UNITED NATIONS CONFERENCE ON TRADE AND DEVELOPMENT

UNCTAD

Science, Technology & Innovation Policy Review

El Salvador

UNITED NATIONS

ECONOMIC COMMISSION FOR
LATIN AMERICA AND THE CARIBBEAN

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ON TRADE AND DEVELOPMENT
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UNITED NATIONS
New York and Geneva, 2011

UNCTAD/DTL/STICT/2011/4

PREFACE

The purpose of UNCTAD's science, technology and innovation policy reviews is to assist governments in developing their national capacities in science, technology and innovation, so that national science, technology and innovation plans and programmes support the various components of the national development agenda and help the productive sectors to compete in a knowledge-based global economy, generating better paid jobs, raising living standards, reducing poverty and promoting a strategy of growth and commercial diversification.

This review is intended to be a tool for learning and reflection, not a rating mechanism but an analytical tool that examines a series of proposals from a neutral external viewpoint. The ultimate objective of the science, technology and innovation policy review of El Salvador is to provide the Salvadorian Government with an up-to-date diagnostic analysis of the effectiveness of its science, technology and innovation-related policies and measures, and strengthen these policies and measures by integrating them in the national development process. It also seeks to improve technological capacity, encourage innovation and incorporate greater added value into production processes.

The science, technology and innovation policy review of El Salvador was instigated at the request of the Salvadorian Government and enjoyed the support of the Vice Ministry of Trade and Industry and the Vice Ministry of Science and Technology. The review was conducted jointly by UNCTAD and ECLAC and forms part of a proposal of technical cooperation to the Salvadorian Government.

The review was prepared by a team of experts under the direction of Anne Miroux, Director of the Technology and Logistics Division of UNCTAD and under the direct supervision of Mongi Hamdi, Chief of the Science, Technology and ICT Service (UNCTAD). Marta Pérez Cusó (UNCTAD) coordinated the review in collaboration with René Hernández (ECLAC). Roberto López Martínez (national system of innovation) and Eduardo Huidobro (agro-industrial sector) prepared reports which served as the basis for the review. The team of experts carried out two missions in the field, in July 2010 and March 2011, and conducted over 50 interviews and two round tables with representatives of government bodies, research institutes, universities, industry associations and chambers of commerce, experts in science, technology and innovation, companies, non-governmental organizations and international cooperation agencies. The national discussion workshop held on 29 March 2011 in San Salvador permitted the gathering of comments on the first draft from a group of over 40 experts and national actors.

Kiyoshi Adachi, the Salvadorian Association of Computer Professionals (ASPROC), Néstor Bercovich, the Salvadorian Chamber of Information and Communication Technologies (CASATIC), Quentin Dupriez, Reina Durán de Alvarado, Ángel González Sanz and Jorge Patiño contributed invaluable material, comments and suggestions. In addition, a great many people in El Salvador generously contributed their time and comments in the preparation of this review. It is impossible to name them all, but the team responsible for this document wishes to express its appreciation to all of them.

This review would not have been possible without the support of Mr Mario Cerna, Vice Minister of Trade and Industry and Dr Erlinda Handal, Vice Minister of Science and Technology. The Directorate of Technological Innovation, headed by Mr Yax Canossa and assisted by Mrs Verónica López and the National Directorate of Science, Technology and Innovation, headed by Dr Alba María Orellana González were closely involved in the review and deserve our since gratitude.

The evaluations and conclusions expressed in the review, however, are exclusively those of the UNCTAD Secretariat and ECLAC.

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ABBREVIATIONS

AFIS:	Support and training in internationalization of Salvadorian companies
ASI:	Salvadorian Association of Industrialists
AVES:	Association of Poultry Farmers of El Salvador
BFA:	Agricultural Promotion Bank
BH:	Mortgage Bank
BMI:	Multisectoral Investment Bank
CAMAGRO:	Agricultural and Agro-industrial Chamber of El Salvador
CAMARASAL:	Chamber of Commerce and Industry of El Salvador
CDB:	Convention on Biological Diversity
CENDEPESCA:	Centre for Fisheries and Aquaculture Development
CENSALUD:	Centre for Research and Development in Health
CENTA:	National Centre for Agricultural and Forestry Technology
CICES:	National Centre for Scientific Research of El Salvador
CIMMYT:	International Maize and Wheat Improvement Centre
CNR:	National Records Centre
CONACYT:	National Council for Science and Technology
CONAMYPE:	National Commission for Micro and Small Enterprises
CORSAIN:	Salvadorian Investment Corporation
DCP:	Directorate of Quality and Productivity
DIDT:	Directorate of Innovation and Technological Development
DIGESTYC:	Directorate General of Statistics and Censuses
ECLAC:	Economic Commission for Latin America and the Caribbean
ENA:	National School of Agriculture
FANTEL:	Special Fund of resources from the privatization of ANTEL (National Telecommunication Administration)
FAO:	United Nations Food and Agriculture Organization
FDI:	Foreign Direct Investment
FEDA:	Special Trust for Agricultural Development
FIAGRO:	Foundation for agricultural technological innovation
FIES:	Higher Education Research Fund
FODECYT:	Fund for Scientific, Technological Development and Innovation
FOEX- FONDEPRO:	Productive Export Development Fund
FOMILENIO:	Millennium Fund
FOMIN:	Multilateral Investment Fund
FUNDE:	National Development Foundation
FUSADES:	Salvadorian Foundation for Economic and Social Development
GDP:	Gross Domestic Product
GPI:	Group for the Promotion of Innovation
IADB:	Inter-American Development Bank
ICT:	Information and Communication Technologies
IES:	Higher Education Institutions
IICA:	Inter-American Institute for Cooperation on Agriculture
INSAFORP:	Salvadorian Institute for Professional Training
ISEADE:	Higher Institute of Economics and Business Management
IT:	Information technology
ITCA-FEPADE:	Central American Technological Institute
JICA:	Japan International Cooperation Agency
KAM:	Knowledge assessment methodology

LDCyT:	Scientific and Technological Development Act
MCC:	Millennium Challenge Corporation
MEGATEC:	Technical and Technological Gradual Learning Education Model
MINAG:	Ministry of Agriculture and Livestock
MINEC:	Ministry of Economy
MINED:	Ministry of Education
MSMEs:	Micro, small and medium-sized enterprises
MSEs:	Micro and small enterprises
NSI:	National System of Innovation
OECD:	Organization for Economic Cooperation and Development
PAES:	Secondary school leaving certificate of education and aptitudes
PAESITA:	Assessment of learning achievements in primary education
PDP:	Productive development project
PPP:	Purchasing Power Parity
PQD:	Five-Year Development Plan
PROCAFÉ:	Salvadorian Foundation for Coffee Research
PROESA- EXPORTA:	Export and Investment Promotion Agency
R&D:	Research and Development
REDISAL:	Network of Salvadorian Researchers
RICYT:	Network of Science and Technology Indicators - Ibero-American and Inter-American
RREE:	Ministry of Foreign Relations
RSI:	Regional System of Innovation
SIEPAC:	Central American Electric Interconnection System
SIGET:	General Superintendency of Electricity and Telecommunications
SINACTI:	National System of Science, Technology and Innovation
SINALIT:	System of Partnership for Agricultural and Forestry Technology
SSF:	Superintendency of the Financial System
S&T:	Science and technology
STA:	Science and Technology Activities
STI:	Science, technology and innovation
UASA:	Autonomous University of Santa Ana
UCA:	José Simeón Cañas Central American University
UDB:	Don Bosco University
UES:	University of El Salvador
UJMD:	Dr José Matías Delgado University
UNCTAD:	United Nations Conference on Trade and Development
UNDP:	United Nations Development Programme
UNESCO:	United Nations Educational, Science and Cultural Organization
UNICAES:	Catholic University of El Salvador
UNSD:	United Nations Statistics Division
UO:	Oriente University
USAM:	Alberto Masferrer University
USPTO:	United States Patent and Trademark Office
UTEC:	Technological University
WEF:	World Economic Forum
WIPO:	World Intellectual Property Organization
WOS:	World of Science
WTO:	World Trade Organization

EXECUTIVE SUMMARY

El Salvador, a small and open economy, poorly endowed with natural resources, needs to base its growth on increased productivity and economic transformation towards activities with a higher added value.

In order to bring about this transformation, the country must focus on developing its own capacities to adopt, use, adapt and generate knowledge. This requires, firstly, investment (both public and private) in knowledge-generating activities and innovation, and, secondly, the strengthening of a national system of innovation which fosters and facilitates these activities and their application in the productive sectors.

There are signs that various efforts have been made in El Salvador, often against a difficult background of scarce resources, to encourage the development of these capacities. Among other things, the Government of El Salvador has invested in knowledge-generating activities and the promotion of a national system of innovation.

The country has various capacities in the sphere of science, technology and innovation which can serve as the basis for progress and successful results. There is scientific research with international impact, especially in the area of the health sciences. There are also the nuclei of good quality education. There are innovative companies, for example in the agro-industrial and pharmaceutical sectors, and some positive experience of university-company collaboration, for example, in the design of specific study programmes. There is interest in various spheres in promoting science, technology and innovation, from various public institutions, non-governmental organizations and international cooperation agencies. However, there is a general lack of interest on the part of the private sector. Lastly, the bases of the legal framework are adequate so that they do not act as a brake on innovative activities.

In addition, in El Salvador, there are a number of factors which offer opportunities for the development of capacities in science, technology and innovation. The country has a good road and air transport system and telecommunications infrastructure (especially mobile phones). There are also national programmes, such as the port of La Unión or Fomilenio, which, given their resources and geographical localization, provide opportunities for the development of technological capacities and innovation, particularly at the regional level. The strong presence of Salvadorians abroad is a channel for access to valuable resources and knowledge. The diversification of production offers opportunities for progress in many areas, such as the beverages and food industry or the pharmaceutical sector, and the opening of trade is an incentive to innovation by increasing competition and by facilitating the purchase of capital goods and access to new technologies. International cooperation makes an important contribution to the development of innovation skills, and there are ample opportunities for greater international collaboration in research and innovation. Lastly, there is broad and continuing agreement in the country on the macro-economic stability policies and openness to the outside which encourages the private sector (domestic and foreign) to have the confidence to invest in the country.

However, at present, El Salvador lacks adequate systemic conditions to develop capacities to adopt, use, adapt and generate knowledge. There is no government body which provides cohesion and direction to policies concerning STI. Neither is there an articulated system of STI policies, but rather isolated policies focused either on science and technology or on innovation, industrial development or exports. No foresight exercise has been carried out to identify research strengths and production capacities, and establish priorities from which development programmes and policy instruments are derived. A lack of monitoring and evaluation of policies and programmes to allow making the necessary adjustments was also observed.

As regards the generation of knowledge, the research sector is weak in human and financial resources, has little private involvement and is heavily weighted towards the social sciences and humanities. Levels of investment in R&D, both public and private, are extremely low. Furthermore, there is little contact between the knowledge generating bodies and the productive sector and current research efforts have little impact on improvements in production. The productive sector does not demand knowledge or technology, there is little awareness of the utility of knowledge in generating value, there are few financing options and a limited number of innovation policy instruments with limited budgets.

The education system suffers from serious weaknesses. Education in general, and higher education in particular, has ample room for improvement, especially in terms of quality, the expansion of science and technology teaching and research work.

In addition, the country must face the challenge of building STI capacities against a background of scarce public resources. The weaknesses of public institutions, for example in the sphere of policy coordination, also represent a threat to the development of these capacities which require broad agreement and clear and continuous guidelines. The heterogeneous nature of business, where there is a large micro and small enterprise sector with low productivity, will also determine the objectives which the country can achieve in STI. The consumption culture acts as a disincentive to productive investment, and the rise in international competition, without greater capacity for technological absorption, among other factors, will cause difficulties to Salvadorian companies. Lastly, the cost of criminality, natural disasters and external shocks (such as the sharp increases in the price of oil or other commodities or drastic reductions in remittances) and the country's fragility in the face of these phenomena, should not be overlooked.

The analysis of innovation in agro-industry and the information and communication technologies sector broadly reaches conclusions similar to the observations on the national system of innovations. Among other things, insufficient levels of investment in R&D were observed, scarcity of trained human resources, especially at postgraduate level, the lack of a national programme to guide development and innovation in these sectors, and a lack of links between institutions and the main stakeholders.

Based on the foregoing diagnostic, a series of recommendations are suggested focusing on five major pillars:

Recommendation No. 1: Establish an institutional and administrative, human and financial framework able to lead and coordinate the development of STI in El Salvador

Establish a regulatory body for science, technology and innovation with the responsibility of defining the major strategic lines in STI, integrating STI in the national development strategy and monitoring and evaluation of policies. This would include coordination of efforts to collect information on STI and the management of foresight activities.

This body must be given the authority, leadership and resources necessary to carry out its mission. Consequently, it is proposed that it should be **headed by the President of the Republic**, and composed of the Ministers of Economy, Education and other ministries of particular relevance (Agriculture and Livestock, Health), as well as high-level experienced representatives of the academic, productive and financial sectors. Given the cross-cutting nature of this body, it would be logical for its secretariat to be included as part of the Technical Secretariat of the Presidency. The implementation of the national policy would be in the hands of the respective ministries.

Recommendation No. 2: Draw up a combination of STI policies and programmes which, linked to economic and education policy, will strengthen general STI capacities

Based on the technological foresight survey and a process of consultation with the various key actors, **identify 3 or 4 priority sectors and strategic technologies** on which to focus active policies.

Establish a short-term **National Science, Technology and Innovation Plan**, with specific and measurable objectives, clearly identified responsibilities and resources, and subject to a control system.

Increase **public investment in STI**, and foster **private investment in R&D and innovation** by establishing incentives, strengthening competitive funds for R&D and innovation, and developing a seed capital and venture capital programme.

Promote **sectoral and regional systems of innovation,** promoting cooperation between agents and establishing framework conditions to allow such cooperation.

Develop a **science, technology and innovation information system** which includes regular surveys of innovation and

the use of ICT in enterprises, monitoring and evaluation of the various STI policies and programmes, and an STI observatory which directs and disseminates the results of these activities.

Recommendation No. 3: Invest in the development of Salvadorian human capital

Strengthen the national education system, by increasing public expenditure on education, strengthening quality control of education, through accreditation and certification of institutions and programmes, and strengthening the teaching of mathematics and the natural sciences.

Facilitate the provision of and access to **high quality postgraduate education**, in particular in the priority areas. Increase the financial resources allocated to these studies, explore models which involve companies in the financing of scholarships, strengthen bilateral cooperation with research centres and postgraduate training centres.

Update the training offered by the Salvadorian Institute for Professional Training (INSAFORP) and strengthen its programme management based on a consultation exercise with the private sector.

Establish a programme for **repatriating and/or taking advantage of Salvadorian talent** abroad.

Recommendation No. 4: Strengthen entrepreneurial innovation

Strengthen programmes of innovation and technology transfer by channelling financial resources for innovation through the support bodies which have promoted it effectively, and establish sectoral technology centres[1] linked to productive activities with the participation of knowledge generating bodies.

Develop **technological intelligence capacities**.

Support the development of technology-based **company incubators**, establishing an incubation fund, promoting the establishment of company incubators, and facilitating the development of venture and seed capital.

Include the development of **technological capacities in the relevant national development programmes**, such as FOMILENIO or the management of the port of La Unión.

Establish a programme of **promotion and training in the management of intellectual property**, for example, in universities and research centres. In the long term, contemplate the establishment of a separate body for the management of intellectual property.

Promote collaboration between universities, technological and specialized institutes and companies, by stimulating joint development programmes between universities and companies, reviewing possible obstacles of a regulatory character; include private sector participation in the design of STI policies and the formulation of study plans, and establish an education and training programme on management and transfer of technology in higher education institutions.

Ensure that one of the cornerstones of the set of policies aimed at promoting structural transformation and productive development (diversification of exports, strengthening productive chains, formation of productive agglomerations and development of a national quality system), is the development of technological and innovation capacities.

Recommendation No. 5: Strengthen research capacities

Establish 4 or 5 **research fellowships** in the priority sectors, develop a **mechanism for accreditation of the country's researchers,** and, based on a national evaluation, draw up a plan to strengthen the **research infrastructure**.

The Review also makes a number of suggestions to promote innovation in the agro-industrial and information and communications technology sectors, which are in line with the recommendations described above.

In the agro-industrial area, it is proposed to:

1) **Develop a national programme for the development of agro-industry, in the framework of a national system of agricultural and agro-industrial innovation,** establishing a joint working group on the promotion of innovation, which supports the identification of two or three priority agro-industrial sectors, and develops the configuration of a national system of agricultural and agro-industrial innovation.
2) **Strengthen the quality of education and training in the agricultural and agro-industrial sector, in particular, the priority sectors or industries,** reviewing education and training needs (students, teachers, extension workers and companies), establishing a programme of scholarships and strengthening the capacities of the ENA.
3) **Support agricultural and agro-industrial research in universities, research centres and companies,** increasing public financing, establishing one or two research fellowships (at postgraduate level) in one or two agro-industries, promoting the participation of agro-industrial companies in research activities, and strengthening agricultural innovation and research by CENTA.
4) **Promote the expansion of innovation in the private sector,** by, among other things, establishing two or three local technological training and innovation centres, reviewing incentives for innovation, developing greater provision of advanced technological services, promoting a culture of entrepreneurial cooperation and innovation, developing the agro-industrial infrastructure, building capacity to adopt good agricultural and manufacturing practices and to comply with sanitary and phytosanitary standards, preparing more specialized technical and market studies for agro-industrial products, carrying out studies in the priority agro-industries, and developing capacities in biosafety and biotechnology.
5) **Strengthen monitoring and evaluation of capacities, policies and programmes,** consistent with the general recommendations provided for the national system of innovation.

In the ICT area, it is suggested to:

1) **Develop a national strategy for the development of the ICT sector,** strengthening the productive aspects of the eCountry Programme, and establishing a forum for dialogue between the education sector, public bodies and representatives of the private sector. This strategy should focus on the following areas.
2) **Improve the quality of education and training,** through financial support for certification and accreditation of persons, institutions and companies; promoting the updating of educational provision, establishing a programme of scholarships, and reviewing the ICT training provided by INSAFORP.
3) **Support ICT research in universities and companies,** by increasing financing of ICT research, and establishing one or two research fellowships in ICT.
4) **Establish a set of measures to develop greater business sophistication in the sector.** It is suggested, among other things, to strengthen the mechanisms of incubation of technology-based companies, strengthen the supply of services and capacities in competitive intelligence, foster the development of other sectors which complement the development of technology-based companies (especially the content industry), consolidate initiatives to support innovation in ICT undertaken by the Ministry of Economy, promote the adoption of ICT by SMEs, promote more electronic government services, and facilitate the participation of domestic companies in public procurement.
5) **Collect information on innovation activities and areas of greatest potential and strengthen monitoring and evaluation of capacities, policies and programmes,** consistent with the general recommendations provided for the national system of innovation.
6) **Complete the current regulatory framework,** in particular, facilitate the adoption of the bills on electronic signatures and transactions, and data protection, and review possible obstacles in the regulatory framework in order to strengthen the impact of public procurement on the development of the domestic ICT industry.

This set of strategic recommendations should be implemented through commitment at the highest level and broad dialogue with all the key stakeholders. The principal starting points will be the establishment of a regulatory body for STI, the conduct of a technology foresight survey and the establishment of priority development areas.

Implementing these activities will require significant efforts and resources. In this regard, UNCTAD and ECLAC are at the disposal of the Government of El Salvador, to the extent that resources are available, to continue to support the development of these proposals through technical guidance, training and the promotion of participatory processes, dialogue and sharing of experiences in the area of STI policies.

INTRODUCTION

There is now broad agreement on the function of innovation as an engine of development and sustained economic growth in the long term. The introduction of new products, process and organizational or marketing methods can transform quantitatively and qualitatively the performance and structure of the economy and society as a whole (ECLAC, 2010a, 2008). As Schumpeter maintains (1934), innovation is an authentic engine of development which, by generating processes of "creative destruction", is capable of promoting and maintaining prolonged cycles of growth over time.

By innovation, we mean the implementation of a new or significantly improved product (good or service), or process, a new marketing method or a new organizational method in business practices (OECD 2005). The dimension of newness is measured in terms of whether the implementation is new for the firm or for the market. Innovation thus includes the acquisition of knowledge and activities of imitation and adaptation, innovation mechanisms which in developing countries are often more important than research and development activities (R&D).[2]

Intrinsic qualitative and quantitative differences between productive sectors and activities exist. There are activities which are considered "positive" for growth in the long term (those which are knowledge intensive), as they generate externalities, processes of technological shift and incentives to innovation and learning which support the accumulation of technological capacities in the long term (ECLAC 2010a, UNCTAD 2007).

It is also found that knowledge and technology act as a catalyst in development processes and the specific characteristics of knowledge and the generation and dissemination of knowledge justifies the intervention of the State.

On the one hand, there is a need to correct various market failures, such as uncertainty, transaction costs, difficulties in diversifying risk, information imbalances, or the lack of knowledge appropriability[3]. These are a disincentive to private investment in knowledge generation, resulting in levels of investment below the social optimum.

On the other, knowledge has tacit elements and its appropriation by companies, individuals and organizations depends not only on the acquisition of machinery or the transfer of a set of instructions, but also on the acquired technological capacities, i.e. knowing how to do and knowing how to learn. Tacit knowledge is generated in specific contexts, based on practice, interaction and learning over time, and it is not transferable. For these reasons, the necessary conditions must be created to allow these interactions and learning to occur, and to develop capacities to absorb technology. The institutional framework influences the capacity of the actors to interact and learn, and thus it conditions the possibilities of generating and using knowledge. This framework conditions, for example, the possible alignment of the needs of knowledge users (i.e. the productive sector) and the activities of knowledge-generating organizations (e.g. universities, public research institutes). This institutional framework, i.e. the set of institutions which interact and complement each other in the creation and dissemination of new technologies and which make up the policy agenda implementation of those policies by governments, is a way of defining what is generally called a National System of Innovation (Metcalfe 1995).

It should be noted that economic openness, and the processes of specialization and growing participation in the international production chains which accompany this openness, do not guarantee the possibility of benefiting from the indirect dissemination of technology. On the contrary, in open economies, knowledge seems more a good reserved for certain groups (club good), non-rivalrous but subject to exclusion with respect to consumption. Position in the value chain determines the capacity to use that good (Cimoli, Ferraz and Primi, 2007). For example, access to capital goods and technology licences have been powerful sources of technological modernization, but have been confined to large, leading companies and have not spread to the rest of the productive system.

Given these characteristics and conditions, a series of coordinated and coherent policies or policy mix are needed to correct the various market and systemic failures, stimulate the development of capacities for assimilation and facilitate the participation of the national productive system in the global economy. Cross-cutting policies

are needed which address market failures and information imbalances, promote training, facilitate the general dissemination and assimilation of knowledge, and allow companies to improve their current position within the limits of their possibilities of innovation. Vertical and selective policies are also needed to support specific sectors and technologies, encourage cooperation and articulation between universities, research institutes and companies, and allow the generation of useful knowledge and entrepreneurial competitiveness at international level. There is also a need for facilitating policies which rectify systemic weaknesses and extend possibilities of innovation to all companies. Policies which promote development of the knowledge infrastructure and establish an adequate institutional framework so that the various actors in the system of innovation interact, learn and have a clear reference framework.

There is no optimal science, technology and innovation policy. The goals and instruments of STI policies must reflect the specific context and needs of each country. Financial capacities, the historic baggage of STI policies and institutions[4] as well as current capacities will determine the relevance of one or another type of policy or instrument.

Lastly, successful experiences highlight the importance of synchronizing STI polices and national social, economic and productive development policies in minimizing coordination failures and the overlapping of different policies and ensuring consistency over time. It is also beginning to be recognized that the success of policies is not determined ex ante, and requires, on the contrary, a continuous learning process based on trial and error mechanisms[5] as well as a strong decision making structure when designing science, technology and innovation institutions and policies (ECLAC 2009, UNCTAD 2007).

Based on these concepts and ideas, this report evaluates the state of El Salvador's capacities in science, technology and innovation. The study examines the various elements of the national system of innovation, evaluating the current capacity of the system to use and generate knowledge.

The purpose of the report is to present a set of recommendations intended to encourage an environment in which the different agents can interact and participate, create the infrastructure and conditions necessary to acquire, use, adopt and generate knowledge, achieve optimal levels of productive investment and achieve robust and durable economic and social results.

The first chapter presents the general context in which productive activities take place in El Salvador. It includes a presentation of the economic and social context which frames the objectives and determining factors of STI and an evaluation of current performance in science, technology and innovation.

Chapter II describes the national system of innovation in El Salvador, based on five strategic functions: cohesion, foresight, management and control, regulation, and production-execution. The chapter also presents the principal innovation policy instruments used in El Salvador.

Chapter III goes on to provide a diagnostic of the national system of innovation, with a view to identifying these strategic areas in which the Government's policies, programmes and actions can have the greatest influence on the development of STI in El Salvador, and analyses the various proposals for strengthening the components and relations of the country's national system of innovation.

Chapters IV and V provide a more detailed examination of the system of innovation in two sectors chosen by the Government of El Salvador: agro-industry, and information and communication technologies (ICT). Agro-industry has a considerable importance, given its potential to create added value and serve as a stimulus for agricultural and rural development. The ICT sector is of great importance on account of its potential for underpinning the development of a new techno-productive paradigm and its cross-cutting character, which enable it to influence a large number of productive activities and sectors.

Finally, Chapter VI offers a series of recommendations designed to strengthen the national system of innovation and a possible road map which marks out the actions which could be taken in the short, medium and long term.

NOTES

[1] Included in the Integral Export Development Strategy 2010-2014.

[2] See, for example, Dosi, Pavitt and Soete (1990).

[3] The lack of possibility of exclusion and non-rivalry in the consumption of knowledge hinders the full appropriability of the benefits of the generation of knowledge and discourages private investment in its generation, resulting in levels of investment below the social optimum.

[4] Achieving effective reform of institutions inherited from the past and redefining and articulating the various aims of institutions created on the basis of different rationales and contexts are some of the main challenges that have to be faced by STI policies (ECLAC 2008, 2009).

[5] As part of the great variety of "learning by doing" or "learning by interacting", forms of internal learning called "learning by failing" have been identified, whereby learning comes more through error than success.

I

General background of science, technology and innovation in the economy of El Salvador

El Salvador is the smallest and, with six million people, the most densely populated country in Central America. It is situated on the shore of the Pacific Ocean, between Guatemala and Honduras. To provide a better understanding of the state and background to science, technology and innovation in El Salvador, this chapter seeks, firstly, to describe the chief economic features which frame the country's technological and innovative development. It then goes on to analyse the country's current achievements in science, technology and innovation.

During the last two decades (in which a series of structural reforms and liberalizing economic policies were implemented following the signing of the Peace Accords in 1992), El Salvador has achieved constant, albeit modest, economic growth, with an average growth rate of 3.5 per cent over the period 1990-2009 (Figure 2).

This economic growth is not sufficiently robust or balanced to promote sustainable social and economic development.

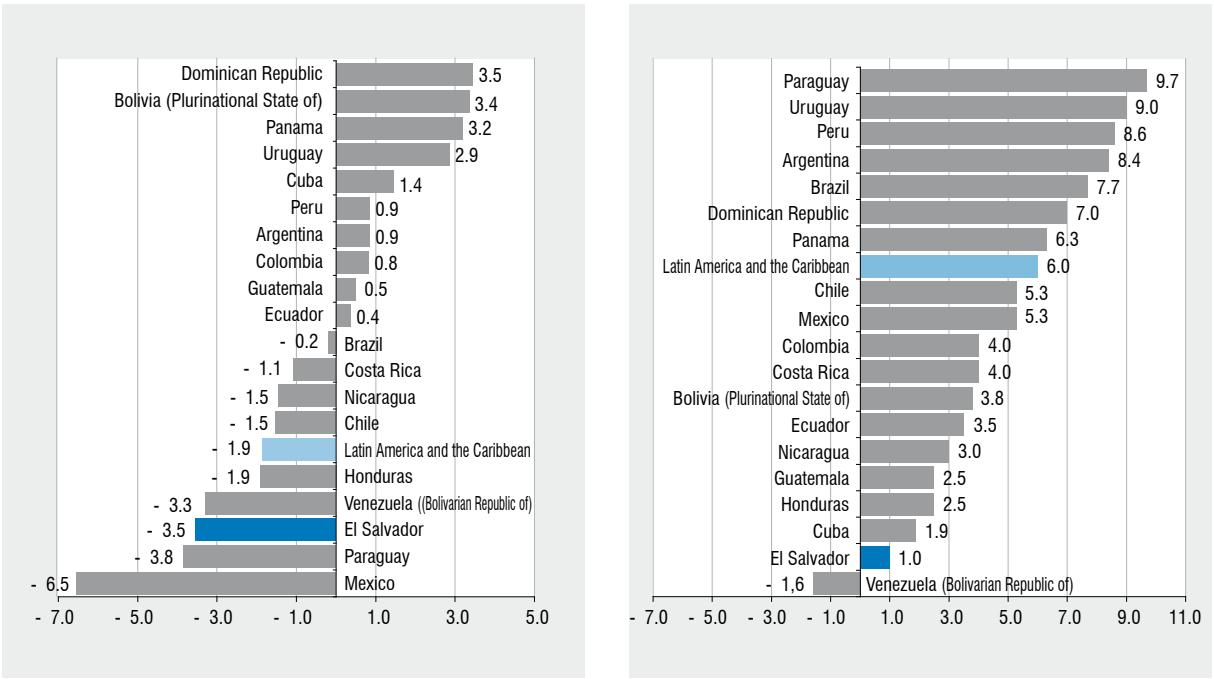
In 2009, gross domestic product (GDP) contracted by 3.5 per cent and grew very modestly (1 per cent) in 2010 (ECLAC 2011). Moreover, the impact of the economic crisis was more serious and the level of recovery much lower in the Salvadorian economy than in the rest of Centroamerican countries (Figure 1).

The inadequate growth is related to the high levels of migration, high under-employment and the constant decline in real wages. Each year, over 60,000 Salvadorians (in net terms) emigrate in search of better opportunities. At present, some three million Salvadorians live abroad[1], and remittances sent by Salvadorians from abroad accounted for 16.4 per cent of GDP in 2009. Forty per cent of the economically active population is under-employed[2], and the labour underutilization rate (unemployment plus under-employment) reaches 50 per cent of the economically active population (UNDP 2010b). Lastly, it should also be noted that since 1992, average real wages have stagnated (UNDP 2010b).

The country's long-term economic development cannot be sustained by family remittances or by a competitiveness based on a low cost labour market. For productive activity in El Salvador to be competitive while at the same time workers are paid a fair wage, productivity must be improved based on technological improvements and business innovation.

Analysis of the performance of the Salvadorian economy shows that the country suffers from low multifactor

Figure 1. Latin America and the Caribbean: annual GDP growth rate, 2009-2010 (as percentage)



Source: UNCTAD, based on ECLAC 2011.

productivity. In other words, innovation and technology have made scant contribution to GDP growth and have even had an adverse impact (Table 1).

Advances in a country's output levels are closely related to its scientific, technological and innovative capacity. The development of productive capacity and dynamic competitiveness requires both the development of human resources that are capable to assimilate, adapt and develop technology in a way that can be integrated in local productive processes, and the development of a set of conditions conducive to innovation and the introduction of improved productive processes.

Table 1. GDP growth and critical factors of growth in El Salvador, 1950-2009

	GDP	Multifactor productivity	Capital	Labour
1950-1959	4.7	1.5	2	1.2
1960-1969	5.6	2.2	1.5	1.9
1970-1979	3.8	-1.3	2.4	2.7
1980-1989	-2.1	-3.2	0.3	0.8
1990-1999	4.9	1.3	1.2	2.4
2000-2009	2.1	-0.2	1.0	1.3

Source: UNDP (2010) – Based on Fusades, 2003.

Section A below provides a summary of the macro-economic performance and structural conditions governing the country's productive performance. Section B, in turn, presents its performance in terms of science, technology and innovation with a summary of the principal science, technology and innovation indicators in El Salvador.

A. PERFORMANCE AND EVOLUTION OF THE SALVADORIAN ECONOMY[3].

1. Macro-economic performance

El Salvador is ranked fourth among Central American economies in terms of GDP, third in terms of per capita income (3,430 dollars), behind Costa Rica and Panama. In terms of human development, El Salvador is ranked 90th according to the Human Development Index 2010, also behind Costa Rica and Panama (Table 2).

In the last two decades, El Salvador has implemented a set of liberal economic policies with the objective of developing an open economy (centred on production for export and attracting foreign investment) and achieving macro-economic balance. A series of structural reforms were undertaken, including a major privatization and liberalization process of the financial, electricity and telecommunications sector and the pension system. In 2001, the Salvadorian economy was converted to the dollar in order to promote stability for investors, reduce inflationary pressures and reduce real interest rates. Several free trade agreements were signed with Colombia, Guatemala and Honduras, the United States (DR-CAFTA), Panama, Mexico, Chile and Taiwan, Province of China. The Salvadorian Government also pursued a prudent fiscal policy.

These structural reforms and economic policies led to the development of the supply of important economic services in the country, the diversification of the economy and a degree of economic stability, with inflation under control, but did not achieve robust or economic growth (Figure 2).

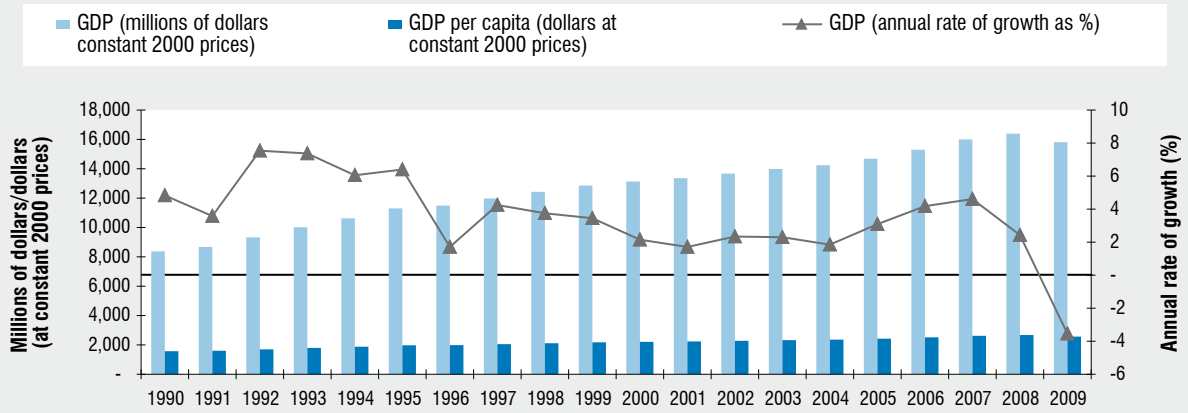
The chief reasons for this sluggish economic growth can be found in low levels of investment and national

Table 2. El Salvador in the Central American context, 2009

	Costa Rica	El Salvador	Guatemala	Honduras	Nicaragua	Panama
GDP (millions of dollars)	29,240	21,101	37,322	14,318	6,140	24,711
GDP per capita (purchasing power parity dollars)	11,106	6,629	4,720	3,842	2,641	13,057
Total population	4,578,945	6,163,050	14,026,947	7,465,998	5,742,800	3,453,898
Area (km2)	51,060	20,720	107,160	111,890	119,990	74,340
Human Development Index 2010 (ranking)	62	90	116	106	115	54

Source: World Development Indicators, World Bank; UNDP (2010a).

Figure 2. GDP growth rates and trends, 1990-2009



Source: UNCTAD, based on World Bank.

savings. El Salvador consumes more than it produces. The inflow of family remittances[4] financed high levels of consumption which could not be satisfied by domestic production and led to the importing of goods and services, thus creating significant distortions in the balance of goods and services. Family remittances have not been used for investment purposes[5] and have even been accompanied by a decline in the rate of national saving. The expansion of private credit has also served to finance high levels of consumption. The high volume of remittances also threatens the country's industrialization, by increasing the price of non-tradeable products and causing a loss of competitiveness in the traditional export sector.

Table 3 shows that El Salvador invests less in gross fixed capital formation than the other Central American countries, both as a proportion of GDP and in absolute terms[6]. In addition, the savings and investment necessary to develop productive capacity have been declining in recent years (Table 4).

Lastly, the low levels of tax revenue and high levels of debt restrict the availability of public resources. It is estimated that, in 2010, total public debt stood at 50 per cent of GDP and the tax collection capacity was only 13.2 per cent of GDP (ECLAC 2011).

In the short term, one of the chief concerns of economic policy is to achieve fiscal targets and the structural reform criteria stipulated in the stand-by agreement signed with the International Monetary Fund (IMF) in 2010 with a precautionary loan of 790 million dollars.

Trade and trade policy

El Salvador has pursued an open trade policy based on the development of the manufacturing industry for export (assembly for re-export). Consequently, since 2005, export manufacturing has accounted for a considerable volume of exports and, after family remittances, is El Salvador's principal source of foreign exchange. The remainder of the export sector is highly diversified. Among the biggest exports are traditional products such as coffee and sugar, as well as other non-traditional items such as prepared medicines. Manufactured products with a high or medium technological intensity are only a small proportion of exports. The principal services exported come under the heading of transport and travel, although transport

Table 3. Gross fixed capital formation, Central American countries, 2009

	Panama	Costa Rica	El Salvador	Guatemala	Honduras	Nicaragua
As percentage of GDP	23.80	26.70	13.12	15.07	22.58	27.31
Growth rate (%)	-6.21	-15.78	-17.43	-15.46	-32.40	-22.54
Millions of dollars	5,881	7,807	2,768	5,624	3,233	1,677

Source: World Development Indicators, World Bank.

Table 4. El Salvador: selected economic indicators, 2004-2009

	2004	2005	2006	2007	2008	2009
Total demand in millions of dollars (constant 1990 prices)	13,194	13,636	14,479	15,339	15,849	14,014
National consumer spending	8,380	8,783	9,201	9,927	10,318	9,408
Household	7,737	8,126	8,530	9,269	9,622	8,682
Public administrations	643	657	671	658	695	726
Gross capital formation	1,540	1,607	1,857	1,754	1,671	1,380
Gross fixed capital formation	1,485	1,513	1,703	1,754	1,671	1,380
Private	1,337	1,317	1,505	1,570	1,466	1,167
Public	148	197	198	184	206	213
Variation in assets	55	94	154	0	0	0
Exports of goods and services	3,274	3,246	3,422	3,658	3,861	3,226
Total supply in millions of dollars (constant 1990 prices)	13,194	13,636	14,479	15,339	15,849	14,014
Imports of goods and services	5,026	5,196	5,684	6,163	6,450	4,948
GDP	8,168	8,440	8,795	9,176	9,399	9,067
GDP per capita (current dollar prices)	2,621	2,846	3,087	3,341	3,609	3,430
GDP per capita (constant 1990 dollars)	1,355	1,395	1,448	1,505	1,535	1,474
Real GDP rate of growth per capita	1.5	3.0	3.8	3.9	2.0	-4.0
Inflation rate	5.4	4.3	4.9	4.9	5.5	-0.2
Family remittances as percentage of GDP	16.1	17.5	18.5	18.1	17.1	16.4
Real rate of GDP growth	1.9	3.3	4.2	4.3	2.4	-3.5
Consumption	2.8	4.9	5.0	8.3	4.3	-9.8
Government	0.1	0.2	0.2	-0.2	0.4	0.3
Private	2.7	4.8	4.8	8.4	3.8	-10.2
Investment	-0.8	0.8	3.0	-1.2	-0.9	-3.1
Exports	1.4	-0.3	2.1	2.7	2.2	-6.9
Imports (-)	1.6	2.1	5.8	5.5	3.1	-16.3
GDP (in millions of dollars at current prices)	15,798	17,214	18,749	20,377	22,107	21,101
Gross national saving	1,918	2,117	2,403	2,025	1,614	2,394
Private	1,700	1,872	2,063	1,570	1,220	2,662
Public	218	245	340	455	393	-268
Foreign saving	642	610	783	1,221	1,682	374

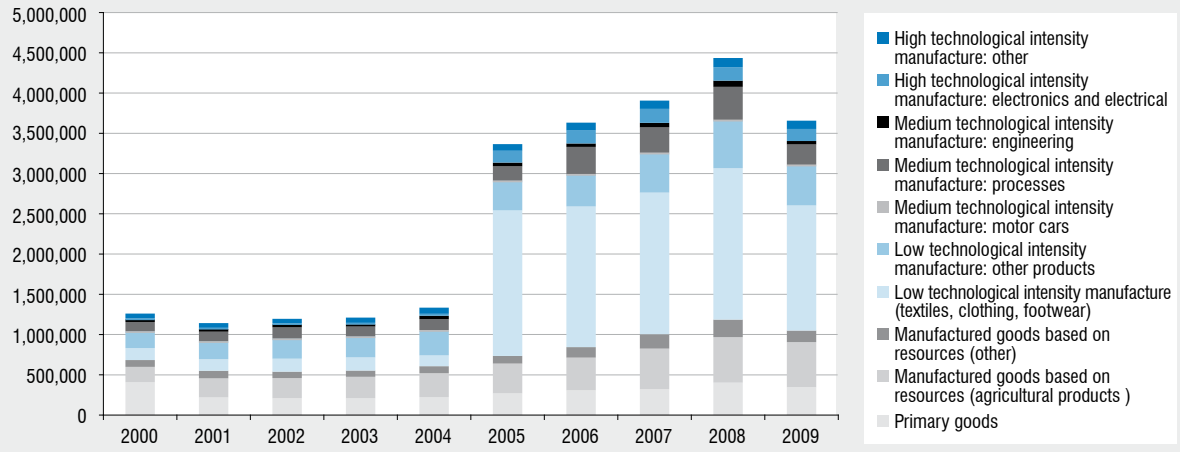
Source: UNCTAD, based on UNDP (2010) and ECLAC data (2010).

shows a negative balance (see Tables 5 and 6 and Figure 3). The appreciation in the real exchange rate (Table 7) has not helped exports of Salvadorian products.

Imports are beginning to recover after their dynamic growth was restrained by the 2009 crisis (Figure 4). The breakdown between consumer goods, intermediate goods and capital goods remained more or less stable, subject to price fluctuations (cf. oil prices). However, a tendency to an increase in the weight of consumer goods in total exports can be seen, together with a fall in transport and communication goods and imports by the export manufacturing industry as a result of the crisis (Figure 4).

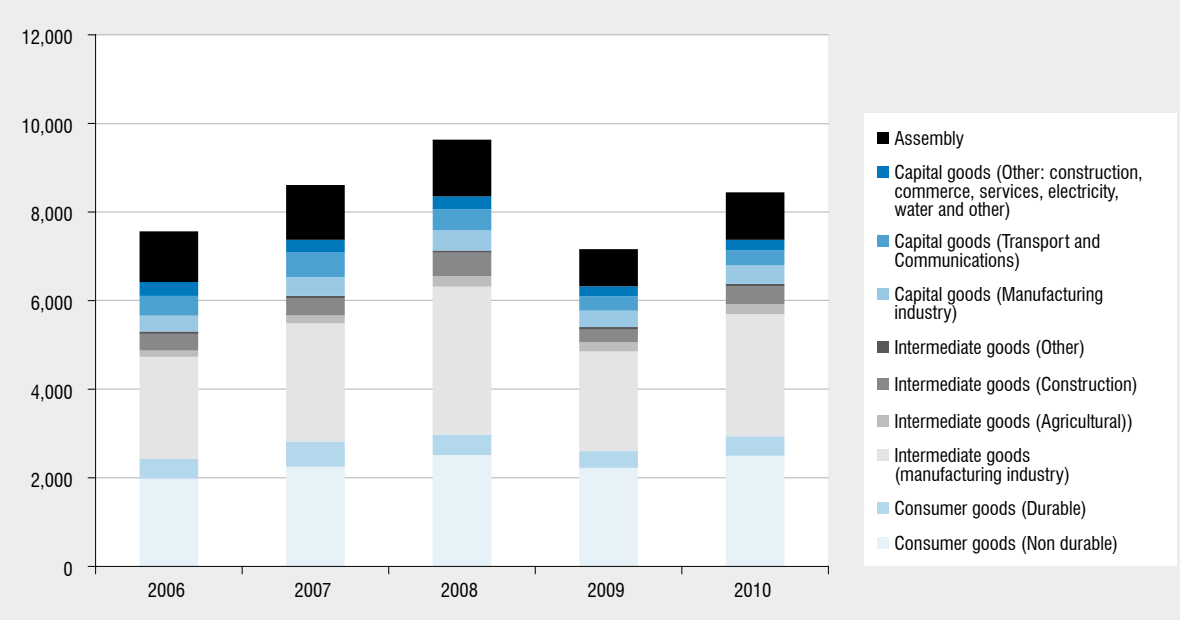
El Salvador relies heavily on trade with the United States. 48.3 per cent of exports are to the United States. The

Figure 3. Trends in exports of goods, based on their technological intensity, El Salvador, 2000-2009 (in thousands of dollars)



Note: the data reported by Comtrade use the Lall product classification to determine technological intensity.
Source: UNCTAD, based on UNSD Comtrade data (February 2011).

Figure 4. Import trends, El Salvador, 2006-2010, (in thousands of dollars)



Source: UNCTAD, based on data from the Central Reserve Bank of El Salvador.

other main trading partners are the Central American countries (Guatemala (13.8 per cent), Honduras (12.8 per cent), Nicaragua (5.4 per cent), Costa Rica (3.6 per cent) and Panama (2.3 per cent))[7].

Against this background, it should be noted that, in July 2010, the Ministry of Economy (MINEC) launched the Comprehensive Export Promotion Strategy 2010-2014 designed to internationalize companies and increase El Salvador's competitiveness. The strategy seeks to diversify markets and products, stimulate the supply of products with added value and promote the competitiveness of Salvadorian products, giving preference, among other things, to strengthening the technological and innovative capacity of Salvadorian companies.

This strategy is described in more detail in Chapter 2.

Foreign direct investment[8]

Between 1995 and 2009, El Salvador attracted a total of 6.3 billion dollars with an average of 421 million dollars per year[9]. El Salvador is placed behind Panama and Costa Rica in its capacity to attract foreign investment, both in absolute terms and per capita (Figure 5). Since 1995, inflows to El Salvador of foreign direct investment per capita have averaged 70 dollars, while Panama and Costa Rica had an average of 346 and 203 dollars respectively.

The main FDI was in the electricity and telecommunications sectors in 1998, as a consequence of their privatization, and in the financial sector in 2007 when Citibank and HSBC made various acquisitions. Another sector which received significant volumes of FDI is manufacturing, especially the textiles industry and, more recently, the electronics, motor parts and agro-industrial markets (UNCTAD 2010).

Table 5. Exports and imports of El Salvador, 2009 (in millions of dollars)

	Exports	(%)	Imports	(%)	Balance
Goods (FOB)	3,860.9	100.00	6,706.1	100.00	-2,845.2
General goods	2,287.3	59.24	5,780.6	86.20	-3,493.3
Coffee	230.3	0.06			
Sugar	88.4	0.02			
Prepared medicines- therapeutic/prophylactic use	97.8	0.03			
Toilet paper sheets for domestic use	96.9	0.03			
Goods for transformation (assembly)	1,487.4	38.52	839.0	12.51	648.3
Services	835.2	100.00	1,260.3	100.00	-425.1
Transport	271.5	32.51	700.4	55.57	-428.9
Travel	319.4	38.24	186.8	14.82	132.6
Communications	141.0	16.88	32.2	2.55	108.8
Construction	24.9	2.98	10.3	0.82	14.6
Insurance	30.1	3.60	174.6	13.85	-144.5
Financial services	1.0	0.12	7.8	0.62	-6.8
Information services	0.1	0.01	4.3	0.34	-4.2
Royalties	0.4	0.05	26.0	2.06	-25.6
Personal, cultural and leisure	0.0	0.00	0.5	0.04	-0.5
Government services	29.1	3.48	29.0	2.30	0.2
Other business services	17.6	2.11	88.3	7.01	-70.7

Source: Central Reserve Bank of El Salvador and ECLAC 2011.

Table 6. Balance of payments of El Salvador, 2004-2009 (millions of dollars)

	2004	2005	2006	2007(p)	2008(p)	2009(p)
Balance on current account	-642	-610	-783	-1,221	-1,682	-374
Balance on goods and services	-2,739	-3,066	-3,724	-4,395	-4,978	-3,270
Exports	4,290	4,392	4,774	5,169	5,652	4,696
Imports	-7,029	-7,459	-8,498	-9,564	-10,629	-7,966
Income	-458	-579	-531	-576	-536	-664
Transfers	2,555	3,035	3,472	3,750	3,832	3,561
Workers' remittances	2,548	3,017	3,471	3,695	3,788	3,465
Balance on capital account and financial	276	929	1,094	400	1,380	500
Reserves	53	59	-72	-280	-334	-429

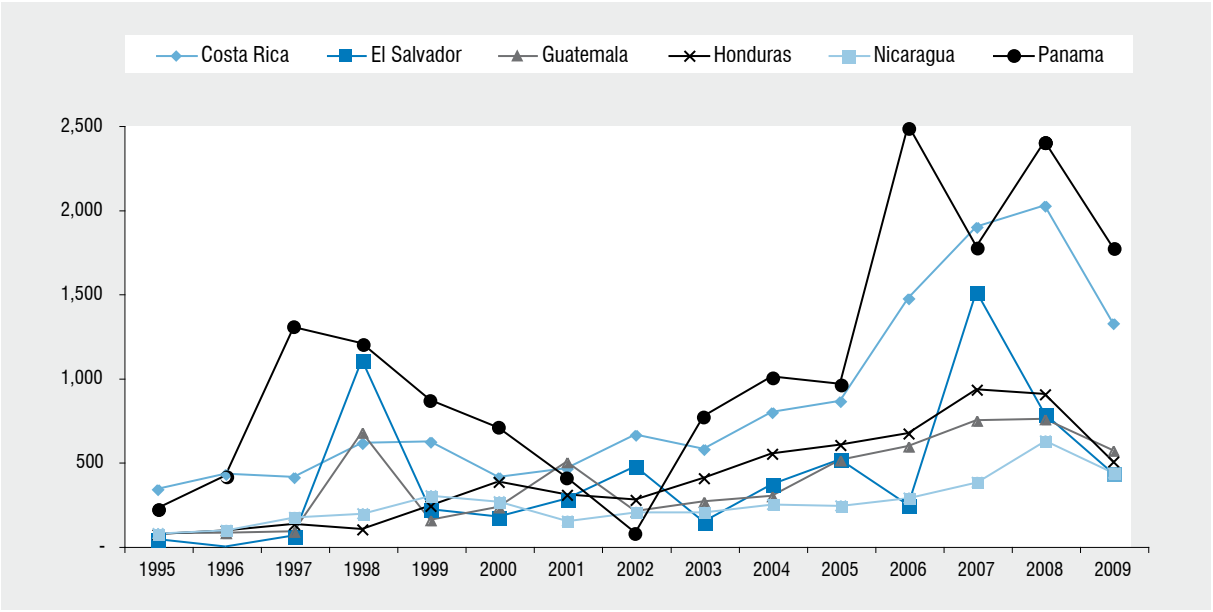
(p) Provisional figures.
Source: Central Bank of El Salvador.

Table 7. Real exchange rate, base 1993=100, 2004-2009

	2004	2005	2006	2007	2008	2009(p)
Real exchange rate (base 1993=100)	97.3	96.1	95.3	93.8	90.8	90.0

(p) Provisional figures.
Source: ECLAC.

Figure 5. Inflows of foreign direct investment, Central American countries, 1995-2009 (millions of dollars)



Source: UNCTAD, foreign direct investment database.

