processes. Other regions or provinces of developed countries, such as Quebec, in Canada, Cambridge, in the United Kingdom, and island nations such as Ireland, have made a firm bid for innovation, particularly the innovation provided by developments in biotechnology. In this way, in the last ten years these regions have managed to increase the productivity of their industries and provide their products with greater added value in both economic and social terms, all thanks to biotechnology.

This international context of boosting competitiveness is also driving the Canary Islands Autonomous Community, in this case led by the Canary Islands Special Zone (ZEC), to study the possibilities offered by the use of biotechnology in the Canary Islands. This includes analysing the scientific and technological capacities of the Islands, identifying the existing needs, and proposing instruments and encouragement measures in accordance with the situation in the Islands.

The Canary Islands are at a decisive economic moment. They have a series of very favourable elements capable of complementing the service-based economic model which sustains the Islands and reactivating mature and traditional markets capable of increasing economic wealth in the region. In this sense, the main potentials of the Islands are:

- A geographical context which is home to the greatest biodiversity of species per square kilometre in Europe. With more than 14,000 terrestrial species, over 600 endemic plants and more than 5,500 marine species recorded, the Islands are home to 80% of the entire Spanish diversity. Considering that 11% of medications are of plant origin, the natural variability of the Islands represents a major competitive advantage, not only for the agri-food industry but also for the pharmaceutical industry.
- A scientific context made up of a panel of very competitive researchers who have been capable of achieving a five-fold increase in public funds obtained for RDI projects. The Canary Islands have 16 Research and Technological Development Centres carrying out activities in biotechnology, with 118 principal researchers and a requisite number of nearly 600 scientists. Their principal research is in areas such as cancer, neurological and metabolic diseases, bio-organics, and improving agricultural varieties.
- A business context with very wide-ranging possibilities for trade, as the Islands are ideally located for trade relations with West Africa, South America and Europe. In addition, the industrial base has an export culture which is unprecedented in comparison with other Spanish Autonomous Communities.
- An administrative context which is very committed to boosting the Canary Islands R&D system, making use of the knowledge economy and innovation as a strategy for differentiating the business base. Regional initiatives are not only oriented towards increasing the budget for research, improving scientific and technological infrastructures and increasing science capital, but also towards increasing economic competitiveness with a policy of tax incentives considered to be the most advantageous in Europe, and programmes for attracting foreign investors. It is also important to highlight the activities undertaken by



the Canary Islands Foundation for Research and Health aimed at boosting the development of biotechnology and biomedicine.

However, these potentials may not be enough to make the Canary Islands a point of reference for biotechnology, as the strategic positioning of other countries and regions could further accentuate the Islands' technology dependence, talent drain and reduction of market shares. The scientific-technological-business environment is undergoing a series of problems for which urgent solutions need to be found in view of the importance of this environment in the region's economy and in job creation.

On the one hand, there is a predominance of small research groups with great difficulty attracting and keeping researchers, which could, in the long term, result in a lack of input and the loss of investigative excellence in the groups. A lack of technological capacity in the groups is also observed, preventing them from carrying out their activity in certain lines of enormous importance for the situation and needs of the region, as in the case of the new "-omics" technologies such as genomics and proteomics, and also in the case of biotechnology applications for the industry and energy sector.

On the other hand, there is little business-based biotechnology and a culture of innovation is lacking, in addition to the possibilities this

technology could provide to the traditional industrial base. This hinders public-private co-operative research and reveals the discrepancies in the sectorial orientation of public and private research funds, technological development and innovation. In the main, public research is centred on biomedicine, while private research is centred on the agri-food sector.

All of this is causing certain deficiencies, such as the difficulty of converting the scientific knowledge of the public research groups into applications and products, or the difficulties investors have identifying solid projects in which to invest.

Such is the context of this study, which aims to help identify the scientific and technological capacities of the Canary Islands Autonomous Community in biotechnology which could be used to improve the region's competitiveness and the health service provided in the region. The study also includes proposed measures whose implementation could be decisive in channelling such capacities towards the development of applications.

Through a panel of experts of acknowledged experience and recognised scientific expertise, aware of the situation in the Canary Islands, nine technology trends capable of improving the current situation and bringing value to the industrial base were identified:

BIOTECHNOLOGY APPLIED TO HEALTH AND PHARMACY

- 1.- Biochips and DNA arrays to support clinical diagnosis and prognosis with genetic and clinical parameters.
- 2.- Study of the genetic variability of the Canary Islands population for genetic and molecular characterisation of diseases.
- 3.- Pharmacogenetic approaches for predicting optimum therapy and reducing side effects.
- 4.- Expert computer systems to support clinical diagnosis.
- 5.- Use of natural organic compound libraries for new drug discovery and development.