2. Structural conditions

2.a Sectoral structure

El Salvador has a diversified economy. In the manufacturing sector, which contributed 24.1 per cent of GDP in 2010), the export manufacturing sector (11 per cent of manufacturing), the chemical industry (9.4 per cent) and milling and baking industry (8.8 per cent) stand out. The commercial sector, which covers retail, hotels and restaurants is the second most important sector, representing 21 per cent of GDP in 2010 (Figures 6 and 7). The infrastructure sector (predominantly transport, storage and communications, but also construction, electricity, gas and water) performed well, and now constituted 14.7 per cent of GDP. In the financial sector, which accounts for 12.3 per cent of GDP, mention should be made of banks and insurance. Government spending fell further and, in 2009, accounted for 5.2 per cent of GDP.

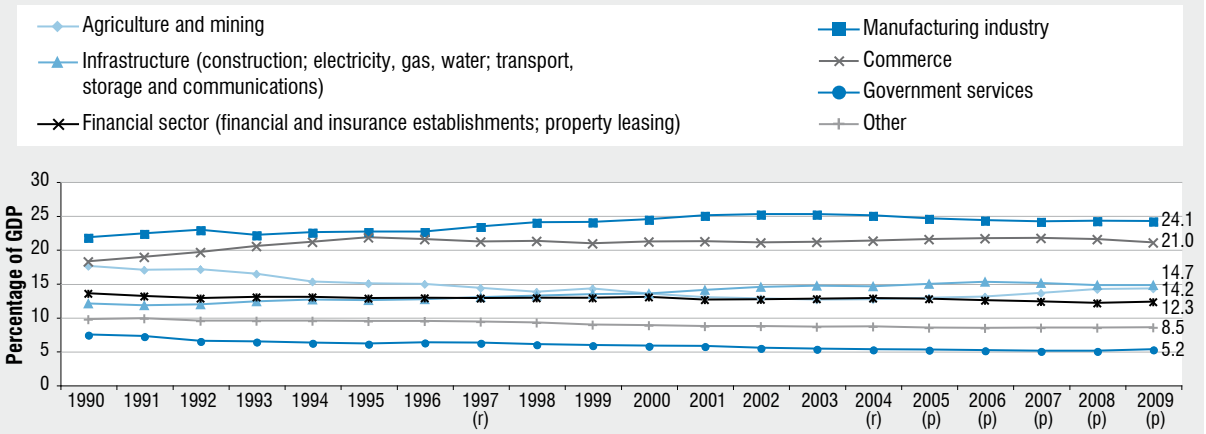
The weight of the agricultural sector in the national economy declined in the period 1990-2003 but has been rising slightly since then. In 2009, the agricultural sector contributed 14 per cent of GDP. This sector, which has undergone major changes, is now mainly concentrated in agricultural products (identified in Figure 8 as other agricultural production), staple grains and livestock. Green coffee, the most important agricultural product in the 1990s, has lost its former pre-eminence (Figure 8).

2.b Entrepreneurial structure

El Salvador's industrial structure is characterized by a large number of micro-enterprises which employ almost 36 per cent of the country's employed population (DIGESTYC 2005). The commercial sector has a large number of establishments, but contributes rather less to the labour market. Commerce concentrates 66 per cent of establishments but employs only 26 per cent of workers (Table 8).

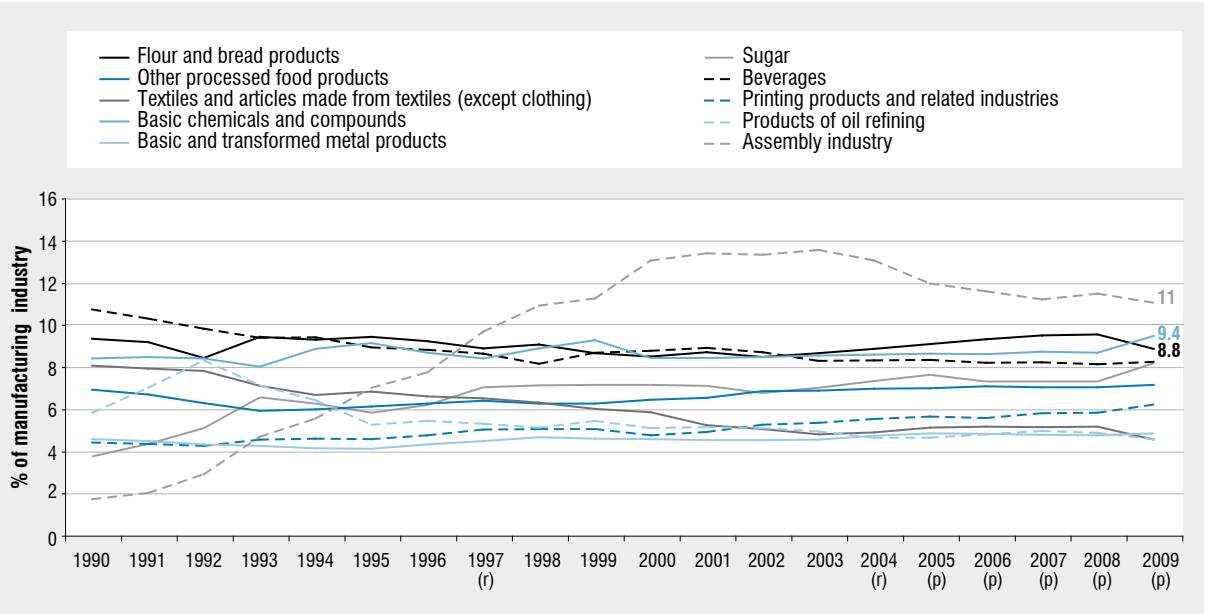
In addition to the external productivity gap (the country's technological capacity straggles behind in

Figure 6. Structure of the Salvadorian economy, 1990 -2009 (as percentage of GDP)



Note: (r): revised data, (p): preliminary data.
Source: UNCTAD, based on data of the Central Reserve Bank of El Salvador.

Figure 7. Manufacturing industry in El Salvador, 1990 -2009

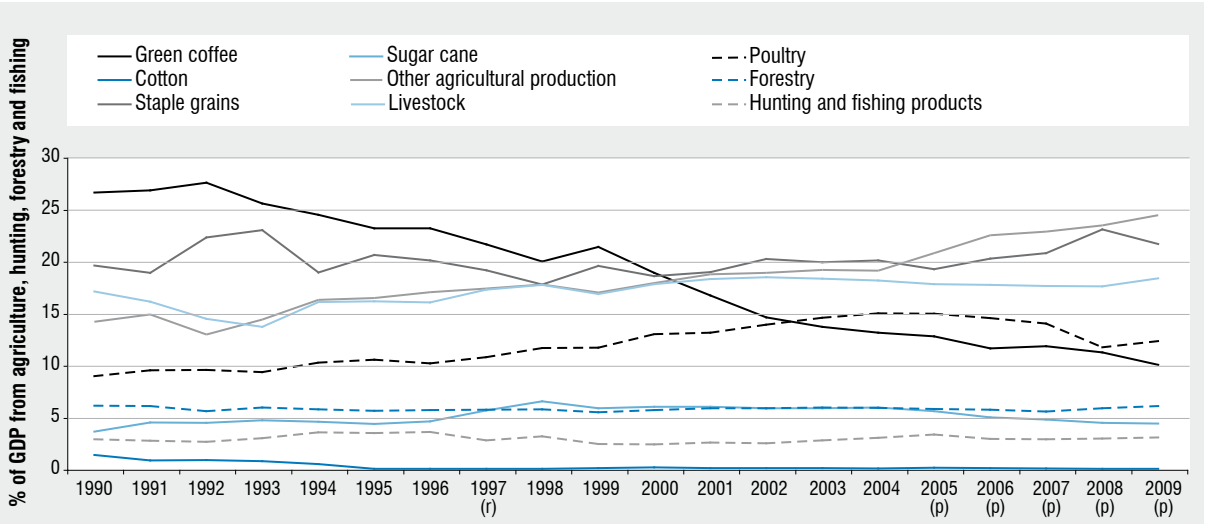


Note: (r): revised data, (p): preliminary data.
Source: UNCTAD, based on data of the Central Reserve Bank of El Salvador.

international terms), El Salvador, like the rest of the Latin American countries, is also characterized by internal productivity gaps. There are marked differences in productivity between different sectors and within sectors, as well as between enterprises (micro, small, medium-sized and large or between national and transnational companies) which are much greater than those seen in industrialized countries (ECLAC, 2010).

While the external gap reflects limited spread of best international practice to a country like El Salvador, the internal gap represents the limited spread of best practice between agents, sectors and enterprises inside the country.

Figure 8. Principal activities in the agricultural sector, El Salvador



Note: (p): provisional data.
Source: Own preparation based on data of the Central Reserve Bank of El Salvador.

Table 8. Entrepreneurial structure by economic activity (economic census of 2005)

	Establishments	%	Persons	%
Services	32,180	18	258,137	37
Industry	22,788	13	195,650	28
Commerce	115,540	66	183,126	26
Transport and communications	4,065	2	30,819	4
Construction	447	0	16,838	2
Agroindustry	79	0	8,860	1
Electricity and water	71	0	5,937	1
Mining and quarrying	8	0	214	0
TOTAL	**175,178**	**…**	**699,581**	**…**

Source: DIGESTYC (2005).

2.c Infrastructure

El Salvador's infrastructure has improved significantly during the last two decades and is now, in general terms, among the best in Latin America (Table 9)[10].

El Salvador has a good road network and air infrastructure (Table 9). The country has four airports with tarmac runways, the most important of which is El Salvador International Airport, the headquarters of the Salvadorian airline TACA. It is envisaged that the 80 million dollar project to expand the airport will start at the end of 2011. The Salvadorian road network covers over 6,600 kilometres, half of which is tarmac. The country has two major parallel west-east corridors. Currently, as part of the Mesoamerican cooperation project, a land corridor is being constructed which will link the Port of Cutuco, El Salvador (Pacific Ocean) with Puerto Cortés, Honduras (Atlantic Ocean).

The port infrastructure has been greatly improved with the construction of a second port in La Unión, which is intended to become the cargo hub for Central America. The construction of the port was completed in 2009, but there have been considerable delays in bringing it into operation due to the difficulty of obtaining approval of its management model.

The electricity infrastructure covers 83 per cent of the territory (97 per cent in urban areas and 72 per cent in rural areas). The country has an installed capacity of

Table 9. The infrastructure of El Salvador, 2010 (ranking out of 139 countries)

General quality of the infrastructure	44
Quality of roads	29
Quality of railway infrastructure	110
Quality of port infrastructure	71
Quality of air infrastructure	33
Passenger seat kilometres available in airlines	86
Quality of electricity supply	60
Fixed telephone lines	70
Mobile telephone subscribers	31

Source: Global Competitiveness Report 2010-2011.

1,490 megawatts (MW) and a net generating capacity of 5,504 gigawatt/hour (GWh) and it is the biggest producer of geothermal energy in Central America.[11] However, the country is a net importer of electricity. El Salvador is part of the electricity infrastructure project of SIEPAC, the first regional electricity transmission system which is intended to reduce the cost of electricity by creating a regional electricity market. It is envisaged that the project will be finalized in 2011.

The telecommunications infrastructure has undergone a remarkable development during the last decade, especially mobile telephony, where there are 113 subscriptions for every 100 inhabitants. Although the number of fixed lines has tripled during the last decade, and there are now 17.5 fixed lines for every 100 inhabitants, the average per inhabitant is still well below that of Costa Rica (Table 10).

2.d. Entrepreneurial competitiveness

According to the Global Competitiveness Index of the World Economic Forum (WEF 2010), El Salvador's competitiveness is in decline. Currently, the country is ranked 82, far below Panama (53) and Costa Rica (56) and slightly behind Guatemala (78). Since 2005-2006, El Salvador has dropped 19 places in a constant sample of 119 countries (INCAE 2010).

Among the strengths of Salvadorian competitiveness, the WEF report highlights the efficiency of the goods market and the level of development of the infrastructure (roads, air and mobile communication) as well as certain macro-economic conditions (in particular, inflation under control), the quality of local suppliers and labour flexibility. However, the country's competitiveness is limited by its scant capacity for innovation, the weaknesses of public institutions and the shortcomings of the education system (Figure 9).

For investors and executives, crime, the instability of policies and limited access to financial resources are the chief obstacles to doing business in the country (WEF 2010).

2.e. Education

Education is a critical factor in the development of competencies and skills for a trained and productive labour force. This key element of technological and innovative development is one of the principal weaknesses of El Salvador.

El Salvador has invested an average of 3 per cent of GDP in education (1999-2011), clearly below the average levels of investment of Costa Rica (some

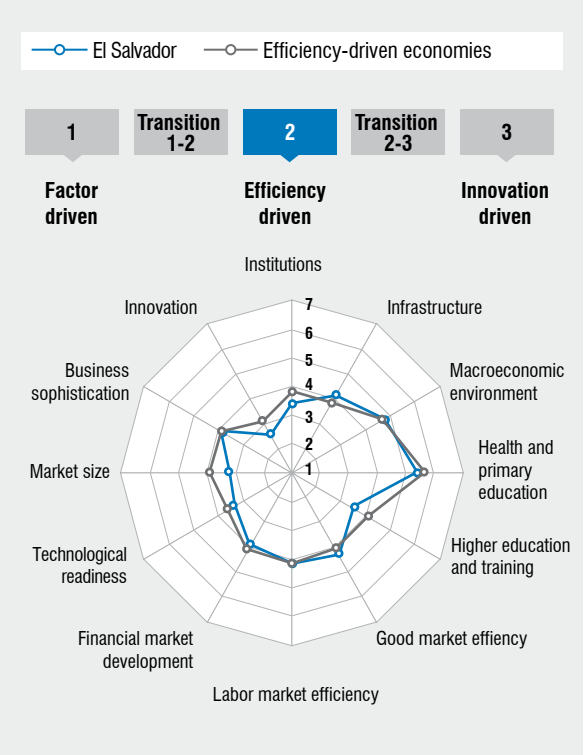
Table 10. Principal ICT infrastructure indicators, 2008

	El Salvador	Costa Rica	Guatemala	Honduras	Nicaragua	Panama
Fixed broadband Internet subscriptions	123,469	107,410	79,000	-	36,058	195,785
Broadband Internet subscriptions (per 100 persons)	2.01	2.38	0.58	-	0.64	5.76
Internet users	650,000	1,460,000	1,960,000	958,000	185,000	934,457
Internet users (per 100 persons)	10.60	32.31	14.32	13.09	3.26	27.49
Mobile telephone subscribers (per 100 persons)	113.32	41.75	109.22	84.86	54.84	115.19
Telephone lines (per 100 persons)	17.56	31.81	10.59	11.28	5.51	15.42
Secure Internet servers*	73	450	123	53	36	296
Secure Internet servers (per million persons)*	11.84	98.28	8.77	7.10	6.27	85.70

(*)=2009 data.
Source: World Development Indicators, World Bank.

Figure 9. Competitiveness of El Salvador, 2010-2011

	Ranking (out of 139 countries)	Score (1 to 7)
Global competitiveness index 2010-2011	**82**	**4.0**
Global competitiveness index 2009-2010	77	4.0
Global competitiveness index 2008-2009	79	4.0
Basic requirements	**71**	**4.4**
Institutions	101	3.4
Infrastructure	59	4.1
Macro-economic stability	64	4.7
Health and primary education	81	5.5
Efficiency enhancers	**87**	**3.8**
Higher education and training	101	3.5
Goods market efficiency	53	4.3
Labour market efficiency	88	4.2
Financial market development	78	4.0
Technological readiness	81	3.4
Market size	87	3.2
Innovation and sophistication factors	**96**	**3.2**
Business sophistication	68	3.9
Innovation	126	2.5



Source: Schwab (2010).

5 per cent) and Panama (over 4 per cent). The budget approved for 2011 is 704.69 million dollars.[12]

Considerable progress has been made in recent years in school coverage but the prolonged low levels of investment in education have limited educational achievements. The set of indicators of educational coverage and quality (Table 11) shows that the country is better placed than Guatemala, Honduras and Nicaragua, but lags behind Costa Rica and Panama. The most significant weaknesses are found in the rate of students staying in school and the coverage of the educational system, especially at secondary and pre-primary level, and in student achievements.

There are gaps in educational coverage in rural areas

Table 11. Indicators of educational coverage and quality in Central America, 2008

	Costa Rica	El Salvador	Guatemala	Honduras	Nicaragua	Panamá
Illiterate population aged 15 years and over (% of population aged 15 years and over), 2010	3.2	16.6	25.2	19.4	30.3	6.0
Public spending on education (% of GDP), 2008	5.1	3.6(4)	3.2	..	3.1(1)	3.8
Net enrolment rate, primary (%), 2008	..	94.2(4)	95.1	..	91.8	98.3
Net enrolment rate, secondary (%), 2008	..	56.4(4)	39.9	..	45.2	65.6
Gross enrolment rate, tertiary (%), 2008	..	24.6	17.7(3)	17.1(2)	18(1)	45.1
Average pupils per teacher, primary, 2008	18(4)	31(4)	29	33	29	24
Average pupils per teacher, secondary, 2008	16(4)	24(4)	17	..	29	15
Rate of survival to 5th grade, 2007 to 2008	96	80	71	78	51	87
Ranking in Education for All Development Index, 2007	..	94	98	87	101	66

Notes: (1) 2003 data, (2) 2004 data, (3) 2007 data, (4) 2009 data.
Source: UNCTAD, based on ECLAC statistical yearbook 2011, Global Education Digest 2010 and FUSADES (2010).

and in the lowest income strata of the population (Table 12), as well as in the final years of secondary and (non-compulsory) pre-school education (Figure 10).

There are still high levels of repetition, abandonment and over-age pupils in primary and secondary education (Table 13). For example, one third of grade one pupils have educational problems (abandonment, repetition or over age) (FUSADES 2009).

As regards quality of teaching, the national education assessments PAESITA[13] and PAES[14], show that a great percentage of students have still not developed the average expected skills and competencies (in mathematics and language). International quality assessments place El Salvador well behind other countries in the region. For example, El Salvador scores well below the average obtained by the countries which took part in the TIMSS 2007 (Gonzáles et al. 2009) for pupils in the fourth and eighth grade in several countries[15]. Similarly, the Second Explanatory Regional Comparative Study (LLECE 2007), carried out in 2006 of pupils in the third and sixth grades in 16 Latin American countries, showed that Salvadorian students scored below the regional average in all the tests except in language in the third grade.

The education system is governed by the General Education Act of El Salvador (amended in 2005), the Higher Education Act (2004) and the Act on the Career of Teacher (amended in 2001). The National Education Plan 2021 (2005) is the second and most recent national plan in the sphere of primary and secondary education but has ceased to be the point of reference. El Salvador does not have a national strategy for tertiary education. The recent Five-Year Development Plan 2010-2014 (2010) indicates eight priority action lines in the area of education: fair access to and keeping pupils in the education system, curriculum, professional improvement and development of the teaching profession, institutional strengthening, continuing training, integration of scientific and technological research, strengthening of higher education and training for work. The principal programmes highlighted in the Five-Year Plan are:

a) Programme of provision of school uniforms, shoes and equipment
b) School meals programme
c) National literacy programme
d) National Programme of education and comprehensive pre-school development
e) Inclusive Education Programme
f) School Buildings Programme
g) Science and Technology Programme
h) Enhancing Teachers' Status (better conditions of work and professional development)

The revision of the financial allocations in the Five-Year Plan and the Budget Act 2011 shows that current efforts are largely focused on expanding school coverage and reducing abandonment of school, and less on improving levels of quality. The two programmes which currently receive the most attention (they are allocated 49 and 18 per cent of the education budget) are intended to improve coverage and to keep pupils in the education system by a general allocation of clothing, school equipment and meals. These programmes are not limited to poor families and represent a considerable current expense which is being financed from foreign loans (FUSADES 2010). In addition, the annual budget allocations for increasing the quality of education and improving school buildings have been reduced (FUSADES 2009).

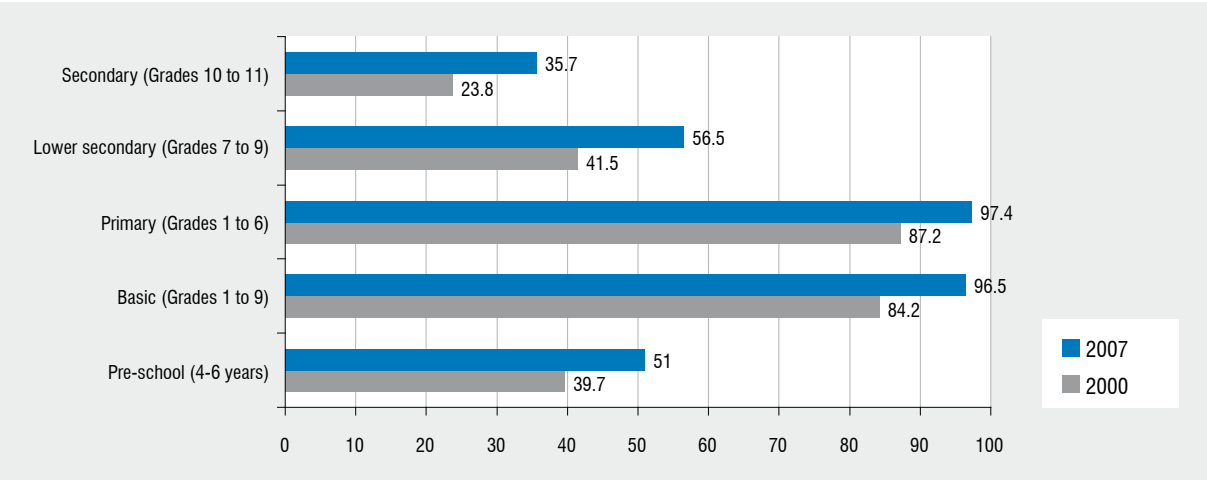
Formal education below the university level is provided by 6,263 educational centres (5,163 public and

Table 12. Percentage of literate persons and average years of schooling, by geographical area and degree of poverty, 1992 and 2007

		1992		2007					
						Relative poverty		Extreme poverty	
	Years	Literacy (%)	Years of schooling	Literacy (%)	Years of schooling	Literacy (%)	Years of schooling	Literacy (%)	Years of schooling
Country	15-24	85	6.2	94	7.9	94.3	7.4	87.1	6
	25-59	73	5.0	83	6.7	79.5	5.2	65.9	3.7
Urban	15-24	93	7.9	96	8.9	96.6	8.3	91	6.9
	25-59	86	7.0	90	8.2	86.9	6.4	77.1	5.1
Rural	15-24	75	4.3	89	6.4	91.2	6.3	84.6	5.4
	25-59	58	2.6	69	3.7	67.8	3.4	56.5	2.6

Source: FUSADES (2009).

Figure 10. Net school enrolment rates, by level of education, 2000 and 2007 (percentages)



Source: FUSADES (2009).

Table 13. Rates of abandonment, repetition and over age pupils, 2003-2007 (percentages)

	2003	2004	2005	2006	2007
Abandonment (1st grade)	8.7	6.5	8.7	8.9	7.7
Repetition (1st grade)	15.1	14.5	13.8	15.6	14.7
Over age (1st grade)	11.2	11.1	10.6	10.4	8.9
Abandonment (7th grade)	6.4	5.7	8.3	8.3	7.4
Repetition (7th grade)	4.6	5.2	5.7	6.8	7
Over age (11th grade)	17.8	10.8	10.2	10.1	10.8

Source: FUSADES (2009).

1,100 private) (MINED 2007). Private education is especially widespread in tertiary education (66 per cent of students enrolled)[16] and in secondary education (27 per cent). Private education covers 19 per cent of children enrolled in nursery schools and 11.5 per cent in primary education (Global Education Digest (2010)).

Higher education[17]

Higher education is delivered in 24 universities (1 public), 9 specialized institutes (4 public) and 6 technological institutes (3 public)[18]. In 2009, there were 143,849 students in higher education and 16,168 students graduated. 92 per cent of the students were enrolled in universities and the rest in specialized institutes (6 per cent) and technological institutes (2 per cent). The University of San Salvador (public) has 31 per cent of the university students.

Table 14 shows the number of students in higher education in El Salvador, by area of education and the level of studies pursued. It should be noted that postgraduate education is still a minority area in El Salvador and has developed chiefly in teaching and business/financial management.[19] There are only two doctorate courses, one in private law and the other in philosophy. In 2009, there were 2,347 postgraduate students, and that year two persons graduated with a doctorate, 558 with a master's degree and 363 completed the teacher training course. Furthermore, the number of students at technical level is small in relation to university students. The limited demand for technical careers is attributed to the lack of prestige of these fields (MINED 2010). However, it is noteworthy mentioning the efforts made through the Technical and Technological Gradual Learning Education Model programme (MEGATEC) to harmonize technical training at the vocational and university level and to link it to the needs of different productive sectors. This programme links secondary and tertiary education in technical areas and responds to local needs for qualified human resources in specific productive activities (FUSADES 2009).

As regards the geographical area, university activity is clearly concentrated in San Salvador (over 55 per

Table 14. Students in higher education by area of education and level of studies, 2009

Area of study	Number of students	%	Level of study	Number of students
Economics, management and commerce	36,595	25	Postgraduate	2,347
Technology	31,838	22	University	119,028
Medicine	23,717	16	Technical	22,474
Law	15,852	11	**TOTAL**	**143,849**
Education	13,619	9		
Social sciences	6,628	5		
Humanities	5,858	4		
Art and Architecture	5,169	4		
Social sciences	2,644	2		
Farming and environment	1,929	1		
TOTAL	**143,849**	...		

Source: Ministerio de Educación – Unidad de Estadística Educativa, 2009.

cent of students). Other important university centres are found in La Libertad (15 per cent) and San Miguel (10 per cent).

2.f. Human development

The country's level of human development, i.e. human wellbeing going beyond economic wealth, places Salvadorians below the average for Latin America and the Caribbean. According to the Human Development Index (UNDP 2010a), El Salvador is ranked 90 out of a total of over 180 countries. The historic results of the index show that considerable progress has been made, although recent years have been marked by a stagnation of human development achievements.

There has been considerable progress in reducing inequalities in incomes, largely due to the positive impact of remittances in lower-income families. However, the inequalities in the distribution of wellbeing (i.e. not only income and wealth but also geographical inequalities and access to health services, education, infrastructure, etc.) put a severe strain on human development. The impact of such inequalities in El Salvador is among the most serious in Latin America and the Caribbean (UNDP 2010b).

The high levels of violence recorded in El Salvador[20] hinder progress in the economic and human development of Salvadorians. The violence is a significant constraint for investors who want to do business in the country (see section 2.d). Furthermore, the violence and crime represent a considerable cost to the State and individuals in terms of prevention, combating and reparation.

In addition, El Salvador is a country which is constantly exposed to natural disasters (earthquakes, tropical storms). The impact of these disasters has been even more serious given the high level of vulnerability of Salvadorians. It is calculated that between 1980 and 2008, an average of 1.5 disasters a year occurred in the country, in which over 7,000 people died. These disasters had an impact of over 16 billion dollars in present values or an annual equivalent of 4.2 per cent of GDP (UNDP 2010b).

B. PERFORMANCE IN SCIENCE, TECHNOLOGY AND INNOVATION IN EL SALVADOR

The analysis and evaluation of performance in science, technology and innovation (STI) require a set of indicators which provide information on investment (in human capital and financial resources) and the results of that investment (patents, publications, technology balance, etc.). Also required are information on innovation activities carried out in the country and the impact of those activities, as well as the relationship and interaction between the various economic, political and scientific actors who form part of the innovation system.

The systematic collection and dissemination of this information would allow better design, management and evaluation of STI policies and programmes. They would also serve as better tools to enable the private sector to develop competitive strategies and collaborate with the academic world and public institutions.

The National Council for Science and Technology (CONACYT) regularly collects data on scientific and technological activities in the higher education sector based on the methodology established by the Ibero-American Network of Science and Technology Indicators (RICYT), in turn based on the Frascati Manual. However, there is no systematic collection of information on research and development activities (R&D) or innovation in the private sector. The lack of such information limits the comparisons that can be made with other countries.

Described below are the principal STI indicators available for El Salvador. It can be observed that there are gaps in the information, chiefly concerning investment in R&D by the private sector and innovation activities carried out in the country.

1. Inputs

Research and development

Investment in R&D, defined as "creative work undertaken on a systematic basis in order to increase the stock of knowledge, including knowledge of man, culture and society, and the use of this stock of knowledge to devise new applications " (Frascati Manual, OECD 2002) allows, on the one hand, increasing the stock of knowledge and, on the other, developing a country's endogenous capacities for innovation. Developed countries invest on average 2,3 per cent of GDP in R&D (OECD 2010).

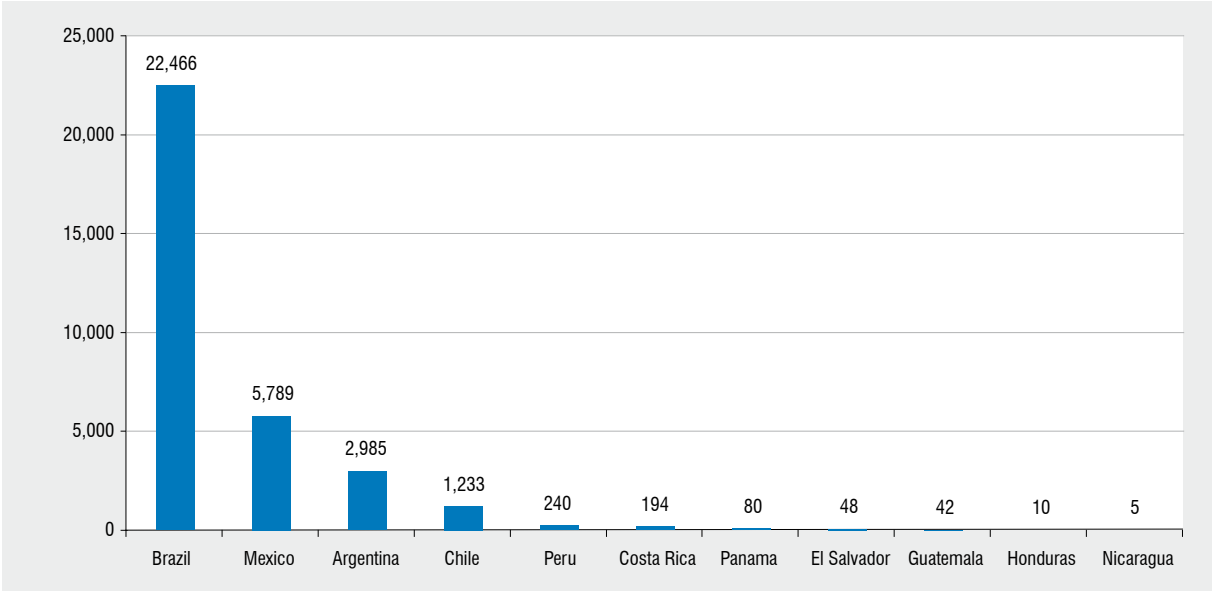
Investment in R&D in El Salvador is limited both in absolute terms and in relation to GDP (Figures 11 and 12). It is estimated that the country invested 0.11 per cent of GDP in 2008. While El Salvador is top of the group of four Central American countries (Guatemala, Honduras and Nicaragua) the country lags behind Costa Rica and Panama, and is far from the levels of investment in R&D in the most advanced Latin American countries in this field (Brazil, Mexico, Argentina and Chile).

It should be recalled that the figures for investment in R&D in El Salvador do not include spending by the private sector. However, we believe that even including private sector expenditure, the pattern would be similar, given that the interviews conducted indicate a very low level of investment in R&D by the private sector.

The latest data available (CONACYT, 2010) show a fluctuation in R&D investment and a slight declining trend (Figure 13).

Expenditure on R&D by higher education institutions

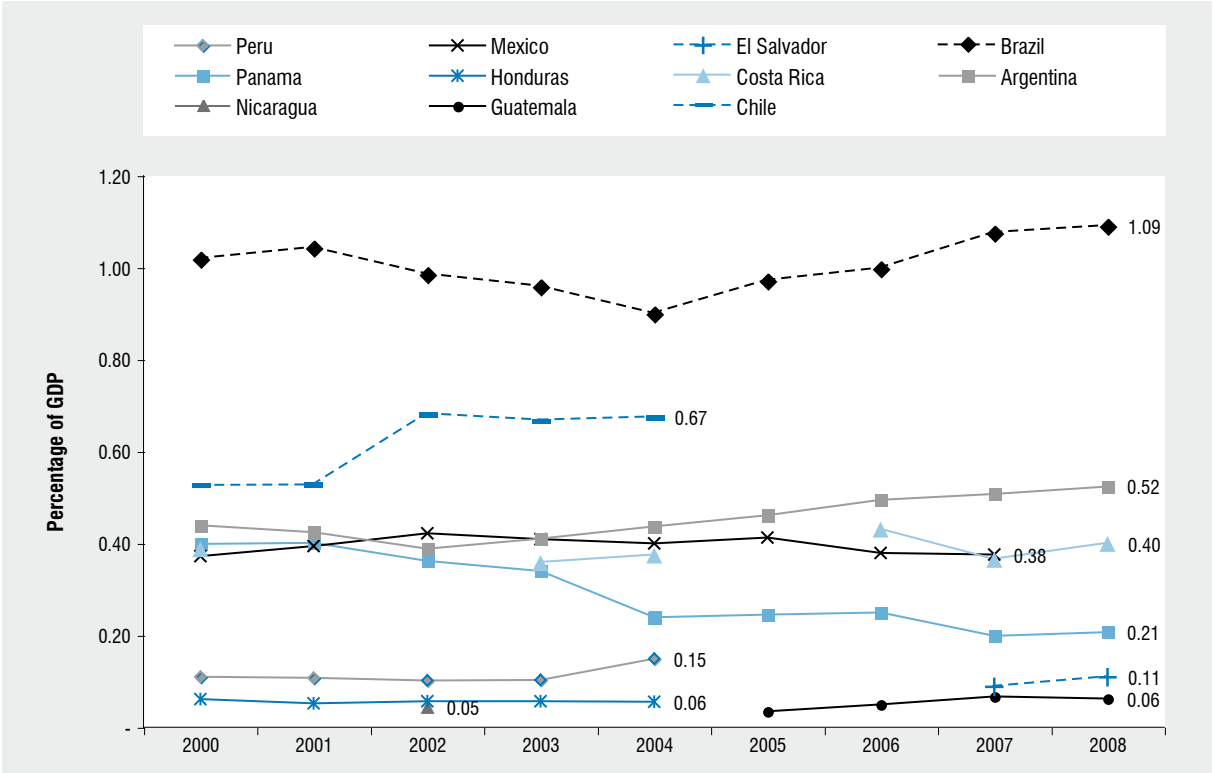
Figure 11. R&D expenditure in El Salvador and other Latin American countries, 2008 (millions of PPP dollars)



Notes: Panama: includes expenditure by the Smithsonian Tropical Research Institute (STRI).
Guatemala: Investment in R&D by the public sector and higher education sector.
El Salvador: Expenditure by the higher education sector and Government.
Brazil, Peru and Guatemala: data for 2004. Chile: dat for 2007. Nicaragua: data for 2002.
PPP: Purchasing Power Parity.

Source: RICYT.

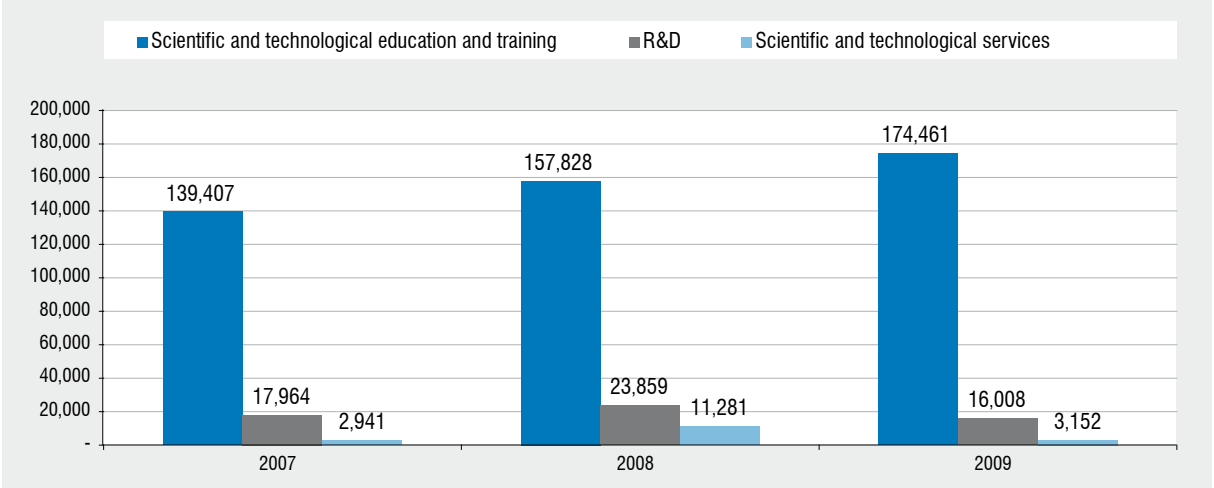
Figure 12. Comparative trends in R&D expenditure, El Salvador and selected Latin American countries, 2000-2008 (as percentage of GDP)



Notes: Panama: includes expenditure by the Smithsonian Tropical Research Institute (STRI).
Guatemala: Investment in R&D by the public sector and higher education sector.
El Salvador: Expenditure by higher education sector and Government.

Source: RICYT.

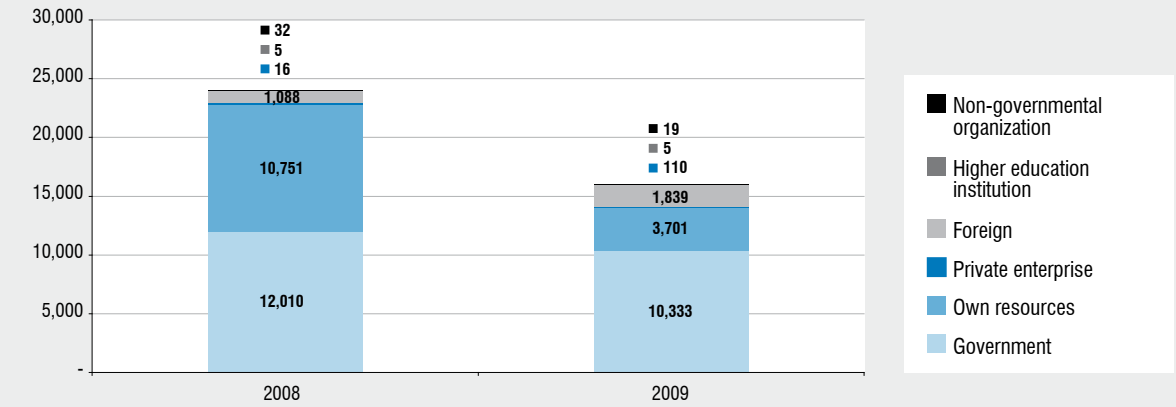
Figure 13. Investment in science and technology activities, 2007-2009 (in thousands of dollars)



Note: Expenditure by higher education institutions.
Source: CONACYT, 2010.

is primarily financed by the Government and the institutions themselves. The latest data reflect a considerable reduction in financing of R&D by higher education institutions. In 2009, the public sector financed 64 per cent of this expenditure while the higher education institutions themselves reduced their contribution

Figure 14. R&D expenditure by source of financing, 2008-2009, (in thousands of dollars)

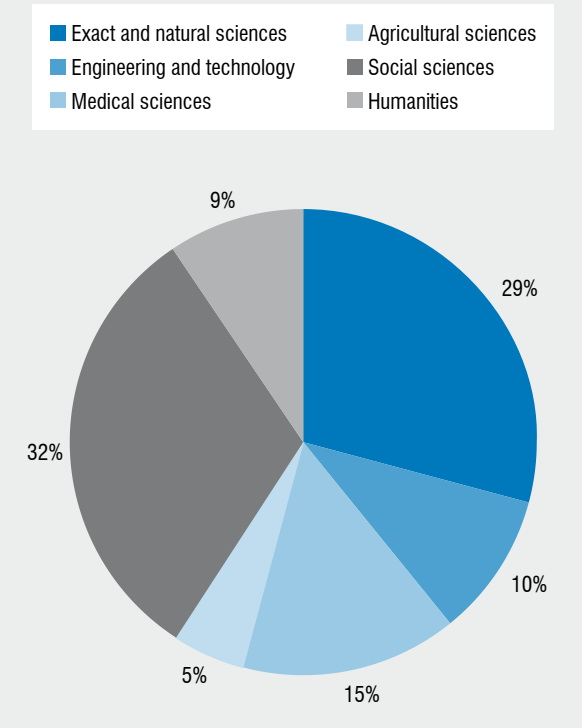


Source: UNCTAD, based on CONACYT (2010).

significantly compared with the previous year to only 23 per cent of total expenditure on R&D. The same year, foreign resources served to finance 11 per cent of that expenditure, while resources contributed by the private sector did not reach one per cent (Figure 14).

A high percentage of expenditure on R&D is destined for the social sciences and humanities (41 per cent of expenditure in 2009). 29 per cent is destined for the natural and exact sciences, followed by medical sciences (15 per cent), engineering and technology (10 per cent) and agricultural sciences (5 per cent) (Figure 15).

Figure 15. Distribution of R&D expenditure by scientific and technological area, 2009 (as percentage)



Source: CONACYT (2010).

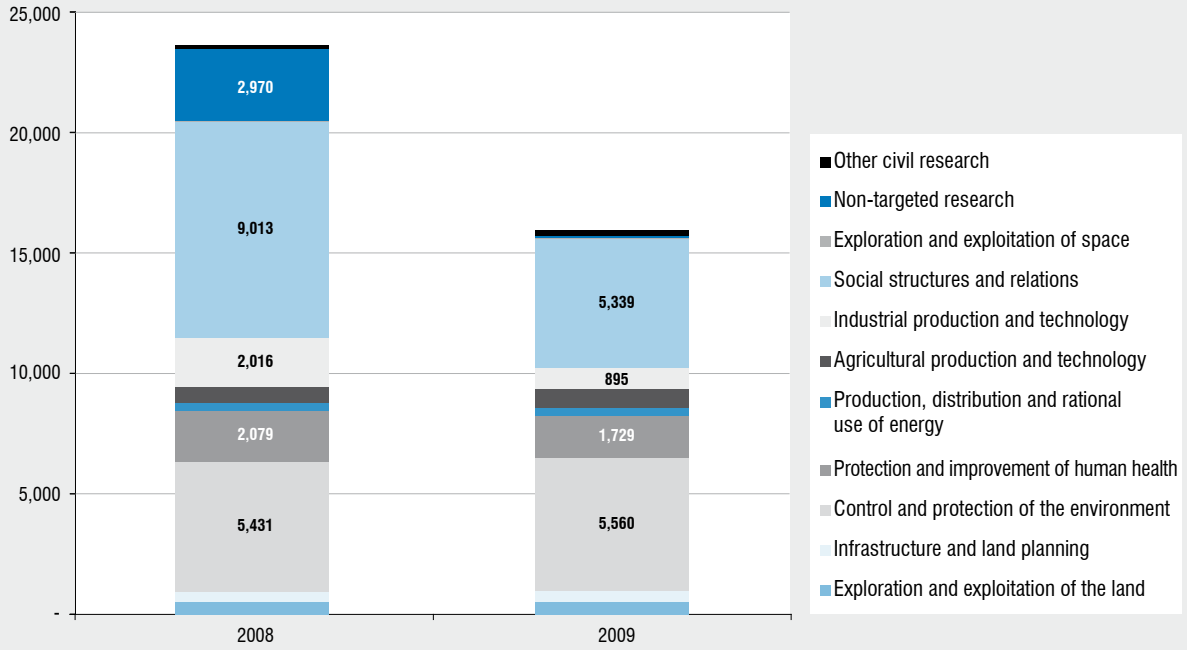
As regards the socio-economic objectives of R&D, investment in protection of the environment (35 per cent of R&D expenditure), social structures and relations (33 per cent) and in third place, human health (11 per cent) should be highlighted. These investment priorities have remained constant throughout the last decade (CONACYT 2010).

R&D projects are chiefly in basic (38 per cent) or applied research (38 per cent). Consultancy and experimental development projects represent 13 and 10 per cent of projects respectively. Trials and testing do not even account for one per cent of projects.

Furthermore, projects tend to be of small scale and of short duration. The budget of 73 per cent of the projects is below 10,000 dollars, and only 10 projects (0.8 per cent) have a budget in excess of 100,000 dollars. In addition, two thirds of the projects have a duration of under one year and only 10 per cent have a duration of more than two years. (CONACYT 2010).

El Salvador has a small nucleus of 291 researchers, not all of whom are dedicated exclusively to research work. If we take into account the time dedicated to research, the number of researchers falls to 85. The number of researchers in El Salvador is meagre, even in comparison with other countries in the region (Tables 15 and 16).

Figure 16. R&D expenditure by socio-economic objective, 2009 (in thousands of dollars)



Source: UNCTAD, based on CONACYT (2010).

Table 15. Staff employed in R&D, full time equivalent and total actual persons, selected countries 2008

	Argentina	Brazil	Chile	Costa Rica	Cuba	Guatemala	Honduras	Mexico	Nicaragua	Panama	Peru	El Salvador
Full time equivalent	56,987	240,482	21,689	1,165	...	1,384	...	70,391	...	1,457	...	85
Total actual persons	79,391	397,720	30,583	18,383	92,839	1,740	2,280	...	870	2,545	8,434	291

Honduras: 2003 Chile, Nicaragua, Peru: 2004 Mexico: 2007 El Salvador: 2009.
Guatemala: The data provided relate only to staff working on R&D projects in the public sector and higher education
Source: RICYT and CONACYT (2010) for El Salvador data.

Table 16. Staff employed in R&D per thousand employed persons, full time equivalent and total actual persons, selected countries, 2008

	Argentina	Brazil	Chile	Costa Rica	Cuba	Guatemala	Honduras	Mexico	Nicaragua	Panama	Peru	El Salvador
Full time equivalent	2.56	1.32	2.03	0.58	…	0.10	…	0.88	…	0.25	…	…
Total actual persons	3.95	2.09	2.77	1.70	1.10	0.14	0.22	…	0.16	0.30	0.39	0.16

Notes: Researchers include R&D fellows.
Guatemala: The data provided relate only to staff working on R&D projects in the public sector and higher education.
Chile, Honduras: data for 2003. Nicaragua and Peru: data for 2004. Costa Rica (EJC): data for 2005. Mexico: data for 2007.
Source: RICYT.

As regards human resources, three factors should be emphasized:

(1) the scant dedication to research activities. In 2009, only 6 per cent (431 persons) of the academic staff carry out research work (Table 17).

(2) the limited education of academic and research staff. Only 36 per cent of researchers[21] have a master's degree or doctorate. Out of the total number of academics, less than a quarter have a master's degree or doctorate (Table18).

(3) women represent 31 per cent of the total number of researchers.

Table 17. Academic staff by function and sex, 2009

	Men	Women	Total	%
Teachers	4,600	2,511	7,111	94
Teachers-researchers	171	123	294	4
Researchers	94	43	137	2
TOTAL	**4,865**	**2,677**	**7,542**	**...**

Source: CONACYT (2010).

Science and technology activities (STA)

Investment in El Salvador in the broadest range of science and technology activities[22] is also limited in comparison with other Latin American countries, although it is worth mentioning that under this heading, El Salvador comes above Panama (Figure 17).

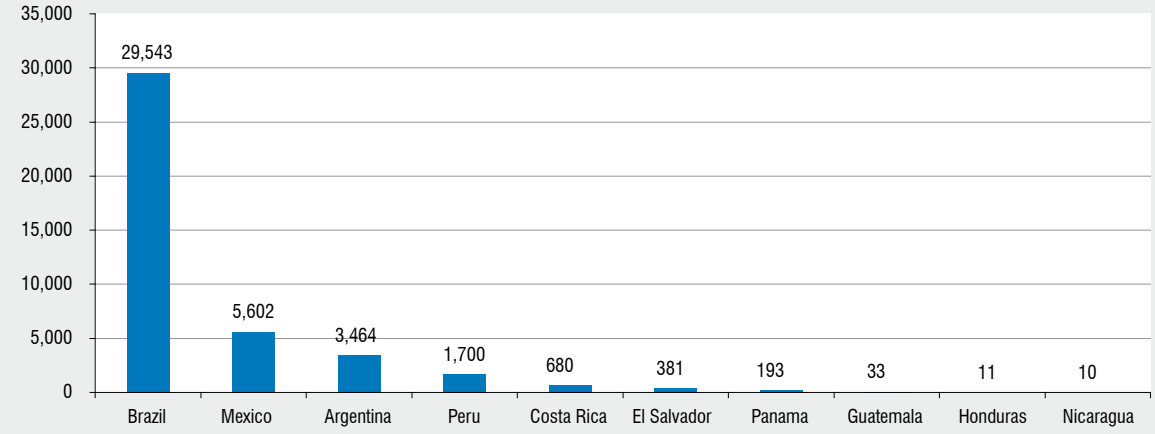
Among science and technology activities, teaching and education is the most important heading, with a rising trend and growing participation of the academic sector. On the other hand, the low level and percentage (2 per cent) of expenditure on scientific and technological services indicate the scant linkages between the academic world and the productive sector (Figure 13).

Table 18. Academic staff and researchers by level of education, 2009

	Doctorate	Master's	First degree	Technical/other
Academic staff	292	1,396	5,546	305
(%)	*4%*	*19%*	*74%*	*4%*
Research	16	32	85	1
(%)	*12%*	*24%*	*63%*	*1%*

Source: CONACYT (2010).

Figure 17. Expenditure on STA in El Salvador and other Latin American countries, 2008 (millions of PPP dollars)



Notes: Panama: Includes expenditure of the Smithsonian Tropical Research Institute.
Mexico: Only includes federal expenditure on science and technology.
El Salvador: Expenditure by the higher education sector and Government.
Guatemala: data for 2006. Nicaragua: data for 2004, Peru and Honduras: data for 2003
PPP: Purchasing Power Parity.

Source: RICYT.

A considerable proportion of expenditure on STA is allocated to the social sciences and humanities (44 per cent of expenditure in 2009). 20 per cent of the expenditure is destined for engineering and technology, followed by the natural and exact sciences (17 per cent) medical sciences (15 per cent) and agricultural sciences (4 per cent) (Figure18).

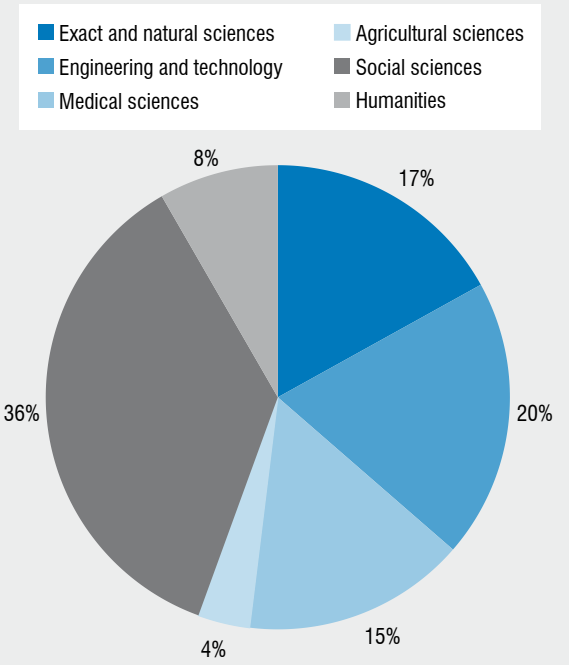
Similarly, by socio-economic activity, expenditure on STA is highly concentrated in the area of social structures and relations. For example, three times as much is spent on this objective than on protection or improvement of human health (Figure 19).

2. Results

One way of studying the results of R&D is through bibliometric and patent analysis (and also utility models and industrial designs). While it is easy to collect indicators in both these spheres, it should be borne in mind that such analyses have some disadvantages. Bibliometric indicators generally refer to the volume of articles published in indexed journals and provide only a rough estimate of the relative quality or importance of different publications. Nevertheless, these indicators serve to identify the principal areas of a community's scientific knowledge, its impact on the scientific community (a proxy for quality) and the level of collaboration.