BIOTECHNOLOGY APPLIED TO AGRICULTURE, LIVESTOCK AND AQUACULTURE

- 6.- Marker-assisted selection for speeding up traditional plant and animal genetic improvement processes.
- 7.- Construction of genetic maps of plant and animal species of economic interest.
- 8.- Development of metabolomics for biochemical characterisation of plant and animal produce and for identifying compounds with high added value for food, pharmacy, chemistry and cosmetics.
- 9.- Establishment and use of germplasm banks for the search for natural diversity with applications in agriculture, livestock and food.

Furthermore, it is not only important to identify areas of priority interest for scientific research, technological development and innovation. It is also necessary to consider measures to complement the current support programmes for these activities; that is, the much discussed encouragement measures to improve scientific excellence, encourage networking among all the participants and speed up the process of obtaining biotechnology applications for industry in the Islands.

It is essential for future development policies in RDI in the Canary Islands to include two types of measures which would allow the strategic position of biotechnology in the Islands to be improved. These are encouragement measures which could feasibly be implemented in the short term, and those whose implementation is somewhat more complicated in view of current programmes, making them more recommendable in the long term.

ENCOURAGEMENT MEASURES RECOMMENDABLE IN THE SHORT TERM

- 1.- Programme for attracting and keeping scientific staff with the aim of increasing scientific excellence in the Islands.
- 2.- Development of Science and Technology Parks to encourage public-private co-operation and a culture of innovation.
- 3.- Development of a technology transfer agency and establishment of scientific projects of industrial interest.
- 4.- Improvement of the incentives for RDI activities to attract investors and promote existing business projects.
- 5.- Maintaining the current tax incentives for investments in the Islands.
- 6.- Strengthening activities to promote and internationalise Canary Islands biotechnology and its context.

ENCOURAGEMENT MEASURES RECOMMENDABLE IN THE LONG TERM

- 7.- Establishment or improvement of service centres for advanced research, particularly in the areas of bioinformatics, genomics, proteomics and metabolomics.
- 8.- Private technology centres to encourage business-based innovation and technological development processes.
- 9.- Financing product development projects aimed at Canary Islands biotech companies.
- 10.- Establishment of a public-private fund of mixed capital to help to channel the major investment potential of the Canary Islands business community towards biotechnology.



In conclusion, we can state that the Canary Islands are very attractive in investment, economic, taxation and social terms, to the extent that they could become a leading biotechnology area in Spain and even in Europe. In order to achieve this, some of the

scientific and technical capacities of the region need to be strengthened, and a series of measures, co-ordinated by the institutions involved, need to be put in place to encourage biotechnology in to order strengthen research, promote scientific and technological co-operation and attract investments.

Annex I: Methodology of the Study

The report was compiled in accordance with the following steps:

- **Synthesis of documents:** Synthesis and assessment of reports of the same nature, with the aim of compiling a list of socioeconomic and technology trends and a list of technologies and likely events of importance up to 2015.
- **Selection of members of the panel of experts:** Identification of the principal participants in biotechnology activities in the Canary Islands from the scientific, technology and economic points of view. Formation of two panels of experts capable of assessing the technological capacities and socioeconomic advantages in the Islands.
- **1st meeting of the panel of experts:** Assessment by consensus of the degree of importance of the technologies chosen as relevant and identification of the technologies critical for the future of biotechnology in the Canary Islands.
- **2nd meeting of the panel of experts:** Assessment by consensus of the priority socioeconomic measures for encouraging biotechnology in the Canary Islands.
- **Analysis of results:** Assessment of the results obtained and definition of the measures, directives and final recommendations.
- **Writing the final report:** Final version sent to the experts of the panel for review.



Annex II: Panel of Experts

ATTENDANTS 1 ST MEETING – SELECTION OF CRITICAL TECHNOLOGIES	
NAME	ORGANISM
Manuel Norte	University of La Laguna
Celedonio González	University of La Laguna
Luís Rodríguez	University of La Laguna
María Jesús Zamorano	University of Las Palmas
Luisa Fernanda Fanjul	University of Las Palmas
Rafael Zárate	Canary Islands Institute for Cancer Research
María José Grajal	Canary Islands Institute for Cancer Research
Cosme García Francisco	Institute of Natural Products and Agrobiology
Donato Monopoli	Canary Islands Technological Institute
Daniel Montero	Canarian Institute of Marine Sciences
José Carlos Rodríguez	Dr. Negrín Hospital
Antonio Tugores	University Hospital Complex - Maternity and Children's Hospital
Eduardo Salido	Canary Islands University Hospital
Rafael Alonso	University Institute of Biomedical Technology
José Antonio Marrero	Laboratorios Pejoseca
Sergio Cáceres	Seaweed Canarias
Ambrosio Hernández	Western Seed