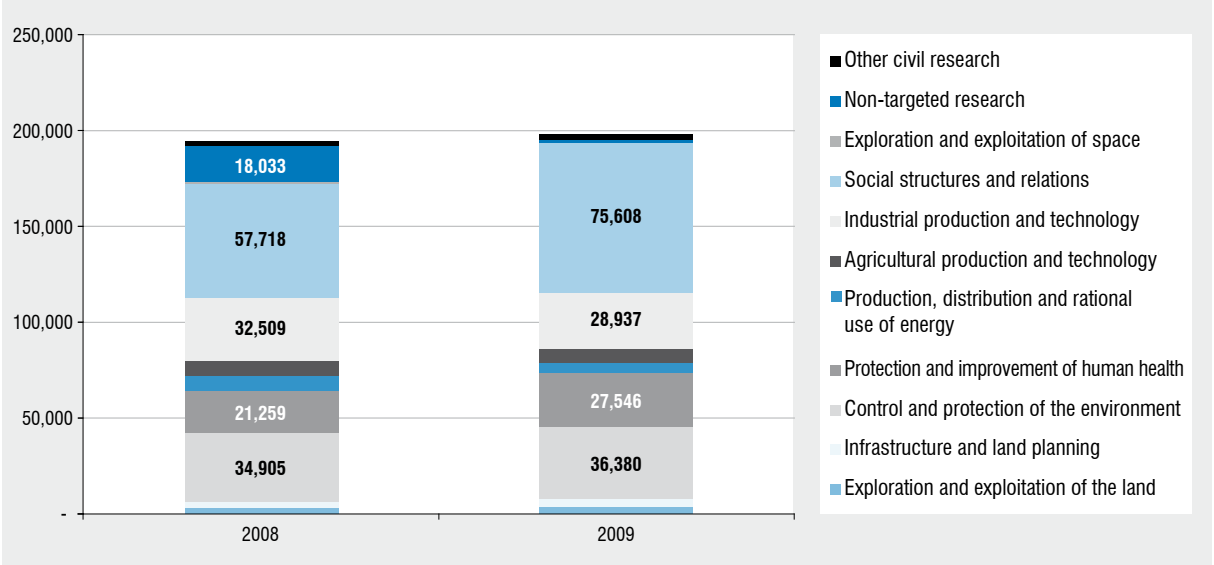
Patent analysis only reflects part of the scientific and technological activity of a country's institutions. There is a great deal of scientific output and innovation which are not necessarily converted into patents. Some minor adaptations, which play a particularly important role in developing countries, can be enormously beneficial but are not necessarily patented.

Figure 18. Expenditure on STA by scientific and technological area, 2009 (as percentage)



Source: CONACYT (2010).

Figure 19. Expenditure on STA by socio-economic objective, 2009 (thousands of dollars)



Source: UNCTAD, based on CONACYT (2010).

a) Bibliometric analysis

For the purpose of this review, a bibliometric study of publications was carried out to help identify the strongest areas of research in El Salvador and to guide decisions in setting priorities. The study includes identification of the principal thematic areas of research, the impact of published articles, the research topics where there is the greatest scientific output and the collaboration networks established with other countries for research.

In summary, the study identified 420 publications in indexed journals in which authors resident in El Salvador participated, with an average of four articles per year in recent years (the lowest number of articles in Central America). The research topics with the greatest number of publications are public, environmental and occupational health and the science of plants. The areas with the greatest impact are immunology, the respiratory system, meteorology and atmospheric sciences, and food sciences and technology. Considering only articles where the main author lives in El Salvador, the areas of greatest impact are oncology, orthopaedics, health policy and services, paediatrics, andrology, nutrition and ophthalmology. The University of El Salvador stands out among all research bodies for its volume of output. As regards the impact of publications, research by Salvadorian bodies shows little impact, with the exception of Rosales Hospital.

Chapter I (section D) provides a more extended summary of the results and Annex F presents the methodological details of the study together with the results obtained.

The CONACYT study (2010) of science and technology activities shows a higher output of scientific literature at national level than reflected in the bibliometric study. It is likely that much of this national output does not have the necessary relevance or quality to appear in indexed journals at international level or that the costs involved in publication are high for researchers. For example, less than 30 per cent of periodical publications in El Salvador have an ISSN number. These statistics on national scientific and literary production also show a high concentration in the social sciences and humanities (80 per cent of journals and/or bulletins).

b) Patent analysis.

Registration of patents by residents is very low, with an average of eight patents registered annually according to the Espacenet register or fifteen according to the RICYT register.

However, in comparative terms, the country is better placed than the other Central American countries. El Salvador has a higher annual average of patents granted to residents and a better ratio of these to total patents granted, with a coefficient of invention (patents applied for by residents in relation to the population) only bettered by Costa Rica.

It should be noted that while the inventors who patent their inventions live in El Salvador, the holders of the operating rights are essentially foreign companies. Only 16 per cent of registered patent holders are Salvadorian.

The principal classes of patents are in medical or veterinary science (13 per cent of all patents).

Chapter II (section D) provides a more extended summary of the results and Annex D presents the methodological details of the study together with the results obtained.

c) Technology balance – Balance of royalties and licence fees

A country's technology balance measures "the amount of a country's income from the export of technical knowledge and services, while indicating a country's competitive position in the international knowledge market."[23]

The technology balance comprises, on the one hand, income from the sale of national technology abroad and, on the other, payments for the acquisition of foreign technology.

In order to facilitate international comparisons and given that there are no sources of information in a sufficiently broken down form to cover the components of the technology balance suggested in the Manual of Santiago (RICYT 2007), the analysis is based only on the balance of royalties and licence fees.

El Salvador, like the other Central American countries, pays out much more than it receives in royalties and licence fees and has recorded significant increases in payments under this heading (Figure 20). Nevertheless, El Salvador seems to bring in comparatively more in royalties and licence fees than the other Central American countries (except Guatemala).

3. Innovation activities and their impact

The design of innovation policies requires detailed information on innovation activities and processes to explain how these processes emerge and develop. This requires detailed information on the factors which induce companies to undertake innovative activities and the main obstacles that they face. It also requires information on the type of cooperation that exists between different economic agents and the type of innovation in which they engage in the country, and the impact of this innovation in terms of sales, exports and patents.

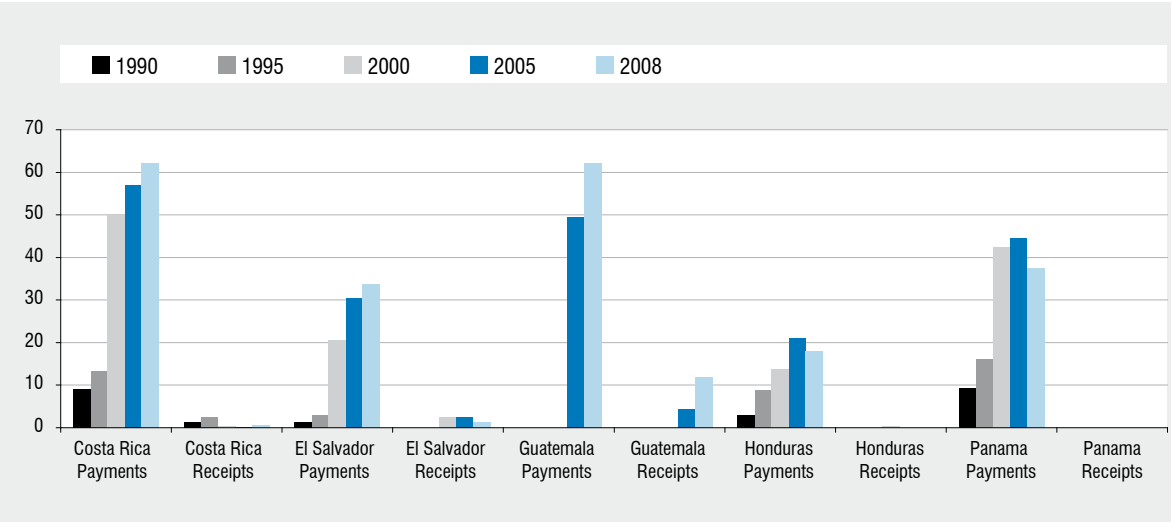
El Salvador does not have systematic information on the innovation activities undertaken by companies in the country[24]. This is a major weakness in the ability to design and evaluate innovation policies.

In Latin America, there is ample experience of development and conduct innovation surveys, although they have often proved to be sporadic. Carrying out an innovation survey requires considerable resources and statistical know-how. In addition, it is desirable for innovation surveys to be carried out on a regular basis so as to be able to evaluate the impact of policies and programmes on innovation. For these reasons, innovation surveys are often carried out by national statistical offices, in El Salvador's case, the Directorate General of Statistics and Censuses (DIGESTYC). In this regard, it will be useful to continue to explore the possibility of DIGESTYC carrying out the first national innovation survey. The Network of Science and Technology Indicators (RICYT) can offer training in carrying out such surveys.

The analysis presented on the context and state of science, technology and innovation in El Salvador highlights some of the country's principal weaknesses. On the one hand, there is the fragile economic performance which will be hard to sustain in the long term without substantial increases in productivity. On the other, the lower levels of investment in education, sciences, technology and innovation give cause for concern, as do the inconsistencies in this expenditure where, for example, much of the research has been directed to social sciences and humanities.

It is clear that the development of productive capacities in El Salvador will require heavy investment in education and training of human capital, diversification of production to knowledge intensive activities and the development of technological capacities to reduce external and internal productivity gaps. To achieve that, it will also be necessary to foster national awareness of the importance of STI and reach a consensus on the most appropriate mechanisms to promote it. The following chapters seek to support the development of this awareness and consensus through a diagnostic of the national system of innovation in El Salvador and how it functions, followed by a series of recommendations.

Figure 20. Royalties and licence fees (payments and receipts), various Latin American countries, 1995-2008 (in millions of dollars at current prices and current exchange rate)



Source: UNCTAD, based on UNSD COMTRADE Data, 2010.

NOTES

[1] There are no reliable data, but it is estimated that some 3 million Salvadorians live abroad, of whom 2.5 million are in the United States. Estimates by the Ministry of Foreign Relations (see Ministry of Foreign Relations 2010 and International Organization for Migration (www.iom.int/jahia/Jahia/el-salvador).

[2] The under-employment rate measures the volume of unemployment [invisible (workers who work 40 hours or more and receive an income lower than the established minimum wage) and visible (workers who, not of their own choice, work less than 40 hours per week)] in the economically active population over a given period of time.

[3] For further details, see UNDP (2010 and 2008), UNCTAD (2010).

[4] In 2009, family remittances, despite being affected by the economic crisis, amounted to 3,465 million dollars and accounted for 16.4 per cent of GDP.

[5] An IMF study shows that 80 per cent of remittances are destined for consumption while only 15 per cent of remittances were destined for education and health, and five per cent for investment and saving (Cáceres and Saca, 2006).

[6] With the exception of Nicaragua which, in absolute terms, invests less.

[7] Based on data from the Central Reserve Bank of El Salvador.

[8] For further details, see UNCTAD (2010).

[9] Based on Foreign Direct Investment database, UNCTAD.

[10] The Global Competitiveness Report places El Salvador in 44th place in terms of infrastructure, only behind Chile (24th place).

[11] ECLAC (2010).

[12] This budget does not include the two priority programmes established in the Five-Year Development Plan 2010-2014.

[13] Assessment of learning achievements in basic education carried out every three years.

[14] Test of learning and aptitudes for secondary school leavers, carried out annually.

[15] Average = 500 points. El Salvador: Mathematics fourth grade = 330/ Eighth grade = 300; Sciences Fourth grade = 390 / Eighth grade = 387.

[16] Global Education Digest (2010).

[17] MINED Report (2010).

[18] MINED information bulletin available at www.mined.sv, uploaded on 18 February 2011.

[19] Over 50 per cent of postgraduate students are pursuing studies in these two areas).

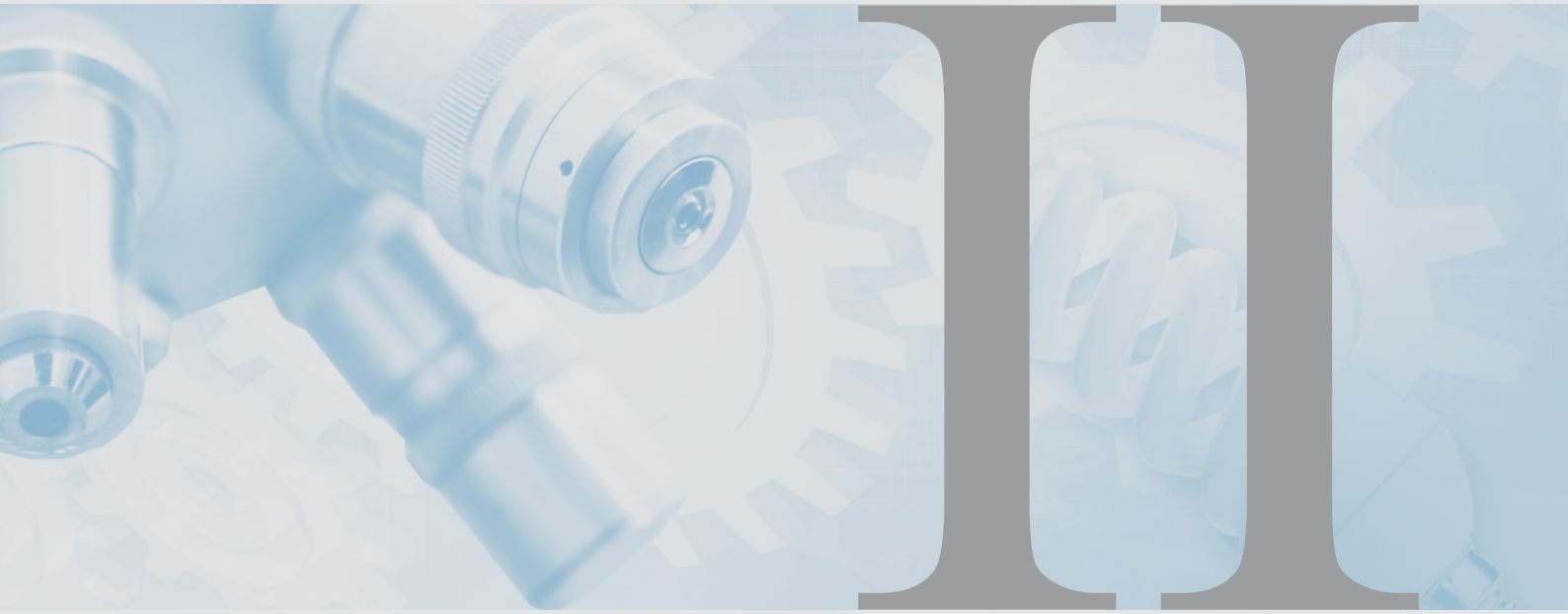
[20] For example, in 2009, 72 homicides were recorded for every 100,000 inhabitants, while the global annual average is estimated at 9 homicides for every 100,000 inhabitants (UNDP 2010b).

[21] That is, those that dedicate over 80 per cent of their time to research activities.

[22] That is, "systematic activities which are closely concerned with the generation, advancement, dissemination and application of scientific and technical knowledge in all fields of science and technology. These include such activities as R&D, scientific and technical education and training and scientific and technological services" (UNESCO, 1978).

[23] Manual of Santiago (RICYT, 2007).

[24] In El Salvador, no national innovation survey has been carried out.



II

The components of the National System of Innovation of El Salvador

A. INTRODUCTION

This chapter describes the components of the National System of Innovation (NSI) of El Salvador, based on the principal functions which characterize any system and which are explained in this introduction. This descriptive chapter will enable the elaboration, in Chapter III, of a diagnostic of El Salvador's NSI and of a series of recommendations to strengthen it.

There are many definitions of national system of innovation[1], but all highlight the existence of a series of actors, public and private, whose activities and interaction create and disseminate new technologies. The approach taken by this review is based on a broad meaning of these definitions with certain more detailed perceptions (included in Annex B) which make this approach more relevant to the conditions in a country where the NSI is emerging. It is important to bear in mind that the concept of national system of innovation must be seen as a reference framework which represents and helps to explain a complex reality. Two possible purposes derive from this approach. One is to serve as an analytical method to approximate the functioning of a nation's productive system, from the viewpoint now called the knowledge economy. In other words, understanding the capacities of national production in terms of the convergence of a series of economic, social and scientific-technological processes intended to generate, disseminate and apply knowledge to the benefit of society, i.e. generate innovation.[2] Secondly, the NSI framework has the purpose of contributing to the design and implementation of specific plans, programmes and policies aimed at improving the functioning of the national productive system, with a view to making it more competitive and thus to tackle the challenges involved in the current dynamic of the global economy.[3]

From the foregoing, two important considerations can be derived to be used in this reference framework:

a) The necessity and usefulness of distinguishing two dimensions of the operation of national systems of innovation: (i) execution, which is how various economic and social agents or actors converge in the generation, diffusion and application of knowledge; and (ii) policy, which is how public policies facilitate, regulate and promote the harmonious functioning of the agents involved in innovation processes.

b) The policy dimension of the NSI approach includes or substitutes the traditional separation between industrial policies[4] and science and technology policies, which means that when there is a reference to innovation policies, what is envisaged is the systemic interaction between science, technology and industry in generating economically useful knowledge.[5]

Thus, innovation policies and their interactions with part of the economic system can be interpreted as forming a system which, to be sustainable[6], must fulfil two fundamental functions due to the dynamic of their processes: immediate reaction and long-term reaction to events in the environment. These fundamental functions are exercised by two subsystems – the executive subsystem (productive and innovative in the true sense) and the policy system – which operate in distinct hierarchical dimensions. These, in turn, fulfil five local sub-functions: production, regulation, control, foresight and cohesion (Table 1).[7]

The first refers to the production of that which the system regards as an objective, which at the same time allows it to exist – in this case the generation and exploitation of knowledge for the benefit of society. As there can be various entities responsible for this production, the second function is to regulate or coordinate them. The third function controls the flow of resources, monitors performance and makes the necessary corrections to ensure that system fulfils its objectives. The fourth function concerns the vision of

Table 1. Functions and dimensions of sustainable systems

Fundamental Function	Local Function	Dimension of Recursion
Immediate reaction	Production and execution	Executing system
Immediate and long-term reaction	Regulation	Link between both systems
Immediate and long-term reaction	Management and control	Link between both systems
Long-term reaction	Foresight	Policy system
Long-term reaction	Cohesion	Policy system

Source: UNCTAD.

the future and the determination of strategies. The fifth dictates the guiding polices which enable the cohesion of the system.

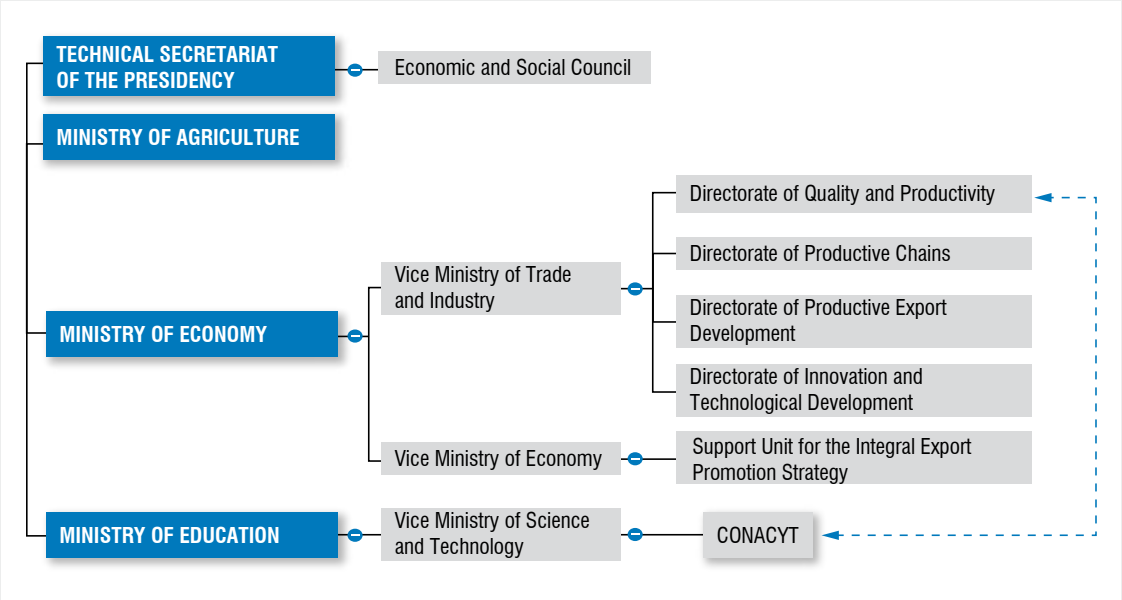
B. GOVERNANCE OF SCIENCE, TECHNOLOGY AND INNOVATION (STI). FUNCTIONS OF COHESION AND FORESIGHT – POLICY SYSTEM[8]

In the Republic of El Salvador, there is no body at present which governs the entire system of science, technology and innovation policies. It would be logical for its governance to rest ultimately with the Presidency of the Republic and the bodies which support the executive, namely the Technical Secretariat of the Presidency and those ministries whose functions are relevant to STI activities,[9] particularly those of Agriculture and Livestock, Economy and Education.[10] Each of these bodies has various interactions with other agents which more particularly design and implement specific plans and programmes, or even execute activities designed to promote STI (Figure 1).

Such is the case of the Technical Secretariat of the Presidency, which was in charge of the elaboration and approval of the Five-Year Development Plan 2010-2014 through the Economic and Social Council; the Ministry of Agriculture and Livestock, with the National Centre for Agriculture, Livestock and Forestry Technology (CENTA) answering directly to it; the Ministry of Economy, which designs and implements concrete measures to promote innovation through the Vice Ministries of Economy (Support Unit for the integral export promotion strategy) and Trade and Industry and their Quality and Productivity, Productive Chains, Export Development (FOEX), and Innovation and Technological Development Directorates; and the Ministry of Education which, through the recently created Vice Ministry of Science and Technology, promotes actions in favour of scientific and technological development.

More specifically, from the legal and regulatory viewpoint, the National Council for Science and Technology (CONACYT) is the higher authority with respect to scientific and technological policy[11]. Under the Act which created it, its mission consist of "Formulating, directing, coordinating and continuously disseminating national polices on science and technology, aimed at the economic, social and environmental develop-

Figure 1. The principal government bodies involved in the system of innovation policies



Source: UNCTAD.

ment of the country". In order to fulfil it, CONACYT was assigned the following roles:

- To formulate and direct national scientific and technological development policies and programmes,
- Advise the Government of the Republic on investment programming and budget preparation of institutions which receive state funding for scientific and technological activities;
- Execute the National Scientific and Technological Development Programme through all the research centres and academic institutions whose activities fall within the fields of science and technology;
- Formulate in coordination with the Ministry of Planning and Coordination of Economic and Social Development, on the basis of national scientific, technological and socio-economic development of objectives, policies on international technical assistance and foreign financial cooperation for science and technology;
- Manage and administer financial resources and national and international technical assistance in support of the National Scientific and Technological Development Programme;
- Promote activities to extend the frontiers of knowledge, by fostering the training of scientists and engineers, education, advanced training and diffusion of science and technology;
- Direct and coordinate the activities and execution of policy in standardization, metrology, verification and certification of quality;
- Ensure the strengthening of academic institutions involved in science and technology;
- Drive the establishment of a legal framework relating to science and technology.[12]

CONACYT is precisely one of the bodies undergoing a process of transformation. Until mid-2010, it was an autonomous institution related to the executive through the Ministry of Economy. Now, its functions related to the promotion of science, technology and innovation are being transferred to the Vice Ministry of Science and Technology, to which it will continue to be attached with the same name. In addition, the functions in the quality sphere will be fulfilled as part of the Salvadorian Quality and Productivity System, by five autonomous entities:

- The National Quality Council, the umbrella body for the system;
- The Salvadorian Standardization Agency (OSN);
- The Salvadorian Technical Regulation Agency (OSARTEC);
- The Salvadorian Accreditation Agency (OSA);
- The Centre for Metrological Research (CIM).[13]

Also worthy of mention is the Innovation Promotion Group (GPI), a multisectoral group established in May 2005 to foster innovation activities.

The goals of the Innovation Promotion Group include:

- Creating a unified, integrated effort, orchestrated by representatives of the private, public and academic sectors, to formulate guidelines for innovation.
- Defining the vision, mission and strategic directions which guide the action of the Group and those who sign up to the national innovation effort.
- Helping to create the necessary conditions to facilitate the establishment and consolidation of the national system of innovation.
- Ascertaining, analysing and validating government and private inputs in this area, as the basis for analysis and management of the effort.
- Contributing to the identification of strategic economic activities to focus efforts and identify the country's best opportunities.
- Analysing expert opinions and driving initiatives, projects and actions required by the national reality to implant the innovation strategy.
- Supporting the promotion and development of the theme of innovation.

The Innovation Promotion Group is a forum for discussion without any binding function or its own budget. Currently, the Group has virtually ceased its activity.

The governance of STI in El Salvador is complemented by the national polices which are described in the following section.

1. National Science, Technology and Innovation Policy, 2006–2030

Chronologically, one of the most recent national policy documents on STI is the one prepared and approved by the National Council for Science and Technology in 2006, updating the previous policy which dated from 1997 (CONACYT 2006). It is structured on the basis of a global framework, (shown in Figure 2), which sets out the general vision of the country centred on social wellbeing and the contribution of science and technology to that wellbeing. It also includes 13 proposals which would form and facilitate the global vision, with a time horizon up to 2030. It should be mentioned that one of these refers to "the existence

of a National System of Science, Technology and Innovation, with functions that would give impetus to technological and scientific activity in the country, create multiple links between institutions and social actors which would encourage the interrelation of the scientific, technological and productive spheres [...]"[14]

The document also includes 21 conditions of factors necessary to achieve the country's vision, 13 areas of knowledge for the development of STI (listed in Table A.1 in Annex A), 10 objectives and 15 general policy action lines, as well as the following strategic components:

- Education and training;
- Scientific and technological information;
- Technology transfer, innovation and development;
- Information and Communications Technologies (ICT);
- Science and technology aimed at the development of the country's regions and zones;
- Science and technology infrastructure;
- Financing of scientific and technological development and innovation.

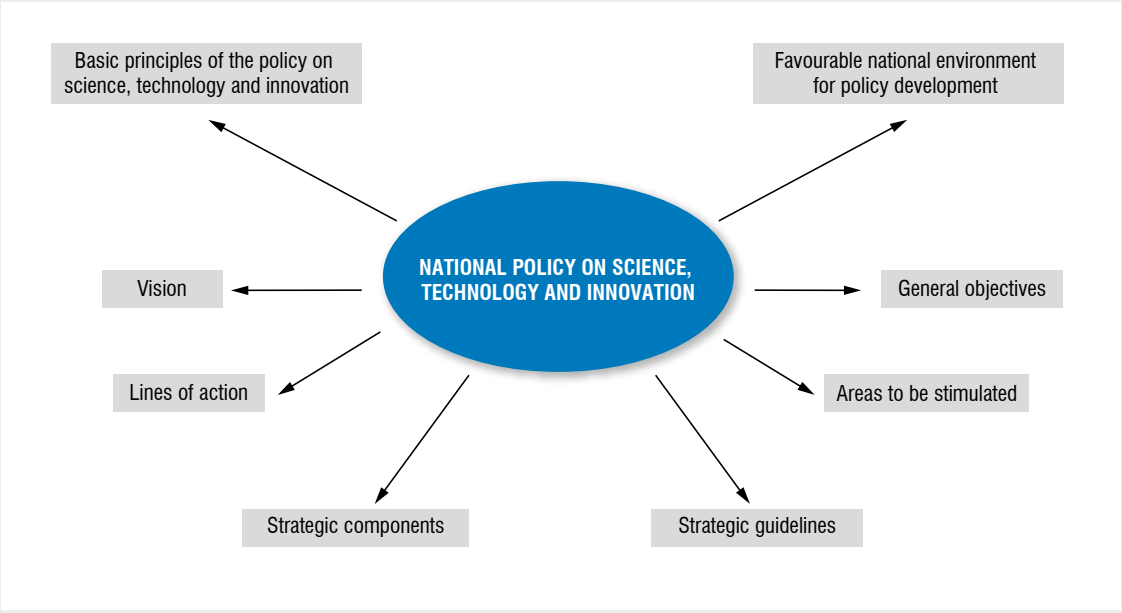
Each strategic component consists of a description, action lines, the respective institutional framework and the "tools"[15] proposed to implement them. It also identifies CONACYT as the coordinating body and the Innovation Promotion Group (GPI) as the liaison body between agents and processes of the national system of STI (SINACTI).

2. The Five-Year Development Plan, 2010–2014 (PQD)

With a much broader scope,[16] as it involves a comprehensive development plan for El Salvador, the five-year plan is the most recent general policy document and its purpose is to guide the formulation of specific policies, including polices on STI (Government of El Salvador, 2010).

The Plan is structured around two strategic objectives: (i) the introduction of a new growth model of integrated, sustainable and inclusive development; and (ii) the entrenching and consolidation of democracy. Naturally, the guidelines of STI activities belong within the first objective. The principal guidelines in the Five-Year Development Plan related to STI are set out in Table A.1 in Annex A. Figure 1 shows the priority programmes and projects in the Five-Year Development Plan and Table 2 shows the total costs of these programmes and projects and the funding gap.

Figure 2. Global framework of the National STI Policy, 2006



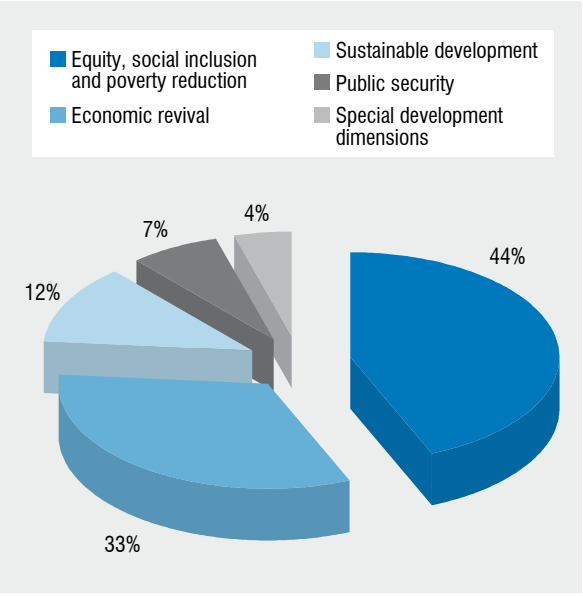
Source: CONACYT, 2006.

Table 2. Priority programmes and projects in the Five-Year Development Plan (millions of dollars)

Strategic area	Overall total (1+2)	Total funding and management (1)	Total funding gap (2)
Equity, social inclusion and poverty reduction	2,100	926	1,174
Economic revival	1,579	713	865
Sustainable development	590	544	46
Public security	336	86	250
Special development dimensions	209	52	157
TOTAL	**4,814**	**2,322**	**2,492**

Note: The subtotal autonomous institutions (ISSS, FONAVIPO-FSV, CEL) is 474.7 millions of dollars overall.
Source: Government of El Salvador, 2010.

Figure 3. Priority programmes and projects in the Five-Year Development Plan by strategic area (percentage)



Source: Government of El Salvador, 2010.

3. National Scientific and Technological Development Plan

The Ministry of Science and Technology has proposed a National Scientific and Technological Development Plan. The reference basis for this plan is as follows: previous work by CONACYT covering the period 2009-2030; the Five-Year Development Plan 2010-2014; and the National Research Agenda prepared by the Ministry of Education through the Vice Ministry of Science and Technology.[17] The general objective of the plan is to establish the criteria for scientific and technological development. Its specific objectives include:

- Putting the development of science and technology as development and innovation tools at the service of society and sustainable economic development;
- Promoting the recognition that R&D are crucial elements in the generation and appropriation of new knowledge to help solve development problems;
- Making research and development and innovation a factor to promote and incentivize entrepreneurial development with social responsibility;
- Educating and training human resources of a number and quality to form a critical mass of professionals to generate strategic change for development;
- Promoting the visibility of scientific and technological information, the communication of advances in science and technology and their use in decision-making;
- Using ICT to stimulate growth and sustainable development;
- Establishing mechanisms to allow the coordination of public and private entities such that science and technology focus on the country's development;
- Contributing to the conformation of a science and technology infrastructure which provides a favourable environment for the development of STI;
- Contributing to the creation of and search for financial instruments and incentives available to the executing agents of the various programmes and activities for the development of STI.

The plan's scope of action is based on the National

Research Agenda which is linked with the Five-Year Development Plan through a synthetic matrix which identifies research strengths in 29 areas and some 156 strategic lines (see Table A.2 in Annex A).[18]

A main objective of the National Research Agenda is to guide the scientific and technological development research activities of national and private research centres.

The management and strategic direction of the plan is the responsibility of the Ministry of Education through the Vide Ministry of Science and Technology which will be supported by its own structure. Its execution will involve all the centres, institutions, entities and bodies in the public and private sector and research and higher education institutions whose activities fall within the field of STI or which devote part of their budget and human resources to these activities. For its part, the Research Agenda takes concrete form in the content of the plan involving 10 programmes and 32 projects (see Table A.3 in Annex A).

4. The comprehensive export promotion strategy

At the beginning of July 2010,[19] the Ministry of Economy launched the export promotion strategy 2010-2014 (MINEC 2010), a document designed to strengthen activities which drive foreign trade. The strategy is structured around five pillars to achieve its goals:[20] (i) the need to invest in processes which encourage exports; (ii) the incorporation of innovation in these processes; (iii) the links between activities involving foreign trade and the generation of quality jobs; (iv) strengthening productive inclusion (productive chains, business partnerships, collaboration, etc.); and (v) taking advantage of free trade agreements. In addition, it is intended that the cross-cutting elements of the strategy will be formed by the integration of innovation and quality systems.

The document sets out five strategic objectives which include 16 strategic areas and various action lines, as described in Table A.4 in Annex 4, from which 21 programmes and instruments are derived. The strategic areas and action lines of the plan most relevant to STI include a set of action lines to promote the national system of innovation, including the creation of five sectoral technological centres, strengthening of the INVENTA gateway, the promotion of an innovative culture, identifying resources for innovation, and the establishment of partnerships.

C. THE ADMINISTRATIVE FRAMEWORK OF SCIENCE, TECHNOLOGY AND INNOVATION. MANAGEMENT, CONTROL AND REGULATORY FUNCTIONS – LINK BETWEEN THE POLICY SYSTEM AND THE EXECUTING SYSTEM

In the Salvadorian case, these functions consist of the implementation of specific programmes and projects to promote STI activities, and the establishment of regulations and systems to monitor and control them. These tasks are carried out by the ministries mentioned above who essentially participate in the design of policies through their vice ministries and other bodies linked to the executive through them (Figure 4). The most important of them are mentioned below.

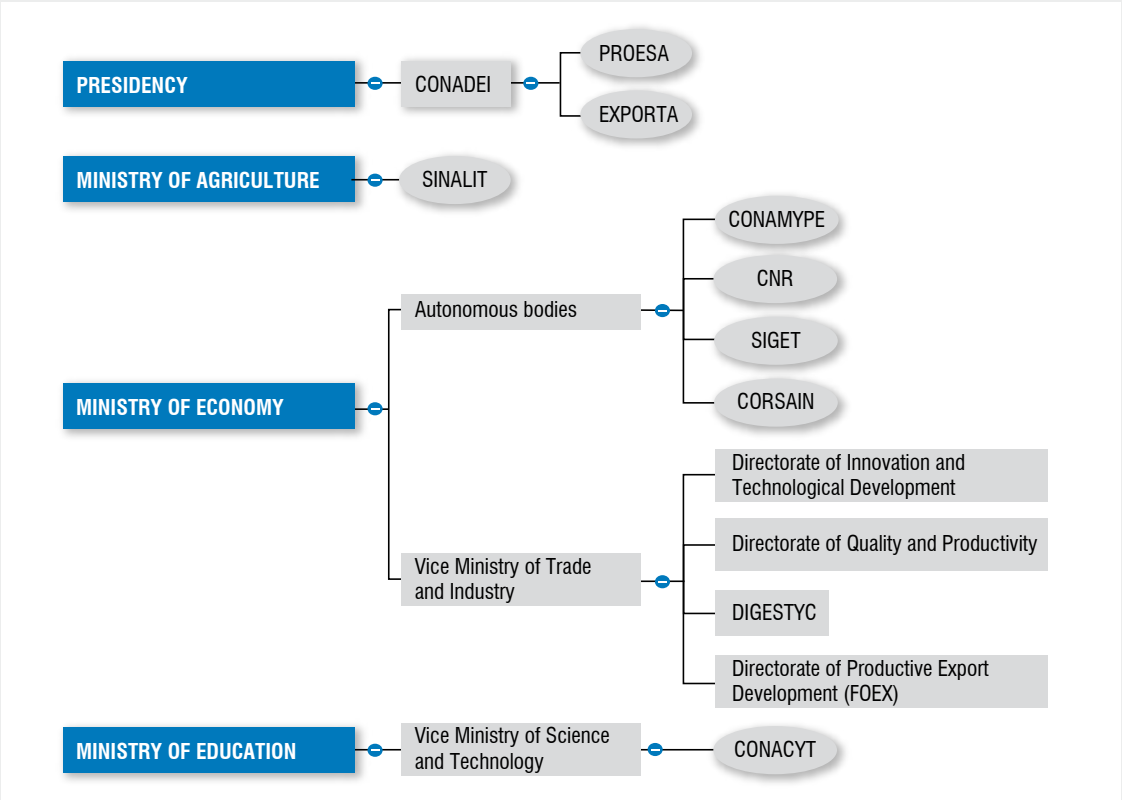
1. Presidency of the Republic

Attached to the Presidency is the National Commission for the Promotion of Exports and Investment (CONADEI), whose functions involve the promotion of exports and access to foreign investment through its EXPORTA and PROESA sections respectively.

2. Ministry of Agriculture and Livestock

One of the components of the Agro-Industrial Conversion Programme has been the National System of Alliances for Innovation and Technology (SINALIT), whose objective was to strengthen the country's capacity to engage in agriculture and livestock, agro-industrial and forestry research and technology transfer. The primary beneficiaries of this system, operated by the Ministry (2001-2009) with support from funds of the Inter-American Development Bank, were agricultural and livestock producers and their organizations, agro-industrial enterprises and others involved in the agriculture and livestock chain, as well as entities that generate and provide technological services, public and private, both national and international.

Figure 4. The principal government bodies involved in the management, control and regulation systems



Source: UNCTAD.

3. Ministry of Economy

The Vice Ministry of Trade and Industry and its Quality and Productivity (DCP) and Innovation and Technological Development (DIDT) Directorates, which, among other things, operate the Inventa and Pixels programmes, are implementing several programmes to promote innovation, chiefly through the latter. The DIDT has the specific objective of facilitating and strengthening entrepreneurial capacities related to innovation and technological development and, in general, to promote entrepreneurship, incubation and entrepreneurial development, as well as contributing to improving regulatory, institutional and operational conditions in both the public and private sphere.

In addition, both Directorates promote innovation in coordination with other entities and programmes of the Ministry of Economy such as the National Commission for Micro and Small Enterprises (CONAMYPE), whose function is to stimulate a range of modern, competitive and profitable micro and small enterprises worthy of capital investment, and the Directorate for Productive Export Development (FOEX), whose mission is to strengthen the competitiveness of micro, small and medium-sized enterprises through non-reimbursable co-financing up to 70 per cent of the total cost of a specific project related to the development of exports, quality, alliances, productivity and innovation.

Also under the aegis of the Vice Ministry, the Directorate General of Statistics and Censuses (DIGESTYC), coordinates and produces national social and economic statistical information.

Other autonomous bodies linked to the executive through the Ministry of Economy and which are relevant to innovation activities are the National Records Centre (CNR) whose functions include registration of intellectual property, and the Salvadorian Investment Corporation (CORSAIN), responsible for promoting and developing companies and enterprises dedicated to industrial activities.

4. Ministry of Education

This Ministry has recently taken charge of the Higher Education Research Fund (FIES), which is a mechanism of the Government of El Salvador for the competitive financing of scientific and technological projects put forward by accredited and state higher education institutions (universities, specialized institutes and technological institutes), seeking to promote and incentivize capacities for their scientific and technological innovation, and to promote links between the academic and productive sectors. In its first funding round, seven projects were implemented for an investment of some 410,000 dollars, and in the second round, six projects were implemented for an amount of 617,000 dollars.[21]

In addition, the recently created Vice Ministry of Science and Technology will absorb the functions of the scientific and technological component of CONACYT. It will be responsible for educational technologies and technical, scientific and technological education, and is currently planning actions which sit better in the field of execution, such as the creation and operation of research centres in the exact and social sciences and technology parks.

5. Laws and regulations

Specifically aimed at STI activities, the only known legal framework is the above-mentioned Act on CONACYT, although at the time of writing this review, it is not known whether the above-mentioned changes in the government structure are yet in force. There is a Scientific and Technological Development Bill which is at the examination stage, but at the time of writing of this document (March 2011) it had still not been approved. Nevertheless, it does propose a series of arrangements which already apply in practice. Among the most important is that the Vice Ministry of Science and Technology is the lead agency for science and technology and responsible for coordinating the formulation and implementation of national policy on STI, serving as the basis for the elaboration of the National Plan for Science, Technology and Innovation mentioned above. The Bill also contemplates:

- The constitution of the National System of Science, Technology and Innovation (SINACTI).
- The establishment of a National Science, Technology and Innovation Observatory.
- Actions in the education sector including: (i) modification of study programmes to include scientific and technological education as a cornerstone of education; (ii) strengthening of postgraduate studies and the introduction of a system of scholarships; (iii) obligation of foreign technology-based companies to include Salvadorian researchers on their staff; (iv) creation of research and technological innovation centres; and (v) establishment of a National System of Researchers.
- Actions to promote science and technology.
- Establishment of additional funding on top of the financing allocated in the education budget of at least 0.1 per cent of GDP.
- Strengthening international cooperation in STI.
- Creation of the Fund for Scientific and Technological Development and Innovation (FODECYT), managed by CONANCYT, in order to finance research projects.
- Generation of incentives for the development of STI.

Other legal instruments which influence innovative activities, essentially by facilitating and stimulating national and foreign productive investment, include: the Industrial Free Zones and Marketing Act (1998); the Investment Act (1999); and the International Services Act (2007), which regulates the establishment and operation of service parks and centres.

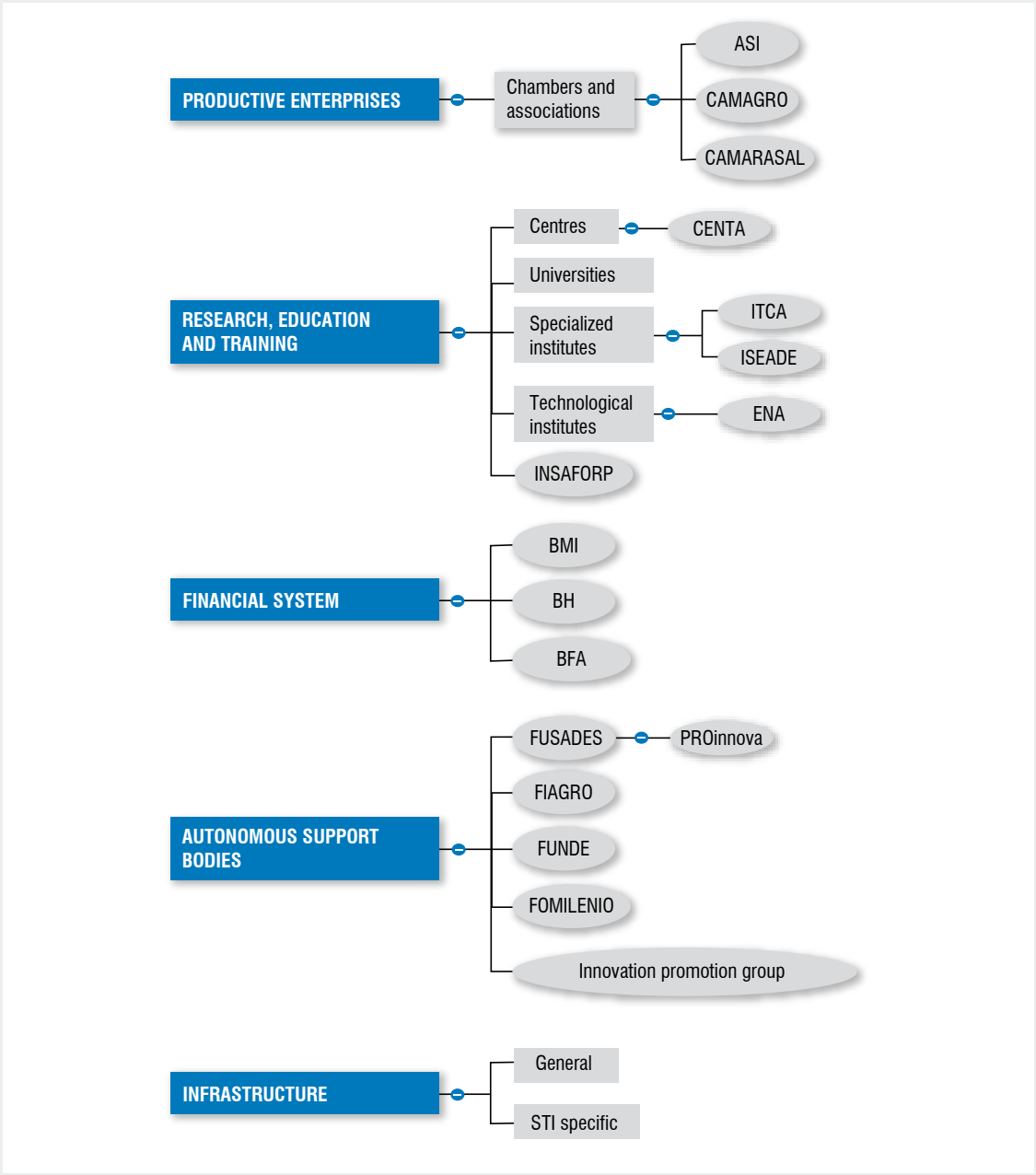
D. OPERATORS IN THE SYSTEM OF INNOVATION. PRODUCTION AND EXECUTION FUNCTION – EXECUTING SYSTEM

The principal agents who, in the case of El Salvador, make up the production system as such include essentially enterprises, which are the cornerstone of the generation of innovation, organizations which generate and disseminate knowledge, the constituents of the financial sector, and independent bodies which promote technological development and innovation (Figure 5).

1. Industry

The industrial structure of El Salvador consists 91.6 per cent of micro-enterprises[22], which employ almost 36 per cent of the country's employed population (DIGESTYC, 2005). The principal economic activities relate to manufacturing industry, branches of the

Figure 5. The principal agents involved in the system of execution and production



Source: UNCTAD.

tertiary sector (chiefly commerce and to a lesser extent transport and storage services) and the primary sector, although the latter has been declining in recent years (see Chapter I, Figure 5). For its part, the secondary sector, which contributes some 22.5 per cent of gross domestic product, is concentrated mainly in industrial assembly services (which have grown enormously in recent years), basic chemicals and derivatives, branches of the food industry, and basic and transformed metal products (see Chapter I, Figure 6).

With regard to capacity for innovation, if we take patenting intensity as an indicator,[23] this is fairly low.

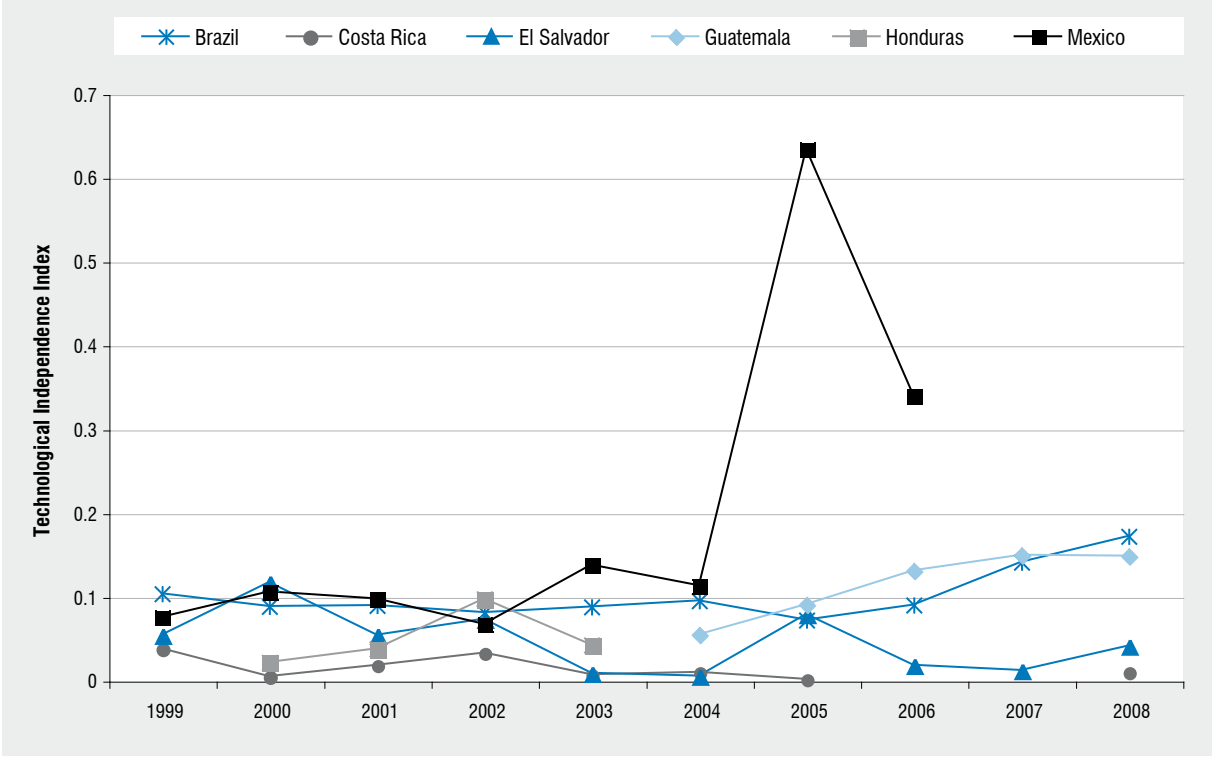
As can be seen in Annex D, the number of patents where the inventors live in El Salvador[24] is about eight per year and the majority of them are awarded to foreign companies which own them. The comparative data in the same annex also show that the intensity of patenting is low (Figures D1 and D2).

Complementing this analysis, Figure 6 shows the low proportion of royalties received by El Salvador for technology licensing and Figure 7 shows that its exports of high technology barely reached 100 million dollars in recent years. Annex D also shows the areas in which there is greater scientific and technological capacity, predominantly in medicine and veterinary science, agriculture and the food industry, and to a lesser extent in the motor and metal engineering, organic chemistry and biochemistry.

Although these data may appear discouraging, it is important to take into account that (according to the interviews) there have been limited public promotion of intellectual property, in particular patents. In addition, the industrial structure described above does not lend itself to the use of instruments of this kind by micro and small businesses. Furthermore, interviews conducted in various companies revealed that on occasion they carry out R&D activities and even include innovations in their products and processes, but without considering it as such and including it in their financial statements. This means that R&D and its application in innovations is greater than can be seen through conventional indicators. Box 1 shows examples of successful innovations in El Salvador which are not captured by national indicators. The work done by these companies includes the acquisition of technology and activities of imitation and adaptation, incremental innovations which, while not radical, have made these companies more competitive and allowed them to expand, including internationally. These results show the importance of incremental, not only radical, innovation.