ATTENDANTS 2ND MEETING – SELECTION OF SOCIOECONOMIC MEASURES	
NAME	ORGANISM
Nicolás Díaz Chico	Canary Islands Institute for Cancer Research
Ambrosio Hernández Cabrera	Western Seed
Juan Manuel Alfonso	Canarian Institute of Marine Sciences
José Antonio Marrero	Laboratorios Pejoseca
Antonio Tugores	Hospital Insular de Las Palmas de Gran Canaria (Island Hospital)
Jose Ramón Jiménez	Canary Islands External Promotion Society (PROEXCA)
Brasília Validates	Institute of Tropical Diseases
Gerardo Morales Hierro	Las Palmas Business-University Foundation
Armando Torres Ramírez	Canary Islands University Hospital
Carmel González	Dracaena Bioresearch
Cesar Plasters	Blue Line
Isabel García	Blue Line
Monica Dorset	Consortium of the Canary Islands Special Zone (ZEC)
José Ceresco	Consortium of the Canary Islands Special Zone (ZEC)

Annex III: Technologies Proposed

HUMAN HEALTH

T1	THERAPY WITH PLURIPOTENTIAL CELLS
	Differentiation of pluripotential or stem cells for in vivo use in organ and tissue regeneration.
T2	AUTOMATION IN THE SEPARATION AND IDENTIFICATION OF PROTEINS
	Use of multidimensional chromatography and mass spectrometry for the study of the proteome and data analysis.
T3	DNA MICROARRAYS AND BIOCHIPS FOR MOLECULAR AND CLINICAL DIAGNOSIS
	Development of cDNA or protein microarrays for determining expression patterns or conducting multiple miniature immunoassays.
T4	ANALYSIS OF PROTEIN-PROTEIN INTERACTIONS OR COMBINATORY LIBRARY
	Development of tools to enable large-scale study of the interactions between proteins.
T5	GENOMIC ULTRA-SEQUENCING
	High speed, low cost analysis of an individual's genetic sequence, including SNPs, for application in prevention, diagnosis and personalised therapy.
T6	PHARMACOGENETICS
	Molecular characterisation of disease sub-types for the prediction of optimum therapy and the reduction of side effects (toxicogenomics).
T7	PROTEIN TERTIARY STRUCTURE PREDICTION AND ESTABLISHMENT
	High throughput crystallisation and diffraction methods (e.g. Synchrotron) and the obtaining of protein tertiary structure prediction models from the sequence.
T8	HIGH THROUGHPUT IN THE PRODUCTION OF TRANSGENIC ANIMAL MODELS
	Production of transgenic animal models for large-scale, systematic use in the validation of targets and the development of model systems in the drug discovery process.
T9	CELL AND TISSUE ENGINEERING (INCLUDING GRAFTS AND BIOMATERIALS)
	Technology enabling histological and functional restoration of organs and tissue. Development of biomechanical devices.
T10	CHEMOTHERAPEUTICS AND MONOCLONAL ANTIBODIES
	Discovery of chemotherapeutics and monoclonal antibodies which help to fight specific pathologies and reduce the side effects of a number of treatments.
T11	BIOINFORMATICS FOR PREDICTING PROTEIN ACTIVITY/FUNCTIONALITY
	Development of tools to provide rapid, reliable analysis of protein structures, interactions and functions for the analysis of possible therapeutic targets and the development of more effective drugs.
T12	VIRTUAL LABORATORIES FOR RESEARCH IN GENOMICS AND PROTEOMICS
	Storage systems which allow appropriate handling of the information contained in the genome and proteome for optimum use and understanding in the development of effective therapeutic solutions.
T13	IMPROVED GENE THERAPY AND GENE VACCINATION VECTORS
	Vehicles for the insertion of genetic material to facilitate the cure of genetic diseases while minimising the risks associated.

T14

EXPERT COMPUTER SYSTEMS TO SUPPORT CLINICAL DIAGNOSIS

Computer tools capable of facilitating answers when the data the doctor is dealing with is molecular.

T15

SMALL INTERFERENCE RNA

Use of siRNA for large-scale functional analysis, therapeutic target validation and gene therapy.

T16

LAB-ON-A-CHIP

Miniaturisation of analytical and complex laboratory processes, achieving the optimisation of protocols, the reduction of reaction volumes and the integration of multiple trials on a single chip.

T17

POPULATION GENETICS (DISEASE ANALYSIS)

Study of the genetic variability of natural populations with the aim of providing faster and more effective response to multiple molecular-based diseases and pathologies.

AGRICULTURE AND FOOD

T18

MARKER-ASSISTED SELECTION

Selection of individuals carrying certain markers associated with a trait of interest, in order to minimise time and optimise the response to the selection of varieties and species.

T19

GENETIC MAPS

Maps for locating the sequences and molecular markers existing in organisms of the same species.

T20

TRANSFORMATION PROTOCOLS AND VECTORS

Vehicles which allow a gene or gene fragment to be inserted into a specific organ or plant tissue or simply into all the cells of a plant.

T21

PROTEOMICS

Analysis of an organism's proteome, consisting of ascertaining the quantitative protein levels at a given moment in order to assess the gene expression.

T22

TRANSCRIPTOMICS (MICROARRAYS)

Functional genomics technique which allows large-scale gene expression analysis.

T23

BIOINFORMATICS

Development of tools to provide rapid and reliable analysis of structures, interactions and protein functions.

T24

AUTOMATED IDENTIFICATION AND SEPARATION OF PROTEINS

Use of multidimensional chromatography and mass spectrometry for proteome study and data analysis.

T25

GENE LIBRARIES AND EST COLLECTIONS

Collection of DNA fragments inserted into vectors such as bacteria artificial chromosomes (BACs) and yeast artificial chromosomes (YACs).

T26

MOLECULAR REGISTER OF VARIETIES

Analysis of differential traits using molecular markers in such a way that it is possible to show that a given genotype can be associated with a phenotype and that this combination is new to the extent that a new variety can be described.

	METABOLOMICS
T27	Study of all the small molecules or metabolites which, together with the macromolecules (proteins and nucleic acids), are responsible for establishing and maintaining cellular homeostasis.
	DIRECTED INSERTION AND DELETION/REVERSE GENETICS
T28	Determination of a gene's function from the study of the phenotypic effects of its manipulation.
	GERMPLASM BANK
T29	Collection, characterisation and use of natural resources of interest for the Canary Islands.
	OPTIMISING THE OBTAINING OF PURE LINES (INCLUDING POLYPOIDS)
T30	Improving the methods for obtaining lines which contain the favourable genes regulating a specific trait of interest.

INDUSTRY AND ENERGY

	DISCOVERY AND DEVELOPMENT OF ENZYMES WITH MULTIPLE APPLICATIONS
T31	Discovery and redesigning of enzymes with new properties, activities or functionality through directed evolution and protein engineering tools.
	NEW TECHNOLOGICAL DEVELOPMENTS FOR THE IMMOBILISATION OF ENZYMES AND MICROORGANISMS
T32	Development of technologies which allow enzyme systems or microorganisms to be stabilised.
	TECHNOLOGICAL IMPROVEMENTS IN PRODUCING, PURIFYING AND STABILISING INDUSTRIAL-USE ENZYMES
T33	To improve the performance, costs and working conditions of these biocatalysers.
	BIOCATALYSIS FOR PRODUCING PHARMACEUTICAL PRODUCTS
T34	Use of biocatalysers to obtain more pure compounds which enable traditional industrial processes to be replaced.
	IDENTIFICATION, ISOLATION, PURIFICATION AND EXPRESSION OF INDUSTRIAL ENZYMES BY HIGH THROUGHPUT TECHNOLOGIES
T35	Enzyme production in the least possible time using high throughput technology.
	PROTEIN EXPRESSION AND PURIFICATION SYSTEMS FOR EFFICIENT INCREASE IN PRODUCTION AND HIGH THROUGHPUT FUNCTIONAL TESTING
T36	Development and optimisation of equipment in processes for obtaining larger product quantities.
	BIOLOGICAL OPTIMISATION OF BIOETHANOL PRODUCTION FROM STARCH
T37	Improvement of the biological stages in bioethanol production processes.
	NEW ENZYME TECHNOLOGIES FOR HYDROLYSIS OF CELLULOSE AND HEMICELLULOSE FOR BIOFUEL PRODUCTION
T38	Improvement of the hydrolytic capacity of the enzymes responsible for biomass pre-treatment processes.
	DEVELOPMENT OF ENZYMES AND MICROBIAL PROCESSES FOR THE CONVERSION OF WASTE WATER AND ORGANIC WASTE
T39	Optimisation of the processes of using organic waste for biofuel production.
	MULTIPLE GENE EXPRESSION SYSTEMS FOR METABOLIC ENGINEERING AND PRODUCTION OF COMPLEX ENZYME SYSTEMS
T40	

Understanding the behaviour of biological networks and, in particular, their dynamic aspects.