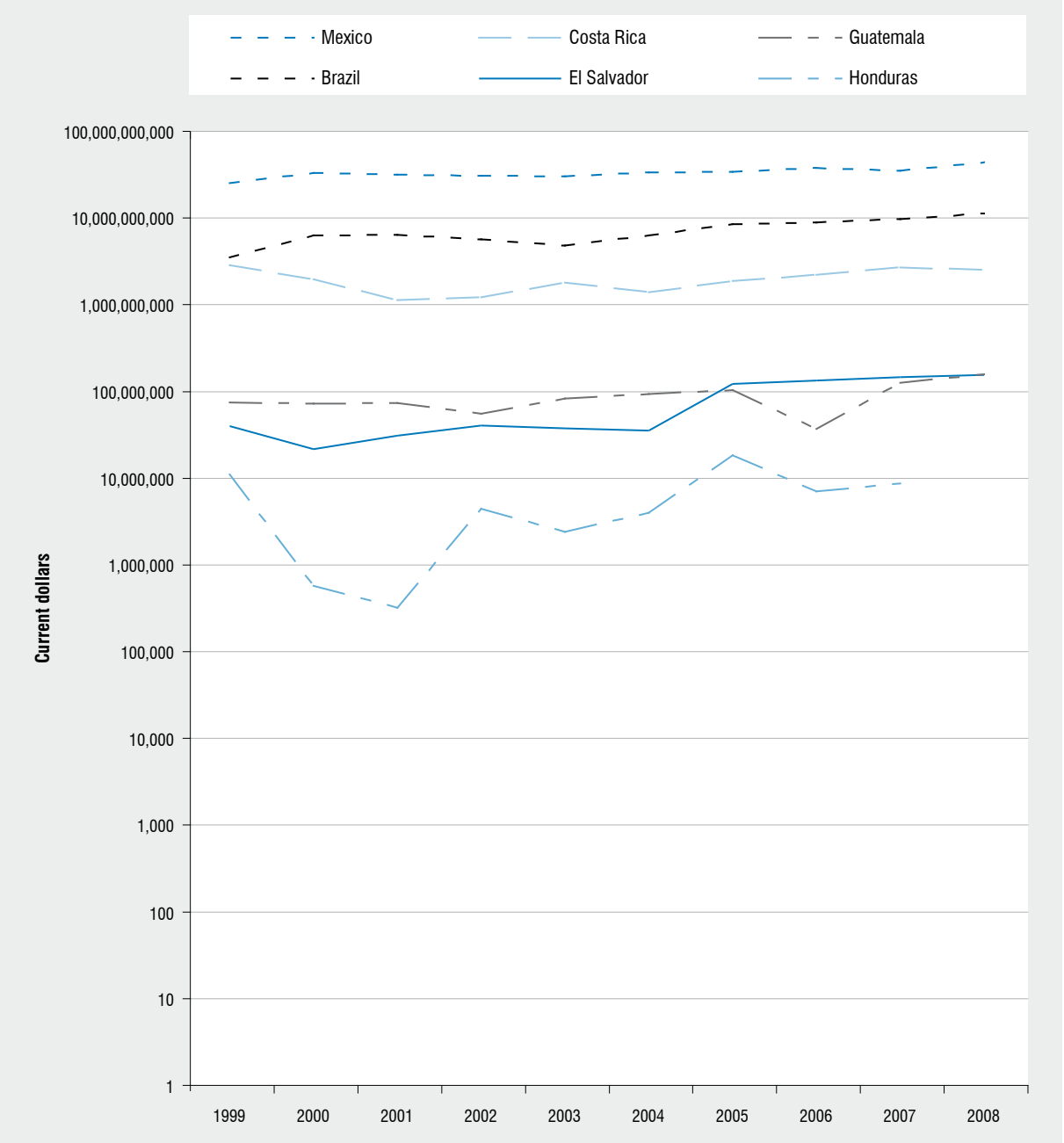
Despite this, innovative activities in the Salvadorian productive sector are few (see Chapter I, Figures 8 and 9), and are largely confined to the introduction of improvements which are new to the organizations through the acquisition of technology. This is influenced by the structural characteristics of the productive sector, as micro, small and medium-sized enterprises generally have less resources for education, training,

Figure 6. Ratio of receipts and payments for royalties and licensing of technology



Source: UNCTAD, based on World Bank data.

Figure 7. High technology exports (logarithmic scale)



Source: UNCTAD, based on World Bank data.

an innovative culture, infrastructure and financing to carry out innovative activities internally.

The productive sector also has various industry organizations which, among other things, fulfil the functions of representation, advice and training. The most important among them are described below.

Salvadorian Association of Industrialists (ASI)

The ASI is a group of some 500 essentially small and medium-sized enterprises, including industry associations in the textiles and dress-making industry, plastics, pharmaceuticals, paper and cardboard, footwear and metal engineering. It carries out actions

Box 1. Examples of successful innovations in El Salvador not captured by national indicators

Laboratorios Arsal S. A. de C. V.

This family company, with a long history in El Salvador, has a wide range of medicines for human and veterinary use which sells in the domestic and Central American market (and is beginning to make inroads in South America).

It has a small R&D department, like other local pharmaceutical laboratories, seeking new markets through competitive product knowledge and research and analysis of patents. Once products with potential have been identified, the internal capacities to develop and manufacture it are analysed, and if the outcome is positive, the process of developing the compounds starts.

During the engineering work of reconditioning and expanding the factory, it was found that there was a need to acquire various specialized accessories. Given the high cost of such equipment, the engineering team, assisted by consultants and small firms, developed and supervised the manufacture of fibre-glass doors and walls and pharmaceutical lamps for the installations. These product and process innovations were completed outside the R&D department and were not included in the accounts and R&D activities.

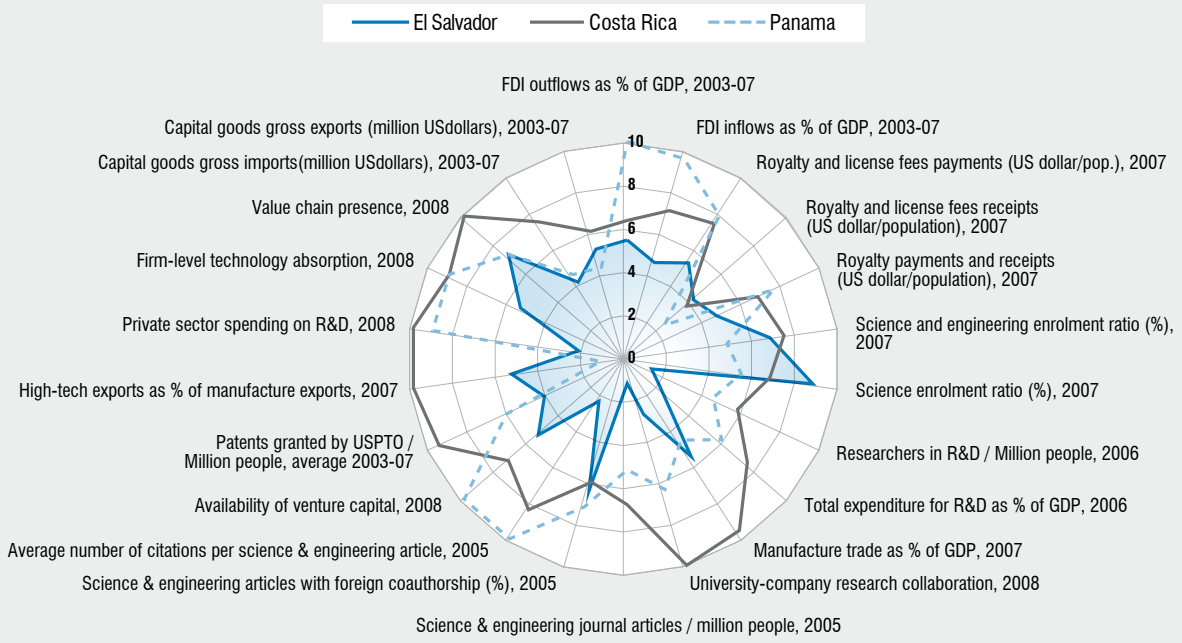
The Coffee Cup[26] and Quality Grains.

These two companies are managed by the well-known Salvadorian businessman, Samuel Quirós, who also has a long background in the motor industry. The Coffee Cup is a chain specialized in gourmet coffee which in 2002 opened its first establishment to meet growing local demand. It has concentrated on perfecting the brand from aspects related to the taste of the coffee blends, to those involving materials and design. For the former, it relies on Quality Grains, a coffee producer with intensive export activities.

The exploitation of the value chain, the emphasis on product quality and the special attention paid to standardization of processes in the distribution phase has facilitated the sale of The Coffee Cup franchises in El Salvador, Guatemala, Honduras and Costa Rica. Towards the end of 2010, it opened its first outlet in Austin, Texas, after several years trying to enter the United States market, and it hopes to open a further ten establishments in the course of 2011, to add to its more than 30 outlets.

Source: UNCTAD.

Figure 8. Indicators of innovation under the World Banks's Knowledge Assessment Methodology (KAM)



Note: Data normalized by reference to the Latin American group of countries.
Source: UNCTAD, based on World Bank data.

to promote the establishment of industrial policies in El Salvador and also provides a series of services to businesses.

The Agricultural and Agroindustrial Chamber of El Salvador (CAMAGRO)

CAMAGRO is a private not-for-profit association. Its prime purpose is to bring together all natural and legal persons operating in agriculture and livestock, forestry, fishing, agro-industrial and related activities. Its general strategy is to design a medium and long-term agricultural policy and take the lead in specific strategies to achieve their adoption by governments, and urge the relevant authorities to implement agricultural policy.

Chamber of Commerce and Industry of El Salvador (CAMARASAL)

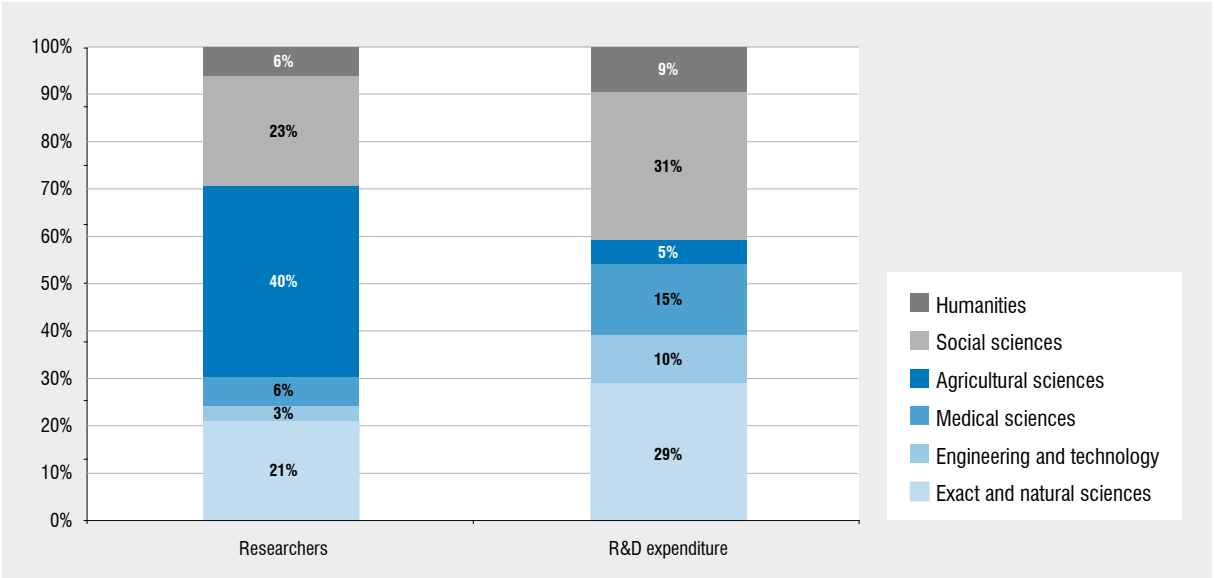
CAMARASAL is a not-for-profit association which provides services and carries out productive activities for the benefit of enterprises, such as advice on business, export procedures, training, market intelligence, business contacts, etc. Its mission is to promote and defend the system of free enterprise, stimulate enterprise development with social responsibility, lead actions and provide services to promote its members' competitiveness and protect their rights. It has various training programmes.

2. Organizations which generate and disseminate knowledge

Research activities in El Salvador are essentially carried out in the CENTA and the National Centre for Fisheries Development (CENDEPESCA) and some of the higher education institutions: universities, specialized institutes and technological institutes. There are 24 universities in the country (one public), 9 specialized institutes (four public) and 6 technological institutes (three public) (MINED 2011)[27]; all of them are duly authorized, although only 8 universities have accreditation.[28] However, according to the CONACYT register of researchers, only 11 universities and 5 institutes carry out research activities.[29]

Human resources devoted to research are rather small (see Chapter I). According to data of the Register of National Scientific Researchers of CONACYT,[30] the total number of researchers comes to 502, of whom 32 have doctorates and 224 master's degrees. In 2009, 134 researchers were listed (16 with doctorates and 32 with master's degrees) in higher education institutions (CONACYT 2010). These statistics on researchers in higher education institutions show major inconsistencies between the number of researchers and the level of R&D investment in each subject area (Figure 9). 40 per cent of these researchers are in the agricultural sciences, but expenditure on R&D in this area accounts for only 5 per cent of total spending. In

Figure 9. Inconsistencies between the number of researchers and investment in R&D by subject area – Higher education institutions, El Salvador, 2009



Source: CONACYT (2010).

higher education institutions, there is a high proportion of researchers in the social sciences and humanities (29 per cent) and relatively high expenditure on R&D in those areas (41 per cent) (CONACYT 2010).

As regards financial resources dedicated to scientific and technological activities (R&D, education in science and technology and science and technology services), total expenditure by higher education institutions in 2009 was 193 million dollars, of which 8.2 per cent relates to R&D and 88 per cent to scientific and technological education. This means that total expenditure on R&D as a percentage of GDP was 0.08 per cent in 2009 (CONACYT, 2010). This percentage, although understated because it does not include R&D investment carried out by the private sector or research centres, still represents very low investment.

With regard to scientific output, a bibliometric study carried out expressly for this review (see Annex F) identified 420 publications in indexed journals to which authors resident in El Salvador contributed;[31] of the total number of articles, in 186 they appear as the lead author, which in recent years means an average of four articles per year in this type of medium. In absolute terms, the number of articles is the lowest in Central America (see Figure F3), but if historic information on investment in R&D and human resources dedicated to science and technology, actual productivity could be estimated with precision. Collaboration in research is primarily with the United States and, to a lesser degree, with Spain and the neighbouring countries of Central America (Honduras, Guatemala and Costa Rica).

The research topics which have been the subject of the most intensive publications relate to public, environmental and occupational health, especially tropical medicine, dermatology, infectious diseases and oncology. There is also a wide-ranging output in plant sciences and their pharmacological applications and biochemical support. Other areas which stand out are ecology, zoology, entomology, veterinary sciences and earth sciences.

Concerning the impact of these articles on the scientific community, the main areas, taking into account all the articles, are immunology, research into the respiratory system, meteorology and atmospheric sciences, and food technology. On the other hand, taking into account only those articles where the lead author is resident in El Salvador, the publications with the greatest impact concern oncology, orthopaedics, health policy and services, paediatrics, andrology, nutrition and ophthalmology. Finally, the research bodies with the greatest output are, in first place, the University of El Salvador, followed a long way behind by the Central American University, the Centre for Diseases Control and Prevention, CENTA and the US Department of Health and Human Services. However, considering the impact of the publications, research by Salvadorian organizations has little impact, with the exception of Rosales Hospital.

Box 2 shows some of the contrasting aspects of research in El Salvador. Given the lack of systematic information on research activities in El Salvador, Box 2 only shows a few examples, collected during the field work and through a survey carried out by the Directorate of Innovation and Technological Development. Although they cannot be considered representative of the research sector and higher education, they give some idea of the efforts to develop capacities, as well as the weaknesses of some of the principal institutions in the sector.

Concerning the quality of higher education, it is difficult to generalize, as there is evidence of differences between institutions (MINED 2009).[33] However, the national statistics are useful in obtaining an overview of the country. According to these statistics, El Salvador's performance is inconsistent and could be described as average (Table 3). For example, there is a high percentage of "class time only" teachers[34] (51.87 per cent) and only a small percentage of the budget is used for scientific research (1.49 per cent).

If, in addition, we use indicators derived from external sources, the results are still average and, in some cases, low and with considerable need for improvement (see Table 4, Figure 10).[35] In particular, major weaknesses emerge in the rates of enrolment in secondary and tertiary education and the quality of teaching, especially in the sciences. To complement the information, several of the interviews conducted in enterprises revealed dissatisfaction on the part of the productive sector with the quality and content of several scientific and technological courses, which were described as out of date and inadequate to train professionals who could take their place in industry without the need for additional training in the company.

Included among the organizations which disseminate knowledge is the Salvadorian Vocational Training Institute (INSAFORP). This is a government institution responsible for the management and coordination of the National Vocational Training System. It involves public or private actions offering professional and technical training, and imparting or enhancing the practical vocational knowledge, aptitudes and skills necessary to carry out productive work appropriate to the socio-

Box 2. Contrasting aspects of research in El Salvador

Resources

The University of El Salvador (UES), given its public character, is undoubtedly the institution with the greatest volume of human and financial resources and facilities for research. Nevertheless, there is an imbalance between these and the fact that it has more facilities than researchers. One example of this is the Centre for Scientific Research and Health Development (CENSALUD), which has excellent facilities (a three-storey building and several well-equipped laboratories) but only has 9 researchers and does not have sufficient technical staff to service the laboratories properly.

With regard to private institutions, these generally allocate only a small proportion of their income to R&D activities. The Autonomous University of Santa Ana is remarkable in that it allocates almost 40 per cent to R&D together with Don Bosco University (UDB) which allocates almost 20 per cent of its resources to the provision of technological services (see Annex E, Figure E.1). In addition, UDB continues to increase its technological research work, with the recent creation of the institutes for research in energy and electronics. Among the technological institutes, the Central American Technological Institute (ITCA-FEPADE) also has advanced facilities for teaching and research in technological areas.

With respect to human resources, according to the small sample of universities available, the average teaching staff with a first degree, engineering diploma or less is 60 per cent. As can be seen from Figure E.2, only the UASA, with 55 per cent of staff with doctorates in medicine or odontology, and the José Simeón Cañas Central American University (UCA), with almost 8 per cent of doctors of philosophy, stand apart (Figure E.4).

Productivity

Research productivity is generally very low, if we rely on the indicator of the number of publications indexed in international databases. As shown by Figure F.15 in Annex F, the total number of this type of publication was 23 during the last decade, which represents about 0.5 articles per year for every 100 researchers, while according to the latest RICYT data,[32] the average for Latin America is 20.1 articles for every 100 researchers. At least, the number of publications shows an upward trend in universities such as UCA and the Alberto Masferrer Salvadorian University, and a considerable revival in the UES.

One aspect which attracted attention during the field study is that the UES does not have a procedure for monitoring and evaluation of current research. It merely allocates budgets to projects which are sometimes subject to some sort of evaluation process, but there do not appear to be deadlines for their duration or mechanisms for evaluating the results.

Links with the productive sector

Activities involving collaboration with the productive sector are still very limited in El Salvador. They are basically confined to a few cases of establishing contact with enterprises to adapt their study programmes to the needs of certain industries and providing technological services. In this aspect, ITCA-FEPADE and UDB stand out. On the other hand, despite the fact that UES has an internal department dedicated to the transfer of knowledge and technology, it does not report any specific activity in this regard, with the exception of information gathered in the field which suggests that the Centre for Research into Nuclear Applications generates a good level of resources from the provision of services.

The private sector is somewhat sceptical about the quality of higher education, which straightaway represents a major obstacle to the willingness of enterprises to initiate any kind of more advanced collaboration with universities, such as commissioning research projects to solve technological problems or develop new processes or products.

Inter-institutional collaboration

This is an aspect of which there is practically no experience in the higher education institutions of El Salvador or other research bodies, as no examples were found of research projects involving several institutions. On the contrary, it was found that different organizations, the recently created National Centre for Scientific Research of El Salvador, CENSALUD and Rosales Hospital, are carrying out projects on a common subject, Chagas disease. Although the projects do not overlap and focus on different aspects of the subject, there is no collaboration of any kind between these institutions that could generate synergies and benefit the researchers and the results of the research.

Source: UNCTAD.

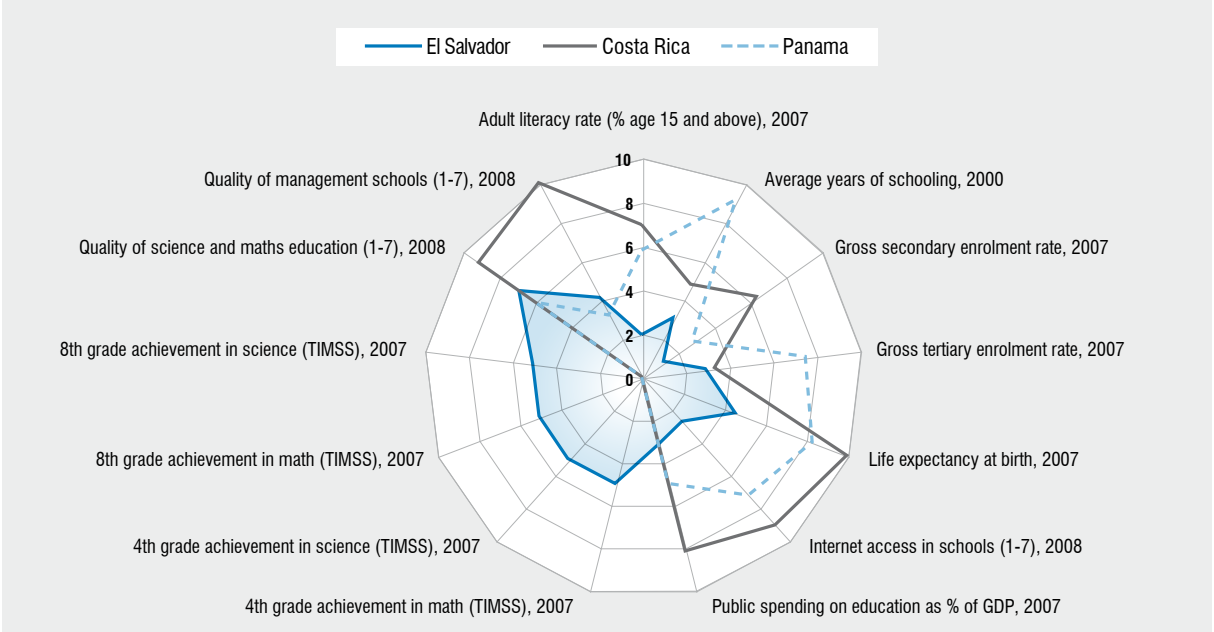
economic devlopment of El Salvador. INSAFORP is financed exclusively by employers' contributions. Its approved budget for 2010 was 26.1 million dollars (INSAFORP, 2010). INSAFORP does not generate income from the sale of vocational training, or other goods or services. INSAFORP does not itself implement training activities, but contracts third parties to undertake this work in accordance with its programmes. In 2009, INSAFORP trained over 310,000 persons, chiefly in marketing (34 per cent), administration (20 per cent), and management (18 per cent). Only 14 per cent were trained in technology, methods and applications, and 2.8 per cent in computer sciences.

Table 3. National higher education indicators, 2008-2009

Indicator	Unit	2009	2008
Students per teacher	Students	16.17	16.18
Students per full-time teacher	Students	48.92	48.22
Number of students per "class time only" teacher	Students	31.05	31.27
Percentage of full-time teachers	Percentage	33.06	33.54
Percentage of "class time only" teachers	Percentage	52.06	51.73
Percentage of teachers with over five years in the institution	Percentage	60.37	59.69
Percentage of teachers with technical diploma	Percentage	4.39	4.81
Percentage of teachers with university degree	Percentage	71.60	73.59
Percentage of teachers with postgraduate qualification	Percentage	24.01	21.27
Number of books per student	Unit	6.47	8.1
Average number of volumes per book title	Unit	1.57	1.99
Students per computer	Students	10.96	11.56
Students per Internet computer	Students	12.11	12.59
Academic space per student	Sq. metre	2.32	2.43
Recreation space per student	Sq. metre	10.17	10.33
Percentage of budget allocated to teaching staff salaries	Percentage	48.31	47.02
Percentage of budget allocated to administrative staff salaries	Percentage	23.47	22.98
Percentage of budget used for scientific research	Percentage	1.54	1.56
Percentage of budget used for social projection	Percentage	3.55	3.47
Percentage of budget used for books	Percentage	0.58	0.5
Percentage of budget used to buy academic equipment	Percentage	1.97	1.82
Average annual cost of technical courses	Dollars	620.32	607.64
Average annual cost of university courses	Dollars	668.92	640.73

Source: MINED 2010c.

Figure 10. Education indicators in accordance with the World Bank's Knowledge Assessment Methodology (KAM)



Note: Data standardzed by reference to the Latin American group of countries.
Source: UNCTAD, based on World Bank data.

Table 4. Indicators of the World Economic Forum on competitiveness related to education

Indicator	Rank out of 139 countries
Health and primary education (Basic requirements)	
Quality of primary education	114
Primary education enrolment rate	70
Higher education and training (Efficiency enhancers)	
Secondary education enrolment rate	106
Tertiary education enrolment rate	85
Quality of the educational system	121
Quality of mathematics and science education	124
Quality of management schools	79
Internet access in schools	105
Local availability of research and training services	83
Extent of staff training	63
Innovation (Innovation and sophistication factors)	
Capacity for innovation	117
Quality of scientific research institutions	133
Company spending on R&D	122
University-industry collaboration in R&D	114
Government procurement of advanced technology products	113
Availability of scientists and engineers	125
Utility patents per million population	90

Source: Schwab, 2010.

3. Support organizations

Salvadorian Foundation for Economic and Social Development (FUSADES)

FUSADES is a private development, not-for-profit organization created in 1983 by a group of independent professionals and entrepreneurs that elaborates public policy proposals in the economic, social, environmental and institutional spheres.

FUSADES has two centres of operations: the Think Tank Centre and the Development Centre. The latter comprises four programmes: Programme to Strengthen Social Action (FORTAS), Programme of Investment Promotion and Diversification of Exports (PRIDEX), the Integral Quality Laboratory (LCI) and the Programme for Promotion of Technological Innovation in SMEs (PROinnova).

PROinnova is a programme to support technological innovation and quality in Salvadorian SMEs, established in 2008, with support from the Multilateral Investment Fund (FOMIN) of the Inter-American Development Bank, through the Technological Innovation Project for Food Exporting SMEs of El Salvador.

In addition, the Integral Quality Laboratory is a centre for laboratory services which provides its services to the agro-food industry and the environmental sphere. The pioneering laboratory was has the necessary ISO accreditation to carry out various types of microbiological analysis (of food and water) and physical-chemical analysis of water. It has the capacity to carry out over 300 types of analysis which allows it to assist enterprises in various aspects of accreditation. It is estimated that it serves about 700 enterprises per year, which means receiving 1000 samples and carrying out 4000 analyses per month. In addition, it has lines of collaboration with the PROinnova programme concerning the evaluation of new products at the development stage. Thanks to its volume of work, the laboratory is totally self-supporting.

Foundation for Agricultural Technological Innovation (FIAGRO)

The Foundation is a private not-for-profit body whose basic objective is to stimulate technological innovation in the agricultural, livestock and agro-industrial activi-

ties of El Salvador by facilitating access to state-of-the-art technologies and innovation projects and technology transfer. Its strategic lines of action include:

- Dissemination of information and development of specific projects in biotechnology
- Conduct of studies and provision of specific advice in various fields
- Technical events for technology transfer, education and training
- Incubation and advice for innovative enterprises in the agricultural and agro-industrial sector
- Execution of projects to support technological innovation in the sector

National Development Foundation (FUNDE)

FUNDE is a non-governmental organization for research, formulation of socio-economic policies, lobbying and promotion of development, the principal target being the most disadvantaged sectors of the Salvadorian population. The Foundation promotes social and economic development by stimulating activities to improve the living standards in the most needy sectors of the population, the socio-economic cooperation between the chief actors and decision-makers, and the sharing and discussion of ideas on the topic of socio-economic development.

Millennium Fund (FOMILENIO)

The Millennium Fund is an autonomous public agency based on an agreement with the Millennium Challenge Corporation (MCC) to implement a five-year programme to reduce poverty and achieve economic growth in the Northern Zone of El Salvador. FOMILENIO's capital consists of the grant of funds by the Government of the United States of America through the MCC.

The general objectives of the programme are: human development, productive development and connectivity. It also incorporates five cross-cutting components: environment, regional development, gender equality, transparency and citizens' participation.

The aim of the Productive Development Project (PDP) is to convert the Northern Zone into an organized economic corridor which produces goods and services, agro-food products and tourist services. It includes specialized services and technical assistance programmes for entrepreneurial development, infrastructure and productive equipment, and investment and credit, focusing on the establishment of six productive chains. The principal beneficiaries comprise agricultural, livestock and forestry producers, and agro-industrial producers and services in the Northern Zone. The provides production and business services, investment services, and financial services.

4. Financial system

Multisectoral Investment Bank (BMI)

The Multisectoral Investment Bank is a public credit institution, with legal personality and its own capital. Its objective is to promote the development of private sector investment projects.

The BMI offers medium and long-term funds which are granted through local financial institutions supervised by the Superintendency of the Financial System (SSF). It is also responsible for providing credit to financial institutions for provision of these resources to final users.

The Five-Year Development Plan strategies include the configuration of a financial system to promote development, comprising the Agricultural Promotion Bank, the Banco Hipotecario (mortgage and loans) and the BMI, in which the BMI will become the National Development Bank of El Salvador .

Banco Hipotecario (BH)

The Banco Hipotecario de El Salvador S.A. was founded in 1935 with the incorporation of major agricultural and livestock associations. The institution remained under the control of private shareholders until 1992, when the State became the principal shareholder. The BH provides specialized support for small and medium-sized enterprises. On 31 March 2010, BH had total assets and liabilities of 431 million dollars.

The Banco Hipotecario focuses its work primarily on the country's productive sectors, including the agricultural sector (which represents 18 per cent of the loan portfolio), the services sector (18 per cent) and the commercial sector (17 per cent).

Agricultural Promotion Bank (BFA)

The BFA was established in 1973 as an official credit institution and a decentralized agency of the Ministry of Agriculture and Livestock. It is managed by the State and the private sector. Its objectives are to provide for the financial needs of micro, small and medium-sized businesses in the agricultural and agro-industrial sectors.

The BFA sources its funds from deposits by the public, the BMI and the Central American Bank for Economic

Integration. During 2009, the total amount of credit disbursed by the bank was 81 million dollars. The principal productive activities financed were staple food production, cattle and crops for export.

5. Collaboration and links between agents

With regard to standardization and regulation, there is good collaboration and contacts between public sector bodies and organizations that generate and disseminate knowledge. Examples are the composition of the executive board of CONACYT, and the validation of the national policy on science, technology and innovation, the wide consultation for the elaboration of the Five-Year Plan, and various other forums for contact in which trade associations, the academic world, independent organizations and the government sector discuss and determine matters related to STI activities.

Nevertheless, it is important to mention (probably due to the lack of a homogeneous vision of the process of innovation and its repercussions on science and technology and industrial policies as a whole), there is a lack of coordination and alignment between public sector bodies themselves. This hampers the generation of synergies in policy actions, which is crucial, especially when available resources are scarce.

As regards the functions of execution and production, links between agents are very rare. On the one hand, public funds allocated to STI activities are very small and do not always promote collaboration between the academic world and industry. On the other, the view of links held by the academic and productive sector is still somewhat narrow, almost exclusively taking the form of the flow of graduates into the labour market. Thus, enterprises consider that a good linkage consist of higher education institutions providing them with properly trained staff, and several higher education institutions make somewhat similar assumptions and establish relationships and even agreements to fulfil the expectations of certain enterprises.

Although this type of cooperation is positive (provided that it does not mean the educational task of higher education institutions is merely to provide labour for the labour market), it is still confined to a very narrow spectrum within the range of potential linkages (Figure 11). With the exception of CENTA, which by the nature of its mission and work is heavily involved in transfer of technology[36], very little of the results of higher education institutions which carry out research are transferred to industry and, of course, no participation in collaboration activities with the greatest impact on national innovation.

This situation should not be attributed to lack of action by higher education institutions, as the key actors in innovation are enterprises. If the latter do not ask for knowledge and technology, the facilitating activity of the public sector and the executing capacity of research bodies count for little.

Following a description of the components of the national system of innovation and its linkages, the principal policy instruments use in El Salvador are described below.

E. PRINCIPAL INSTRUMENTS OF INNOVATION POLICY

This section describes the principle instruments of STI policy in El Salvador, using a classification based on the nature, characteristics or mechanisms for the utilization of these instruments (i.e. whether the measures are direct or indirect and also the type of financing involved). It should not be forgotten that for these measures to work properly, it is also necessary to have a series of environmental conditions (Figure 12) which were amply reviewed in Chapter I.

1. Direct financing measures

Public research

This is carried out through CENTA, CENDEPESCA and the university and public education institutes mentioned above. As indicated above (Table 4), however, resources destined exclusively for research are very slim.

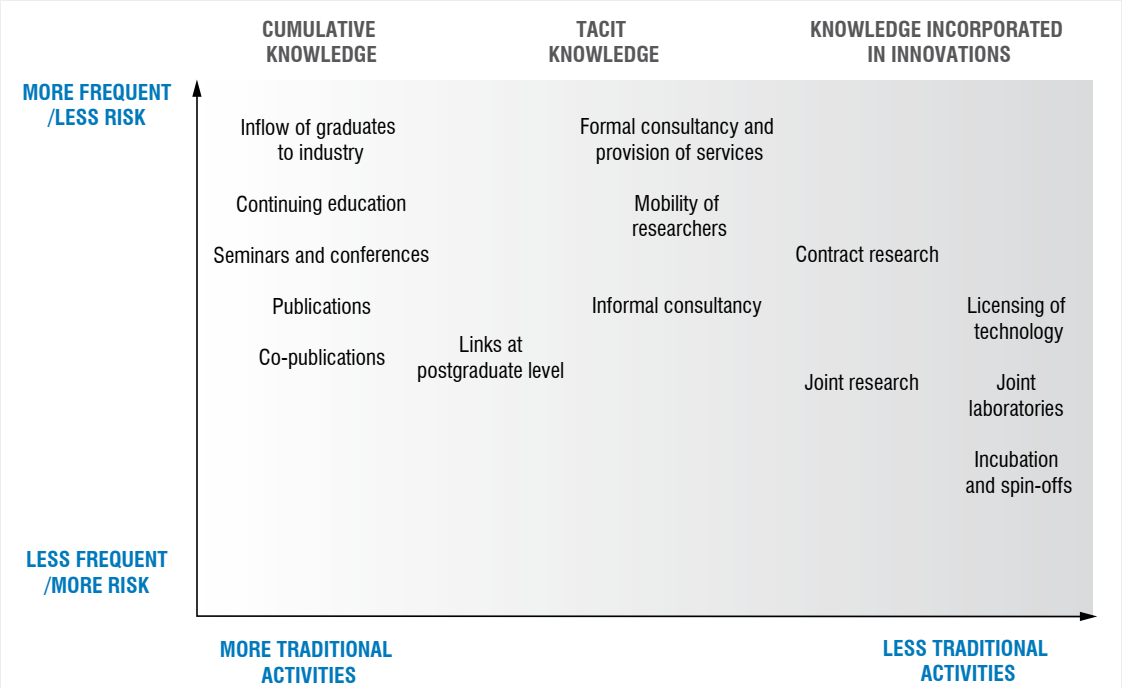
Training of human resources

Although at very low levels, the Government of El Salvador operates funds for scholarships in higher education: the FANTEL scholarships for higher education and the scholarship fund of the Central Reserve Bank, both of which are managed and implemented by autonomous private bodies (the Salvadorian Foundation for Integrated Education and the Business Education Development Foundation, respectively). INSAFORP also provides scholarships for agronomic studies in the National School of Agriculture.

R&D&I financing funds

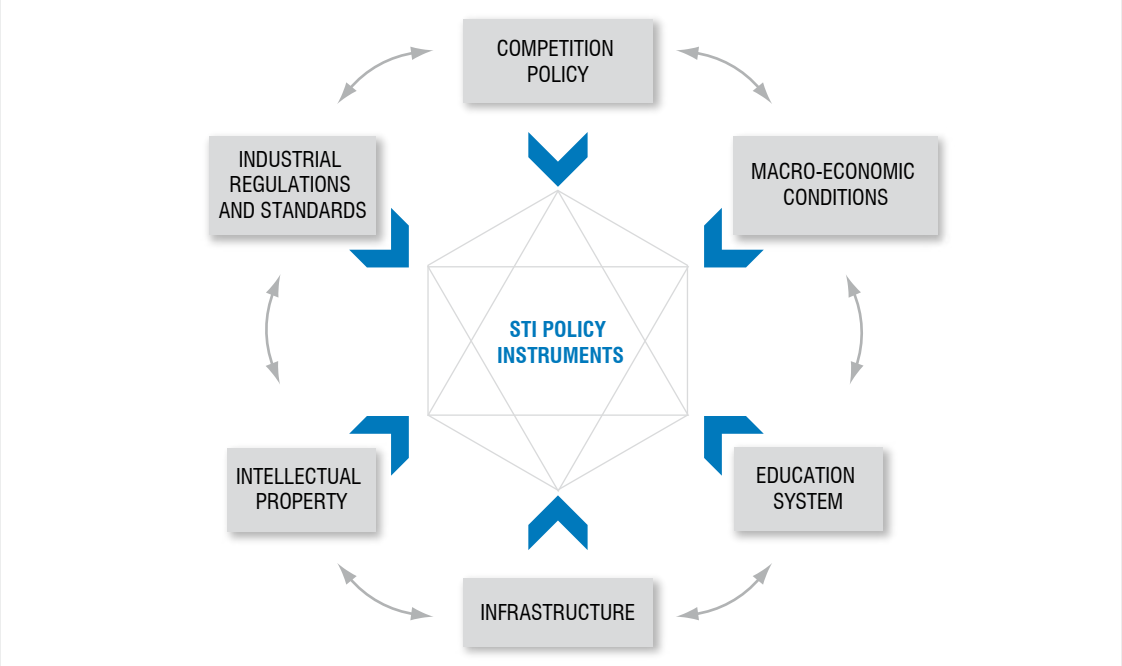
The funds identified are the FIES, FOEX–FONDEPRO and FOMILENIO, although the latter is managed

Figure 11. Range of collaboration activities and linkages



Source: UNCTAD.

Figure 12. Environmental conditions for the operation of STI policy instruments



Source: UNCTAD.

autonomously. There are other funds of autonomous organizations such as those managed through PROinnova, but they cannot be included as policy instruments of the Government of El Salvador.

Support for scientific infrastructure

This is provided through resources from the annual budget for public research centres and higher education institutions. There is no strategy or multi-annual plan for the development of scientific infrastructure.

2. Indirect regulatory measures[37]

Intellectual property

The body responsible of managing intellectual property, as well as other records, is the National Records Centre. This body has ISO quality certification, and its procedures have been well automated and digitized since 2008, although it does not have on-line search facilities, and it carries out its work in accordance with the internationally established times[38]. Its capacity for dissemination of the benefits of intellectual property is limited, which is reflected in the lack of use made of the various forms of protection and limited use of them as sources of technological information.

Quality system

The body responsible for this function until recently was CONACYT. However, as seen in section B, this function will be transferred to a new body in the Ministry of Economy, the National Quality Council, which will coordinate the functions of four agencies responsible for metrology, accreditation, standardization and technical regulation. For example, in interviews, weaknesses were detected concerning capacity for international accreditation in the pharmaceutical sector.

3. Other direct measures

Scientific and technological information services

This area has essentially been covered by CONACYT, either through the Technological Information Centre, and the compiling of STI statistics and generation of indicators, as well as other dissemination services. Similarly, the Directorate of Innovation and Technological Development (DIDT) in the Vice Ministry of Trade is working in this area (sectoral units, for example).

Promotion of networks and systems for the dissemination of an entrepreneurial and innovation culture

The main instruments found under this heading are the responsibility of SINALIT, operated by the Ministry of Agriculture and Livestock, the programmes of the Directorate of Innovation and Technological Development and, to some extent, some of the actions coordinated by INSAFORP. However, as a whole, these efforts are still modest and, as mentioned above, do not take advantage of the synergies what could be generated by coordinated action.

4. Catalytic financial measures

Loans and guarantee funds

These are operated through the organization in the financial system described in section D.4. There is still no experience of instruments which would have the greatest impact, such as venture capital or seed capital.

5. Combined or mixed measures

Creation of industrial conglomerates or clusters

The actions of FOMILENIO include targets which to some extent serve this objective, as does SINALIT in the Ministry of Agriculture and livestock.

Foresight

The development of the Five-Year Plan implies a long-term forward-looking exercise for the country, but there has so far not been any integrated attempt, at national level, to conduct an STI foresight exercise that would allow the identification of some priority areas.

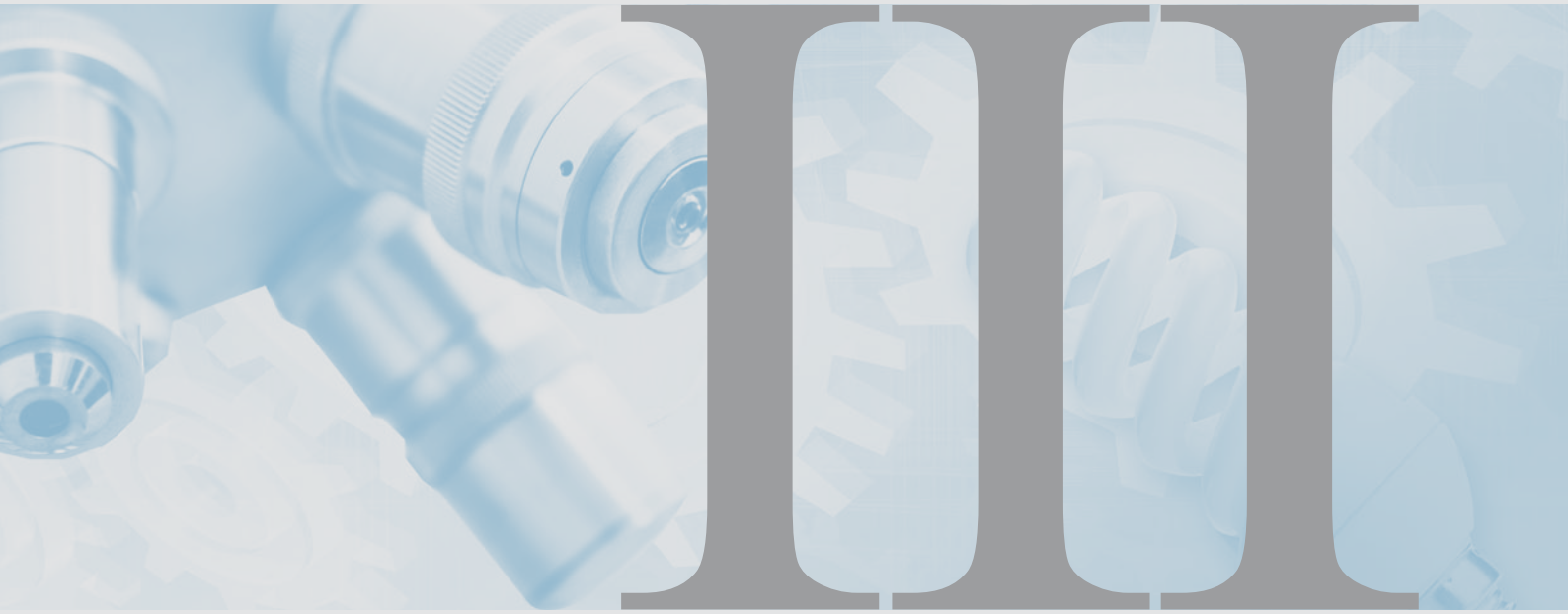
6. Other

International cooperation

International cooperation is one of the mechanisms most used to implement actions in support of STI activities. Some of the chief actors in EL Salvador are UNDP, German cooperation through GIZ, Japanese cooperation through the JICA and United States cooperation through FOMILENIO. International banks, such as the IADB and World Bank have also been important actors.

This chapter has listed and described the components of the national system of innovation of El Salvador, its linkages and the STI policy instruments deployed by the Government of El Salvador. This description, together with the evaluation of Salvadorian performance in science, technology and innovation, described in Chapter I, will provide the basis for a diagnostic of the national system of innovation and the formulation of a series of recommendations to strengthen it in Chapter III.

NOTES See page 59.



II

El Salvador: a National System of Innovation – work in progress. Diagnostic of the system and proposals for its development

The description in Chapter II of the components of the El Salvador's national system of innovation (NSI) allows us now to undertake a diagnostic of that system (section A). Based on this diagnostic, section B discusses a set of proposals for strengthening the components and links of the NSI, illustrated by the experience of other countries and best practice in the design of STI policies, programmes and instruments.

A. GENERAL DIAGNOSTIC

In El Salvador, the two systemic conditions which would constitute a solid and sustainable national system of innovation do not exist. On the one hand, there is no joined-up system of STI policies, but rather isolated policies targeting either science and technology or else innovation, industrial development or exports. Furthermore, resources allocated to them are very limited, even in comparison with the Central American and Latin American environment. On the other hand, there are incipient subsystems for generation of knowledge and production with very limited capacity for collaboration. These factors and processes are described in detail below.

1. Functions of cohesion and foresight

As evidenced by the information provided in chapter II, there is no government body which specifically provides cohesion and direction to policies concerning STI activities. In theory, this work should have been the responsibility of CONACYT, but this was a body with a very weak position in the government hierarchy and lacked the necessary resources to carry out the tasks originally assigned to it. It could even be said that the work done by CONACYT was laudable, given the precarious situation in which it found itself. Moreover, the Innovation Promotion Group, established to promote a single, integrated and multisectoral effort to formulate guidelines for innovation has practically ceased to function.

STI occupies a lowly position in the Government's hierarchy of priorities and decision-making and has a small budget. Currently, in reality and in accordance with the Scientific and Technological Development Bill (presented by the Ministry of Education) and a future Innovation Act (responsibility of the Ministry of Economy), this responsibility will fall to the Vice Ministries of Science and Technology and Trade and Industry. This shows the lack of a more integrated approach to innovation, which would encourage the participation of other government agencies and coordination between science and technology policies and innovation policies.

As a consequence, the various ministries and even the Technical Secretariat of the Presidency have proposed policies along one line or another, which, despite being well-intentioned, do not provide complementarity or synergies which could multiply their effectiveness. A clear example of this situation is the fact that both the Ministry of Education and the Ministry of the Economy have programmes to strengthen the national system of innovation which, without containing fundamental contradictions, do not contemplate the common strategic lines which, aligned with State policies at the highest level, would generate synergies. However, shortly after the completion of the Review, MINED and MINEC worked on a joint proposal for a Policy in Innovation, Science and Technology which could help to remedy this situation.

In addition, the industrial policy, the innovation policy, the science and technology policy as well as the public-private partnership policy are being developed in an isolated manner, without taking into account what, among others, the Ministry of Agriculture and Livestock or the Ministry of Health, are doing in the area of STI.

With respect to foresight, the Five-Year Plan has been produced, representing the country's development vision and plan. However, this excellent work lacks specific detailed programmes, at least as regards STI. What does exists, the National Science, Technology and Innovation Policy 2006-2030 and the recent National Plan for Scientific and Technological Development are very broad and ambitious. The National STI policy includes 13 areas of knowledge for scientific and technological development, while the National Plan for Scientific and Technological Development proposes 29 areas and 156 strategic lines. With investment in R&D of some 16 million dollars[39] and 500 researchers, it seems unlikely that such ambitious plans will come to fruition.

Under the same heading, the Integral Export Promotion Strategy (2010-2024) is a much more realistic proposal, with goals that are seen to be achievable and specific programmes and instruments. However, it is not clear, for example, how the five strategic sectors that it sought to stimulate were defined, especially ICT where it was

found that there was insufficient capacity. Moreover, the document contains certain inconsistencies in that the lines of action do not fully correspond to the programmes and instruments. Neither does it contain elements that link the strategic goals with the programmes, nor indicators for monitoring and making the necessary adjustments.

In short, no national foresight exercise on STI has been carried out from which would emerge a reasonable and limited number of priority areas in which, as well as research strengths and production capacity, potential applications in areas of economic and social relevance would be envisaged. This first step should lead on to development programmes and policy instruments to direct the scarce resources to activities with the greatest potential and impact.

2. Management, control and regulatory functions

When it comes to management, the basic problem is the lack of policy coordination among the principal government bodies. Given the limited amount of policy instruments and resources, managing them does not present a problem and there are adequate organizations to satisfactorily fulfil the necessary functions. The same can be said of the legal and regulatory aspects in general.

With regard to the Scientific and Technological Development Bill, although it contains various very positive actions, it also includes aspects or actions which may cause problems and/or are formulated ambiguously, notably:

- The hierarchical position of the management of STI at vice-ministry level and in the education sector. This orientation presents difficulties primarily because it does not reflect the multi-sectoral character of the activities in question and the fact that, to some extent, it replicates the model already tried with CONACYT of managing STI policy at a level subordinated to a ministry.
- The constitution of the National System of Innovation, Science and Technology, a fairly common practice in Latin America, reflects a narrow interpretation of the systemic visions applied to STI which can generate misleading expectations concerning the nature of a national system of innovation.
- Added to the foregoing is the problem of the future Innovation Act, which the Ministry of Economy will be responsible for presenting. Although the Scientific and Technological Development Bill provides that the two laws will complement each other, it may be difficult to reach agreement on the limits of action of the two ministries involved in the sphere of innovation.

Another aspect about which no information was found concerns monitoring, evaluation and adjustments (control) carried out in conjunction with the STI policies measures that are applied. In fact, during the workshop held to analyse the first draft of the review, the lack of an evaluation culture was confirmed. This lack of monitoring and evaluation can be found at the level of policy design as well as at the programme and project implementation level, and there is even a lack or insufficiency of preliminary diagnostics as well as formal methods of monitoring progress and evaluating impacts. Examples of these shortcomings are:

- The creation of new research centres, although their constitutions and structure is still not clear.[40] In this regard, no diagnostic is known which would justify its creation, especially when, given the scarcity of resources, it might be preferable to strengthen the infrastructure and staff of existing public research organizations.
- The project to create a "technology park", without any evidence of a preliminary analysis being carried out, including a comparison of the successes and failures of this type of initiative in Latin America[41] and the viability of implementing one in El Salvador.
- The proposed industrial policy[42] which is being drawn up by the Vice-Ministry of Trade and Industry which, although it does have a preliminary diagnostic includes innovation as one of its lines, its specific instruments do not include evaluation and monitoring from the design stage.

3. Production and execution function

The key component of what could form El Salvador's system of innovation, the productive sector, is still embryonic and is too heavily concentrated in micro-enterprises. Although some industries do exist with certain strengths in the local environment, few of them are competitive in the Latin American region and neither do they show any inclination to innovation.

Furthermore, the research sector is weak in terms of both human and financial resources, being almost totally dependent on the higher education sector, and lacks competitiveness in Latin America. Education in

general and higher education in particular also have considerable room for improvement if they are to catch up with the most developed Central American countries.

Consequently, the contacts between knowledge generating bodies and their users for productive purposes is very limited. This is due to a variety of factors apart from the structural weaknesses of those involved mentioned earlier. Among these the following should be highlighted: low demand for knowledge and technology in the productive sector, which also means lack of awareness of the usefulness of knowledge to generate value, the scarce and limited financing options, and the small range of innovation policy instruments and the related budgetary constraints.

With respect to the functioning of industrial chambers and associations as well as support bodies, while there are no quantifiable data to evaluate their work, the actions they take are positive. However, in the case of the former, their involvement in promoting innovation and fostering an innovative culture has been limited and some are not powerful enough to influence the State in taking decisions in favour of their members. As regards the latter, their scope of action depends very much on their budgets and size, but they generally perform well. In addition, the work of FUSADES deserves special mention, as one of the organizations whose work has had an important impact on the promotion of enterprise activity in general as well as of innovation.

Finally, the institutions of the financial system have only been marginally involved in the promotion of innovation, with the exception of the BMI, which has worked in partnership with other bodies and has supported large-scale programmes and projects. However, a problematic aspect concerns the lack of staff in the financial system trained in the evaluation of business plans or innovative projects.

B. STRENGTHENING THE COMPONENTS AND RELATIONSHIPS OF THE SALVADORIAN SYSTEM OF INNOVATION

Based on the above analysis of the Salvadorian system of innovation, the following section suggests a series of actions necessary to strengthen the system's components and relationships.

1. Political and social conviction and commitment

The first step that should be taken to bring about the emergence of the system of innovation in El Salvador, which will allow it to convert itself from an efficiency-based economy to a knowledge-based economy, consists of changing the perception that the State and society have of innovation. This involves:

1. The conviction, from the highest level of government and society in general, that the generation of knowledge and technological innovation have become the driving forces of growth and social and economic development. The governance of STI should be headed in the last resort by the Presidency of the Republic. However, up to now, political debate in El Salvador does not show any sign of sufficient attention to STI topics which justifies political involvement at the highest level, even though an intention to work in this direction can be observed. In reality, this responsibility currently falls on the Vice-Ministries of Science and Technology and Trade and Industry.
2. Under this heading, the agreement, adoption and dissemination of an up-to-date definition of innovation is essential to explode the myth of this concept and include at least four types of innovation that are recognized today: product, process, organization and market innovation, as well as the various degrees of originality that innovation may present – new to the company, new to the local market and new to the global market. This new, unified vision of the concept of innovation has implications which will be discussed in sections 2 and 5.

   In addition, it would be helpful with respect to dissemination to use the concept of open innovation, which is an approach based on the idea that companies cannot confine themselves to their own research activities in order to be innovative and that they can and must use external as well as internal knowledge (Chesbrough, 2003). This concept, while it may be a new form of management discipline that refers to old ideas, could be useful in inducing in the business world a systemic vision of innovation.
3. Forming an integrated vision of productive development centred in innovation (including higher edu-

cation, scientific and technological development, productive articulation) and supported by environmental conditions which include education (basic to higher secondary), foreign direct investment and export promotion.

4. The will to overcome differences between state entities and economic agents to allow the implementation of the changes necessary in all areas, so that STI becomes effectively the driving force of the economy and, ultimately, society as a whole. Specifically, differences of approach were observed, on the one hand, between the Ministries of Education and Economy with respect to STI policies and policy instruments. Secondly, in the field work and the review of the STI development plan, a preference was observed in the approach of the Vice-Ministry of Science and Technology for the promotion of science at the expense of the development of policies aimed at the development of entrepreneurial innovation. This resulted in insufficient attention to the needs of enterprises for technology and innovation.

   It should be emphasized that coordinating the work of the ministries is more than just holding joint working meetings and agreeing on certain matters. It involves the alignment and convergence of the agendas of the ministries concerned and elimination of duplication of efforts by some bodies.

5. The establishment of realistic plans, programmes and policies, with clearly defined goals and objectives, as well as appropriate performance indicators to measure achievement of goals in the allotted time.

6. The allocation of the necessary human and financial resources necessary to achieve the goals set out in the plans, programmes and policies.

The following sections put forward some recommendations on areas which require particular attention. However, it is necessary to point out that: (i) this process must rely on four fundamental pillars: investment, education, research and entrepreneurial development; and (ii) it is a long-term process which, although it may bear fruit in the short term, must be sustained through several government administrations if it is to achieve a significant impact on the country's social and economic development.

2. Direction and cohesion

In addition, the responsibility for the development and sustained improvement of these four pillars belongs to both the public and private sector, although the composition of their contributions can vary according to the different specific circumstances in which they are involved. In other words, the launch of this process means that the highest authorities of the State must take charge of the direction and cohesion of the Salvadorian system of innovation but there are important aspects relating to research, training and investment which must also be assumed by the private sector.

The natural division of functions of the Executive into ministries can be an obstacle to the operation of systemic policies, since the different entities could assume that promoting STI is their exclusive responsibility, when what is required are cross-cutting policies which allow each ministry, in coordination with the rest, to adopt policies aimed at national innovation. Thus, it would be desirable for El Salvador to have a supra-ministerial body (whose head would naturally be the President of the Republic) which would take charge of the functions of direction, coordination, foresight and establishment of general policy lines which, with regard to the objectives of innovative development, would allow the various ministries to operate as a system.

With respect to the systemic operation of both the government structure and the various executing agents, it is crucial to stress that the concept of national system of innovation (like any system of human activity which has a purpose) is not a physical entity or institution. It cannot be created by a law or decree. It is simply a methodological framework which allows us to comprehend a complex reality in order to manage it in a coherent manner so as to orientate it towards a given goal.

3. Foresight and setting of priorities for research and development

The launch of the process of transformation and the development of its pillars must be **defined and orientated** by means of an **in-depth national foresight exercise** which, up to now, has only been undertaken in terms of the country's general foresight. However, the specific part relating to the development of STI has not been developed in an integrated way. Neither is there any sign of the pursuit of an appropriate foresight methodology through a review of international experience on this subject.

It needs to be considered that this type of study or exercise can only be carried out when there is the will and capacity to take the necessary decisions to implement the recommendations which result from them. This means that the participation of decision-makers in these exercises is crucial, as is the involvement of the executing agents involved in the areas covered by the four pillars mentioned above.

The outcome of this foresight work would be possible scenarios of development in science, technology and innovation, from which the most desirable and probable would be selected. It would also include the specific actions necessary to achieve it (or to avoid evolving towards an undesirable scenario). Due to resources constraints, these actions must include priorities for scientific and technological development in a few areas which combine at least: (i) current existence of research and production capacities or the potential to develop them in the short term; and (ii) the prospect of opportunities for exploiting these capacities through innovations with a high economic and social impact in the medium and long term. Analyses of the bibliometric and patent studies type, such as those presented in the annexes, are tools which can be very useful in justifying the choice of priority areas.

It is necessary, therefore, to carry out a comprehensive analysis of those industrial and research areas which are really strong and which employ local capacities. That would be followed by a review of whether the strengths have a consistency and what are the areas and sectors in which it is possible to obtain immediate results, those which need to be strengthened and developed in the medium term, and even deciding whether some of them will have to be abandoned or developed in the distant future. It should be clear that the setting of priorities means making strategic sacrifices, i.e., ceasing to finance areas which are not among those identified as key to El Salvador's development.

The foregoing represents the starting point for setting priorities, defining concrete goals to be achieved in specific timeframes, appropriate indicators to measure performance, and the budgetary and investment amounts to be allocated to each. The results of the foresight exercise should thus be translated into specific programmes which are clear as to the contribution each makes to achieving the general goals, designating the entities responsible for their execution, with well-defined timeframes and criteria for evaluation of their achievement.

4. Organizational structure and management

The analysis has highlighted the fragmented vision of the innovation process, how a phenomenon which is part science, part technology, part management, part industrial capacities, etc. has generated a lack of alignment between the policies set by the different ministries whose responsibilities converge in innovative activities. It has given rise to a degree of privilege to policies on the primary generation or supply of science and technology, i.e. those which assume that it is enough to promote research to generate interactions which lead to innovation. The systems approach and network features of the innovative process, however, show that this type of policy is insufficient. It is necessary to involve different agents and both supply and demand aspects.

a) Statistics, information and indicators

The proper functioning of the supra-ministerial body mentioned in section 2, and of the ministries involved in innovation actions, requires modernization in terms of the gathering of information and generation of STI indicators. As has been seen, CONACYT has done good work in this sense, but it has not been very systematic and there is still plenty of room for improvement in this field, especially with regard to carrying out regular surveys of innovation and adoption and use of information and communication technologies in the productive sector.

This means, firstly, modernizing the digital and telecommunications infrastructure, which would interlink the various national bodies which provide services and carry out actions related to STI. It also means modernizing the models on which the gathering of information is based and translating data into indicators that provide useful information for decision making. These information gaps must be corrected, and, as far as possible, aligned with international standards[43] to allow international comparison of R&D and innovation activities in El Salvador.

b) Evaluation

An aspect which, nowadays, is fundamental to the design and implementation of public policies and which in the case of STI policies is highly important (due to the multi-factorial character of innovation) is the integration of evaluation and monitoring mechanisms in the work of designing policies, instruments and

programmes. In the case of El Salvador, the perception is of a deficient, indeed almost non-existent, culture of evaluation with regard to bodies involved with science, technology and innovation activities, including the country's public university itself.

Only by systematic monitoring and evaluation of the results of policies, instruments and programmes is it possible to know with certainty the effectiveness and efficiency in the use of resources, or to obtain feedback on the utility of programmes and instruments, so as to allow their informed adjustment or even their cancellation.

That is why both the Technical Secretariat of the Presidency and the ministries involved in creating the vision of productive development based on innovation need to contemplate the training of their staff on the design and evaluation of public policies. They, in turn, would be responsible for sharing their knowledge so as to generate a multiplier effect and disseminate the culture and skills required for evaluation.

5. STI policy instruments

The types of STI policy instruments are very varied and have generally been the subject of two main approaches: the nature, characteristics or mechanisms for deployment and their objectives or goals. The first approach distinguishes, for example, whether the measures involve financing or not, are direct or indirect, or whether they are cross-cutting (of general application) or target certain sectors or specific groups.

On the other hand, the second approach tries to identify the deficiencies or weaknesses which the instruments are seeking to correct. In general terms, identifying these deficiencies uses the concept of innovation possibility frontiers,[44] distinguishing between policies which modify the innovation possibility frontiers of all the enterprises and policies which induce enterprises to position themselves at a different point within their current possibility frontier. The former are policies which could be called facilitating (or systemic), while the latter consist of corrective policies, i.e. of a more orthodox kind (from an economic perspective).

The most common practice consists of adopting a mixed approach, constructing matrices which combine the range of types and objectives to characterize what some authors call the *policy mix* of a country in particular.[45] From now on, we will use this approach to identify the principal STI policy instruments in El Salvador. Table 1 shows a possible policy mix, and an approximation of its current use in El Salvador. Table 1 also serves to exemplify instruments which can be explored in the future.

Based on Table 1, some of the instruments which are still not used in El Salvador and which could be considered include: increasing the funds allocated to training at postgraduate level in the identified priority areas; an increase in funds allocated to R&D and innovation with collaboration between various entities which generate and use research, including higher education institutions, research centres, enterprises and hospitals which carry out research; an increase in funds allocated to R&D and innovation in enterprises; the design of tax incentives or exemptions for R&D in enterprises; the development of a culture which promotes technological foresight and intelligence in enterprises; the development of technological intelligence services; promoting the creation of mechanisms for the transfer of knowledge in universities, from technology transfer offices to incubators for science and technology-based enterprises; the creation of a mechanism for accreditation of the country's researchers (although it could be solely honorary and need not necessarily involve economic incentives, along the lines of some models used in Latin America) which recognizes the work of those who distinguish themselves in pure and applied research and development and transfer of technology.

One aspect which it is important to take into account when defining the policy mix, and which is connected with the definition of innovation discussed in section 1, is the need to have differentiated policy instruments for medium-sized and large enterprises and for MSMEs. Based on the identified priority areas, these instruments contemplate distinct objectives (targets to be achieved by the instrument), requirements, funds and credits. What is vital is not to forget that both types of enterprise need to be supported and that they have different needs for innovation.

Related to the above and the aspects mentioned earlier concerning the setting of priorities, it is also important to mention that STI policies should not be confused with social policies. Given the number and needs of MSMEs in El Salvador, it is easy to fall into the trap of trying to support the maximum possible number of enterprises. However, this only leads to a dispersion of resources. It is not an STI policy but rather a response to other social objectives which, while legitimate, are not STI objectives.

Table 1. STI policy mix matrix and approximation of its current use in El Salvador

		Deficiencies targeted [a]		
		Corrective or orthodox policies		Facilitating or systemic policies
Deployment mechanisms	Policy instruments	←		→
Direct financing measures	Research in public bodies	■■■		□
	Funds for university research	■■		□
	Training of human resources (scholarships and mobility)			■■
	Support for STI infrastructure			■■
	Funds for entrepreneurial R&D		■■	□
	Support for R&D in collaboration			■■
	Public sector procurement			□
Indirect financing measures	Tax incentives for R&D by volume	□		□
	Progressive tax incentives for R&D	□		□
Catalytic financial measures	Seed and venture capital		□	
	Networks of investment "angels"			□
	Guarantee funds for credit to MSMEs			■■
	Guarantee funds on net capital of MSMEs			□
Other direct measures	Competitive-technological intelligence services	■■		
	Technology brokerage services (transfer)			□
	Dissemination of an entrepreneurial and innovation culture			■■
	Promotion of networks			■■
Indirect regulatory measures	Intellectual property rights	■■■		
	Competition policies	■■		
	Metrology and standardization			■■
Mixed measures	Technological Development Centres			□
	Incubation of enterprises			□
	Creation of clusters			■■
	National STI foresight exercises			□

[a] *It should be noted that the orientation range of some instruments may vary in many of the cases. For example, tax incentives for R&D can be of general application (the same rules for all enterprises) or may target certain groups (reduced requirements or greater benefits for MSMEs).*

■■■ *Intensive use of the instrument*
■■ *Little use of the instrument*
□ *Not used*

Source: UNCTAD.

It is important to emphasize that the successful application of a policy instrument in a country depends on its coherence with the established objectives and its management. Box 1 provides a set of good practices in the use of STI policy instruments which may be useful as a guide to their design and management.

Sectoral and regional systems of innovation

The construction of a national system of innovation must be based, firstly, on building the capacities of the smallest components of the system, the small producers, while at the same time, strengthening the components which have already reached a certain level of development. There is no doubt that, in this respect, various policies in El Salvador have been more oriented to the traditional productive sectors such as agriculture, livestock and agro-industry. However, from a sectoral perspective, these efforts need to be expanded to generate productive chains in other industries with potential, such as pharmaceuticals and

Box 1. Good practices in the use of STI policy instruments

The successful application of a policy instrument in a country depends on the characteristics, objectives and form of management of that instrument. It cannot be assumed that the transplantation of a successful policy instrument will be likely to work well in another country, since its success depends on its perceived objectives, design and management. The following is a set of good practices in the use of STI policy instruments which may be useful as a guide to their design and management. These good practices stem from the experience of other countries, chiefly in Latin America. Some examples from countries which have used these instruments are included as a guide – the lists of examples are not exhaustive.

Postgraduate scholarships

General description: Programmes or funds for internal or external training/strengthening mechanisms

Potential beneficiaries
Direct: Individual persons: students or researchers
Indirect: Research centres, enterprises and society in general

Scope: Mainly aimed at priority areas

Type: Intermediate, between corrective and facilitator (see Table 1)

Orientation: Generation of knowledge

Origin of resources: Public, international cooperation and, exceptionally, enterprises

Examples: Argentina, Brazil, Chile, Mexico

Good practices
- Attention to strategic sectors or those with potential impact
- Alignment with STI development priorities
- Complemented by programmes to strengthen quality national postgraduates
- Complemented by repatriation programmes and other mechanisms to encourage return
- Transparent evaluation mechanisms and accredited evaluators
- Promotion of enterprise participation in specific financing programmes
- Systematic evaluation mechanisms

Financing of R&D and innovation projects

General Description Programmes or funds for financing research, development or innovation projects/collaboration

Potential beneficiaries
Direct: Public research centres, enterprises or both
Indirect: Society in general

Scope: General and targeted according to national policies

Type: Generally corrective/may be converted to facilitator (see Table 1)

Orientation: From generation of knowledge to innovation

Origin of resources: Public, international cooperation loans and enterprises

Examples: FONDECIT and FONDEF-Chile; Mixed Funds-Mexico; FINCYT-Peru

Good practices
- Attention to strategic sectors or those with potential impact, regional needs and micro enterprises and SMEs
- Alignment with industrial development policies and other spheres of public policy
- Promotion of research-industry collaboration
- Competitive funds
- Collaboration in advanced training
- Transparent evaluation mechanisms and accredited evaluators
- Systematic evaluation mechanisms

Tax incentives for R&D and innovation

General description: Tax reductions to stimulate technological development and innovation

Potential beneficiaries
Direct: Enterprises
Indirect: Public research centres and higher education institutions (collaboration) and society

(cont.)

Box 1. Good practices in the use of STI policy instruments (cont.)

Scope: Ranging from general to aligned with national policies

Type: Basically corrective (see Table 1)

Orientation: Innovation

Origin of resources: Public

Examples: Chile, Mexico

Good practices

- Appropriate design, balancing support for large enterprises and MSMEs
- Legal and regulatory framework
- Simplicity of mechanism (transparency and accessibility)
- Low administrative costs for the public sector and enterprises
- Long-term reliability and stability of the mechanism to allow planning by enterprises
- Clear criteria and definitions relating to STI activities
- Systematic evaluation mechanisms

Enterprise incubators-accelerators

General description: Organizations which provide a wide range of services to support primarily new enterprises

Potential beneficiaries

Direct: Individual entrepreneurs, enterprises
Indirect: Public research centres and society in general

Scope: Generally targeted (specific sectors and MSMEs)

Type: Corrective (See Table 1)

Orientation: Innovation

Origin of resources: Public, private or mixed

Examples: Brazil, Chile, Mexico

Good practices

- Attention to strategic sectors or those with potential impact, regional needs and micro enterprises and SMEs
- Alignment with industrial development policies and other spheres of public policy
- Alignment with STI development policies
- Concentration of resources and convergence of instruments
- Gradual progress, contemplating the available critical mass and market opportunities
- Covering the pre-incubation-acceleration spectrum
- Participation in networks
- Systematic evaluation mechanisms

Source: UNCTAD.

metal engineering, for example. It is even possible to envisage the convergence of sectors which have strengths with others where it is worthwhile generating capacities, such as health or metal engineering, and information and communication technologies, in order to generate policy instruments aimed at the development of new products and services with export potential.

As a **complement to sectoral policies**, it would also be desirable to explore the development of regional systems of innovation (see Annex C). Although El Salvador is a small country, its diversity means that zones can be identified which require special attention in aspects of development, or can be characterized by a certain specialized production (an example of this is the FOMILENIO's work in the country's northern zone). The complementarity between policy instruments to generate value chains and the promotion and stimulation of production in the regions, generating productive zones or corridors, can be a more effective mechanism for strengthening the national system of innovation, by substituting policies which require major investment and for which the necessary conditions to implement them are not sufficient in El Salvador (like the as yet ill-defined proposal for technology parks).

Investment and financing

There is an urgent need to increase national spending

or investment in R&D, since, compared with Latin America, El Salvador's spending is among the lowest. Precisely due to the scarcity of resources, the orientation of resources to priority sectors and areas of research with high future potential is vital, by means of policy instruments which can take advantage of existing strengths both in research and productive development.

However, this increase in national investment is not just the responsibility of the State. It is essential to increase the participation of private capital in the financing of STI activities through a mix of policies. These policies must contribute through training and cultural change, as well as through well designed incentives (such as indirect and tax incentives, or competitive funds for research projects), so that private investors involve themselves in the national commitment to innovation and assume undertakings with higher levels of risk.

The proposal included in the Five-Year Plan to create a development bank through the combined work of the existing entities (BMI, BH and BFA) is appropriate. However, it would be important to ensure that resources actually exist and the access to them is rapid and efficient. Likewise, the broad and correct effort to obtain funds from international cooperation should not be overlooked but should even be intensified, also as a function of the priority development areas.

Promotion of a systemic vision and innovative culture

The systemic approach to innovation can be applied and operates at different hierarchical levels. Part of the STI policy mix must be focused on disseminating the benefits of this approach to training entrepreneurs and researchers and training them in it. The application of these concepts to the organization and operation of productive firms and knowledge generating entities is one of the foundations or the glue needed to construct, from the bottom up, regional and sectoral systems of innovation, which in turn become facilitators of the coordination of a national and even supra-national system of innovation.

This dissemination and training must culminate in a cultural change, which we have discussed, which is also necessary to achieve the commitment of all the actors to the transition from an efficient economy to one based on knowledge and innovation. The responsibility for this transition is a shared one, and there must be an awareness that although it can be directed and coordinated by the State, it is the economic and productive actors who will make this possible through investment and work.

6. Education

A reform and modernization of the educational system at all levels, as well as an increase in public spending in this area, is essential to support the change in the medium and long term. Education policies have an impact on all areas of national development and have been fundamental companions of those relating to STI in many countries, irrespective of their stage of development. Fundamental changes are necessary, from the training of the teachers themselves and their access to continuing education, to the reformulation of study plans and programmes to strengthen the teaching of mathematics and the natural sciences. An interest for science and technology, curiosity and the capacity to solve problems need to be promoted from the early childhood age.

In the case of tertiary education, it is further necessary to increase significantly the financing allocated to postgraduate studies. Models can be exploited which represent targeted support, both to academic institutions which offer quality programmes (which are subject to strict evaluation criteria) in areas defined as priorities, and students taking master's degrees and doctorates in those programmes. Similarly, models can be exploited which involve enterprises in the financing of scholarships for students working on subjects of value to those enterprises. It is also important to increase bilateral and multilateral international cooperation agreements to allow a substantial increase in the number of Salvadorian postgraduate students in quality programmes in various countries.

Finally, it is also vital to generate programmes of incentives for repatriation or eventual benefiting from Salvadorian talent which has stayed in other countries after the end of their postgraduate studies, or which has emigrated in search of better opportunities to use their abilities. In this regard, there are various experiments in Latin American countries (sometimes designed to attract human capital in general) which could be examined with a view to trying to adapt them to conditions in El Salvador. These include the establishment of centres of excellence (FONDAP in Chile), the UNESCO fellowships (operating in several countries), repatriation grants accompanied by research posts in universities (in Mexico), or the

programme to attract top R&D talent in Panama. Some of these programmes involve the creation of an environment conducive to distance collaboration by local research groups or hosting foreign-based researchers for a given period of time. Other are aimed at generating the conditions to attract national or foreign researchers based abroad to settle permanently in El Salvador.

With regard to the training offered to enterprises, it is also recommended that the activities of INSAFORP should be reviewed and modernized, to make it more proactive and a true driver of an innovative culture. According to information obtained in various interviews and other studies (Arritt, 2006), it is also necessary to reinforce the accreditation of the consultants contracted to carry out the training.

Following on from this analysis of the national system of innovation, Chapters IV and V provide a more detailed analysis of the system of innovation in the agro-industry and the information and communications technology sectors. Although the innovation activities, the configuration of the actors and their relationships are different in each sector, the analysis of those sectors corroborates the general diagnostic of the national system of innovation.

NOTES

1 See for example, the definition suggested in the introduction (Metcalfe 1995).

2 By innovation, we mean: "…the **implementation** of a **new or significantly improved** product (good or service), or process, a new marketing method or a new organizational method in business practices" (OECD 2005). In this generally accepted definition, the currently accepted dimension of newness is measured in terms of whether the implementation is new for the firm or for the market, which gives it a broader meaning than the previous distinction between radical and gradual innovations – for example, the acquisition of technology is a form of innovation (OECD and Eurostat 2005).

3 See Annex B for a theoretical discussion of NSI.

4 In the strict sense of industrialization, not the broad sense of productive development.

5 This view of innovation policies, traditionally limited to the attention paid to the vectors of industrialization, even predates the concept of NSI (Rothwell and Zegveld 1981); on their inclusion in this approach, see Dalum et al. 1992 and Lundvall and Borrás 2005.

6 Capacity to maintain an identity independent of other systems within a shared environment, i.e. the system's ability to maintain an independent existence.

7 Model based on Beer 1972, 1984, 1985.

8 With respect to science, technology and innovation, the structure of the Salvadorian Government has been in a state of change since the Government of President Funes took office, thus at the time of writing this review, there may be certain bodies whose tasks and functions are in a state of transition.

9 Given the country's natural resources, orientation and productive goals.

10 This list of ministries is not exhaustive, since, for example, the Ministries of Health and Tourism, as well as others, may be involved in STI activities. Here we are simply considering those with the most intensive activities in this area.

11 Act on the National Council for Science and Technology, Legislative Decree N° 287, Official Journal, 10 August 1992. However, the new Scientific and Technological Development Bill assigns this responsibility to the Vice minister of Science and Technology (see Section C.4).

12 Ibid.

13 Bill on the Salvadorian Quality System, Ministry of Economy, version received in May 2011, but still under consideration by the Legislative Assembly.

14 CONACYT, 2006, p. 5.

15 Not necessarily STI *policy instruments*.

16 And a more realistic time horizon, up to 2010, involving two future reviews.

17 Prepared with the support of the scientific community of El Salvador.

18 The priorities in research, development and innovation are identified by a survey of activities carried out by research centres and universities in El Salvador and their potential.

19 http://www.minec.gob.sv/index.php?option=com_content&view=article&id=663:eife&catid=1:noticias-ciudadano&Itemid=77.

20 By 2024, it is proposed approximately to triple the number of exporting companies, increase by 25 per cent the number of destinations, triple export revenues and increase by 25 per cent the number of products exported.

21 Source: http://www.mined.gob.sv/index.php/noticias/1-institucional/4263-seminario-sobre-investigacion-y-presentacion-de-proyectos-fies-.html, information dated December 2009, collected in September 2010.

22 Defined as enterprises with four employees or less.

23 Which may perhaps not be the best indicator but provides a reasonable approximation in the absence of more precise information.

24 This does not mean that they have Salvadorian nationality.

25 Defined as the ratio of royalties received and paid for licensing of technology.

26 Taken in part from Argumedo (draft) and various press information.

27 MINED (2011) MINED Information Bulletin available at www.mined.gov.sv

28 Voluntary certification of academic quality for higher education institutions.

29 However, this registry (available at www.redisal.org.sv) includes organizations for which there is no evidence that they carry out research, while it does not include universities which do, in fact, carry out research, such as the Alberto Masferrer Salvadorian University or the Benjamín Bloom Hospital.

30 Register of National Scientific Researchers of the Salvadorian Research Network (REDISAL), www.redisal.org.sv, information collected in February 2011.

31 The research period runs from 1941, although there are only three publications before 1972, the year when they began to be more frequent and regular.

32 http://www.ricyt.org/index.php?option=com_content&view=article&id=149&Itemid, data obtained in May 2011.

33 In addition, in the interviews conducted, both positive and negative comments were made on some universities, technological institutes and educational bodies.

34 This indicator reflects the percentage of teachers contracted only to teach classes (*hora clase*) in relation to the total teaching staff of the institution. "Class time only" teachers have no responsibilities other than to teach the class for which they are contracted. Thus, this is not conducive to helping students outside the classroom and they do not participate in research projects and the social project of the institution (MINED 2010c).

35 Schwab (2010).

36 However, in interviews with autonomous bodies, it was stated that CENTA's transfer activities could still be significantly improved.

37 These instruments may also be seen as forming part of the environmental conditions.

38 It should not be forgotten that demand for intellectual property services in El Salvador is low.

39 Investment in R&D by the higher education and government sectors in 2009.

40 The Report of Activities (MINED 2010a) reports the creation of the Centre for Scientific Research of El Salvador and the National Centre for Research in the Social Sciences, as well as research projects carried out. It does not have data on the physical infrastructure and number of researchers belonging to them, but only short documents relating to the initial planning.

41 Which can be traced back to the mid-80s where there is an abundance of failed experiments.

42 Draft (March 2011).

43 The OECD Frascati manuals or UNESCO standards, for example.

44 Which can be defined as the ratio of the improvement in performance [from an innovation] to specific expenditure on R&D incurred to achieved it, in a given period of time; alternatively as the ratio of the time required to achieve a specific improvement to the cumulative effort required to achieve the improvement. Cf. Nordhaus (1969).

45 See, for example, Boekholt et al. (2001).

IV

Innovation in the agro-industrial sector

A. AGRO-INDUSTRY IN EL SALVADOR

Agro-industry, that is the sub-series of manufacturing activities whereby primary and intermediate products derived from the agricultural, livestock, fisheries and forestry sectors are processed (FAO, 1997), includes a broad range of processes of varying degrees of technological sophistication. It includes processes which have an industrial and not merely an artisanal component, and which range from mere preservation of products and operations closely related to harvesting, to the production, using modern methods and heavy capital investment, of articles such as textile products, paste and paper. Agro-industrial activity is distinguished from other industrial sectors by the seasonal nature of its raw materials, their perishable nature and fragility, as well as their variability in terms of quantity and quality.

Agro-industry is an important sector for El Salvador for several reasons. Agricultural and agro-industrial activities represent 22.8 per cent of national GDP and 19.4 per cent of exports (Tables 1 and 2). Because agro-industrial activity is based on agricultural inputs and provides work opportunities in rural areas, it provides a stimulus for agricultural and rural development and poverty reduction. Agro-industrial activities encourage better use of agricultural products by improving preservation and can help to improve food security. In addition, agro-industrial processes add more value to agricultural products and provide opportunities for

Table 1. Agriculture and manufacturing, by branch of economic activity in millions of dollars (constant 1990 prices) and as a percentage of GDP

Branch of Economic Activity**	1990 Millions of dollars	2000 Millions of dollars	2010 * Millions of dollars	1990 % of GDP	2000 % of GDP	2010 % of GDP	Growth 1990 - 2010 (%)
Agriculture, Hunting, Forestry and Fishing	**821**	**925**	**1,168**	**17.1**	**12.3**	**12.9**	**42.3**
Green coffee	218	174	143	4.5	2.3	1.6	-34.6
Cotton	11	1	0	0.2	0.2	0.0	-100.0
Basic grains	160	171	198	3.3	2.3	2.2	23.2
Sugar cane	29	55	55	0.6	0.7	0.7	87.4
Other agricultural products(1)	116	165	289	2.4	2.2	3.2	149.1
Livestock	140	164	222	2.9	2.2	2.5	58.5
Poultry	73	120	154	1.5	1.6	1.7	111.2
Forestry	50	52	72	1.0	0.7	0.8	45.1
Hunting and fishing products	23	22	35	0.5	0.3	0.4	50.0
Agro-industry	**485**	**704**	**895**	**10.1**	**9.4**	**9.9**	**84.5**
Meat and meat products	40	33	35	0.8	0.4	0.4	-11.8
Dairy products	25	53	65	0.5	0.7	0.7	161.9
Fish products	0	0	0	0.0	0.0	0.0	200.0
Flour and bread	97	146	199	2.0	1.9	2.2	106.4
Sugar	38	123	158	0.8	1.6	1.7	310.2
Other processed food products	72	111	157	1.5	1.5	1.7	120.1
Beverages	111	151	177	2.3	2.0	1.9	59.0
Processed tobacco	37	0	0	0.8	0.0	0.0	-100.0
Leather and leather products	52	68	79	1.1	0.9	0.9	51.5
Wood and wood products(2)	14	21	26	0.3	0.3	0.3	79.0
National GDP	**4,801**	**7,531**	**9,082**				**89.2**

**= provisional data. **= selected branches based on their relation with agro-industry.*

(1)= includes ornamental plants and flowers, (2) includes Peruvian balsam

Source: UNCTAD, based on data from 2011 published by the Central Reserve Bank of El Salvador (www.bcr.gob.sv).

Table 2. Agricultural and agro-industrial exports of El Salvador (in millions of current dollars)

	1995	2000	2005	2009	2009 (%)
Food and animals	699	681	589	812	16.2
… coffee and coffee substitutes	498	379	170	248	5.0
… sugar, molasses and honey	55	70	106	132	2.6
… sugar confectionery	8	18	12	16	0.3
… fish, crustaceans, molluscs and preparations	38	31	73	101	2.0
… milk, cream and derivative products (except butter and cheeses)	2	11	4	6	0.1
… cheeses and curds	0	0	3	6	0.1
Beverages and tobacco	13	26	49	98	2.0
Non-edible raw materials, except fuel	28	23	31	46	0.9
Oils, fats and animal and vegetable wax	8	8	7	11	0.2
Hides and products made from hides	2	1	2	3	0.1
Cork and wood products (except furniture)	2	3	2	2	0.0
Total agro-industry	**751**	**742**	**679**	**972**	**19,4**
Total exports of goods	**1,645**	**2,941**	**3,418**	**3,797**	**75,8**
Total exports of goods and services	**2,040**	**3,640**	**4,546**	**5,007**	**100,0**

Source: UNCTAD, based on Globstat and UNCTADStat data.

greater economic profits. Furthermore, given its geographical limitations, El Salvador has little chance of succeeding as a producer of large volumes of agricultural products, and its advantages will lie more in the specialization in niche products, including agro-industrial products. Even without having large agricultural output in the country, it is possible to develop an important agro-industry by importing raw materials from other countries in the region, although this would require greater trade integration in Central America.

Although there are no specific figures for Salvadorian agro-industry, the study of the principal branches of the primary sector and those branches of manufacturing industry based on processing of primary products, shows a diverse set of activities. In the last two decades, these economic activities, with some exceptions, have shown growth but their weight in the national economy has been reduced (Table 1). The relative importance of sugar, dairy products, flour milling and baking products and processed foods should be highlighted. On the other hand, there is a significant reduction on the production of green coffee and the disappearance of cotton growing and tobacco-related activities.

Coffee remains the main Salvadorian agricultural export product, although it has lost ground as a proportion of GDP. Sugar is the second biggest export product. The evolution of production and exports of the most important agro-industrial products is analysed in part 1.2 of Section B.

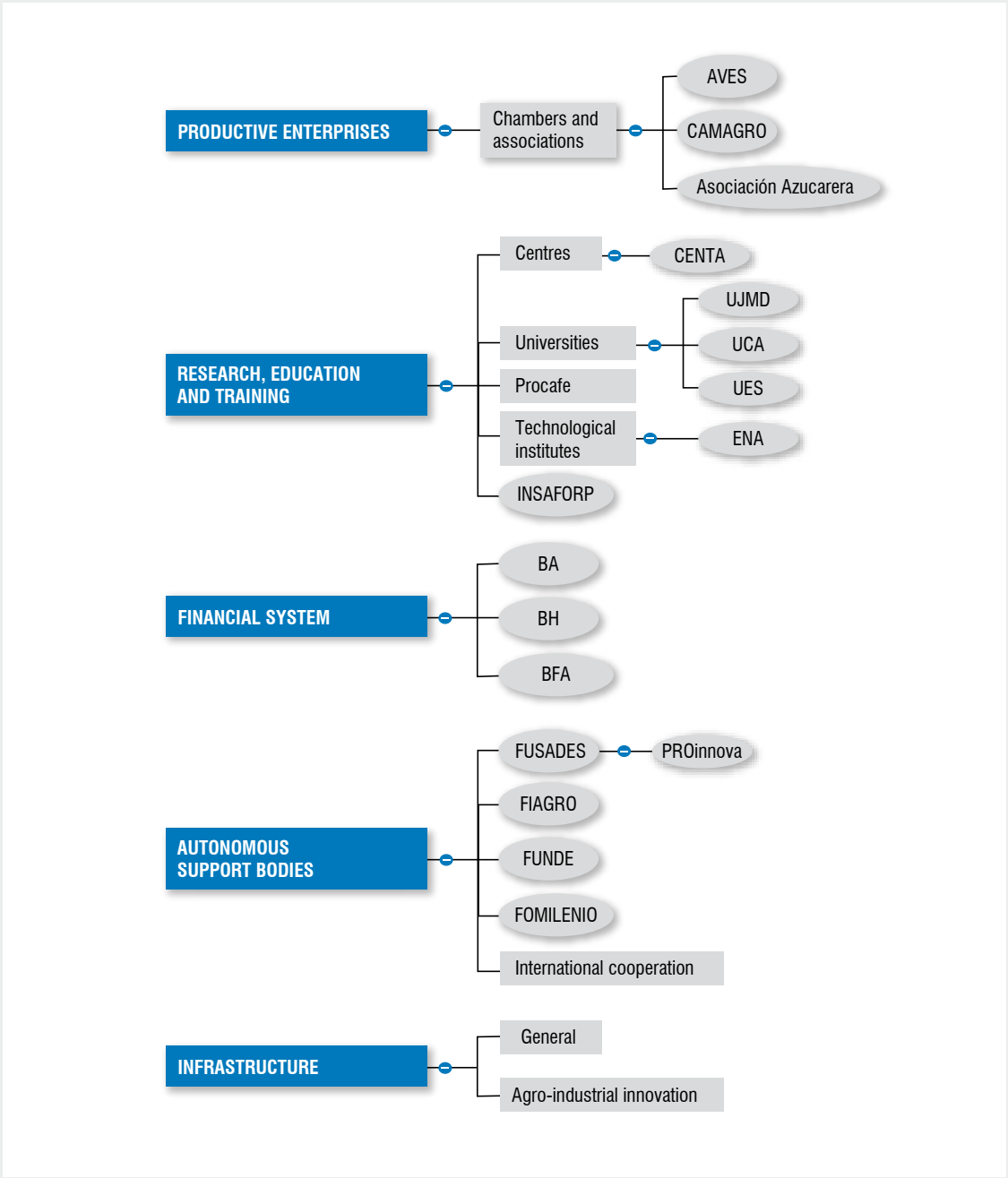
B. DIAGNOSTIC OF THE SYSTEM OF INNOVATION IN THE AGRO-INDUSTRIAL SECTOR

This section presents a diagnostic of the system of innovation in the agro-industrial sector. A great many of the observations made here refer to agricultural innovations and not specifically agro-industrial ones. It is considered important to include these references given the importance of the agricultural sector to agro-industrial activities.

1. Production and execution function – executing system

The principal agents which execute agro-industrial are enterprises and agricultural producers. They are supported by research, education and training centres, the financial system, and support bodies (see Figure 1). These activities are carried out in the framework of the available overall and innovation-specific infrastructure.

Figure 1. The principal agents involved in the system of execution and production



Source: UNCTAD.

1.1. Support infrastructure for agro-industrial innovation

The growth of an innovative agro-industry in the country will largely depend on the availability of a solid infrastructure which facilitates product innovation and marketing of those products.

El Salvador lacks the supportive infrastructure for promoting agro-industrial innovation. In the first place, it

does not have a developed national quality system[1]. There are difficulties in implementing quality systems (due to the lack of qualified national human resources) which particularly affect smaller enterprises. Inspection capacities to check and enforce sanitary and phytosanitary standards are inadequate. Moreover, shortcomings can be observed in the infrastructure of good quality laboratories: some types of analysis cannot be carried out in the country, training of laboratory staff is not always adequate, and the infrastructure and equipment that is available is not properly used. Although the development of quality systems does not necessarily lead to innovation activities, it is a prerequisite for commercialising the products. The availability of a quality infrastructure also allows the development of new products. The configuration of a National Quality System (Chapter II) and the availability of financial and human resources to implement it will be crucial to the development of agro-industry.

In the area of biotechnology, the country does not have an infrastructure of research laboratories equipped for advanced techniques in biotechnology[2].

As regards the infrastructure for the development of agro-industrial enterprises, it is worth mentioning the work done by various programmes and organizations, in particular PROinnova and FIAGRO, to promote the development of innovative agro-industrial enterprises. However, there are no funds or permanent support programmes for the incubation of agro-industrial enterprises nor a business/technology park for agro-industrial enterprises.

The experts consulted also pointed out the absence of an organized system of collection centres or wholesale markets to facilitate the commercialisation of the inputs needed by agro-industry. Moreover, the country has a limited number of suppliers of machinery for agro-industry and depends on foreign suppliers. In addition, the supply of packaging to meet the requirements of different products is limited.

Lastly, weaknesses in the overall infrastructure, in addition to those mentioned in Chapter I, should be mentioned, as they affect agricultural production and the marketing of agro-industrial products: a limited cold store infrastructure at the international airport of El Salvador, where there are no proper installations for handling frozen or refrigerated products for export; poor development of the road network in rural areas which makes the transport of agricultural products more difficult and more expensive and the slow down in the modernization of water management.

1.2. Enterprises

As discussed below, three types of enterprises can be observed in El Salvador, according to their level of investment in R&D and innovation. Firstly, there are a limited number of large and medium-sized agro-industrial enterprises which carry out R&D activities using their own resources, engage in innovation activities (generally in the development of new products and adaptation of processes), and recognize the strategic value of innovation. The turnover of these enterprises generally puts them outside the scope of government support programmes for innovation. Some of them have an innovation department with a specific budget allocated. Others allocate budgets to innovation on an ad-hoc basis. These enterprises tend to acquire well-known foreign brands of machinery to obtain correspondingly high quality products, they obtain specialist technical assistance from abroad or from recognized domestic consultants, and keep themselves informed through foreign travel and international contacts. Box 1 illustrates the experience of two of these enterprises.

A second group comprises enterprises, mostly small with some medium-sized, which seek all possible public and private support to grow and become exporters. Innovation is not a strategic element for these enterprises, which tend to make their innovation activities subordinate to the support they can obtain.

Lastly, there is a group of subsistence enterprises, with artisanal production processes which often do not meet even minimum quality standards and which have little capacity or interest in innovating.

There is no detailed information on the level of private investment in R&D or innovation activities in agro-industrial enterprises. In terms of the results of R&D, there is some limited patenting activity in the country, but this is mainly in the areas of health and veterinary science, agriculture and the food industry. In total, 17 patents were identified in these three areas in the period 2001-2010 (Annex D). However, the operating rights for these patents are essentially owned by foreign companies. For example, of the five patents in the food industry, three are owned by a single foreign multinational.

The agricultural and agro-industrial sectors consist of a large number of subsectors, each with its own particular conditions. This study has examined those agro-industries which by virtue of their production value, raw materials that they use and/or the labour

Box 1. The experience of innovative Salvadorian agro-industrial enterprises

Case A. Nobs Hidrofusión – An innovative enterprise in essential oils

This company, with over 25 years' experience in the cultivation of vetiver grass and other plants (aromatic, grasses, ornamental) and trees (fruit and forest), went into the development of processes to extract essential oils. Vetiver grass is one of its principal products and is produced entirely for export. Thanks to the determination of processes, times and extraction yields for different plant species, it has developed the production on a commercial scale of other essential oils. Its R&D work was carried out independently, without support from any public institution, based on knowledge acquired, studies and trial and error.

Nobs Hidrofusión opened the way into the international market for vetiver essential oil (chiefly in the United States and the European Union) with the support of foreign cooperation. At the request of its customers, it successfully modified the extraction process to obtain top quality "Haiti Type" vetiver essential oil – the vetiver oil for which there is the highest demand and price in the international market. The first sale of 200Kg was made in 2008. The sales prices obtained are well above the best purchase prices at international level. This super-price has been achieved by the excellent quality of the product, shown by analyses carried out by a German laboratory and the certification obtained.

The company engages in three main activities. The sale of vetiver grass, a plant used to control soil erosion, was the main source of income until 2008, when it was overtaken by sales of essential oils. The sale of trees and other grasses and the construction of gabions generate modest but stable income. The third activity is the production and sale of essential oils of vetiver, coffee, styrax and cascarilla.

Since 2008, it has been developing a project to sell biomass/foliage of vetiver plants to a sugar mill to use in the generation of electricity. The first tests have been carried out and negotiations are at present under way with a sugar mill. FIAGRO has supported the formulation of this investment project.

The company enjoys international recognition for its experience and the quality of its essential oils, which have international certification such as the 100% organic certification issued by the German company BCS Öko-Garantie and the Kosher certification issued by the Rabbinate based in Costa Rica.

Sales of essential oils rose from less than 22,000 dollars in 2004 to 225,000 dollars in 2010. Projected sales for 2011 are over 400,000 dollars.

Case B. Agroindustrias San Julián – A processing company which produces dairy products, raises pigs, produces coffee, engages in forestry and produces charcoal.

This family agro-industrial company, founded in 1985, combines the manufacture of dairy products, breeding and fattening of pigs, forestry, coffee using drip irrigation and vegetables. Through a strategy of horizontal integration, it maximizes the use of its resources. The company has 47 hectares in the Department of Sonsonate, and a milk processing plant, an animal food processing plant, pig breeding and fattening units, forestry for charcoal and fine woods, and production of process coffee. It currently generates over 320 direct jobs.

Agroindustrias San Julián (Agrosania S.A. de C.V.) is one of the leading Salvadorian dairy companies and exports to Guatemala, Honduras, the United States and Canada. It has been a pioneer at national level of the introduction of new packaging (e.g. *Zipper* vacuum packs and *Doy Packs* with cream dispensers), the introduction of new products in the market (such as loroco cream or dips made from cheese and natural ingredients). It has also been innovative in production processes and is the only Central American company which recovers milk solids using ultra filtration equipment. Part of the whey and other by-products of the dairy plant are used for pig feed.

The company pursues a policy of quality differentiation and complies with BPM and HACCP quality standards, and is currently in the course of obtaining ISO 22000 certification. It has also invested 750,000 dollars in installing a waste water treatment plant, refrigeration and milking equipment, as well as modern steam boilers. These improvements introduced over five years have generated excellent results in terms of quality and market share.

Thanks to the use of state-of-the-art technology in pig production, including imported genetic strains, automated feeders and raised floors, optimum weights have been achieved in minimum time. The company has its own food factory and solid separators for the use of the dung which, combined with charcoal waste, is used to produce organic fertilizer used in shady woodlands in coffee plantations. It is currently engaged in a 200,000 dollar project for the production of methane gas which will be used in the boilers and will allow energy savings of 12,000 dollars per month.

The forestry division has three production areas: coffee growing, forestry and charcoal production. It is the only company in the country which has implemented drip fertigation in its coffee plantations. With an initial investment of 2,500 dollars per hectare, this system has improved productivity to 35 quintals (1 quintal = 100Kg) of green coffee per hectare, exceeding by far the national average of 6 to 8 quintals per hectare. They have an ecological process which can remove the coffee pulp almost dry to save water. The resulting pulp is used in turn for the production of organic fertilizer.

(cont.)

Box 1. The experience of innovative Salvadorian agro-industrial enterprises (cont.)

The plantation of woodland provides shade for the coffee bushes. The managed pruning of these trees is used to produce and market fine wood and as an energy source. The company has special furnaces which produce high quality charcoal in only 72 hours, whereas artisanal methods require 15 days to produce charcoal of lower quality.

This company, for which R&D is a strategic element, has achieved sustained double-digit growth from its inception, based on investment in innovation programmes using its own capital and bank financing. The chief sources of information it uses to innovate are the Internet, foreign travel and contracting of foreign experts. The company gives prizes to its workers who contribute innovative ideas, both to reduce production costs and to develop new products and services. The company has had little government support, as it is considered large, but has received support from international cooperation and non-governmental organizations. Its executives have been trained abroad and maintain contacts with experts in other countries.

Source: UNCTAD based on communications with the managers of these companies.

that they employ, are most important to the Salvadorian economy (Tables 1, 2 and 3). They are analysed separately below.

The *Agricultural and Agroindustrial Chamber of El Salvador* (CAMAGRO) is the most representative organization of the agricultural and agro-industrial sector, and affiliates over 20 associations from various subsectors. Its principal mission is to influence agricultural and agro-industrial policies. It also collects and processes strategic information for the sector and provides services to promote its affiliates' competitiveness. CAMAGRO does not carry out or promote innovation and technology transfer activities. Although it has no particular commitment to the sphere of innovation, CAMAGRO could play an important role in promoting a culture of innovation and the establishment of appropriate conditions in which agro-industrial innovation could prosper. It is worth noting that, given the heterogeneous characteristics and widely scattered nature of producers, CAMAGRO can only represent a fraction of small producers.

1. Coffee industry

Table 3. Number of establishments and jobs in Salvadorian agro-industry, according to the 2005 economic census

		Number of establishments	Total employees at 31 August 2004
Coffee	014004 Coffee processing	51	4,612
	154908 Coffee roasting and grinding	2	19
	014007 Rice processing	10	472
Meat and meat products	1511 Production, processing and preservation of meat	31	3,536
	….151103 Poultry slaughterhouses	4	2,050
	….151105 Preparation, preservation and elaboration of meat products	17	1,454
	1512 Elaboration and preservation of fish	7	1,946
	1513 Elaboration and preservation of fruit and vegetables	18	515
	1514 Elaboration of oils and fats of vegetable and animal origin	2	521
	1520 Elaboration of dairy products	73	2,693
	1531 Elaboration of flour milling products	12	886
Maize	1532 Elaboration of starch and derivative products	2,779	3,720
	…. 153202 Milling of wet maize (milling for nixtamal)	2,710	3,600
	1533 Elaboration of prepared feeds for animals	25	422
	1541 Elaboration of bakery products	2,096	10,815
Sugar	154201 Manufacture and refining of sugar cane and other by-products (sugar processing plants)	8	3,757
	154202 Milling of sugar cane to produce sugar candy and other products (presses)	4	68
	1543 Elaboration of cocoa and chocolate and confectionery products	27	616
	1544 Elaboration of macaroni, pasta and similar	5	98

Source: UNCTAD, based on VII Economic Census 2005 (DIGESTYC 2005 and disaggregated data supplied by DIGESTYC).

Coffee production contributes 1.5 per cent of GDP (Table 1) and is an important activity in family agriculture, where small producers, account for 82 per cent of producers, and 11.5 per cent of total production (Procafé, 2010). The results of this agro-industry are closely related to international prices of green beans. As in other coffee producing countries, the added value of exports is low because a high proportion is green coffee. The development and export of processed coffee (whole roasted bean or ground roast and others) does not appear to be an option for El Salvador, given the consolidated structure of international specialization with, on the one hand, producer countries like El Salvador and, on the other, processing countries that have developed technologies and competitive advantages in the business of roasting, blending, and brand development and placement.

Furthermore, the production of special coffees (including gourmet, fine, sustainable, fair trade and organic coffees) has shown remarkable growth in El Salvador. In the season 2008-2009, special coffees accounted for 38 per cent of coffee exports (Table 4). According to the sources consulted, the premium price on special coffees is over ten dollars per quintal. The development of special coffees appears to be a decision that would accord with the country's current potential.

The production of coffee itself faces major challenges in terms of research, technology transfer and training, including agronomic management of production (renovation of coffee plantations, disease and pest control, etc.) and improvement of varieties. Productivity in coffee production has fallen markedly in the last twenty years (see Procafé, 2010) mainly due to the ageing of plantations. Renovating the coffee plantations is thus a fundamental task. Investment in technological infrastructure (e.g. drip irrigation) would also help to improve productivity. For example, one of the business owners interviewed confirmed that the introduction of drip irrigation improved productivity from 8 to 38 quintals of green beans in a single season. The majority of innovation and research efforts have been concentrated in production (for further details, see the work done by PROCAFÉ in section 1.5).

Although in general, low levels of innovation can be observed in coffee processing, there are success stories of innovative companies which have developed high added value products such as special coffees and have even made important organizational innovations such as developing a vertical business like Coffee Cup, a successful franchise serving coffee to the final consumer (see Box 1 in Chapter 2). The expansion of this type of organizational innovation is limited by the size of the domestic market and international competition, but there is ample scope for developing the special coffees sector.

2. Sugar industry[3]

Annual sugar sales topped 200 million dollars in 2009, 45 per cent of which were for exports. The area under sugar cane cultivation and the volume of cane harvested and sugar produced has remained fairly stable in recent years. Productivity levels have remained constant (variations in yields of sugar extraction can be basically explained by meteorological conditions which affect the sugar content of the cane), and have remained within international standards[4]. These satisfactory yields are due to the use of imported machinery from Brazil and the United States, the use of plants of good genetic quality (*in vitro* reproduction in the National School of Agriculture (ENA)) and the technical assistance provided to the producers.

Sugar companies use similar technologies and competition in the sector is limited, as the profitability of the chain is influenced by transport costs from producer to factory.