Annex IV: Measures Proposed

REGIONAL SCIENCE POLICY INSTRUMENTS

- | | |
|-----------|---|
| I1 | CREATION OF REGIONAL R&D CENTRES
Research centres aimed at optimising the scientific and technological capacities in strategic fields and attaining the minimum levels required. |
| I2 | SERVICE CENTRES FOR ADVANCED RESEARCH
Support bodies for the development of RDI activities of research groups, aimed at improving their capacities and increasing scientific quality. |
| I3 | NEWS OFFICE AND LOBBY
Agency with the objective of improving, publicising and developing the quality of biotechnology activity and co-ordinating and structuring basic and applied research. |
| I4 | REGIONAL R&D PROJECTS IDENTIFIED AS PRIORITY
Programme structured with specific areas of aid for research and technological development projects in the field of biotechnology, once the projects have been identified as priority. |
| I5 | PROMOTION AGENCY AND NETWORKING
Communication portal for scientists, businesses and members of the public interested in establishing networks between industry and research centres. |
| I6 | INVESTMENT FUND FOR BASIC RESEARCH
Fund aimed at improving capabilities in scientific excellence and creating new centres of reference in areas of greatest economic importance. |
| I7 | PROGRAMME FOR ATTRACTING AND KEEPING SCIENTISTS
Programme to facilitate the hiring and keeping of science staff at the region's scientific centres. |

SCIENTIFIC AND TECHNOLOGICAL POLICY INSTRUMENTS

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| I8 | SCIENCE AND TECHNOLOGY PARKS
Parks aimed at increasing wealth in the region by promoting a culture of innovation and competitiveness in the companies and institutions located in the park or associated with it. |
| I9 | CO-OPERATIVE PUBLIC-PRIVATE RESEARCH PROJECTS
Demand-oriented projects aimed at the needs of the private sector, with shared financing. |
| I10 | RESEARCH CONSORTIUMS (OWN LEGAL ENTITY)
Consortium of universities, research centres and industries whose activity is centred on financing strategic projects for each participant. |

I 11 **TECHNOLOGY TRANSFER AGENCY**
 Organism responsible for managing all relations with the entities financing university research and for the commercialisation of research results.

I 12 **THINK TANK FOR SERVICES RELATED TO R&D AND BUSINESS-BASED RESEARCH**
 Modular structures created with the aim of responding to specific needs in research fields of great interest (both individual fields as well as research conducted in conjunction with other universities, administrations, organisms or companies).

TECHNOLOGY POLICY INSTRUMENTS

I 13 **PRIVATE TECHNOLOGY CENTRES**
 Business entity which promotes, supports and drives all the innovation and technological development processes in order to improve competitiveness in the business sphere.

I 14 **PRODUCT DEVELOPMENT PROJECTS AIMED AT SMES**
 Sectorial programme specifically based on biotechnology to encourage RDI activities in industry.

I 15 **INCENTIVES FOR RDI ACTIVITIES**
 Programme aimed at improving the positioning of the region's biotechnology industry based on tax incentives for hiring science staff and undertaking activities in R&D in companies.

I 16 **SME CREATION AND SUPPORT CENTRES**
 Structure to facilitate the creation, progress and administration of technology-based companies arising from the academic and business spheres.

I 17 **MIXED FUND OF PUBLIC-PRIVATE CAPITAL**
 Capital fund with financial participation from both the regional administration and regional financial entities.

I 18 **TAX INCENTIVES TO ATTRACT INVESTORS**
 Incentives to reduce the tax burden and encourage companies to make investments.

I 19 **PUBLIC-PRIVATE PROGRAMME TO MANAGE PROJECTS**
 Shared financing programme to support the creation of large-scale strategic innovation and technological development projects which will increase the competitiveness of companies.

I 20 **PROGRAMME TO PROMOTE A BUSINESS ANGELS NETWORK**
 Operational network of venture capital aimed at small and medium-sized enterprises to stimulate growth and competitiveness of industry.

I 21 **ACTIONS TO PROMOTE AND INTERNATIONALISE CANARY ISLANDS BIOTECHNOLOGY**
 Support services for companies in the region for foreign trade activities.