Table 4. Coffee exports, 2004 -2009 (thousands of quintals)

	2004/05	2005/06	2006/07	2007/08	2008/09
Total exports	1,711.8	1,668.9	1,591.5	1,913.9	1,791.3
Green coffee	1,707.8	1,665.0	1,587.9	1,911.9	1,789.6
.. of which special coffees	302.1	385.8	444.5	519.0	684.0
Processed coffee	4	3.9	3.6	2.0	1.7
Percentage special/green	17.7	23.2	28.0	27.1	38.2
Percentage processed/green	0.23	0.23	0.23	0.10	0.09

Source. Salvadorian Coffee Council, Salvadorian Foundation for Coffee Research (PROCAFÉ).

Of the six factories[5] in the country, four have an innovation manager (Izalco, El Ángel, La Cabaña and Chaparrastique). All the factories are certified in ISO 9000 as well as in Kosher and in Good Manufacturing Practice. One of the principal sources of innovation for these enterprises is the adoption of technologies or adaptation of existing technology similar to that observed in other countries, as for example the adoption of processes for self-generation of energy using cane pulp.

In the last four years, the sugar industry has improved its sugar refining capacity in two refineries, increasing the proportion of sales of refined sugar to 20 per cent of total sugar exports.

The Sugar Association of El Salvador is the trade organization which groups the six sugar factories (sugar cane processing plants). It is a consolidated organization but does not include the entire productive chain. The association has promoted the interests of sugar factories but has not promoted the development of new products.

There is also a small rural and artisanal industry producing *panela*[6] for domestic consumption. Officially, the 2005 economic census shows that there are only four establishments (presses). However, in reality, the number of establishments is somewhat higher, due to the fact that the majority are informal rural micro-enterprises. Opportunities to export this product exist and with the necessary support, in terms of technological development, quality, and organization which allows economies of scale, this small agro-industry would have growth potential

3. Honey and its derivatives

El Salvador has over 68,000 hives distributed in 2,050 apiaries (MAG, 2009) and ninety per cent of the production is exported, mainly to Germany. In 2010, exports of honey were over five million dollars. Exports are mainly in bulk although cosmetic products and food supplements based on honey have been developed, as well as natural medicine by-products. The private sector has been supported by international cooperation agencies and, in specific cases, by certain government institutions, especially for opening markets. As far as it is known, no research programme for the development of honey-based products exists in El Salvador.

The *National Bee-Keeping Commission of El Salvador* (CONAPIS), created in 1998 by executive decree of the Ministry of Agriculture and Livestock, operates like a trade association and has provided technical training for bee-keepers to improve the yield of hives and the quality of the products. This technical training has been provided by a team of nine CENTA experts who were expressly trained in bee-keeping. By 2005, they had trained 374 bee-keepers who own over 34,000 hives (Gochez 2008). Given its limited availability of funds, CONAPIS has had difficulty in continuing to provide financial support for the work of the CENTA experts. It should be noted that its principal guidelines do not include support for research into the processing of honey and its derivatives.

4. Processed fishing and fish-farming products

In 2010, the fishing sector exported over 65 million dollars of processed fish products[7] (chiefly tuna steaks) and the fish-farming sector represented some ten per cent of fish and fish-farming exports in 2006 (Table 5).

Up to the end of the nineties, shrimp fishing was the main activity of the Salvadorian fishing industry. Over-fishing and the effects of natural phenomena have reduced its importance. Nowadays, the tuna industry is the main commercial fishing activity. The Calvo Group set up in 2002 with a tuna plant in Puerto de la Unión, which employs over 1600 workers. This plant processes tuna steaks for export to Spain where they make high added value products, some of which are then imported into El Salvador to satisfy domestic demand. Artisanal fishing accounts for some 50 per cent of the total volume of fishing.

Since 2001, fish-farming[8], especially inland fish-farming, has developed considerably, driven by support from international cooperation (University of Cantabria, undated). The main products are marine and freshwater shrimps and tilapia. The development of this sector will depend, among other things, on the sector's capacity to respond to problems of water quality, seed quality or diseases associated with shrimps. In these areas, research and technology transfer have an important role to play. Although specific research is being done, in farming of tilapia, for example, there is no national fish-farming research programme.

Nor, as far as it is known, has research been done in El Salvador on the processing of fish and fish-farming products.

Table 5. Production of the fisheries and fish-farming sector, 2006

	Millions of dollars	% of total fish and fish-farming exports
Industrial fishing	43.6	60.7
Marine artisanal fishing	18.4	25.6
Inland artisanal fishing	3.4	4.7
Total fishing	*65.4*	*91.1*
Inland fish-farming	5.1	7.1
Marine fish-farming	1.3	1.8
Total fish-farming	*6.4*	*8.9*
Total fishing and fish-farming	**71.8**	**100.0**

Source: Fishing and Fish-Farming Statistical Yearbook 2006 (CENDEPESCA) according to University of Cantabria (undated).

5. The maize industry

Maize cultivation is a primary step for a large number of economic activities (e.g. production of *tortillas, pupusas, y tamales*). The area sown with maize has remained stable although output and yields vary from year to year, chiefly due to climatic conditions. A slight increase in productivity can be observed (Figure 2), thanks to technological improvements and government programmes which supply improved seed to small farmers. Although white maize is the most widely cultivated crop, El Salvador imports some ten per cent of the white maize consumed in the country (Ángel, 2008).

In the white maize industry, there are two types of enterprise. On the one hand, we find two large companies which process nixtamalized white maize[9] for human consumption (DIGESTYC 2005). To make this flour, they use imported machinery and technologies. According to Trade Map data, El Salvador exported 32 million dollars of nixtamalized maize to the rest of the Central American region in 2010. These exports are mainly from one of the companies, as the other major company is part of a transnational with plants in several countries in the region. Exports of flour have been growing strongly (2001-2007) and much of the imported white maize ends up being re-exported as flour (Ángel 2008).

The other segment consists of over 2,700 artisanal maize flour mills distributed throughout the country. These companies use machinery which was originally imported, but workshops can be found now in the country which make it and provide repair services. This traditional sector does not generally apply safety standards and does not differentiate its products. An exception is those medium-sized enterprises which used nixtamalized maize soda dough to make *tamales* and/or *pupusas*, which they package and freeze and sell mainly in the nostalgia market in the United States.

There are two Salvadorian companies which make snacks based on yellow maize which sell their products in the domestic and international market (Ángel, 2008). All the yellow maize consumed in the country is imported.

6. The rice industry

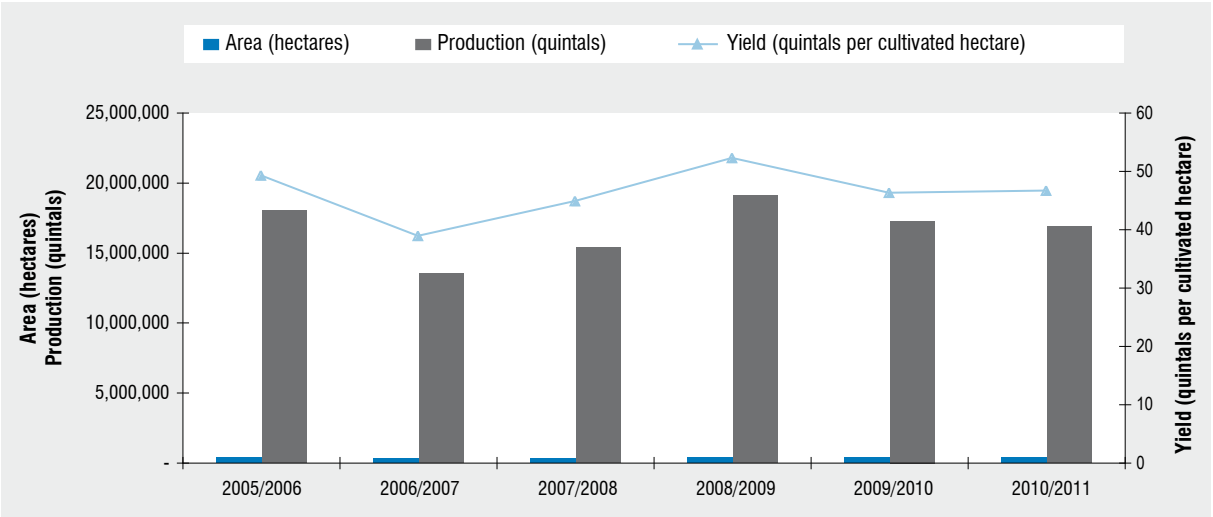
Rice is one of the most important components of the Salvadorian diet but its production in the country is limited. Ninety per cent of the consumption of gold rice is imported (Ángel 2008).

There are ten rice processing companies which generate 472 jobs (DIGESTYC 2005). For some years, the main companies have incorporated new processes and products generating pre-cooked rice, rice flour and, in at least two of them, lines unrelated to rice have been developed, making incursions into the food and drinks area, especially for export to the ethnic market in the United States. The machinery and technology used come mainly from the United States.

7. The beans industry

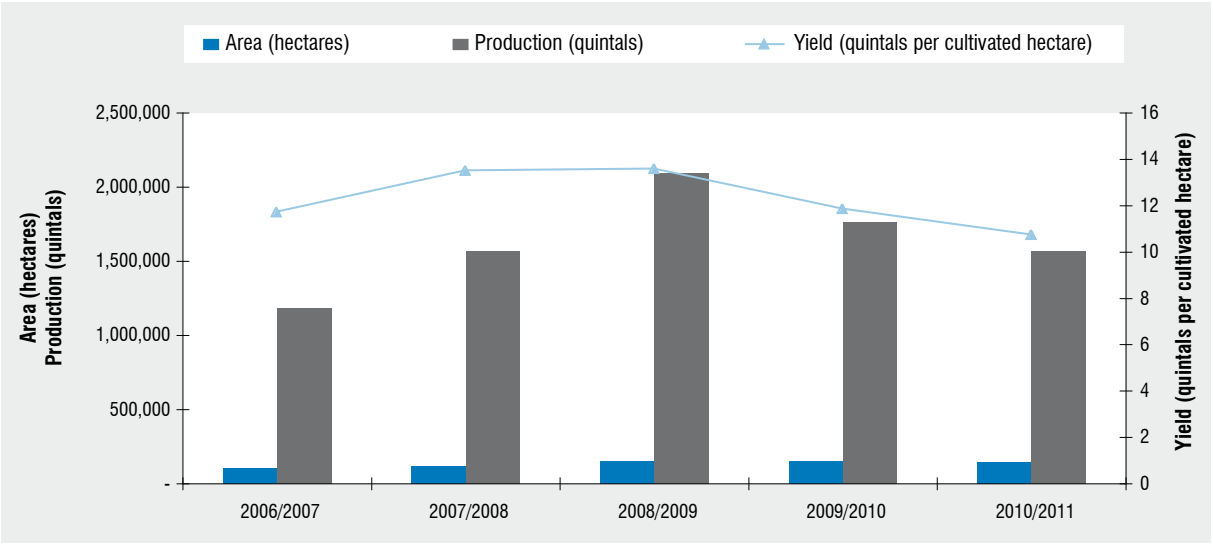
The cultivation of beans is characterized by great variability, both in area under cultivation and total production (Figure 3). The differences in productivity fall within the normal range, given the great influence of levels of precipitation and climatic phenomena on this crop. The great variations in area under cultivation are mainly due to farmers' expectations, prior to sowing, of the price of the future harvest.

Figure 2. Cultivated area, production and yields of maize, 2005-2011



Source: UNCTAD, based on data from the Agricultural Statistical Yearbook, MAG.

Figure 3. Cultivated area, production and yield of beans, 2005-2011



Source: UNCTAD, based on data from the Agricultural Statistical Yearbook, MAG.

Beans are one of the crops which form part of the basic diet of the majority of Central American countries. Having sufficient levels of supply at an affordable price is crucial for all the countries in the region. The impact of policies to promote production of beans (e.g. distribution of improved seed to small farmers) has not been sufficient to respond to the growth in demand. Policies are often adopted which discourage exports (e.g. exclusion from free trade agreements with countries outside the Central American area) (IICA 2008).

There are opportunities to improve productivity through technical programmes on seed selection. At present, many small farmers select from their own grains for use as seed, without adequate technical support.

The transformation of beans into added value products such as, for example, boiled and fried beans packed in cans, packets or *doy packs* has increased in importance in the last decade. No specific information is available on this industry, as beans are just one product among many in companies' processing lines.

8. The sorghum industry

Sorghum is mainly used for poultry and animal feeds and its production is a traditional agricultural activity. To a more limited extent, sorghum flour is used in some common bakery products (it is mixed in proportions of not more than 30 per cent with wheat flour). In the poorest rural families, it is a human food resource. CENTA has, for several years, been developing and encouraging the use of sorghum in bakery, obtaining good quality products from sorghum flour. Sorghum is also a grain which represents an important raw material for the manufacture of prepared animal feeds.

9. Dairy processing industry[10]

Two types of dairy processing enterprise can be found in El Salvador. On the one hand, there are a large number of artisanal enterprises which process milk without acceptable hygiene standards (e.g. unpasteurized milk). On the other, around ten formal companies have hygienic processes and use pasteurized milk and the latest generation of machinery. The largest companies have innovation departments or managers for the development and launch of new products. They receive international advice and, in at least one case, have support from foreign technicians to maintain the equipment. This group of companies, together with the poultry industry, invest most in innovation. They are accustomed to launching a least two new products per year in the market and innovation forms part of their business strategy. Innovation chiefly involves importing foreign technology and training, purchasing of technological services abroad, investment in quality control, and internal product development (sometimes by trial and error). The main sources of information for innovation are attendance at fairs or specialist tours and participation of employees in product development. These processors have professionals who have been trained abroad, especially post-graduate training. These companies do not form partnerships with other domestic companies, but only with milk suppliers, and markets are developed individually.

Milk production amounts to about 500 million litres per year, of which six per cent is destined for own consumption, 13 per cent is processed in artisanal businesses without acceptable standards of hygiene (unpasteurized milk), 23 per cent is sold for consumption as fluid milk and 58 per cent is processed by dairy plants which use good practices (MAG, 2009). Milk production is also characterized by two different scenarios. On the one hand are specialized dairy farms (accounting for only three per cent of the herd but producing 40 per cent of total milk output) which use hygienic milking methods and apply adequate health practices. The other group of companies, dairy and beef farming, mainly produces milk without applying hygienic practices in milking.

Exports of dairy products, chiefly cheeses, represent between 10 and 20 per cent of domestic production. The principal dairy products exported are cheeses. El Salvador imports milk to satisfy domestic demand.

10. Poultry industry

This industry, which accounted for 1.7 per cent of national GDP in 2010 (see Table 1) has a high level of technology and management, although for some time its products were the traditional ones (eggs, fresh and frozen chicken). For over a decade there has been a move to the development of higher added value products (first cutting and selling pieces, later developing a range of prepared packed and fast-food chicken products). Competition between companies is strong and product innovations are quickly copied by other companies in the country. Innovation in this sector has been possible thanks to the professionals trained abroad. The results obtained have led these companies to step up their R&D activities and launch two to three new products on to the market each year.

The El Salvador Association of Poultry Farmers (AVES), which has a membership of over one thousand poultry farmers, has organized the industry and successfully defended its interest, but it depends on the capacity of the Ministry of Agriculture and Livestock to consolidate epidemiological surveillance programmes and maintain the country's sanitary status free of avian diseases. In addition, there are also a large number of unrepresented family poultry farms which national sanitary programmes do not cover.

11. Prepared animal feeds

The development of the poultry, pig and cattle industry has stimulated the growth of the prepared animal feeds industry (i.e. balanced mixtures of pelleted nutrients intended for animal feed). For example, the largest manufacturer of prepared animal feeds belongs to a group which owns a poultry business.

The bulk of the raw materials used in the formulation of prepared animal feeds (soya flour, yellow maize and sorghum) are imported and supply chain integration

with local grain producers is very limited. In addition, cattle farmers buy sugar cane molasses to add energy to food rations. Seventy per cent of yellow maize and sorghum imported from the United States is used to make concentrates. All the soya flour needed for this purpose is imported (Ángel, 2008).

Driven by their customers' demands, especially in the poultry sector, the concentrated feeds industry has developed high quality standards.

Statistics from the El Salvador Association of Poultry Farmers (AVES)[11] show that production of concentrated feeds rose between 2004 and 2007. The fall seen in 2008 probably reflects expectations of lower consumption with the onset of the global crisis.

12. Essential oils and resins

The essential oils industry is relatively small and is concentrated in just a few companies. This industry requires the use of specialized machinery, equipment and processes, as well as of scientific knowledge regarding oil extraction and filtration to enable the elaboration of products with a quality acceptable to the international market (the domestic market is very small).

Peruvian balsam is a resin of El Salvador traditionally used in the production of natural medicines and which is also used for essential oils, cosmetics and foods. The production of balsam is an artisanal extraction activity which has not changed its methods since colonial times. It is carried on by small farmers who supply their product to collectors or exporters. At present, this resin, whose quality is superior to that obtained in other countries, is exported unprocessed. If R&D activities were undertaken, the balsam could have greater added value.

Neither the essential oils nor the resin industry make a significant contribution to the current economy, but, given the growth in consumption of natural products, development opportunities for this sector exist if value can be added to these products. The processing of balsam, even employing basic processes such as filtration, is already an important source of added value. Complying with international quality demands is the main concern of today's producers.

One of the companies in this sector[12] is concentrating on extraction of essential oil from lemon grass, another is constantly experimenting with the extraction of various essential oils (including coffee, vetiver, cascarilla, styrax and liquidambar) and has managed to developed a fairly wide and flexible range of products to adjust to market demand.

Domestic production is still small. There are no specific data on domestic production, but the volume of exports (Table 6) gives an approximation of total production. It should be noted that the export turnover of one of the main companies shows figures higher than those shown in the Trade Map database.

Table 6. Exports of essential oils and balsam, 2008-2010 (in thousands of dollars)

Products	2008	2009	2010
Essential oils, nse*	98	93	198
Balsam	1,414	485	886

**nse: essential oils not specified elsewhere.*
Source: Trade Map, International Trade Centre.

13. Fruit and vegetables

No reliable and sufficiently disaggregated up-to-date statistics are available, but it is estimated that a around 70 per cent of fruit and vegetables consumed in the country (both as human foods and agro-industrial transformation) are imported.

The supply of fruit and vegetables, and products based on fruit and vegetables, is highly diversified. Table 7 shows the principal exports. The vegetable sector has concentrated in the development of products of Salvadorian cuisine (tamales, pickles) destined for sale to Salvadorian emigrants living in the United States. There are a growing number of enterprises in the processed tropical fruit sector, in mainly micro and small enterprises that are developing products, albeit on a small scale and with little innovation and differentiation. Due to the stimulus given by the planting of orchards (see the MAG National Orchard Programme), there is beginning to be a national supply of some tropical fruits of varieties accepted in international markets (although the export of the fresh fruit is limited by phytosanitary requirements).

The supply of raw materials for this industry is a critical factor. El Salvador has difficulty in expanding domestic production. Investments in technology (protection and irrigation systems, improved access to water sources) are required throughout a scattered area. Furthermore, other countries such as Guatemala and Honduras have lower production cost structures.

Against this background, the growth of these agro-industries requires the development of agreements with regional suppliers.

In the ethnic food, fruit and vegetable industry, innovation activities are focused on the development of processes for the manufacture of traditional products on an industrial scale, including standardization of processes and the adoption of food safety measures. These developments take place individually at company level – each company tries to keep its formula secret and there is no collaboration between them.

14. Natural dyes

El Salvador's aniline or indigo has special quality characteristics due to the concentration of indigotine. During the colonial period, it was one of the principal export products of El Salvador. It is an industry with enormous possibilities of expansion and integration in the future. For some years, efforts have been under way to reactivate its cultivation, processing and use in products dyed with aniline. In this regard, research is needed into the extraction of the dye, as the "point" is still determined in the traditional way, by eye, by the person in charge. Because scientific parameters are not used, qualities and yields are not standardized.

15. Textiles industry

While the Salvadorian textiles industry makes an important contribution to GDP (Chapter I), at present it is based on assembly for re-export which uses imported inputs and does not have any links with local agro-industries. Inputs for the local textiles industry are also imported.

1.3. Financing

There is no explicit information, but the agro-industrial sector claims to have difficulty in financing its activities in general and innovation in particular. At the end of 2010, less than four per cent of the total value of loans granted by financial institutions were for the agricultural sector [13]. Of the 325 million dollars lent to the agricultural sector, the Agricultural Bank lent 26 per cent of the total value of loans. The Agricultural Promotion Bank and the Banco Hipotecario lent 24 and 19 per cent respectively.

The development finance institutions in El Salvador are those which are making the greatest efforts to help the agricultural sector. According to data of the Superintendency of the Financial System, in 2010, the Agricultural Promotion Bank (BFA) allocated 58 per cent of its portfolio to the agricultural sector and the Banco Hipotecario (BH) 17 per cent. For their part, private banks allocate an average of three per cent of their portfolio to agricultural loans, although it should be highlighted that the Banco ProCredit allocated nine per cent of its portfolio to this sector.

In addition, as an indication, less than ten per cent of the total value of loans granted in 2010 were for the manufacturing industry.

As described in Chapter II, a national development bank is being created which will eventually include venture capital. For this bank to be a key element in the financing of innovation in the agro-industrial sector, it will be necessary to promote change of mind-set to one which encourages investment in innovative projects even if they carry greater risk. It will also be necessary to have specific capacities to finance

Table 7. Principal fruit exports, 2008-2010 (in thousands of dollars)

	2008	2009	2010
Coconuts, Brazil nuts and cashew nuts (merey, cajuil, anacardo)	427	536	317
Citrus fruit, fresh or dried.	946	739	1,860
Fruit and nuts, uncooked or cooked by steaming or boiling in water, frozen	1,596	1,552	1,325
Total Fruit	**2,969**	**2,827**	**3,502**
Other vegetables	3303	3846	3421
Beans, including shelled, cooked, frozen	1146	1103	946
Peppers, genus capsicum or genus pimiento	2784	2115	2466
Other fresh or refrigerated vegetables	487	556	486
Common beans, dried, shelled	9,200	5,197	2,869
Total Vegetables	**17,061**	**13,221**	**10,422**

Source: UNCTAD, based on data from TradeMap database.

technological projects in the agricultural and agro-industrial area. In addition, PROinnova is promoting the development of investment angels.

The *Special Agricultural Development Trust* (*FEDA*), created in 1996, is intended to promote modernization of the agricultural and agro-industrial sector by means of long-term financing of investments which increase production, employment and competitiveness in the agricultural sector. FEDA allocates funds to an interest rate subsidy of three percentage points on loans granted by intermediary financial institutions from their own resources. The operation in the agro-industrial sector has been limited because the intermediary institutions require loan applicants to satisfy the same requirements as those established for other economic activities.

FOEX-FONDEPRO is the only fund in the country which offers lines of support and credit to agro-industry. This non-reimbursable fund is aimed at MSMEs (i.e. enterprises with annual turnover of less than seven million dollars) and co-finances up to 70 per cent of the total value of the project. In the adoption of technology line (machinery and equipment) support up to 60 per cent is provided to a an enterprise which presents a project individually and up to 70 per cent in the case of a group of enterprises in association. The fund's maximum contributions are 25,000 dollars for individual projects, 100,000 for group projects, 15,000 for specific group activities and 75,000 through competition as seed capital for projects of innovative entrepreneurs. These funds are limited in amount and insufficient to meet total demand from small and medium-sized enterprises.

The fund has five lines: innovation and technology, quality and productivity, productive chains and association, market development and innovative enterprise. The innovation and technology line co-finances visits by international experts, university advice to companies, consultancy services for product design, improvement and certification, specialist product and process testing services, and the acquisition and adaptation of technologies provided that they allow improvements to productive processes and do not merely increase installed capacity. This line represented about half of the 1.8 million dollars allocated in 2008 (Vicens and Stark, 2009). In all, over 900 proposals were financed between 2002 and 2008 for a total amount of 5.4 million dollars. The impact of this financing was reflected in the export performance of the beneficiary companies. Exports of these companies rose by 136 per cent between 2002 and 2008. Moreover, the rate of growth of exports of non-traditional products of these companies was above the national average. The programme management is recognized as good, but it is faced with problems of financing, as it does not have a regular supply of funds.

1.4. Organizations which disseminate knowledge

The supply of professionals in the areas related to agro-industry is not adequate. Every year 150 engineers and 150 technicians graduate in agro-industry related-areas (Table 8), but the quality of the education does not meet the expectations of the private sector. Moreover, the lack of more advanced and specialized education is a major weakness. Currently, there are no doctorate course offers in areas related to agro-industry and the number of graduates with master's degrees is still small.

The private sector also said in the interviews that the current supply of technological services does not meet the needs of agro-industrial companies.

The *National Centre for Agriculture, Livestock and Forestry Technology (CENTA)* (section 1.5) provides technology transfer and extension services, including in the agro-industrial area. In the technology transfer sphere, CENTA has a Technical Supervision Unit, 35 extension agencies and a technical training unit. CENTA's technology transfer activity is limited. For more than 12 years, the staff have been assigned functions of distributing seed and inputs to small producers which, although necessary, consumes scarce resources and diverts technical extension staff from their proper technology transfer functions. It is estimated that some 70 per cent of staff time is devoted to the distribution of agricultural packages, displacing resources available for research and technology transfer activities as such (RUTA, 2010). CENTA suffers from budgetary problems and limited links with the private sector.

The *National School of Agriculture (ENA)* provides training for professionals in the agricultural sector. The institution stands on 210 hectares of land where the soil is high quality, and where its students can "learn by doing", cultivating basic grains, fruit and ornamental trees. It also has dairy and beef cattle, pigs, bees, rabbits, goats, sheep and fish-farming. The school also has a dairy, fruit and vegetable

processing plant, in which the students learn the basics of these agro-industrial processes. The ENA offers studies in agronomic methods, and graduates can continue their studies in the José Simeón Cañas Central American University and take the agro-business degree. This school has trained the majority of agronomic technicians working in the country. The school's main obstacle is its limited budget which, among other things, affects the recruitment of top quality teachers.

Dr. José Matías Delgado University (UJMD)
The Food Engineering Faculty provides the education most related to agro-industry. Its small budget limits the purchase and renovation of the latest machinery as well as better salaries for the teaching staff. There is no information available regarding research activities of this faculty, which seems to indicate that such activities are limited.

José Simeón Cañas Central American University (UCA)
The Department of Process Engineering and Environmental Sciences provides laboratory and research services to companies in general.

University of El Salvador (UES)
Provides training in agro-industrial engineering, agronomic engineering and a degree in veterinary science. There is no known research by the UES in the agro-industrial field.

Zamorano University of Honduras.
Although located in Honduras, this Pan-American school is very important to El Salvador's agro-industrial activity because of its proximity to the country, its high standard of education and the technological services that it provides. It currently provides degree-level education in the food industry and agro-business management.

1.5. Organizations which generate knowledge

CONACYT's statistics show little research activity in agricultural sciences in Salvadorian universities and technical institutes. El Salvador is one of the Central American countries which invest least in agricultural research, both in absolute terms and as a proportion of

Table 8. Education in agro-industry related subjects, El Salvador, (2005-2009)

	Institution	Student population					Graduates				
		2005	2006	2007	2008	2009	2005	2006	2007	2008	2009
Master of energy resource management	UDB	-	-	-	-	9	-	-	-	-	-
Master of agronomics	UES	-	-	-	1	-	-	-	-	1	-
Master of environment and natural resources	UCA	27	17	51	35	17	-	5	8	4	8
Master of science and food technology	UJMD	-	7	5	-	-	-	-	-	-	2
Subtotal: postgraduates		**27**	**24**	**56**	**36**	**26**	**0**	**5**	**8**	**5**	**10**
Degree in agro-ecological studies	Lutheran U.	110	101	114	106	67	6	25	26	8	3
Degree in agro-industrial studies	UES, UJMD	-	-	-	-	62	-	-	-	-	19
Degree in agronomics	UES, UO, UNICAES	770	690	704	698	822	106	93	83	84	65
Degree in food technology	UJMD	195	222	229	283	336	20	9	6	11	18
Degree in agro-business management	UJMD	-	-	-	4	18	-	-	-	-	-
Degree in veterinary science	UES, UO	511	511	577	606	601	23	14	35	35	41
Degree in agro-business	UCA	-	-	-	10	10	-	-	-	-	-
Subtotal: graduates		**1.586**	**1.524**	**1.624**	**1.707**	**1.916**	**155**	**141**	**150**	**138**	**146**
Agronomics technician	ENA	99	131	158	250	323	33	36	30	45	-
Food preparation technician	UJMD	-	351	423	429	446	-	73	107	164	151
Subtotal: Technicians		**99**	**482**	**581**	**679**	**769**	**33**	**109**	**137**	**209**	**151**

UES, University of El Salvador; UJMD, Dr. José Matías Delgado University; UO, Oriente University, UCA, José Simeón Cañas Central American University; UNICAES, Catholic University of El Salvador.

Source: UNCTAD, based on MINED (2010) and information available on institutional websites.

agricultural domestic product (Table 9). As described in Chapter I, only five per cent of investment in R&D by higher education institutions is destined for the agricultural sciences and ten per cent to engineering and technology. On the other hand, 40 per cent of researchers (50 persons) work in the agricultural science field. The number of researchers in agricultural sciences has declined considerably. In 1981, there were 120 full-time equivalent researchers, but by 2006, this number had fallen by 35 per cent (IFPRI-IICA 2008). A matter of concern is that Salvadorian researchers are the least qualified at regional level. In 2006, one researcher in five had a postgraduate qualification (IFPRI - IICA 2008).

In El Salvador, a high percentage of research is financed by the Government and carried out by public institutions, in particular, CENTA. Higher education institutions have little capacity for research in the agricultural sphere. In 2006, 78 per cent of full-time equivalent researchers in agricultural sciences were working in public institutions, and although there was increased involvement, researchers in higher education institutions only accounted for 13.8 per cent of the total.

The bibliometric analysis (Annex F) indicates that categories in which there are the most publications include plant sciences, agronomics, biology and zoology. On the other hand, these are not areas in which the greatest impact is achieved. In terms of impact, the publications which stand out are in food science and technology, ecology, microbiology and fisheries. However, these publications rely on the involvement of a primary author not resident in El Salvador.

The *National Centre for Agriculture, Livestock and Forestry Technology (CENTA)* has the mission of regulating, planning and managing the support for the generation and transfer of technology, as well as technical assistance in agriculture and forestry. For its research activities, it has a Technological Research Management Department, which includes biometrics and socio-economics units, experimental station, seed technology, research laboratories and programmes. The centre mainly carries out research into staple grains, with good results in the development of genetically improved lines. The research is carried out under agreements with international research centres such as the International Maize and Wheat Improvement Centre (CIMMYT). This research work is a response to the value of promoting the supply of staple grains for domestic consumption, but is little related to farmers' needs (RUTA, 2010). The other research areas are more limited. In the agro-industrial field, CENTA presents results of agro-industrial processes applicable to small producers but with limitations with regard to the development of products on a large scale.

For a couple of decades, the institution has been faced with serious budget problems, which have been reflected in staff reductions and the number of extension agencies, as well as a lack of resources to operate properly in the areas of research and technology transfer. Various efforts to strengthen the institutions have had limited success.

The ENA carries out research in many areas. Of particular note is the work done on sugar. The Sugar Association of El Salvador recognizes ENA's contribution in the in vitro production of vegetable material from sugar cane as very valuable. It should be noted, however, that, in 2009, less than one per cent of the annual budget of 2.3 million dollars was allocated to scientific research activities (MINED 2010). Furthermore, the level of education of the staff of the school limits the level of research that it can do. In 2009, ENA did

Table 9. Agricultural research and development: El Salvador in the Central American context, 2006

	Number of agencies studied	R&D expenditure (millions of 2005 dollars)	Number of researchers (full-time equivalent)
Belize	7	2.6	16.7
Costa Rica	16	29.9	282.9
El Salvador	6	5.7	76.9
Guatemala	7	8.3	102.4
Honduras	12	11	123.7
Nicaragua	8	24.1	133.4
Panama	7	10	166.7

Source: UNCTAD, based on IFPRI-IICA 2008.

not have a single teacher with a postgraduate qualification and 20 per cent of the teachers had technical level education MINED (2010).

The *National Centre for Fisheries Development (CENDEPESCA)*, under the MAG, is the national fishing authority responsible for research and regulation of fishing at national level. Despite the lack of an adequate budget, specialist staff and technical resources to carry out the various research required for the development of the sector and the design of regulatory measures, it has been possible to carry out important studies thanks to international cooperation[14].

The *Salvadorian Foundation for Coffee Research (PROCAFÉ)* was created in 1990 as a result of the privatization of the Salvadorian Coffee Research Institute. This private institution is financed and managed by coffee-growers through representatives of the country's four coffee trade associations. PROCAFÉ supports the coffee sector with research and technology transfer, and provides technological services to the coffee industry (see Box 2).

CENSALUD has facilities for microbiological analysis of food and waters but does not have paid posts for researchers and does not offer services to the private sector.

Agricultural research activities are concentrated on crops (over 90 per cent of time is devoted to research in this area) and research into livestock, fisheries, forestry, harvesting and natural resources is minimal (IFRI-IICA, 2008). The principal research activities in biotechnology in the country are centred on molecular characterization and plant propagation. They are carried out by CENTA and the ENA. There are no modern biotechnology research facilities (Solleiro et al., undated).

El Salvador does not have any regional/international research centre such as those that exist in other countries in the region. Like the rest of Central America, the country does not have any private company that does research in the agricultural sciences.

1.6. Support organizations

The PROinnova programme of FUSADES, founded in 2007 to stimulate development, innovation and exports of companies in the food sector, has developed 24 innovation projects and is facilitating the development of another 23. It is also supporting the conversion of the FUSADES Integral Quality Laboratory into a Technological Centre which can provide technical assistance and services related to product development, useful life, sensorial analysis,

Box 2. PROCAFÉ - Supporting research and technology transfer

PROCAFÉ, a private foundation financed by coffee-growers, supports the coffee sector with research and technology transfer, and provides technological services to the coffee industry. It has three coffee technology centres for the validation of varieties, production of certified seeds and coffee seedlings. It also has a beauvaria *bassiana* fungus laboratory to combat coffee borer beetles (the most damaging pest for coffee bushes).

The research activities are centred on the development of new varieties, agronomic management of coffee bushes, including pest control, and the development of special coffees. The results of this research include the launch of cuscatleco coffee (a coffee variety with high yields) and the development of a borer beetle trap. The principal technological services provided by PROCAFÉ included soil and leaf analysis, and the development of diagnostics and investment projects for producers applying for credit. The majority of the research, technology transfer and innovation activities are related to coffee-growing, and to a limited extent to coffee processing (i.e. selection, roasting and marketing). However, PROCAFÉ has also supported training in roasting and tasting of coffee and has been promoting the development of the appellation of origin of Apaneca-Ilamatepec coffee.

The Foundation is financed two-thirds from a levy on coffee-growers of 0.5 dollars for every quintal of green coffee supplied by the producer and processed by the roaster, processor or export processor[15]. The other third is funded by income from the provision of specialist services and products. The funds available for PROCAFÉ's research thus fluctuate with coffee production.

PROCAFÉ participates in PROMECAFE, the Regional Cooperation Programme for the Technological Development of Coffee-Farming in Central America, Panama, the Dominican Republic and Jamaica and collaborates with other international institutions such as the International Centre for Tropical Agriculture (CIAT) based in Colombia and the Centre for Agronomic Research for Development (CIRAD) in France for the development of the coffee borer beetle trap. PROCAFÉ has collaborated with the University of El Salvador in student theses and work experience and provides training through various secondary education institutions.

Source: UNCTAD, based on PROCAFE (2010) and PROCAFE information available at www.procafe.com.sv

labelling, etc. The programme provides integral support from enterprise diagnostics and strategic orientation of the business, to support on technological matters, management, registration of patents and trademarks, access to financing, laboratory analysis services and product labelling. The programme has financial resources (the budget for 2011 was 1.1 million dollars) and a team of eight staff and a roster of 16 consultants.

The *Foundation for Agricultural Technological Innovation (FIAGRO),* established in 2002, provides access to technology and development of innovation projects in the country's agricultural and agro-industrial sector. FIAGRO's principal programmes are centred on knowledge management and innovation through events and tools for dissemination, studies, guides and technical manuals, and foreign travel for technological apprenticeship. FIAGRO has administered the technical and financial execution of 27 innovative projects in the agricultural and agro-industrial sector of El Salvador financed by SINALIT.

FIAGRO has developed specific competencies in two areas: biotechnology and renewable energy. It is currently the technical assistance window (providing advice on pre-feasibility and feasibility studies for the implementation of projects) for a line of credit of 27 million dollars. FIAGRO also supports company incubation activities and enterprise development. The AGROINNOVA programme, implemented from 2004 to 2008 with an allocation of 358,500 dollars, identified innovative ideas, trained over 200 entrepreneurs in preparing business plans, evaluated over 100 business plans and granted seed capital to the most outstanding entrepreneurs. The total amount of investments made by entrepreneurs exceeded ten million dollars. There are currently 36 enterprises in operation.

The PROinnova and FIAGRO programmes and their impact on the development of innovations are well received by the private sector. Even large companies, which do not benefit from their services, participate in events organized by the two institutions.

The Millennium Fund (FOMILENIO) (see Chapter II) has a productive development component with a budget of 87 million dollars over five years. Its aim is to develop business opportunities, mainly supporting poor farmers to produce and market high value products. This component provides technical assistance and commercial development services to producers, promoting the development of suppliers in different value chains. In the agricultural sphere, the main two chains have been market gardening and dairy. As of March 2011, the market gardening programme, centred in the development of collection centres and market intelligence, generated over 3,800 jobs. As of March 2011, the dairy programme had generated over 700 jobs and increased by eight the number of dairy producers' associations working in cooperation with two dairy cooperatives. For their part, the latter are promoting the development of quality measures, collection, transformation and marketing of milk. The programme is faced with difficulties in working with a great many small poorly organized groups of producers. FOMLIENIO does not carry out research and development of new producers, nor does it collaborate with knowledge generating centres which support development and technology transfer activities.

The National Development Fund (FUNDE), while playing a minor role in the promotion of innovation in the agro-industrial sector, has carried out studies of policies and legislation which address topics of relevance to the development of the agro-industrial sectors, such as the impact on the sector of trade agreements or intellectual property rights.

INSAFORP (see Chapter II) finances student scholarships to allow them to study in the ENA (50 scholarships) and the Zamorano University (currently 20 half-scholarships and 5 full scholarships). Up to 2010, INSAFORP has awarded scholarships to 222 Salvadorian students. INSAFORP has also financed various training in the agricultural and agro-industrial sphere (e.g., for a while, it financed training and attendance at international events in the field of fish-farming). INSAFORP does not have an integral programme of support for training in the agro-industrial field, and does not have detailed information on its activities as a whole in the sphere of agro-industrial innovation.

1.7. International cooperation

International cooperation makes an important contribution to the country's agro-industrial development. A large number of support programmes for agricultural and agro-industrial innovation have been developed thanks to financing and/or technical support from international cooperation and funds. Several of these programs, although achieving positive results, have not been continued once the funds ran out. There

have also been varying results. For example, German cooperation (GTZ) supported the Ministry of Agriculture and Livestock from 1998 to 2003 in the diagnostic and improvement of the capacities of micro and small agro-industrial enterprises selected by the Directorate of Agro-business. The results were minimal due to the limited business capacities (both in knowledge and experience and resources). The management capacity of four enterprises was improved, but this did not have a significant impact on their subsequent development. GTZ also supported the importing of two solar dehydrators. However, they failed to standardize process or quality, and the equipment could not be used for commercial production of dried products.

Canadian cooperation supported the development of an agro-industry based on loroco, an edible flower, native to El Salvador. With the support of the Department of Food Technology of Dr. José Matías Delgado University, progress was made in research into post-harvest processes (packaging and preservation) of the loroco flower. Despite having financial support for the building of a processing plant, the project was more or less abandoned due to the problems of reaching agreement among loroco producers. It is currently financing a research programme for the revival of the production and marketing of indigo, working in conjunction with the Balsam Association and the University of Alberta, Canada.

The Inter-American Institute for Cooperation on Agriculture (IICA), an institution of the Inter-American System, has supported various agro-industrial programmes in the country, in particular, the national fruit programme. It is currently supporting the development of producers in the fruit chain in the framework of the FOMILENIO programme.

2. Cohesion and foresight functions – policy system

The country's agricultural sector has suffered a major decline during the last two decades. In general, economic policies have lacked continuity and have been marked by an anti-agricultural bias (RUTA, 2010, FUSADES, 2008). The reduction in public spending was a disincentive to private investment in the agricultural and agro-industrial sector, and limited the capacity of important public institutions such as CENTA. In the last decade, direct transfer programmes (inputs, equipment, machinery) took on considerable importance, in 2009 accounting for 60 per cent of public expenditure (RUTA, 2010), and displaced expenditure on research and technology transfer. In addition, the greater importance of loans and international cooperation encouraged the dispersion of resources and weakened the capacity of the Ministry of Agriculture and Livestock to establish priorities and bring cohesion.

From 2007, public spending on agriculture strengthened and since 2009 there has been a commitment to reactive the agricultural sector, enshrined in the Ministry of Agriculture's Strategic Sectoral Plan 2010-2014. The programme contains ten action programmes, one of them on technological innovation which includes the establishment of a national system of agricultural technological innovation, a competitive fund for agricultural innovation; and a national network of local technological innovation centres. Food security continues to attract the attention of the current efforts of the Government of El Salvador with respect to agriculture. This preoccupation has been reflected in the continuation of the annual distribution of farm packages (improved seeds and fertilizers) to small farmers. The Family Agriculture Plan established in 2011[16] comprises four components, of which the most prominent is the programme of distribution of farm packages. The plan also includes a programme of support to productive chains between small producers and trade, and another between trade and industry, as well as a programme for agroindustrial innovation[17]. For the implementation of the Family Agriculture Plan, the MAG will receive 30 million dollars in addition to its annual budget of 54 million dollars. The amount of resources allocated to the agricultural innovation programme is not known.

The country does not have a specific policy of support for innovation in the agro-industrial sector. Various different policies directly or indirectly mention agro-industry among their priorities. Figure 4 shows the principal bodies involved in innovation policies in the agro-industrial sector. The National Science, Technology and Innovation Policy 2006-2030 (Chapter II) includes agro-industry among its 13 areas of knowledge (fishing and agriculture). The Five-Year Development Plan, while considering agricultural development as strategic, does not specifically mention agro-industry. The National Research Agenda prepared by MINED includes agro-industry as one of the 29 strategic areas. The Integral Export Promotion Strategy identifies the agro-food industry as one of the five priority sectors. At regional level, El Salvador

has signed the Central American Agricultural Policy 2008-2017, which includes a major component on competitiveness and agro-business.

At sectoral level, the principal sectors, coffee and sugar, have governing bodies. The *Salvadorian Coffee Council*, created in 1989, is the governing body for coffee-growing in El Salvador. It is an autonomous state institution, but its executive includes private sector participation. Its mission is to direct and formulate national policy on coffee-growing.

There is no national programme for promotion of the agro-industrial sector which establishes priorities within the sector or a national agro-industrial research programme.

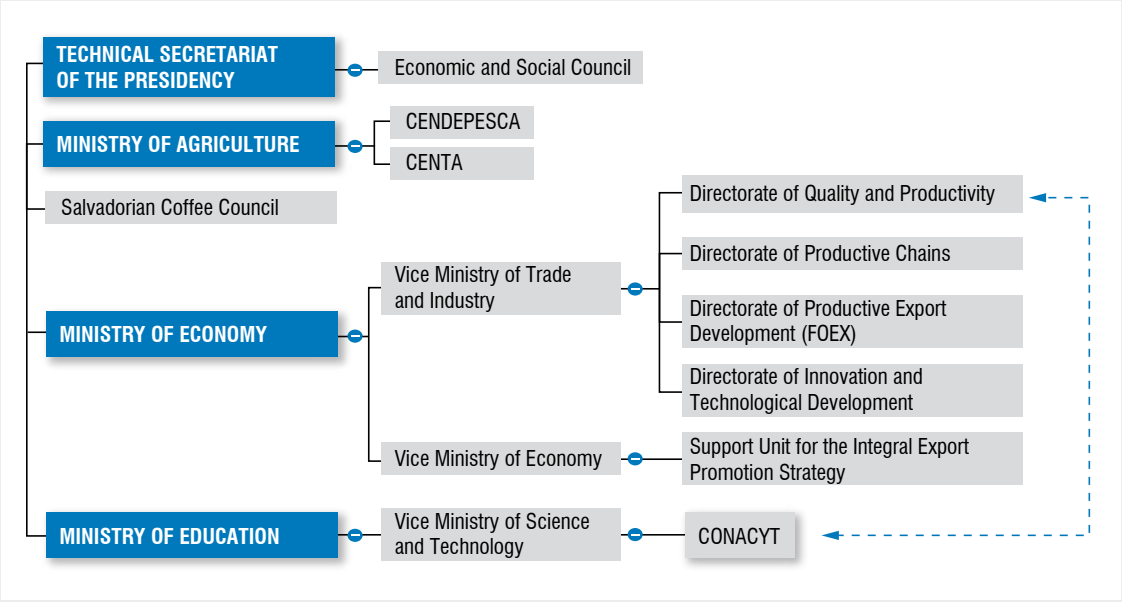
As a conclusion, El Salvador does not have an articulated and functional system of agricultural and agro-industrial innovation. The policies are fairly ambitious and available resources are scarce. Priorities need to be set, both in general and within the agro-industrial sector, together with a clear and coherent allocation of resources. In particular, the development of competitive agro-industries needs to give priority to promotion of the companies' capacity to absorb technology, i.e. prioritizing public spending on technology transfer and training, financial incentives for innovation and the development of linkages between all the actors in the system.

3. Management, control and regulation functions – link between the policy system and the executing system

There is broad consensus on the importance of agro-industry for the country and there are a large number of public sector institutions whose objectives and/or functions include some kind of support for agro-industrial development (Figure 5), although none of these institutions, except CENTA, state them explicitly. The support provided to the agro-industrial sectors has mainly focused, apart from on technology transfer to the relevant productive sectors, on the development of suppliers, markets and quality systems. In a more limited way, there has been support for the development of new agro-industrial enterprises. Support for R&D in the agro-industrial sphere has been very limited.

Coordination of agro-industrial programmes is limited. Levels of relations between different institutions vary. Generally, there is more collaboration between institutions that come under the same ministry. However, the relationship between the ENA and CENTA, two institutions under the umbrella of the

Figure 4. The principal bodies involved in innovation policies in the agro-industrial sector



Source: UNCTAD.

MAG, is confined to specific aspects. The objectives of support for innovation are noteworthy, but effective relations between them are weak and there has been a failure to create synergies.

In addition, there are also limitations in geographical scope. Various departments have specific potential, characteristics, resources and needs which require different kinds of intervention. Due to the scarcity of resources, much of the support for agro-industrial development is managed in San Salvador.

It should be highlighted that large companies and some medium-sized companies, do not benefit from the public programmes, among other things, because the requirements of those programmes exclude enterprises of a certain size, the amounts of financing for the required investment are very limited and/or the information and/or support services offered to not meet the needs of these companies. The larger innovative companies develop their own innovation strategies and use their own funds to finance them.

The following highlights the principal bodies which have innovation support programmes and projects of relevance to agro-industry, and the principal outlines of the regulatory framework of concern to agro-industry. The information provided below is based on interviews with staff of the various institutions and information available on institutional websites.

Table 10 provides a summary of the budgets of the principal public institutions for promotion of agro-industry. The figures relate to the total budget of each institution or department since there are no detailed data on the budget allocated to innovation. Although the figures are general, they reflect the limited level of resources available and the relative weight of the different institutions.

3.1. Ministry of Agriculture and Livestock (MAG)

The MAG is logically the relevant public body for the development of agro-industry which has the largest budget (Table 10). However, as indicated in the previous section, a large proportion of expenditure is devoted to programmes of direct transfer of inputs and not research and technology transfer (RUTA 2010).

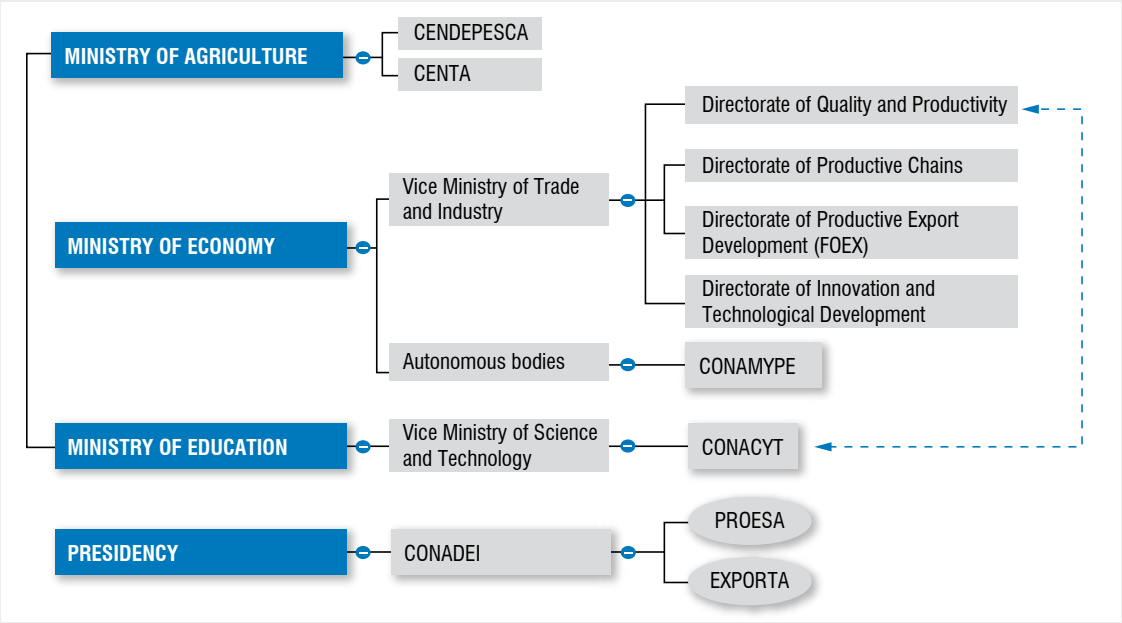
SINALIT (Chapter II) has promoted research in the agricultural and agro-industrial sector. This programme of competitive funds was co-financed by an IADB loan of 2.2 million dollars and contributions by entrepreneurs reached over 190,000 dollars in cash and 2 million dollars in kind. This programme, implemented with the help of FIAGRO, was probably the most structured effort with the greatest resources undertaken in the country to drive innovation in primary production and agro-industry. Its results were limited by the excessive administrative requirements and demands of the programme.

Table 10. Budgets of the principal public institutions that participate in the promotion of agro-industry

	Department	Budget 2011 (in dollars)
Ministry of Agriculture and Livestock	Directorate of agricultural economy and orientation of agribusiness	16,758,935
	National Centre of Agricultural and Forestry Technology	5,214,230 (for research and technology transfer)
	National School of Agriculture	2,691,515
Ministry of Economy	Directorate of Innovation and Technological Development	379,515
	Directorate of Quality and Productivity	552,230
	Programme of Support for the National Quality System	4,120,000
	Directorate for Productive Export Promotion (FOEX-FONDEPRO)	3,694,575
	Directorate of Productive Chains and Export Development	216,530
	CONAMYPE	1,825,000
Ministry of Education	Vice Ministry of Science and Technology	3,540,645

Source: UNCTAD based on official data.

Figure 5. The principal government bodies involved in the management, control and regulation systems



Source: UNCTAD.

El MAG also implemented the *National Fruit Programme (FRUTAL-ES)* with the help of the Inter-American Institute for Agricultural Cooperation (IICA). The programme, established in 2000, invested over six million dollars. This integral research and technical assistance programme promoted the development of technical capacities for fruit growing and processing and the development of markets in which to sell it. The chief technological components included the use of improved genetic material and the development of value through fruit processing. The most notable results include: technical assistance for over 3000 small and medium-scale farmers, substitution of some fruit imports, access to international markets, development of training programmes and material at technical and higher level, and the development of producers' associations and nurseries (Riveros et al., 2008). The new meso-American fruit-farming project will continue this work. It should be noted that the main beneficiaries of this programme were small farmers. In addition, like other programmes, the agro-industrial development component had a lower priority than in the development of production or markets. The programme did not include an agro-industrial research component.

In the vegetable sphere, another notable effort was a project sponsored by USAID, the United States cooperation agency implemented from 2002 to 2009. This project, implemented by the company Fintrac, provided technical assistance and irrigation and nursery inputs to market gardeners, but did not include an agro-industrial component.

The *Directorate of Agricultural Economy and Orientation of Agribusiness* in the MAG generates and publishes agricultural statistics.

3.2. Ministry of Economy (MINEC)

The Ministry of Economy (MINEC), and in particular the Vice Ministry of Industry and Trade, support agro-industrial development through various departments. The principal activities and results of the last two years are described below.

The *Directorate of Innovation and Technological Development* provides support to enterprises in the food and drinks and agro-industrial sectors through the INVENTA platform, among others, stimulating the key actors in the agro-food area, training SMEs in the sector (12), organizing the dissemination of best innovative practice, and supporting enterprises in the

sector in the process of obtaining co-financing from the Productive Development Fund (FOEX-FONDEPRO). The principal obstacles faced by this department are the lack of institutional strength to design, evaluate and monitor the unit's various interventions in this sector as well as a lack of resources to allow it to expand its framework of operation and geographical scope.

The *Directorate of Quality and Productivity* has supported improvements in the quality and productivity of two pilot agro-industrial MSMEs and has certified a specialist consultant. It has also promoted improvements in quality, productivity, and food safety of agro-industrial MSMEs. The principal obstacles faced by this department are the lack of human resources to provide wide geographical support, the lack of inter-institutional coordination for the elaboration, verification and surveillance of technical standards and regulations on agro-industrial products, the lack of consistency in learning processes and implementation of quality tools and systems, as well as shortcomings in the technical competencies of the staff of the bodies responsible for inspection and verification of compliance with technical standards and regulations.

The *Programme of Support for the National Quality System* is intended to promote the new legal framework of the National Quality System (standardization, technical regulations, accreditation and metrology), and to ensure the approval, implementation and international recognition of the System. The programme has strengthened the proposal for a general framework for conclusion of agreements on mutual recognition of technical regulations and procedures for evaluation of conformity, of especially importance for agro-industrial products. The programme has also made technical contributions to the Quality Bill and has raised legislators' awareness concerning the content of the Bill. The main obstacle to the development of the national quality system is the failure by the National Assembly to approve the Act on the Salvadorian System for Quality and Productivity.

Other institutions of the Ministry of Economy (e.g., the Directorate of Productive Export Development, the Directorate of Productivity Chains and CONAMYPE) also promote productive development in general.

3.3. Ministry of Education (MINED)

The Vice Ministry of Science and Technology has little part to play in agro-industrial development. Although agro-industry is one of the 29 areas identified in the National Research Agenda, there are no known activities that have taken place or are planned in this area. Moreover, the new National Centre for Scientific Research of El Salvador (CICES) does not include agricultural or agro-industrial research among its priorities.

3.4. Legal framework

A legal framework, including an intellectual property regime, trade law, labour and contract law, and regulations on food safety, standards and biosecurity which provides certainty, promotes competitiveness and safeguards the fundamental interests of various groups of producers and consumers is a factor which facilitates innovation and agro-industrial development.

The comments received on regulation indicate as the main concern the limited implementation in some sectors of basic hygiene standards and, in general, little adoption of certification of good agricultural and manufacturing practices, as well as difficulties in assuring adequate tracing of products. Entrepreneurs and experts also identified the existence of economic and trade policies which, although meeting the need of food security or the demands of specific groups of producers, make inputs for agro-industrial enterprises more expensive.

With regard to intellectual property, El Salvador is a member of WTO, WIPO and a part to the Patent Cooperation Treaty. Concerning biotechnology, El Salvador has ratified the Convention on Biological Diversity (CBD)(Legislative Decree No. 833, 1994) and the Cartagena Protocol on Biosafety to the Convention on Biological Diversity (Legislative Decree No. 85, 2003). Since 2008, the planting of genetically modified organisms has been permitted in the country (see Special Regulations for the Safe Use of Genetically Modified Organisms, Decree No. 78). El Salvador still does not have legislation on the protection of plant-breeders' rights but the Free Trade Agreement with the United States requires El Salvador to ratify or acced to the International Convention for the Protection of New Varieties of Plants (1991)(UPOV Convention 1991). FUNDE has presented an alternative proposal[18].

To sum up, the priorities with regard to the legal framework relate to the application of regulations on food safety and the adoption of quality standards, as well as coordination of policies and legislation of various kinds which, indirectly, affect the competitiveness of the agro-industrial sector.

C. CONCLUSIONS AND RECOMMENDATIONS

In the agro-industry of El Salvador, a wide diversification of the supply can be seen as well as a renewed public and private interest in developing the sector. There are successful cases of innovative companies which have managed to consolidate, diversify and export their agro-industrial products. There are also numerous opportunities to develop Salvadorian agro-industry, such as, for example:

- the development of ethnic foods and their expansion to other markets,
- the expansion of special coffees,
- the development of fish-farming,
- the transformation of traditional raw materials, such as Peruvian balsam,
- the utilization of raw materials which are abundant in El Salvador, such as honey, in the manufacture of other products in the country,
- the processing and manufacture of products based on fruit and vegetables,
- the adoption of quality processes in artisanal activities, or
- the transformation of the artisanal manufacture of panela into industrial.

The development of each of these opportunities, as well as others, requires a combination of actions at various levels: governance, financial resources, research, technology transfer, access to specialized services and infrastructure, etc. The bottlenecks (Table 11) facing expansion of an innovative Salvadorian industry are chiefly:

- the limited national human resources, at professional and technical level, trained in agro-industrial technology and innovation,
- the meagre levels of investment in research in public research centres and higher education institutions,

Table 11. Principal strengths and weakness, opportunities and threats to innovation in the agro-industrial sector

STRENGTHS	WEAKNESSES
• There are private sector institutions well-equipped to support agro-industrial innovation. • FOEX-FONDEPRO provides financial support (part non-reimbursable) for innovation projects. • Innovative activity of a nucleus of companies, mainly large enterprises.	• Lack of an agro-industrial programme to guide efforts. • Confused national STI policies which meet other objectives (legitimate but not STI). • Discontinuity of public programmes to support agricultural and agro-industrial innovation. • Little public priority to investment in R&D and innovation, and weakening of CENTA. • Limited national human resources, at professional and technical level, trained in agro-industrial technology. • Lack of articulation of institutions related to agro-industrial development, chiefly between companies and higher education and research institutions. • Lack of interest and confidence between Salvadorian companies to group together and develop on a joint basis. • Scant access to financial resources for agro-industrial innovation. • Limited adoption and capacity to implement quality regulations and standards.
OPPORTUNITIES	**THREATS**
• The niche market of Salvadorians resident in the United States. • Large number of institutions, chiefly in the public sector, which have defined specializations and capacities to support companies which seek to innovate. • Broad recognition of the key role of agro-industrial development. • El Salvador's biodiversity offers important inputs for natural cosmetics, natural medicines and effective food supplements. • Project for the establishment of a national development bank. • Programmes to support the development of suppliers.	• International and regional competition. • Policies (of El Salvador and other countries) which affect the supply of certain important inputs. • Policies which prioritize expenditure in agricultural inputs instead of investment in infrastructure, innovation and development of markets. • Weaknesses of Salvadorian agriculture (system of tenure and land market, land constraints, lack of associative activity, irrigation infrastructure, greenhouses, collection centres). • Risk aversion and limited interest in investment in innovation. • Appropriation of Salvadorian biodiversity by foreign companies.

Source: UNCTAD.

- the lack of collaboration between companies and/or research and/or educational institutions,
- an inadequate supply of technological and scientific services, including a limited supply of scientific and technological consultancy services, as well as a shortage of technicians who, for example, can repair and maintain machinery,
- an inadequate quality infrastructure to support innovation,
- weaknesses in entrepreneurial collaboration under some headings between producers and processors or between companies in the same industry, and generally between companies in different industries,
- limitations in the agricultural sector which affect agro-industrial development, including, among other things, scarce agricultural investment and structural limitations.

Recommendations

The development of a national agro-industry centred on the generation of high value niche products requires technological, scientific and innovation capacities. For the continuous development of such capacities, it is essential to have an integrated system of innovation capable of articulating an agro-industrial strategy around a common vision, identifying needs, and establishing priorities and commitments.

Bearing in mind the links between agro-industry and the agricultural sector, an agro-industrial system cannot be conceived separately from the agricultural system. For this reason, we will speak of a system of agricultural and agro-industrial innovation. This does not mean that the specific concerns of agro-industrial development must be watered down, and for that reason, it is proposed to create a working group on the promotion of agro-industrial development, comprising representatives of the Ministries of Agriculture and Livestock, Economy and Education, as well as of the private sector, higher education institutes and support organizations, including international cooperation. This working group would promote the establishment of a national programme for agro-industrial innovation to orientate the development of the sector in the long term, identifying goals, actions, budgets and responsibilities. It will be necessary to carry out a prospective study to identify two or three subsectors with the greatest economic and social potential in the medium term, in order to focus public efforts on these areas.

Innovative activity is mainly carried out by the private sector, and its capacity to work in association and its interest in innovating is essential. It is equally crucial for the private sector to participate in research activities and the design, implementation and financing of innovation programmes.

For its part, public commitment to agro-industrial development must be reflected in the priority attached to expenditure, in this order, on technology transfer activities, development of infrastructure to support innovation, and agro-industrial research. A greater proportion of the agrarian budget could be allocated to these activities instead of financing of transfer of inputs.

Public efforts must be directed towards those companies which have the capacity to generate the most impact. This requires adapting support instruments so as to incentivize additional investment in innovation by small, medium-sized and large enterprises. This requires the use of a varied set of instruments, including some new ones, such as, for example, tax incentives and/or provision of technological intelligence services, and revision of existing ones so that, for example, they encourage greater levels of investment in innovation by larger companies. The design of effective instruments requires having a good information system which, among other things, indicates the principal factors which hold back innovation, a precise idea of the specific objective that it is sought to achieve, and an evaluation of the impact of the instruments already in use.

Based on these considerations and the analysis, it is recommended to:

1) Develop a national programme for the development of agro-industry, in the framework of a national system of agricultural and agro-industrial innovation

- Establish a working group on the promotion of agro-industrial development, comprising representatives of the Ministries of Agriculture and Livestock, Economy and Education, as well as of the private sector, higher education institutes and support organizations.
- Identify, in collaboration with the private and academic sector and based on criteria of economic and social impact, two or three priority agro-industrial sectors.
- Establish a national programme for the development of agro-industry which identifies a set of priority actions in terms of education, research, innovation and infrastructure. This programme must focus on the identified agro-industrial sectors, establish the respective responsibilities of both public and private actors, and allocate the necessary resources.
- In general, and in collaboration with the different

actors, develop the draft Sectoral Strategic Plan 2010-2014 (MAG) for the configuration of a national system of agricultural and agro-industrial innovation.

2) Strengthen the quality of education and training in the agricultural and agro-industrial sector, in particular, the priority sectors or industries.

- Review education and training needs (students, teachers, extension workers and companies) in agricultural and agro-industrial studies and promote the updating of educational provision in these areas.
- Establish a programme of scholarships for students and teacher training, for postgraduate training in El Salvador and abroad.
- Establish a fund to implement specialist courses on agro-industrial subjects. The funds must facilitate the participation of international experts.
- Strengthen the capacities of the ENA, in general and in the agro-industrial sphere, in particular, providing it with more resources for investment in research facilities, research and technology transfer activities and recruitment of teachers.

3) Support agricultural and agro-industrial research in universities, research centres and companies.

- Increase public financing of agricultural and agro-industrial research.
- Increase the funds available through FOEX-FONDEPRO for innovation, so that they can be used by a greater number of agro-industrial enterprises.
- Establish one or two research fellowships (at postgraduate level) in one or two agro-industries identified as having the most potential and in which at least one higher education institution and one company in the sector collaborate.
- Promote the participation of agro-industrial companies in research activities through their participation in the design of the national programme for agro-industry and encourage participation in the proposed research fellowships.
- In general, strengthen agricultural innovation and research by promoting the participation of producers in research activities, revising CENTA's role in research and the resources allocated to it, and allocating more resources to technology transfer and research activities.

4) Establish a package of measures to promote agro-industrial innovation.

- Establish two or three local technological training and innovation centres, focused on the selected agro-industries. These centres must facilitate technology transfer and research to solve specific production problems. Private sector involvement in these centres will be vital.
- Establish incentives to encourage innovation that meet the needs of large innovative companies, including the development of venture capital, guarantee funds, and tax incentives for investment in innovation activities.
- Support the development of advanced technological services, identifying needs for such services, establishing incentives for the establishment of providers of those services and encouraging cooperation agreements with foreign technological centres which can provide them.
- Continue supporting entrepreneurial activity and establish a set of actions to promote a culture of innovation in the agro-industrial sector.
- Promote the development of agro-industrial infrastructure (processing and packaging plants, cold chain, storage centres) identifying priorities for infrastructure, increasing public funds for investment in priority areas and providing financial incentives for private investment in infrastructure (e.g. financing feasibility studies for the establishment of factories and establishing financial facilities for private investment).
- Increase capacity to adopt good agricultural and manufacturing practice and to comply with sanitary and phytosanitary standards, allocating more resources to training of farmers and producers and development of institutional capacities in this area.
- Continue preparing market studies for agro-industrial products and carry out more specialized studies in the priority agro-industries.
- Facilitate the development of capacities in biosafety and biotechnology.

5) Strengthen monitoring and evaluation of capacities, policies and programmes.

Consistent with the recommendations of a general character for any system of innovation, it is recommended:

- Through a prospective study, identify the niches with the greatest added value and potential, and those on which public efforts should be focused.
- Monitor, evaluate and publish in a systematic manner the impact of policies and programmes to support the sector, and the impact of different economic, agricultural, health and environmental policies on agro-industry.

NOTES

[1] See, for example, the exhaustive study by Arritt (2006) in the quality system in the agro-industrial sector. Many of the problems described were also mentioned during the interviews conducted.

[2] See, for example, Falck-Zepeda et al. (2009) or Solleiro et al. (undated).

[3] The analysis in this section is based on information provided by the Sugar Association of El Salvador and the exchange of information with experts of that association.

[4] According to calculations by FAO (see http://faostat.fao.org/), yields from sugar cane (in metric tonnes) per harvested hectare were 78.5 (2008) and 91.9 (2009) in El Salvador, while the average yield worldwide was 71.4 and 69.6 respectively.

[5] Data provided by the Sugar Association of El Salvador.

[6] A local candy.

[7] According to United Nations COMTRADE database.

[8] See study of the fisheries sector in Latin-American countries: El Salvador.

[9] Nixtamalized maize is maize cooked in water with lime. Nixtamalization facilitates, among other things, the making of tortillas and control of microbe activity.

[10] Information based on BMI (2006) and information provided by managers of dairy processing plants.

[11] See www.aves.com.sv.

[12] Information on personal communication with Mr Javier Francés.

[13] Information based on data of the Superintendency of the Financial System (www.ssf.gov.sv).

[14] See FAO country profile at www.fao.org/fishery/countrysector/FI-CP_SV/es.

[15] Decree 43 (June 2009).

[16] See Government of El Salvador (2011).

[17] The programme is centred on the following areas: added value and market intelligence, new technologies, agricultural computerization, bioenergy, strategic alliances with international research and innovation organizations and inter-institutional coordination between the Agricultural Promotion Bank and CENTA's agricultural extension service.

[18] See the proposed Act on access to genetic resources and participation in the profits: a bill agreed for El Salvador prepared by FUNDE (Aguiñada Arévalo, 2009).

V

Information and communication technologies

Information and communication technologies (ICT) have become a crucial tool for business performance by allowing better communications, advanced information processing and interaction at a distance between entrepreneurs, suppliers, consumers, public agencies, etc. In other words, ICT allow productive improvements in the performance of enterprises. Thus, the value of a national ICT sector lies not only in its contribution to the public sector but, more importantly, in the value that it can add to other productive activities carried on in the country.

At the request of the Government of El Salvador, what follows is an examination of the ICT innovation system, with the aim of making recommendations designed to strengthen innovation in this sector. The ICT sector is defined as those industries whose products (goods and services) are intended to fulfil or enable the function of information processing and communication by electronic means, including transmission and display. This sector includes the ICT manufacturing industries, ICT services industries (ICT publications, telecommunications, information technology and computer services, websites and data processing, and repair of computers and communications equipment) and commercial ICT industries (wholesale of computers and electronic equipment)[1].

A. THE GLOBAL CONTEXT OF THE ICT SECTOR

ICT have increasingly penetrated all spheres of society. Despite contracting by 3 per cent in 2009 as a consequence of the economic recession, the ICT sector returned to global growth and it is estimated that in 2010, the global market totalled 3.7 billion dollars (WITSA, 2011). In other words, expenditure on ICT was the equivalent of 6.2 per cent on global GDP. The ICT market is dominated by the communications subsector (58 per cent), followed by the computer services subsector (20 per cent). The hardware and software subsectors account for 13 per cent and 9 per cent of the sector respectively (WITSA 2011).

Software services and computer services are the segments of the ICT sector which have shown the most growth in the last few years and which offer the best entry opportunities for developing countries. Although software production is concentrated in developed countries, there are some developing countries which have achieved significant penetration in international markets. India has been one of the most successful cases in terms of quantity. It is estimated that income from the software and computer services sector in India reached 63,700 million dollars in 2010 (of which 77 per cent is exports mainly to the United States and the United Kingdom) rising from 1.2 per cent of GDP in 1998 to an estimated 6.1 per cent in 2010. This industry generates some two million direct jobs in the country[2].

The expansion of ICT has also been reflected in the significant increase in the percentage of the workforce which can be characterized as information workers, i.e. workers whose primary occupation is information processing[3] in various countries in recent decades (Table 1). Participation has increased dramatically in all the countries of Latin America, but is still far behind that of the developed countries (the average for Europe and North America is 50 per cent) and the Asian countries (average 31 per cent) (Katz, 2009). In El Salvador, there has been considerable progress and, by 2006, it was estimated that a quarter of the workforce were information workers.

In turn, in recent years, and in close association with the spread of ICT, there has been an expansion of a series of activities which are known generically as "information technology (IT) enabled services", which provide a variety of services at a distance which previously required geographical proximity (accountancy, human resources management, procurement management, computer maintenance, etc.). The number of transnational companies which establish or contract offshore centres to provide these services increases day by day, basically to try and reduce costs but also to access human resources and diversify the geographical base of their operations. Just as in software and computer services, some developing countries, especially China and India, have positioned themselves as attractive locations for the provision of these services.

These activities form part of the "new knowledge economy" and share common characteristics: i) all have export growth rates higher than sectors of the "old economy", ii) they tend to pay higher wages and generate more employment, with high skill levels, than the economy on average; iii) by basing their development on the capacity for innovation and training, they generate "side-effects" which benefit the rest of the economy; iv) productivity increases rapidly and there are opportunities for "late" entry (as shown by the experience of some of the countries

Table 1. Percentage of the workforce considered as information workers[1] in Latin America

	1960s decade		2000s decade	
	Percentage	Year	Percentage	Year
Argentina	21	1960	29	2006
Brazil	12	1960	26	2004
Chile	15	1960	31	2005
Colombia	14	1975	27	2000
Ecuador	7	1962	25	2006
El Salvador	**6**	**1961**	**26**	**2006**
Guatemala	6	1964	...	...
Mexico	11	1960	25	2006
Panama	14	1960	28	2006
Peru	9	1961	23	2001
Uruguay	21	1963	33	2006
Venezuela (Bolivarian Republic of)	14	1961	21	2002
Average	**12**	**...**	**27**	**...**

[1]Katz considers as information workers all those who work in sectors 1, 2 and 3 of the ILO International Standard Classification of Occupations (ISCO which includes professionals, technicians; legislators, senior officials and managers; and office clerks.

Source: Katz (2009.

mentioned above) as they are sectors which have not yet reached maturity from a technological point of view (ECLAC, 2008). From the perspective of developing countries, they are activities which can contribute to a development and international insertion strategy which is not exclusively based on the relative abundance of natural resources or low cost labour.

Three types of IT-enabled services can be distinguished:

- *front office* services (call centres and customer service centres),
- *back office* services (data capture, human resources, payroll, finance and accounting, purchasing, transcription), and
- outsourcing of knowledge-intensive activities (financial analysis, data mining, engineering, research and development, insurance processing, architectural design, distance learning and publishing services, medical diagnoses, journalism).[4]

The skills required by the different types of service vary from basic training (data capture and some call centres), sometimes supplemented by knowledge of English, to high levels of knowledge (design, medical diagnosis, financial analysis, R&D). Likewise, international markets for outsourcing of these services are at different stages of maturity. The most established market is international outsourcing of computer services. Customer services, finance, infrastructure management, human resources and knowledge services are expanding. However legal and procurement services are still at an embryonic stage (UNCTAD 2009).

B. DIAGNOSTIC OF THE SYSTEM OF INNOVATION IN THE ICT SECTOR

1. Production and execution function – executing system

1.1. Infrastructure

The telecommunication sector has attracted 917 million dollars for foreign investment into El Salvador in the last two decades. The liberalization of the telecommunications market and the privatization of the system in 1998 were an important factor in attracting foreign investment and the development of the sector.

The number of fixed telephone lines has tripled in a decade, rising to 1.1 million lines in 2010 (SIGET). The high growth levels seen following the liberalization of the sector have eased off and currently growth levels are fluctuating between zero and seven per cent annually[5]. The fixed telephony market still has a dominant operator (CTE) with 90 per cent of the market (UNCTAD 2010c).

The mobile telephone market, on the other hand, is more dynamic and competitive. The three main operators (Tigo, Claro and Telefónica Móvil) share some 30 per cent of the market. The development of mobile telephones has been dramatic. There are currently 122 subscriptions per 100 inhabitants, 90 per cent of which are prepaid. The high number of subscriptions can be explained in part because consumers often use two or more mobile telephone services to take advantage, among other things, from differences in the costs of calls of different operators and coverage. In addition, the country has 11 carriers which provide international telephone services and have allowed the expansion of international calls at cheaper rates[6].

Internet services, especially broadband, have also grown rapidly. At the end of 2009, Internet subscriptions had been almost entirely replaced by broadband subscriptions, reaching a total of 146,062 subscriptions (SIGET, 2010). Foreign investment led the expansion of the country's fibre optic network, which almost tripled in only six years, from 2,564 Km in 2003 to 7,163 Km in 2008 (UNCTAD, 2010c). Telefónica was the first company to offer broadband Internet services and currently has a leading position with 90 per cent of the market (UNCTAD, 2010c). In terms of broadband penetration, El Salvador is further ahead than other countries in the region, but still somewhat behind Costa Rica, Panama and other leading countries in the Latin American region (Table 2).

In terms of affordability, installation costs of telephone lines have fallen from 331 dollars in 1998 to 40 dollars in 2010[7]. On the other hand, the monthly subscription and local calls (residential and commercial) for fixed telephones have increased (UNCTAD 2010c).

There are opportunities to improve the affordability of ICT, especially fixed telephones. A comparison of prices [8] at regional level, taking into account purchasing power parity and the level of gross national income (Table 3) shows that the basket of ICT prices is perceptibly lower in Costa Rica and Panama, and also in Guatemala in the case of fixed telephones. The debate on the costs of ICT, in particular, basic line charges for fixed telephones, led the Legislative Assembly of El Salvador to decree, in April 2010, a strengthening of the functions of SIGET to determine and revise the maximum amount of basic telephone charges and reduce the cost of access to fixed telephones to 6.14 dollars per month (excluding VAT) (Official Journal of El Salvador, 2010).

Infrastructure for innovation in ICT

In addition to general ICT infrastructure, which covers access, use and impact of ICT for companies and

Table 2. ICT penetration, selected Latin American countries, 2009 (per 100 inhabitants)

Country	Fixed telephony	Mobile telephone subscriptions	Internet users	Broadband Internet subscriptions
Brazil	21.42	89.79	39.20	7.51
Chile	21.07	96.94	33.98	9.81
Costa Rica	32.60	42.59	34.48	6.01
El Salvador	**17.83**	**122.77**	**14.42**	**2.42**
Guatemala	10.08	123.39	16.25	0.78
Hondurasa	11.12	103.32	9.80	0.00
Mexico	17.72	76.20	25.95	9.05
Nicaragua	4.44	55.80	3.48	0.82
Panama	15.55	164.37	27.79	5.82

[a] *Broadband Internet subscription data (fixed) is for 2008.*
Source: UNCTAD (2010b).

Table 3. Affordability of telecommunications, basket of prices, Central America, 2009

Country	Basket of ICT prices	Sub-basket of fixed telephony as % of GNI per capita	Sub-basket of mobile telephony as % of GNI per capita	Sub-basket of fixed broadband as % of GNI per capita
Costa Rica	0.84	0.80	0.46	1.24
Panama	2.18	2.34	0.96	3.23
El Salvador	4.47	3.96	2.44	7.01
Guatemala	7.39	3.48	3.27	15.42
Nicaragua	19.68	5.26	15.54	38.25

GNI: Gross National Income.

The ICT basket of prices is a compound index calculated as the simple mean of the fixed telephony, mobile telephony and broadband sub-baskets.

Source: ITU 2010.

individuals and, thus, the potential for expansion of the ICT sector, it is important to examine whether there is an adequate infrastructure for innovation in the ICT sector. In this case, we mean the existence of an infrastructure which allows for research, development and innovation in ICT, such as, for example, software testing laboratories, technology parks or incubators of technology-based companies, or an infrastructure which facilitates ICT research.

El Salvador lacks supportive infrastructure for innovation in ICT. There are some university ICT laboratories[9], but these are used primarily for educational activities and do not provide services to the ICT industry. There are no software quality control laboratories. Neither does El Salvador have a consolidated support infrastructure for incubation of technology-based companies. There is no developed provision of seed capital funds, there are no technology parks nor consolidated efforts for the incubation of technology-based companies. Germina is a recent proposal for the incubation of technology-based companies promoted by Francisco Gavidia University, but it still too early to see any results.

In the framework of infrastructure to support research, it should be noted that seven higher education institutions in El Salvador are connected to the Salvadorian Advanced Network of Research, Science and Education (RAICES)[10]. This network provides dedicated Internet connections for the academic community and connects with others in the Latin American region and in Europe. The network allows the conduct of research which requires access to, or processing of, a large volume of information, as can occur with research projects which have a large ICT development component. However, there is no more detailed information on its use and impact.

1.2. Access to and use of ICT

El Salvador has high rates of access to mobile telephony but limited access to fixed lines (17.8) and Internet (14.4), especially broadband (2.4 in subscriptions)(see Table 2).

Salvadorians mainly access the Internet through paying access points (mainly cybercafés) (most frequent place of use for 44 per cent of users) and at home (35 per cent) (Table 5).

At departmental level, there is an important digital divide in terms of household Internet and fixed telephony access (see Table 4) and major efforts are needed to achieve greater fixed telephone and Internet coverage for the country as a whole. For example, in the majority of departments, less than 3 per cent of households have Internet access, while in La Libertad and San Salvador, over 11 per cent of households have Internet access.

On the other hand, mobile telephone penetration is high throughout the country and the variation between departments much less (with a minimum penetration of 74.3). Given the mobile telephone coverage, the development of government electronic services on a mobile platform could be of particular interest.

Internet use is mainly aimed at educational activities and communications (Table 5). The available data do not tell us what percentage of users use the Internet to interact with the public administration, to carry out

banking transactions or to buy goods and services. As recommended by ECLAC[11], it would be interesting if the Multi-Purpose Household Survey reported Internet use in multiple places and multiple activities by each individual surveyed, rather than being restricted to the most frequent place of use and activity.

It is also important to have information on access to and use of ICT by enterprises, especially small and medium-sized enterprises. Like many countries, there has been no official survey in El Salvador of access to and use of ICT in enterprises. The Partnership for Measurement of ICT for Development[12] can advise on and support the collection of information in this sphere.

The only information available on the use of ICT by MSMEs in El Salvador is the survey of over 150 Salvadorian enterprises carried out in 2004 as part of a study of five Central American countries (Monge-González et al., 2005). Seven years have passed since the survey was carried out, during which time great changes have taken place (e.g. the expansion of mobile telephony, the growth in the ICT-based services sector and the development of Web 2.0 (from on-line software services to social networks or social media)[13], but its analysis can provide some relevant indications: larger companies had greater levels of access to ICT and the use of ICT by MSMEs was not very sophisticated. For example, less than a third of Salvadorian MSMEs used computers to carry out administrative functions (accounting, stock management, sales analysis, etc.) and only 5 per cent used ICT for productive processes. The Internet was mainly used as a source of information and as a means of communication. Only 8 per cent of the MSMEs interviewed used the Internet to participate in public tendering and 17 per cent of SMEs used electronic banking. Moreover, the development of electronic commerce was incipient: less than 5 per cent of MSMEs placed orders or paid their suppliers via the Internet or email.

The conduct of another survey of access to, use and impact of ICT in the business sector would provide further insights regarding the development of its access and use. The survey carried out in 2004 provided very interesting information on a wide range of relevant areas. This could be taken as a reference point but should be updated in order to identify the use and impact of the new ICT tools by companies, obtain more details of the main barriers and incentives for the adoption of different ICT tools and the impact

Table 4. Households with Internet, fixed telephone and mobile telephone access in El Salvador, as percentage, 2009

	Households with Internet access	Households with fixed telephone access	Households with mobile telephone access
Total Country	**6.4**	**34.2**	**80.6**
Total Urban	**9.5**	**45.6**	**83.6**
Total Rural	**0.5**	**11.8**	**74.8**
Ahuachapan	1.5	17.3	75.0
Cuscatlán	1.7	21.6	76.4
Sonsonate	2.3	21.8	75.3
La Paz	1.1	22.5	74.3
Morazán	2.2	23.0	74.6
Cabañas	1.6	23.4	77.1
Usulután	2.0	24.2	76.8
La Unión	2.1	24.7	78.7
San Vicente	2.6	26.7	75.0
Santa Ana	5.2	29.2	83.5
Chalatenango	3.3	32.2	78.0
San Miguel	6.4	33.5	78.9
La Libertad	11.6	37.2	83.5
San Salvador	11.1	50.4	85.5

Source: UNCTAD, based on DIGESTYC (2010).

Table 5. Internet users by place of use and type of activity (percentage of total users aged over 10 years), 2009

Place of use		Most frequent type of activity	
At home	34.9	Buying or ordering goods and services	0.3
At work	9.7	Communication	17.8
In educational establishment	9.4	Electronic banking	0.6
Places with paying access (cybercafé, infocentres)	44.0	Formal education and training activities	67.3
		Interaction with government organization or public authorities	0.3
		Other	13.8

Source: UNCTAD, based on the Multi-Purpose Household Survey, 2009 (DIGESTYC, 2010).

of public policies and programmes on the adoption of these tools.

1.3. Enterprises

At present, there are no reliable data on the ICT industry in El Salvador. The last economic census, carried out in 2005 (DIGESTYC 2005), indicates that the share of this sector in GDP was around 7 per cent, and that 95 per cent of that contribution came from the telecommunications sector.

In that year, there were 1,077 enterprises in the ICT sector[14], chiefly in the area of telecommunications services (829 enterprises) and computer services (221 enterprises). In that year, over 8,200 persons were employed in the sector. Total sales reached 923 million dollars, of which 95 per cent were telecommunications services. Computer service accounted for 38 million dollars. It should be borne in mind that various major industries in the ICT sector (e.g. sales of computers or data processing services) did not report in the economic census in 2005.

During the conversations which took place, industry representatives, entrepreneurs and the relevant academic institutions indicated that the ICT sector in El Salvador is composed of 5 large hardware and software companies, each with a turnover of between 10 and 25 million dollars, and another group consisting of 75-100 companies. A high percentage of software companies are software licensing companies and less than one third sell services.

The opinions gathered indicated that there is no significant research and development among companies in the sector, and that there is a predominance of generic software and, therefore, less added value.

Among the most widespread services are adaptation of enterprise resource planning software (ERP) and software programming for other companies, generally in the most common languages (e.g. Java). Demand for software in the country is led by the banking sector, but this sector tends to buy abroad.

Software developers find it hard to survive, and those companies that do manage to grow do so thanks to a regional strategy. According to a study carried out by Exporta[15], a high percentage of the 44 companies interviewed had had experience of exporting their services, mainly in the Central American area, the United States and the Caribbean. However, international trade data show limited reach of Salvadorian ICT exports, and a level of imports somewhat lower than other countries in the region (see Figure 1).

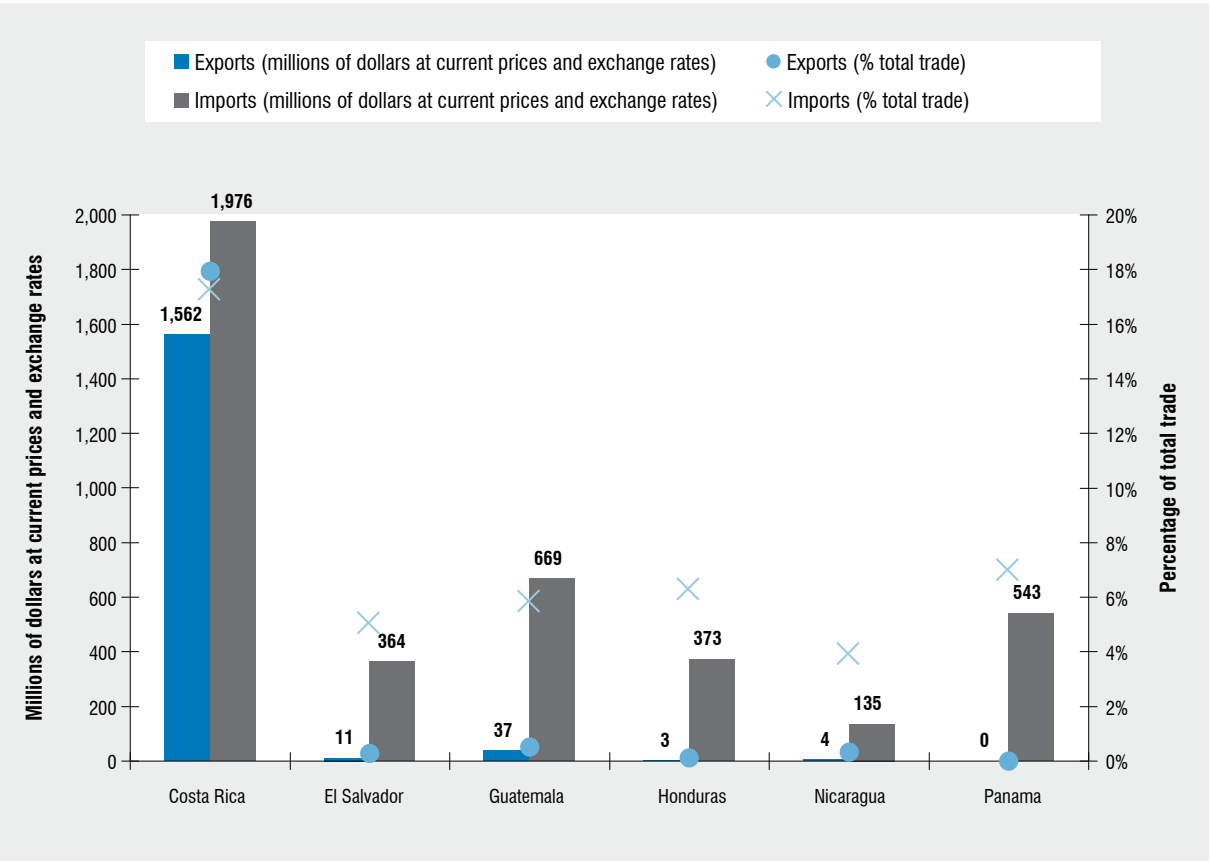
The international certification of software companies is an important factor for their development and international expansion. No specific data is available on the number and level of certification of Salvadorian companies. Although there was an initiative to certify national companies (see Exsource group in Box 2), the enterprises are still not certified.

In El Salvador, apart from Exsource group, there are two ICT industry associations:

(1) the Salvadorian Chamber of Information and Communication Technologies (CASATIC), which represents the ICT manufacturing and marketing sector. CASATIC was established in December 2010 by some twenty-five companies.

(2) the Salvadorian Association of Computer Professionals (ASPROC) which represents information technology professionals.

Figure 1. Importance of ICT in international trade, countries of Central America, 2009



Source: UNCTAD, based on Globstat data.

IT-enabled services

Since 2004, El Salvador has experienced considerable growth in the market for outsourced services, especially call centres. A considerable number of foreign companies have established themselves in the country to set up call centres. At present, El Salvador has 40 call centres, of which 20 work exclusively for customers abroad, and have generated 9000 jobs (Frost & Sullivan, 2011). El Salvador offers proximity to the United States and competitive wages in comparison with other Latin American countries. The principal market in this sector is the United States (85-90 per cent of the market) and knowledge of English in this sector is in great demand (Frost & Sullivan, 2011). The development of this sector was promoted by the International Services Act, 2007 (see Box 3) and forms part of the integral export promotion strategy. This strategy seeks to encourage the migration of current supply to other more complex services.

The commercial data show that the wider range of IT-enabled services still plays a small role in El Salvador, both in absolute terms and in comparison with other countries in the region (Table 6) and in relative terms with regard to trade in services in El Salvador (Table 7). Furthermore, these services have been growing slowly since 2000.

Table 6. Export of IT-enabled services in Latin America (millions of dollars), 2008

Argentina	Brazil	Costa Rica	El Salvador	Guatemala	Honduras	Mexico	Nicaragua	Panama
5,405	17,603	1,407	206	409	230	2,873	36	1,249

Source: UNCTAD, based on UNCTADstat data.

Table 7. Trade in IT-enabled services (millions of dollars at current prices), El Salvador, 2000-2008

	Imports				Exports			
	2000	2005	2008	Annual growth (%) 2000-08*	2000	2005	2008	Annual growth (%) 2000-08*
IT-enabled services	**333**	**313**	**386**	**2%**	**194**	**186**	**206**	**1%**
IT-enabled services as % of total services	*36%*	*26%*	*19%*	...	*28%*	*16%*	*14%*	...
Communications services	27	25	45	6%	86	123	154	7%
Insurance services	113	102	189	7%	63	32	30	-9%
Financial services	38	13	12	-14%	7	7	1	-18%
Computer and information services	14	3	5	-12%	4	..	1	-16%
Royalties and licence fees	21	30	34	6%	2	2	1	-7%
Other business services	119	138	100	-2%	31	21	19	-6%
Personal, cultural and leisure services	1	2	1	0%	1	...	...	.. ...

** Annual compound growth rate.*
Source: UNCTAD, based on UNCTADstat data.

The content and information media sector

The availability of relevant up-to-date and dynamic content, in Spanish, is an incentive to use ICT. The promotion of national content industries, especially those for education and training, information services for businesses and investors, or content with marketing potential (i.e. content for mobile phones) complements the development of the ICT industry. In 2008, 83 companies had been identified in the creative industries, chiefly in graphic design, architecture, animation and digital imagery. These industries generated 2,000 jobs, 70 per cent of which were concentrated in 11 companies.

Box 1 highlights a series of interesting initiatives which are taking place in the country. In the software industry is the Exsource group, a group of companies dedicated to the development of software applications. In addition, recent years have seen a proliferation of various initiatives in the area of digital animation, including short films for television, animation for video games and videogames for web platforms and, to a lesser extent, for mobile platforms. There are also groups of Salvadorians who are getting involved in the development of mobile phone applications, an embryonic sector which, not being consolidated at global level, offers entry opportunities. The Government of El Salvador is supporting initiatives in the area of mobile phone application and digital animation through the Inventa platform and the PIXELS programme (see section B.3).

1.4. Financing through the market

In El Salvador, there are no specific mechanisms for private financing of R&D in ICT, such as seed capital, business angels or venture capital. It should be noted that software development companies are faced with additional difficulties in obtaining financing due to their lack of sufficient physical assets, the risk inherent in an activity based on innovation and the reluctance of the financial system to get involved in this type of business.

FirstTuesday, a meeting place for businessmen, investors and entrepreneurs of innovative businesses is a recent initiative and a step in the right direction in identifying financing needs and bringing investors and entrepreneurs together.

1.5. Bodies which disseminate knowledge

The principal input in the software sector is knowledge. In El Salvador, a large number of universities and higher education institutions provide education in computer technologies. Annex G is a summary of current educational provision.

El Salvador has a considerable number of students in areas related to information technology at degree or technical level (see Table 8). However, the number of university students who ultimately graduate is considerably lower. To encourage a larger percentage of graduates, it will be important to understand the

Box 1. Examples of Salvadorian potential in ICT and ICT-based services

Software development

Exsource group is an affiliated group of companies dedicated to research and development of software applications established in 2003 in the framework of a programme for the development of clusters. Its start-up was made possible thanks to financial support of 400,000 dollars provided by the Government of El Salvador, the Inter-American Development Bank and private companies. Its objectives include promotion of quality in the sector through CMMI certification of the 17 affiliated companies. It currently has a software factory constituted by five companies which generates 30 direct jobs and has an annual turnover of more than 200,000 dollars.

Mobile phone applications

Mindblock is the first Salvadorian company to devote itself mainly to the development of video games. It was formed towards the end of 2010, bringing together talents from various disciplines. On 14 February 2011, they launched their first formal product on the market, under the name "Pest Fest", which is available for iPhones, iPods and iPads in iTunes, and the download costs 0.99 dollars. The three partners in the company met thanks to the Pixels programme. This programme also allowed them to publicize their skills and products.

Digital animation

Virtual Grafix Animation Studios, established in 2000, is a company which specializes in 3D animation, architectural visualization, multimedia projects (production of CDs and DVDs), television commercials, audiovisuals and graphics, and has successfully exported its services to the United States, Panama, Guatemala and Honduras.

Happy Punk Panda Studios is a company with five years' experience dedicated to digital animation and the development of digital advertising campaigns.

The animation industry requires the involvement of publishers, producers, illustrators, animators and scriptwriters. At present, there is a need to improve the teamwork with specialists in these different areas in order to be able to offer products of better quality. In addition, the industry demands better trained animators who can carry out more complex tasks, such as, for example, creating pace and acceleration and bringing characters to life.

Given the size of the domestic market, it is important for both companies to obtain support for exports and access to market intelligence. These are areas where public programmes could be very effective.

Source: UNCTAD, based on MINEC (2011), www.virtual-grafix.com, www.pixelsawards.com/, www.mindblockgames.com, http://happypunkpanda.com/

causes of dropping out or falling behind in studies. Measures of various kinds, student support or adaptation of education programmes could improve the graduation rate.

The number of postgraduate students of computer studies, information technologies or systems is very small, and there are no doctorates in this area. Various people mentioned the need for more specialized postgraduate courses which could meet the expectations for the development of an innovative local industry. There exist academic institutions interested in providing these courses, but without a greater availability of scholarships for students, the demand is insufficient.

Several experts consulted also mentioned the need to have a greater supply of computer and systems technicians. The student population in technical studies related to information technologies is small (5,824) compared with university level students (12,936). However, given the low rate of graduation of university students in these areas, the number of graduating technical students has been higher than university graduates in the last two years.

INSAFORP also offers training courses in computer techniques. In 2009, this institution (see Chapter 2) trained over 800 people in this area. INSAFORP's training work could be amplified, both in number (currently it only represents 2.8 per cent of the total number of people trained by the institution) and the type of courses offered, offering more specialized or advanced ICT courses.

Several experts pointed out that the educational provision does not adequately meet demand in the sector. On the one hand, there is an underlying demand for people with technical level training as well as specialized training. On the other, university students are trained in a wide range of subjects to give them more opportunities for finding work and there is a lack of more specialized education. The experts consulted indicated various areas (for

Table 8. Training in information technologies in El Salvador

	Student population					Graduates				
	2005	2006	2007	2008	2009	2005	2006	2007	2008	2009
Master of computer studies	15	20	8	4	-	-	-	12	-	-
Master of systems	-	-	-	-	22	-	-	-	-	4
Master of communication technologies	-	-	5	9	7	-	-	-	-	7
Subtotal: postgraduates	**15**	**20**	**13**	**13**	**29**	**-**	**-**	**12**	**-**	**11**
Computer engineer	7,206	2,818	2,180	2,213	3,910	331	104	147	162	296
Systems engineer	-	4,403	5,633	5,984	4,284	-	215	246	296	224
Telecommunications engineer	300	316	341	389	416	-	3	3	17	29
Degree in computer studies	5,022	3,662	3,440	3,755	3,514	207	204	532	431	395
Degree in systems	-	917	911	879	812	-	35	74	59	65
Subtotal: graduates	**12,528**	**12,116**	**12,505**	**13,220**	**12,936**	**538**	**561**	**1,002**	**965**	**1,009**
Computer technician	2,167	1,987	2,018	2,984	3,295	418	397	517	749	836
Electronic communication technician	62	58	71	-	-	11	16	13	-	-
Systems technician	1,688	2,202	2,597	2,632	2,371	290	364	456	787	664
Telecommunications technician	-	-	8	113	158	-	-	-	23	33
Subtotal: Technicians	**3,917**	**4,247**	**4,694**	**5,729**	**5,824**	**719**	**777**	**986**	**1,559**	**1,533**

Source: UNCTAD, based on MINED data (2010).

example, software development for mobile phones) with potential and which require specialized training. In general, these educational programmes seem to be updated on a reactive basis.

In El Salvador, various institutions offer certificates in information technology. The wide number of possible certificates, from supplier certificates (e.g. Microsoft or CISCO) to internationally recognized third party certificates (e.g. CMMI at its five levels), as well as their cost, makes choosing them difficult for both students and the institutions that offer them. A continuous dialogue between the private sector and educational institutions could be used to design and offer training and certification programmes which meet industry demands.

1.6. Bodies which generate knowledge

In El Salvador there are a limited number of organizations which carry out R&D in the area of ICT. There are no statistics in this respect, but the information gathered suggests scant investment in R&D both in the productive sector and the educational sector. On the one hand, bearing in mind the type of activities carried out by companies in the sector and their size, investment in R&D by the private sector cannot be very high either. As shown in Section B.1.5, software development companies in the country are few. On the other hand, in 2009, higher education institutions allocated 4.6 million dollars to the exact and natural sciences in total (which include information and computer sciences) and 1.6 million dollars to R&D in engineering and technology which include, among other things, computer engineering (Table 9). In the educational sector, some R&D activities are carried on, although many of them are student dissertations. The bibliometric study expressly carried out for this review (see Annex F) did not identify any relevant publication in these areas.

Neither does the number of ICT researchers appear to be very high. In 2009, there were a total of 27 researchers in the exact and natural sciences in total (which include information and computer sciences) and four in engineering and technology which include, among other things, computer engineering (Table 9).

It should be noted that not all software development activities can be considered as R&D activities. According to the Frascati Manual, (OECD 2002, pp.46 and 47), for a software development project to be

Table 9. R&D expenditure and personnel in exact and natural sciences and in engineering and technology, 2009

		Expenditure on R&D (dollars)	Researchers	Teacher-researchers
Exact and natural sciences	Mathematics, information and computer sciences, physical sciences, chemical sciences, earth sciences, biological sciences	4,648,730	27	15
Engineering and technology	Civil engineering, electrical engineering, electronic engineering, information engineering, mechanical engineering, materials engineering, medical engineering, environmental engineering, environmental biotechnology, industrial biotechnology, nanotechnology, other engineering and technology	1,601,620	4	88

Source: UNCTAD, based on CONACYT data (2010).

classified as R&D, its completion must be dependent on a scientific and/or technological advance, and the aim of the project must be the systematic resolution of a scientific and/or technological uncertainty. Software-related activities of a routine nature, such as business application software and information system development using known methods and existing software tools, are not to be included in R&D. (OCDE 2002).

Among the principal educational institutions which undertake research in this field, special mention should be made of ITCA and Don Bosco University. ITCA promotes applied research projects. In 2009, it carried out six research multi-disciplinary research projects, including a software development project that applied artificial intelligence technology. In addition, as a result of research projects in earlier years, ITCA-FEPADE has obtained copyright registration for four computer programmes (ITCA-FEPADE, 2010). The school has three laboratories in the information technology area: hardware design, electric machines and PLC[16], and network design. These laboratories were built with the help of international cooperation.

The research projects carried out by Don Bosco University include:

- Development and implementation of supercomputer models,
- Development of fourth generation technologies in mobile applications, and
- Development of a didactic computer for teaching basic programming.

This University has several ICT-related laboratories, including a computer laboratory and an electronics laboratory.

2. Cohesion and prospection functions – policy system

In the last fifteen years, various processes and strategies have been established to promote the development of the information society in El Salvador (see Figure 2). The principal initiatives were:

- The reform of the telecommunications sector in 1996 which brought about the development of the sector (see section B 1.1. above).
- The "Connecting to El Salvador's Future" initiative in 1999, which stimulated the development of infocentres in the country.
- A draft National Information Technology Policy prepared by the National Information Technology Committee and endorsed by CONACYT, but which was not approved at government level.
- The establishment of a National Commission for the Information Society, comprising participants from the public and private sector, academia and civil society.
- The "eCountry Programme" launched by the President of the Republic of El Salvador in 2005. This integral programme unites the various ICT initiatives and incorporates new ones.
- The National eCountry Programme Strategy 2007-2021, drawn up by the National Commission for the Information Society in 2006. It identifies five strategic lines (infrastructure, electronic government, development of the knowledge society and human resources in ICT, the ICT industry and electronic commerce, and the legal and institutional framework).
- The establishment of the Technology and Computer Innovation Unit of the Government of El Salvador

(ITIGES), under the Private Secretariat of the Presidency in 2009.

- The Integral Export Promotion Strategy 2010-2014, and the strategic planning bases 2010-2014, which focuses on export and investment development in the IT sector, business processes based on ICT and the creative industry.

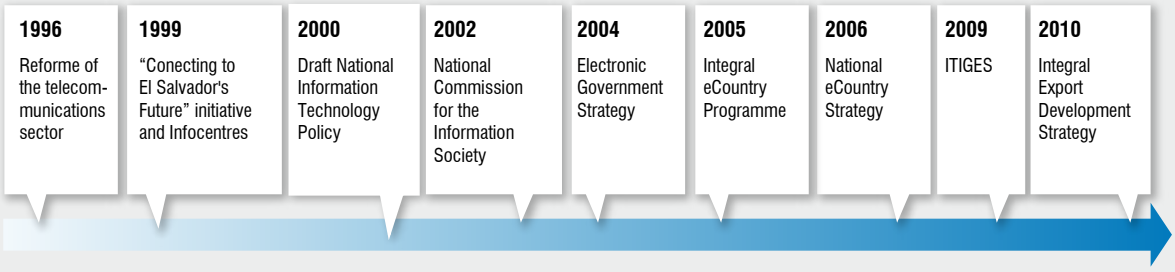
The eCountry Programme includes a strategic line on the ICT industry and its collaboration with the rest of the productive sector. It should be noted that in practice the eCountry Programme is not being used as a reference framework.

Various government bodies have been responsible for the design of these plans and programmes (and even the implementation of activities) in the ICT area (see Figure 3), but no entity has been assigned responsibility for the governance of the information society which, among other things, is concerned with the vision of the future and the determination of integral strategies, and which lays down policies that can bring cohesion to the system.

It should be emphasized that no evaluation or monitoring has taken place of the achievements at national level in the development of the information society which would allow the necessary adjustments to be made. Neither have there been any technological foresight studies which allow priorities to be set for the development of ICT infrastructure.

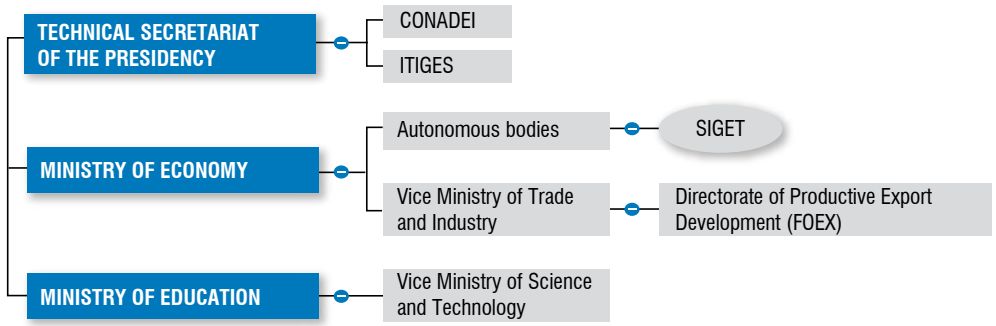
As regards innovation policies in the ICT sector, El Salvador does not have a specific policy in this area, but public policies on support for science, technology and innovation[17] include the ICT sector as one of the priority sectors. However, as mentioned in Chapter III, in general, these plans are very broad and ambitious for the available resources.

Figure 2. Initiatives of the Government of El Salvador to create an information and knowledge society



Source: UNCTAD, based on the National eCountry Programme Strategy (CNSI 2006) and ITIGES (2010).

Figure 3. The principal government bodies involved in the system of ICT policies



Source: UNCTAD.

3. Management, control and regulatory functions – links between the policy system policies and the executing system

In El Salvador, there are various public institutions responsible for the implementation of programmes and projects in the ICT area (see Figure 4). The principal institutions and programmes are described in detail below, based on the five strategic lines identified in the eCountry Programme: infrastructure, electronic government, human resources in ICT, ICT industry and regulatory framework.

Infrastructure

In the telecommunications sphere, the main institutional reference is the General Superintendency of Electricity and Telecommunications (SIGET), the regulatory body for the sector. However, there is no institution responsible for laying down telecommunications policy like the telecommunications boards that exist in other countries.

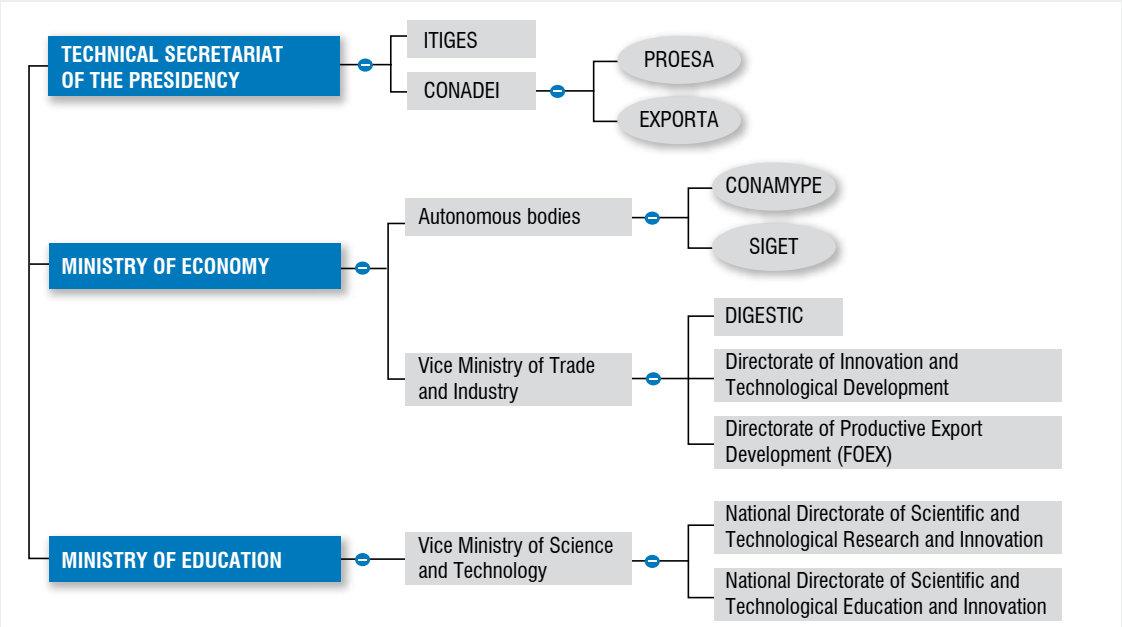
Electronic government

In the sphere of electronic government, the Technology and Computer Innovation Unit of the Government of El Salvador (ITIGES), under the Private Secretariat of the Presidency, is responsible for the development of electronic government. Its work strategy is focused on the development of electronic government in the strict sense, and does not include responsibilities for the development of the ICT infrastructure, regulatory framework, development of an ICT industry or the use of ICT by the business sector[18].

The work programme has focused on the standardization of ministry gateways[19] and a programme of e-regulations which provides on-line information on all procedures involved in doing business in El Salvador. Special mention should be made of the on-line tax declaration services, developed by the Ministry of Finance, and the interrelation with the bank to make payments in real time.

Other government institutions have developed electronic procedures on their own account (e.g. the Social Housing Fund and the National Records Centre), but the number of institutions which allow transactions with the public administration is still limited, and there is no interface between the different institutions[20].

Figure 4. The principal government bodies involved in the ICT management, control and regulation systems



Source: UNCTAD.

Through public procurement, for example by contracting software development services, the administration can support the development of the local ICT industry. Several of those involved indicated that at present the role of ICT public procurement as a factor in the development of a local ICT industry is limited. On the one hand, public investment has focused on replacement of hardware. On the other, ITIGES has its own team which develops software applications. Furthermore, some companies in the sector have difficulty in being able to conclude contracts with the public administration and have decided not to offer their services to the public sector.

Education and research in ICT

One of the seven components of the National Scientific and Technological Development Plan proposed by the Vice Ministry of Science and Technology (see Chapter 2) is the development of ICT based on two programmes: (1) development of the knowledge-based society, with projects to strengthen access to and use of ICT, and (2) development of MSMEs in ICT.

Currently, the Vice Ministry of Science and Technology is promoting the use of ICT in the national education system through its ICT access projects in schools, promotion of responsible use of the Internet and promotion of knowledge of programming and application of software among the teaching profession. The annual financing required for these three programmes is one million dollars[21].

As well as public programmes, there is a series of programmes supported by civil society and private sector organizations which support the development of technical capacities in children and adolescents. For example, the Connection to Development Association, through a network of telecentres, offers ICT access services and training in their use for artisans and MSMEs (ECLAC, 2010c). The Ágape Association[22], has a training programme in ICT, English and investment for young people with limited resources.

Through the Higher Education Research Fund (FIES), in its two rounds, three research projects in the area of ICT have been financed (see Table 10) for a total amount of 198,000 dollars, matched by an investment of 66,000 dollars by the higher education institutions.

No public programmes for the development of an infrastructure for innovation in ICT are known (e.g. support for incubation of ICT companies or the development of quality software laboratories). The new National Centre for Scientific Research of El Salvador (CICES) does not include ICT research among its priorities.

Promotion of the ICT industry

The International Services Act, 2007, grants benefits and tax incentives to national and foreign investors in the area of information technologies.

The promotion of ICT, business process outsourcing based on ICT and a related content industry form part of the current plan for export and investment promotion (see Bases of Strategic Planning 2010-2014 of the National Export and Investment Promotion Commission (CONADEI, 2010). In these areas, the strategy identifies the following objectives.

In information technology:
- Specialization and certification of professionals, technicians and companies in the country
- Promotion of software companies or developers and attraction of investment in data processing and outsourcing of IT
- Creation of incentives for the software sector
- Improvements in accounting of software exports.

Business process outsourcing, voice and non-voice services:
- Development of bilingual human capital

Table 10. Projects in the ICT area financed by FIES, 2008 and 2009

IES	Project	Financing (in dollars)		
		FIES	Counterpart	Total
Don Bosco University	Development and implementation of supercomputer models	49,988	16,662	66,650
Francisco Gavidia University	Creation and implementation of an incubator for information and communication technology companies	100,000	33,333	133,333
Catholic University of El Salvador	Voice over IP platform (VoIP) in advanced networks using open code	47,980	15,993	63,973

- Investment Promotion (PROESA)
- Development of local industry (EXPORTA)
- Adaptation of the regularity framework
- Maintenance of the existing industry

In business processes which make intensive use of knowledge – creative industry:
- Financing and entrepreneurship
- Promotion and attraction of investment
- Legal and institutional framework

In addition, the National Scientific and Technological Development Plan proposed by the Vice Ministry of Science and Technology (see Chapter II) also includes a programme of development of MSMEs in the ICT sector. It includes three specific projects:
- Support for the creation and development of enterprises in the ICT sector
- Support for ICT enterprises to bring them under the International Services Act
- Incentives for the use of ICT in distance learning, electronic commerce, multimedia production, telemedicine and others.

These plans do not identify specific objectives for these programmes, nor the financial and human resources to implement them, not do they assign responsibility for their execution and evaluation. There is no budget and/or fund dedicated to the promotion of the ICT industry. Neither has an entity been explicitly designated, with responsibility for promoting the development of the ICT industry and the use of ICT in the country's productive activities.

In addition, the Directorate of Innovation and Technological Development in the Ministry of Economy, through the Pixels programme and the Inventa platform, promotes innovation in this sector chiefly by contributing to the creation of conditions which facilitate entrepreneurial capacity building and through coordination with different bodies and programmes. The Pixels Digital Animation Awards is a digital animation competition organized by the Ministry of Economy. The TIGO Mobile Challenge, a competition sponsored by FUSADES in conjunction with Francisco Gavidia University, held for the first time in 2010, seeks to stimulate the development of applications for mobile devices.

All these proposals and initiatives are highly pertinent and necessary but the current scope and financing of the programmes is insufficient to support the development of an innovative ICT and ICT services sector.

To be able to achieve strategic advances, a wider range of resources will be necessary, including higher levels of public and private investment in R&D in ICT, greater university-company collaboration to link up research activities, generate innovative products, adapt educational provision and develop a range of technological services which meet the needs of the industry, as well as an infrastructure for innovation in ICT. The lack of a forum for effective interaction to discuss needs and possibilities in this area is a major institutional gap. It will also be necessary to coordinate related support policies in the sector, that is, a complete alignment of the respective work agendas to generate synergies and, ultimately, greater impact.

As mentioned above, there is no up-to-date information on the ICT industry and its activities nor on the use of ICT by Salvadorian companies. DIGESTYC collects data on the ICT industry in its economic census, although not all the headings are listed and the last census dates from 2005. DIGESTYC also collects information on the use of ICT by individuals through its household survey, but up to now it has not collected information on the use of ICT by companies. CASATIC, the Salvadorian Chamber of Information and Communication Technologies, has included as part of its work plan[24] the elaboration of a census of ICT companies in El Salvador, in order to be able to undertake a needs assessment. In March 2011, it still did not have the financing to carry out the census.

Regulation

Box 2 provides a summary, albeit not exhaustive, of the regulatory framework in the ICT sphere. The UNCTAD study of the prospects for harmonizing cyberlegislation in Central America and the Caribbean (2010Aa) provides more detailed information on the current state of Salvadorian legislation concerning electronic commerce.

It should be emphasized that, in El Salvador, there is no special legislation governing electronic commerce, but there are various general laws which apply. In legal proceedings, especially with regard to the evidential value of electronic documents, there are not specific rules (UNCTAD, 2010a). In 2000, a preliminary Electronic Commerce Bill based on the UNCITRAL model law was prepared but not approved (Molina Tamacas, 2009). Since then, various bills have been proposed in this sphere. In the regulatory sphere, the main priorities to encourage the development of the

ICT industry are the approval of a law on electronic signatures and a law on data protection.

Several representatives of the private sector also mentioned limitations in El Salvador's regulatory framework in promoting public procurement of software from domestic companies. CASATIC and ASPROC, in their proposal to the Government of El Salvador, advocate adaptation of the law in order to favour the participation of domestic companies which tend to be of smaller size and have greater difficulties in participating in public procurement processes. In particular, they suggest adapting contract periods and urged that in contracting foreign companies, the participation of domestic companies, which could provide support, should be required. The reform of the Public Procurement and Contracts Act (LACAP) approved in May 2011 seeks, among other things, to streamline public contracting and encourage the participation of domestic MSMEs. It provides, for example, that central and local government entities must procure from or contract with domestic micro, small and medium-sized enterprises to the value of at least 12 per cent of the annual budget for procurement and contracting of goods and services, subject to guarantees of quality.

The Legislative Assembly of El Salvador, the principal legislative body of El Salvador, does not have a committee dedicated to matters of science, technology and innovation. The Committee on Culture and Education of the Legislative Assembly marginally deals with aspects of science and technology, and the Committee on Economy and Agriculture analyses, among other things, legislation regulating telephony services.

Box 2. Salvadorian legislation on ICT [1]

Telecommunications

- Telecommunications Act. Legislative Decree No. 142 (1997) and Telecommunications Reform Act. Legislative Decree No. 379 (2010) which approved digital portability.

Electronic transactions and electronic signatures

- Legislative Decree No. 523 (2001). Reform of Legislative Decree Nº 529/1999 on Simplification of Customs (1999).
- Banking Act. Recognizes the legal validity of electronic transactions and the use of electronic signatures.
- Act of Electronic Entries of Value in Account. Recognizes the use of electronic media for electronic transactions.

Consumer protection

- The Consumer Protection Act does not contain specific provisions on electronic commerce, but as the means by which suppliers offer their products and consumers acquire them are not distinguished, the general rules apply to on-line transactions.

Intellectual property (relating to telematic media)

- Decree 604 (1993) Promotion and Protection of Intellectual Property Act.

El Salvador has ratified:

- The WIPO Copyright and Performances and Phonograms Treaties.
- The Universal Copyright Convention.
- The Brussels Convention on relating to the Distribution of Programme-Carrying Signals Transmitted by Satellite
- The Central American Convention for the Protection of Intellectual Property.
- The Dominican Republic - Central America - United States Free Trade Agreement .
- The Agreement on Aspects of Trade-related Intellectual Property Rights.

Electronic government

- Decree No. 79 (2004): Creation of the National Commission for the Information Society. Reforms incorporated by Decree No. 140 (2005)
- Legislative Decree No. 868 (2000). Public Procurement and Contracts Act. Reforms incorporated by Decrees 140 and 203 (2009) and Decree No.725 (2011)
- The Tax Code authorizes tax declarations through electronic communication networks

(cont.)

Box 2. Salvadorian legislation on ICT [1] (cont.)

- The Simplification of Customs Act, establishes the basic legal framework for the adoption of mechanisms for the simplification, facilitation and control of customs transactions through the use of automated information exchange systems.
- The International Services Act, regulates the establishment and functioning of service parks and grants benefits and tax incentives to national and foreign investors, including in the area of information technologies and R&D.

Access to public information

- Act on Access to Public Information, approved by Legislative Decree 534 (2010), guarantees the right of access of all persons to public information.

Principal legal initiatives

- Electronic Communications and Signatures Bill.
- Bill to reform the Criminal Code of El Salvador (to cover computer crime), presented to the Legislative Assembly in July 2010.
- Data Protection Bill.

Source: UNCTAD (2010a) and based on official documents.
(1): Non-exhaustive list.

C. CONCLUSIONS AND RECOMMENDATIONS

The level of development of the local ICT industry is still embryonic and cannot be described as a system of innovation in ICT as such.

The country has strengths and opportunities to develop the ICT sector. There is a wide range of training, both at technical and graduate level, and, to a lesser extent, postgraduate. There are a considerable number of companies established in the country, including international companies and a large number of smaller entrepreneurs and companies. Various bodies, public and private, express interest in promoting the development of ICT and the country has a developed ICT infrastructure which allows such activities.

Nevertheless, it cannot be said that the local ICT industry is a competitive innovative sector at international level. The sector is still small and has difficulty in exporting its services. The level of investment in R&D is meagre, the links between universities and the private sector are limited and there are bottlenecks in training and accreditation and certification of institutions and companies. International and regional competition, given that there are more competitive actors in the Central American region itself, is a major threat to the development of this heterogeneous sector, which is also faced by limited Internet use for government and banking transactions. Support for the sector is limited by the scarcity of available public resources.

The emergence of an innovative ICT sector requires an adequate provision of well qualified human resources, more investment in R&D (both in the educational system and by the private sector), entrepreneurial capacity to develop and market services, and an appropriate regulatory framework to encourage investment in ICT and supply and demand for services in this area. In order to generate more value, given the limited scale of the domestic industry, it will be important to develop specific niche markets where companies can compete at international level.

If it is desired to reverse this situation, what is needed is to reinforce and consolidate the strategic vision of support for the sector. A series of recommendations are presented below.

Recommendations

1) Develop a national strategy for the development of the ICT sector.

- Strengthen the productive aspects of the eCountry Programme, promoting greater concern among all those involved to strengthen the ICT sector, identify a set of priority actions to develop the sector, establishing the responsibilities of the various actors and identifying the necessary resources. These actions must be centred around the five areas listed below.

Table 11. Principal strengths and weaknesses, opportunities and threats of the ICT sector

STRENGTHS	WEAKNESSES
• Ample education and training provision • Ample supply of companies and entrepreneurs in the ICT area • Various bodies (public and private) express interest in promoting ICT. • Developed ICT infrastructure, especially in the main economic centres	• Limited scale and international competiveness of the sector • Limited provision of specialized education, especially at postgraduate level. • Low level of investment in R&D in the sector • Few links between universities and the private sector • Low levels of adoption of international certification, educational accreditation and quality control in the sector. • Important elements of the legal framework not yet established • Limited access to financial resources for ICT (lack of seed and venture capital, limited public funds) • Limited consolidation of a joint strategy for the public, private and academic sectors to develop the sector. • Lack of conviction of the importance and cross-cutting impact of ICT in productive activities
OPPORTUNITIES	**THREATS**
• Support initiatives for innovation: digital animation, mobile phone applications • Opening up of trade: opportunities to increase technological capacity, purchase of capital goods, access to new technologies, incentives for innovation • Electronic government • Foreign investment – International Services Act • Support from international cooperation • Public and private initiatives in support of access to and training in ICT for disadvantaged sectors • International and regional collaboration on ICT	• Regional and international competition. • Scarcity of available public resources. • Limited Internet use to carry out bank transactions and transactions with state organizations and public authorities • Heterogeneous businesses: broad micro and small enterprise sector with low productivity.

Source: UNCTAD.

- Establish a forum for dialogue between the education sector, public bodies and representatives of the private sector which, among other things:
- facilitates the process of identifying areas with the greatest potential
- examines the educational needs of the sector and promotes the updating of educational provision
- identifies opportunities for joint research
- identifies services required by the business sector
- which could be provided by the academic sector.

2) Improve the quality of education and training in the ICT sector.

- Develop a programme of financial support for certification and accreditation of persons, institutions and companies in the ICT sphere.
- Examine educational needs in the sector and promote updating of the educational provision in the area.
- Establish a programme of scholarships for students and training for teachers, for postgraduate training in El Salvador and abroad
- Review the ICT training provided by INSAFORP and adapt it on the basis of a review of the needs of the business sector in the short and medium term.

3) Support ICT research in universities and companies.

- Increase financing of ICT research.
- Require participation of companies in research funds for higher education institutions.
- Establish one or two research fellowships in ICT (at postgraduate level) in areas identified as having the greatest potential, in which at least one academic institution and one company in the sector collaborate.

4) Establish a set of measures to develop greater business sophistication in the sector, where Salvadorian companies can consolidate, carry out larger-scale projects, compete at international level, and provide specialized and added value services.

It is recommended to:

- Strengthen the mechanisms of incubation of technology-based companies.

- Strengthen the supply of services and capacities in competitive intelligence in the ICT sector.
- Foster the development of other sources of financing for the sector (development of venture capital, guarantee funds, fiscal measures).
- Promote entrepreneurial development of other ICT-related sectors which complement the development of technology-based companies, especially the content industry .
- Develop the programme to promote foreign direct investment in the sector, with priority to investment in areas with the greatest potential and added value, or which complement them.
- Consolidate initiatives to support innovation in ICT undertaken by the Ministry of Economy, providing them with more resources and promoting their outsourcing.
- Establish a set of actions to promote the adoption of ICT by SMEs.
- Encourage further development of electronic government services, especially those which are most relevant to companies and/or based on mobile platforms, and facilitate the participation of domestic companies in public procurement related to the their development and that of other ICT services.

5) Collect information on innovation activities and areas of greatest potential in this sector, carry out a prospective survey of the ICT sector and strengthen monitoring and evaluation of capacities, policies and programmes.

Consistent with the recommendations of a general character for the whole system of innovation, it is recommended:

- To support the conduct of a national survey of innovation which specifically includes the ICT sector, in order to identify current capacities, incentives and barriers to innovation and potential.
- Also, ensure that the proposed national prospective technological study identifies niches with the greatest added value and potential in the ICT sector and on which public efforts should concentrate.
- Systematically monitor, evaluate and publish the impact of policies and support programmes in the sector.
- Monitor access to and use of ICT in small and medium-sized companies.

6) Complete the current regulatory framework in order to stimulate the use of ICT and confidence in the sector and drive its development:

- Facilitate the adoption of the bills on electronic signatures and transactions and on data protection.
- Review possible obstacles in the regulatory framework in order to strengthen the impact of public procurement on the development of the domestic ICT industry.
- Raise awareness among the principal actors, especially members of the Legislative Assembly, on the regulatory aspects of ICT.
- In the medium term, consideration must be given to updating the regulatory framework to take account of mobile telephony.

This set of recommendations needs to be fleshed out on the basis of a broad consensus and commitment of all those concerned. It is therefore proposed, as a first step, the establishment of a forum for dialogue between the education sector (including higher education institutions and INSAFORP), the private sector (including Exsource group, CASATIC and ASPROC) and public bodies (including ITIGES, the Ministry of Economy, the Ministry of Education and SIGET). This forum must, first of all, identify the specific areas of the ICT sector with the greatest potential and on which efforts are to be centred. As far as possible, the identification of these priority areas must be supported by the national prospective technology survey.

Given the current size of the sector, it is not considered appropriate to establish a specific governing body for ICT, and it is considered that the proposed governing body for science, technology and innovation (see recommendations in Chapter VI) could provide guidelines to foster innovation in the ICT industry. The forum for dialogue suggested here could support the STI governing body in the ICT sphere.

Some of the recommendations which could be implemented in the short term include the review of the educational needs of the sector, consolidation of the initiatives to support innovation in ICT which are currently being taken by the Ministry of Economy and Exsource group. Subsequently, depending on the results of the prospective survey, these activities may need to be adjusted.

NOTES

[1] OECD definition 2006-07. In OECD (2009) Guide to measuring the information society, 2009.

[2] Figures from NASSCOM, chamber of commerce for the information technologies sector of India.

[3] The concept of information workers is a much broader concept than workers in the ICT sector.

[4] See UNCTAD 2009.

[5] See SIGET 2011.

[6] See UNCTAD 2010c.

[7] ITU World Telecommunications Indicators database.

[8] The international comparison of the cost of Access to ICT between countries is not simple, and requires a number of assumptions. For more details of the methodology used in the elaboration of the ICT basket of prices, see ITU (2010).

[9] Don Bosco University, ITCA.

[10] José Simeón Cañas Central American University, Don Bosco University, Technological University, Francisco Gavidia University, Catholic University of El Salvador, Specialized School of Engineering ITCA and the University of El Salvador.

[11] See Observatory for the Information Society in Latin America and the Caribbean, OSILAC, (2010 p. 104).

[12] See measuring-ict.unctad.org/.

[13] For further information on the importance of the architecture of technologies designed for services and Internet services for companies, see UNCTAD (2009).

[14] Based on the OECD definition of ICT sector in 2002 (based on the International Standard Industrial Classification, Rev 3.1).

[15] See reference in CONADEI (2010).

[16] Programmable Logic Controller.

[17] The National STI Policy of El Salvador 2006-2030, the draft National Scientific and Technological Development Plan (2011), the National Research Agenda 2010, and the Integral Export Development Strategy 2010-2024.

[18] See ITIGES (2010) and Lito Ibarra (2009).

[19] See www.presidencia.gob.sv/index.php/temas/ticas/estandarizacion-y-actualizacion-de-los-sitios-web-de-las-instituciones-del-gobierno, 15 September 2010.

[20] See ECLAC (2010).

[21] According to the draft budget for the execution of the National Scientific, Technological and Innovation Development Plan (2011).

[22] See Ágape-Supérate programme at www.agape.com.sv.

[23] As a result of this project, starting in 2010, Francisco Gavidia University has GERMINA, an ICT enterprise incubator. Its mission is to foster and stimulate entrepreneurship and accelerate the gestation of innovative projects in technology, to transform them into successful companies.

[24] See draft ICT-based strategic development projects of El Salvador prepared by CASATIC and ASPROC (2011).

VI

Conclusions and recommendations. A road map for strengthening the system of innovation of El Salvador

A. CONCLUSIONS AND RECOMMENDATIONS

The economic and social development of El Salvador requires scientific, technological and innovative capacities. El Salvador, a small and open economy endowed with limited natural resources, needs to base its growth in increased productivity and productive transformation towards activities with a higher technological content that increase the production of higher added value goods and services. This would foster a virtuous circle of learning and dissemination of technology and, ultimately, would allow the country to be competitive internationally. Achieving this requires the development of capacities to adopt, use, adapt and generate knowledge. These capacities develop with investment (both public and private) in activities which generate knowledge and STI as well as with the strengthening of a national system of innovation that promotes and facilitates these activities and their application in the productive sectors.

El Salvador lacks adequate systemic conditions to develop capacities to adopt, use, adapt and generate knowledge. There is no governmental body which provides direction and supervises policies concerning STI. Neither is there an articulated system of STI policies, but rather isolated policies focused either on science and technology or on innovation, industrial development or exports. No foresight exercise has been carried out to identify research strengths and production capacities, and establish priorities from which development programmes and policy instruments are derived. A lack of monitoring and evaluation of policies and programmes to allow making the necessary adjustments was also observed.

As regards the generation of knowledge, the research sector is weak in human and financial resources, has little private involvement and is heavily weighted towards the social sciences and humanities. Levels of investment in R&D, both public and private, are extremely low. Furthermore, there is little contact between the knowledge generating bodies and the productive sector and current research efforts have little impact on improvements in production. The productive sector does not demand knowledge or technology, there is little awareness of the utility of knowledge in generating value, there are few financing options and a limited number of innovation policy instruments with limited budgets.

The education system suffers from serious weaknesses. Education in general, and higher education in particular, has ample room for improvement, especially in terms of quality, the expansion of science and technology teaching and research work.

Despite these shortcomings, there are a number of capacities in the sphere of STI which can be developed and on which successful results can be built. There is scientific research with international impact, especially in the health sciences. There are also high quality educational nuclei. There are innovative companies and some positive experiences of university-company collaboration, such as the design of specific study programmes. There is interest in various quarters in promoting science, technology and innovation, from various public institutions, non-governmental organizations and international cooperation. However, there is a general lack of interest on the part of the private sector. Lastly, the bases of the legal framework are adequately established such that they do not put a brake on innovative activity.

The country also has a number of factors which offer opportunities for capacity building in science, technology and innovation. El Salvador has a good road and air transport system and telecommunications infrastructure (especially mobile telephony). There are also national programmes, such as the port of La Unión or Fomilenio which offer opportunities for development of technological capacities and innovation. The strong presence of Salvadorians abroad is a channel of access to valuable resources and knowledge. Productive diversification provides opportunities for progress in many areas and the opening up of trade is an incentive to innovation by increasing competition and by facilitating the purchase of capital goods and access to new technologies. International cooperation makes an important contribution to the development of innovation skills, and there are ample opportunities for greater international collaboration in research and innovation. Finally, the country enjoys broad and continuing agreement on the macro-economic stability policies and openness to trade which encourage private sector (domestic and foreign) confidence to invest in the country.

The country must face the challenge of building STI capacities against a background of scarce public resources. The weaknesses of public institutions, for example in the sphere of policy coordination, also represent a threat to the development of these capacities which require broad agreement and clear

and continuous guidelines. The heterogeneous nature of business, where there is a large micro and small enterprise sector with low productivity, will also determine the objectives which the country can achieve in STI. The consumption culture acts as a disincentive to productive investment, and the rise in international competition, without greater capacity for technological absorption, among other factors, will cause difficulties to Salvadorian companies. Lastly, the cost of criminality, natural disasters and external shocks (such as the sharp increases in the price of oil or other commodities or drastic reductions in remittances) and the country's fragility in the face of these phenomena, should not be overlooked.

Based on the foregoing diagnostic, a series of recommendations are suggested focusing on five major pillars:

1. Establish an institutional and administrative, human and financial framework able to lead and coordinate the development of STI in El Salvador

Establish a governing body for science, technology and innovation with the responsibility of defining the major strategic lines in STI, integrating STI in the national development strategy and monitoring and evaluation of policies. This would include coordination of efforts to collect information on STI and the management of foresight activities. By its nature, this governing body should be positioned at a hierarchical level much higher than currently occupied by CONACYT.

This body must be given the authority, leadership and resources necessary to carry out its mission.

Table 1. Principal strengths, weaknesses, opportunities and threats in the national system of innovation of El Salvador

STRENGTHS	WEAKNESSES
• Pockets of scientific research • Results in areas of the health sciences • Pockets of high quality education • Pockets of innovative enterprises • Specific experiences in university-enterprise collaboration • Various bodies (public and private) show interest in STI. • Adequate bases of legal framework established	• Lack of coordination between institutions and lack of alignment of STI policies • Scarcity of resources allocated to STI • There is no foresight survey of STI to establish clear priorities • Lack of monitoring, evaluation and learning from STI policies and programmes • Weak research sector, dependent on higher education and heavily weighted to the social sciences and humanities • Weak education system, low quality, little orientation to scientific and technological education • Few links between research activities and production • Limited access to financial resources for STI (lack of seed and venture capital, limited public funds) • Weak national quality system
OPPORTUNITIES	**THREATS**
• Development of road and air infrastructure • Development of telecommunications, especially mobile • Development programmes: port of La Unión, Fomilenio etc. • Diversified productive activities • Open trade: opportunities to increase technological capacity, purchase of capital goods, access to new technologies, incentives to innovation • Foreign investment and low rates of inflation. • Support from international cooperation • Salvadorians abroad • International and regional cooperation in STI	• Scarcity of available public resources • Heterogeneity of enterprises. Broad micro and small enterprise sector with low productivity • Commercial and consumerist culture • International competition. Without greater capacity to absorb technology, among other factors, Salvadorian companies will have difficulties • Weaknesses of public institutions • Cost and fragility in the face of criminality, natural disasters and external shocks • Macro-economic imbalances: low levels of investment and saving, facility of fiscal accounts

Source: UNCTAD.

Consequently, it is proposed that it should be **headed by the President of the Republic**, and composed of the Ministers of Economy, Education and other ministries of particular relevance (Agriculture and Livestock, Health), as well as high-level experienced representatives of the academic, productive and financial sectors. Given the cross-cutting nature of this body, it would be logical for its secretariat to be included as part of the Technical Secretariat of the Presidency.

In addition, the implementation of instruments, the development of regulations and application of national policy should be in the hands of the respective ministries. Given the limited volume of funds, and in order to ensure greater proximity between the design of instruments and the beneficiaries, it is considered that, for the time being, management of STI funds should best be decentralized. However, it will be essential for the governing body for science, technology and innovation to play a major role in the management and monitoring of these funds.

2. Draw up a combination of STI policies and programmes which, linked to economic and education policy, will strengthen general STI capacities in El Salvador and the development of STI in a selected number of sectors and technologies

Based on the technological foresight survey and a process of consultation with the various key actors, **identify 3 or 4 priority sectors and strategic technologies** on which to focus active policies to strengthen technological capacity and innovation.

Establish a short-term **National Science, Technology and Innovation Plan**, with specific and measurable objectives, clearly identified responsibilities and resources, and subject to a control system.

Progressively and constantly **increase public investment in STI**, encouraging investment in the development of Salvadorian human capital, collaboration activities, technological support services for small and medium-sized enterprises, the development of STI infrastructure and the national quality system.

Foster **private investment in R&D and innovation** by, among other things:

- establishing incentives (e.g. tax incentives)
- strengthening competitive funds for R&D and innovation projects proposed by private investors
- ensuring that the reform of the national development bank includes the establishment in the short term of a seed and venture capital programme. This programme will require the development of capacities for venture capital management.

Promote **sectoral and regional systems of innovation**:

- promote the development of a system of agricultural and agro-industrial innovation, based on the recommendations made for this sector
- establish a series of actions to promote the development of one or two regional systems of innovation. The principal objective of this programme would be to promote cooperation between regional agents and establish framework conditions to allow such cooperation.

Also develop a **science, technology and innovation information system** which allows the design, monitoring and evaluation of STI policies. This would include:

- carrying out regular innovation surveys
- carrying out regular surveys of access to and use of information and communication technologies by the country's enterprises
- collecting information on investment in R&D outside the higher education sector,
- establishing mechanisms for monitoring and evaluation of the various STI policies and programmes
- establishing an STI observatory with the objective of directing and disseminating the results of monitoring and evaluation of STI policies.

3. Invest in the development of Salvadorian human capital

Strengthen the national education system in order to ensure adequate quality and orientation, including:

- Constantly and progressively increasing public expenditure on education, encouraging investment in infrastructure and improvements in the quality of education.
- Based on an evaluation and a wide consultation process, develop a national strategy for higher education.
- Establish a set of actions to increase the quality of education provision. Promote the accreditation and certification of educational institutions and programmes. Strengthen quality control of Salvadorian education, steadily raising minimum quality standards.

- Strengthen teaching of mathematics and the natural sciences by reformulating study programmes and strengthening teacher training in these areas.

Establish a set of programmes to facilitate the provision of and access to **high quality postgraduate education**, in particular in the priority science and technology areas. Consider, among other things:

- Significantly increasing the financing allocated to high quality postgraduate studies, in particular in the areas defined as priorities.
- Explore models which involve companies in the financing of scholarships for students working on subjects of interest to those companies.
- Strengthen bilateral cooperation with research centres and postgraduate training centres, in order to increase the number of Salvadorian postgraduate students in programmes in various countries and the participation of international experts in training courses held in El Salvador.

Based on a **review of the activities of INSAFORP** and in consultation with the private sector, establish a series of actions to strengthen the programme management and update the training offered. It would involve strengthening the content and quality of training in science, technology and innovation. Among other things, establish programmes which meet the training needs identified in the 3 or 4 priority strategic areas.

Establish a programme for **repatriating and/or taking advantage of Salvadorian talent** abroad.

4. Strengthen entrepreneurial innovation

Develop a series of instruments to encourage the acquisition, adoption, dissemination and development of technology in Salvadorian enterprises, including:

Strengthening programmes of innovation and technology transfer for SMEs, providing them with the necessary **financial resources**: firstly, by increasing the channelling of financial resources for innovation through the support bodies which have promoted it effectively, and, secondly, by putting into practice the proposed development of sectoral technology centres[1]. Ensure that they are closely linked to productive activities and promote the design and development of activities with the participation of knowledge generating bodies (universities, specialized institutes, and research centres).

Develop **technological intelligence capacities**.

Support the development of **enterprise incubators**, especially technology-based companies, establishing an incubation fund and promoting the establishment of enterprise incubators.

Facilitate the development of **venture and seed capital** in El Salvador, through institutional reforms which establish the necessary legal and organizational framework, and through financial contributions.

Include the development of **technological capacities in the relevant national development programmes**, such as FOMILENIO or the management of the port of La Unión. Establish a working group made up of local actors, evaluate the capacities required and, through a process of consultation, establish a programme of action to strengthen technological capacities and support technology transfer.

Establish a programme of **promotion and training in the management of intellectual property**, for example in universities and research centres. In the long term, the establishment of a separate body for the management of intellectual property could be envisaged.

Promote collaboration between universities, technological and specialized institutes and companies, as well as technology transfer, promoting the role of the university and institutes both in the development of technology and scientific knowledge, and its transfer and application to the productive sectors. For example:

- Stimulate joint development programmes between universities and companies, including a review of possible obstacles of a regulatory character.
- Include private sector participation in the design of STI policies, consulting entrepreneurs and representatives of industry associations.
- Establish an education and training programme on management and transfer of technology in higher education institutions.
- Stimulate private sector participation in the formulation of study plans in universities, technological and specialized institutes and in INSAFORP work programmes.

Strengthen the set of policies aimed at promoting structural transformation and productive development (diversification of exports, strengthening of productive chains, development of clusters and promotion of a national quality system), ensuring that one of their cornerstones is the development of technological and innovation capacities.

5. Strengthen research capacities in El Salvador

Establish 4 or 5 **research fellowships** in the priority sectors, and provide them with the necessary financial resources.

Develop a **mechanism for accreditation of the country's researchers** which recognizes the work of those who distinguish themselves in basic and applied research, and development and transfer of technology.

Based on a national evaluation of the **research infrastructure**, and consistent with the priority STI areas identified, draw up a plan to strengthen and expand the STI infrastructure at national level, including the public and private sector. The plan would favour the collaboration, complementarity and a joint commitment of the various users and promoters (central government, various higher education institutions (public and private), productive sector and international cooperation).

B. ROAD MAP FOR THE STRENGTHENING OF THE SYSTEM OF INNOVATION

Based on the above recommendations, Figure 1 shows a possible road map, indicating the factors and actions which are planned or in progress, and those which could be implemented, to guide the strengthening of the innovation system of El Salvador.

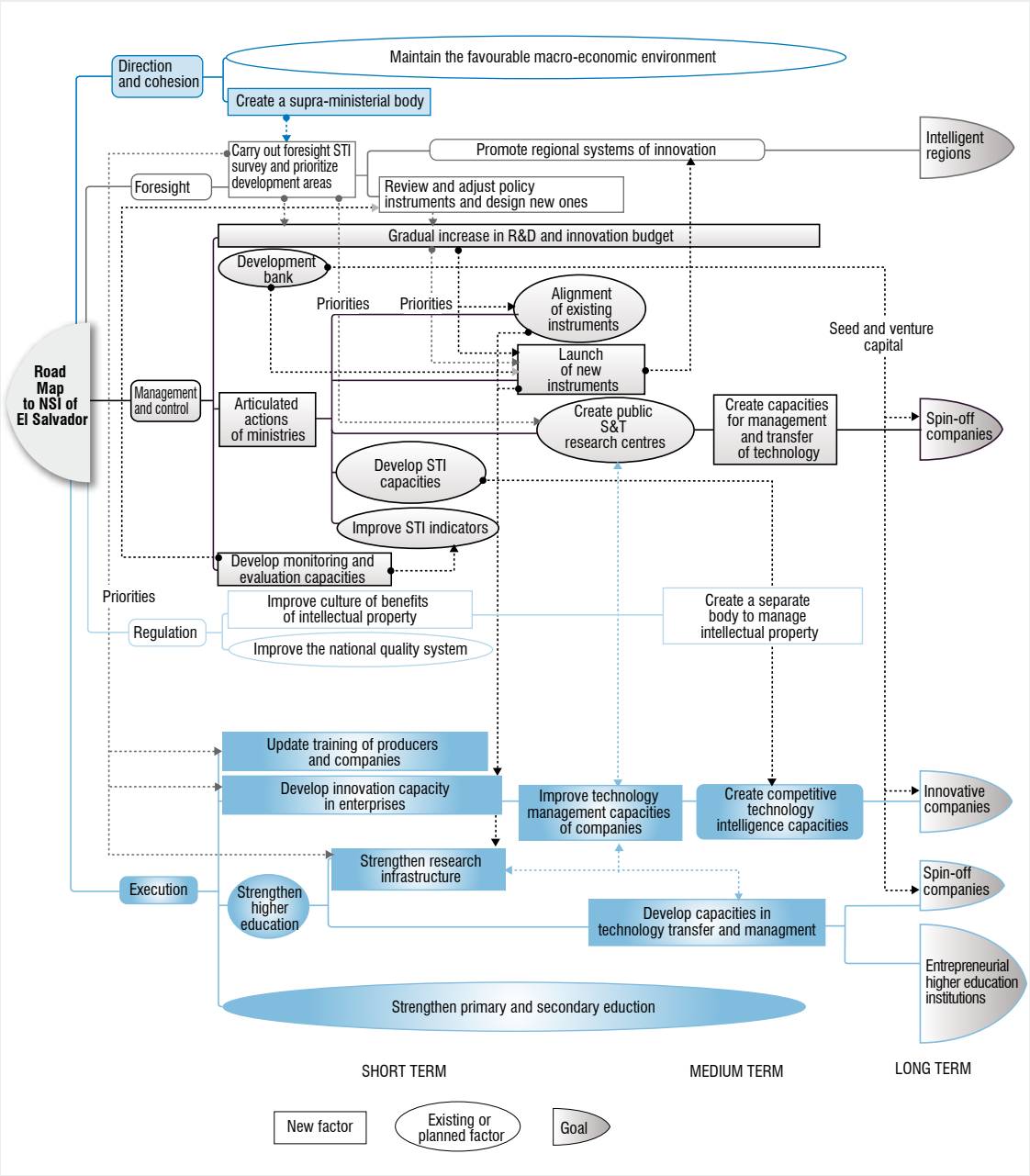
The road map classifies actions in accordance with the specific functions of the system. It differentiates between actions already contemplated and new proposals, suggests whether their implementation should be contemplated in the short, medium or long term, and includes a series of influencing relationships. For example, under the foresight function, it is suggested that a foresight STI survey should be carried out and development areas prioritized. These actions directly influence the increased budget allocated to R&D and innovation, the creation of public research centres, the upgrading of the capacities of producers and companies, improvement of the enterprises' capacities for innovation, and the strengthening of human resources and research infrastructure in the higher education sector. Similarly, the setting of priorities leads to the review, adjustment and design of policy instruments, which in turn influences the budget allocated to R&D and innovation, and consequently also impacts on the instruments which are directed at companies and the bodies which generate and disseminate knowledge.

This road map must be cemented, firstly, by commitment at the highest level to support the putting into practice a series of strategic actions and, secondly, by broad dialogue with all the key actors.

From the analysis carried out and this road map, it can be seen that the principal starting points for strengthening the Salvadorian NSI are the establishment of a governing body for STI, the conduct of a foresight technological survey and the establishment of priority development areas. These activities, essential to be able to establish priorities and design effective instruments, may require some time. In turn, many actors are impatient to see more results from innovation and/or are discouraged by the perception that the policies and programmes implemented have had little effect. In order not to discourage these actors, the Government of El Salvador can demonstrate its commitment to STI, as well as by launching the above processes, by determined support through a series of actions which can yield short-term results. These can then be adjusted based on the results of the foresight survey. Some of these short-term actions would include: increases in STI funding for existing successful mechanisms, such as, for example, the FOEX-FONDEPRO funds destined for co-financing innovation activities; continuation of assistance for successful independent support programmes and organizations (FIAGRO, PROinnova); the establishment of funds for postgraduate scholarships; and strengthening of consultation between the public, private and academic sectors (which can take the form of sectoral cells).

The road map outlined here requires significant efforts and resources which may currently be available in limited measure in the country. In this regard, UNCTAD and ECLAC are at the disposal of the Government of El Salvador, to the extent that resources are available, to continue to support the development of these proposals through technical guidance on the design of specific instruments, and training through the UNCTAD and ECLAC programmes in specific areas. In addition, UNCTAD and ECLAC can support participatory processes of dialogue and sharing of experiences in the area of science, technology and innovation policies, with the objective of building capacity in these policies and learning best practice in this sphere.

Figure 1. Road map for the strengthening of the system of innovation of El Salvador



Source: UNCTAD.

Bibliography

BIBLIOGRAPHY

Aguiñada Arévalo S., Ortiz Aguilar C., y Cabrera Medaglia J. (2009). Acceso a recursos genéticos y participación en los beneficios: una propuesta de ley consensuada para El Salvador. FUNDE. 2009.

Andersen, E.S. (1994). Evolutionary economics : post-Schumpterian contributions. London, Pinter.

Ángel A. (2008). Análisis de mercado de granos básicos en Centroamérica: enfoque en El Salvador. Para el Programa Mundial de Alimentos. Julio 2008.

Argumedo, P. El Salvador: Transitando hacia una economía del conocimiento (borrador). San Salvador, FUSADES (DEES).

Arritt F. (2006). Determinación de la Competitividad de Sectores Claves: Sector Agroindustria. Informe Final. Consultoría realizada para el Ministerio de Economía.

Beer, S. (1972). Brain of the firm : the managerial cybernetics of organization. London, Allen Lane, the Penguin Press.

Beer, S. (1984). The Viable System Model - Its Provenance, Development, Methodology And Pathology, Journal Of The Operational Research Society 35(1): 7-25.

Beer, S. (1985). Diagnosing the system for organizations. Chichester, J. Wiley.

BMI (2006) Cadena Agroproductiva del Subsector Lácteos. BMI y CAMAGRO. Programa FORTAGRO. San Salvador, marzo 2006.

Boekholt, P., Lankhuizen, M., Arnold, E., Clark, J., Kuusisto, J., Laat, B.d., Simmonds, P., Cozzens, S., Kingsley, G., and Johnston, R. (2001). An international review of methods to measure relative effectiveness of technology policy instruments, in Technopolis Reports. Amsterdam: Technopolis.

Cáceres L. R. and Saca N. N. (2006). What Do Remittances Do? Analyzing the Private Remittance Transmisión Mechanism in El Salvador IMF Working Paper.

Carmen Molina Tamacas (2009). El Comercio electrónico sin regulación. ElSalvador.com. 7 febrero 2009.

CASATIC y ASPROC (2011). Propuesta de proyectos estratégicos de desarrollo de El Salvador basados en las Tecnologías de la Información y las Comunicaciones. Febrero 2011.

CEPAL (2008). La transformación productiva 20 años después: viejos problemas, nuevas oportunidades (LC/G.2367 (SES.32/3)), Santiago de Chile.

CEPAL (2009). La inversión extranjera directa en América Latina y el Caribe, 2008 (LC/G.2406-P), Santiago de Chile.

CEPAL (2010a). Innovar para Crecer. Desafíos y oportunidades para el desarrollo sostenible e inclusivo en Iberoamérica.

CEPAL (2010b). Istmo centroamericano: estadísticas del subsector eléctrico. Informe preliminar del segmento de la producción de electricidad. lc/mex/l.961, 30 abril 2010.

CEPAL (2010c). Monitoreo del Plan eLAC2010: Avances y desafíos de la Sociedad de la Información en América Latina y el Caribe. Noviembre 2010, CEPAL. Naciones Unidas.

CEPAL (2011). Balance preliminar de las economías de América Latina y el Caribe.

Checkland, P. (1981). Systems thinking, systems practice. Chichester, Wiley.

Chesbrough H. (2003) Open innovation: The New Imperative for Creating and Profiting from Technology. Harvard Business School Press.

Cimoli M., Ferraz C. y Primi A. (2007). Políticas de ciencia y tecnología en economías abiertas: la situación de América Latina y el Caribe. Serie Desarrollo Productivo nº 165. CEPAL. Santiago de Chile, diciembre de 2007.

CNSI (2006). Estrategia Nacional del Programa de ePaís. Comisión Nacional para la Sociedad de la Información, Agosto 2006.

CONACYT (2006). Política Nacional de Ciencia, Tecnología e Innovación. San Salvador, Consejo Nacional de Ciencia y Tecnología,.

CONACYT (2009). Indicadores de ciencia y tecnología. Estadísticas sobre actividades científicas y tecnológicas. Sector de educación superior y gobierno. San Salvador, Consejo Nacional de Ciencia y Tecnología.

CONACYT (2010). Indicadores de Ciencia y Tecnología. Estadísticas sobre actividades científicas y tecnológicas. Sector de educación superior.

CONADEI (2010). Bases de la planificación estratégica 2010-2014. Documento de trabajo No.1, Enero-marzo 2010. CONADEI. PROESA.

Cooke, P. (2001). Regional innovation systems, clusters, and the knowledge economy, Industrial and Corporate Change 10(4): 945-74.

Dalum, B., Johnson, B., and Lundvall, B.-Å. (1992). "Public policy in the learning society", in: Lundvall, B.-Å., Ed., National systems of innovation : towards a theory of innovation and interactive learning. London ; New York. Pinter. 1992, pp. 296-317.

David, P. and Foray, D. (1994), "Accessing and expanding the science and technology knowledge base. A conceptual framework for comparing national profiles in systems of learning and innovation." Paris: Organisation for Economic Co-operation and Development.

Diario Oficial de El Salvador (2010). Diario Oficial de El Salvador, 14 Abril 2010. Tomo 384. Número 67. San Salvador.

DIGESTYC (2005). VII Censos Económicos 2005. San Salvador, Ministerio de Economía.

DIGESTYC (2010). Encuesta de Hogares de Propósitos Múltiples 2009. DIGESTYC, Ministerio de Economía, Julio 2010.

Doloreux, D. (2004). Regional Innovation Systems in Canada: A comparative study, Regional Studies 38(5): 481-94.

Doloreux, D. and Parto, S. (2005). Regional innovation systems: Current discourse and unresolved issues, Technology in Society 27(2): 133-53.

Dosi, Pavitt y Soete (1990). The economics of technical change and international trade. New York University Press.

Edquist, C. (1997). "Systems of innovation approaches - Their emergence and characteristics", in: Edquist, C., Ed., Systems of innovation : technologies, institutions and organizations. London ; Washington. Pinter. 1997, pp. 1-35.

Edquist, C., Hommen, L., Johnson, B., Lemola, T., Malerba, F., Reiss, T., and Smith, K. (1998). The ISE Policy Statement - The Innovation Policy Implications of the 'Innovation Systems and European Integration' (ISE) Research Project. Linköping, European Commission.

Falck-Zepeda J., Falcón C. Samapaio-Amstalden M. J., Solleiro Rebolledo J. L. Trigo E. y Verástegui J. (2009). La biotecnología Agropecuaria en América Latina. Una visión cuantitativa.

FAO (1997). El estado mundial de la agricultura y la alimentación 1997.

Freeman, C. (1987). Technology policy and economic performance : lessons from Japan. London, Pinter.

Freeman, C. (1995). The National System of Innovation in Historical-Perspective, Cambridge Journal of Economics 19(1): 5-24.

Freeman, C. (2002). Continental, national and subnational innovation systems --complementarity and economic growth, Research Policy 31(2): 191-211.

Frost & Sullivan (2010). El Salvador in Motion: From Call Center to BPO - What is the Salvadorian Outsourcing industry doing to diversify in a competed Market? 20 May 2010.

FUSADES (2009). Cómo está El Salvador, 2009.

FUSADES (2010). Informe de coyuntura social. DEES, noviembre 2010.

Gobierno de El Salvador (2010). "Plan Quinquenal de Desarrollo 2010-2014," Secretaría Técnica de la Presidencia (Ed.).

Gobierno de El Salvador (2011). Plan de Agricultura Familiar.

Gochez M. (2008). Diagnóstico de la situación actual de CONAPIS. FAO, junio de 2008.

Gonzales, P., Williams, T., Jocelyn, L., Roey, S., Kastberg, D., and Brenwald, S. (2008). Highlights From TIMSS 2007: Mathematics and Science Achievement of U.S. Fourth- and Eighth-Grade Students in an International Context (NCES 2009–001 Revised). National Center for Education Statistics, Institute of Education Sciences, U.S. Department of Education. Washington, DC.

Ibarra L. (2009). Innovación tecnológica en Casa Presidencial. Blog "Conversaciones en Línea con Lito Ibarra". 1 noviembre 2009.

IFPRI-IICA (2008). Agricultural R&D in Central America. Policy, investments and institutional profile. ASTI Regional Report. November 2008.

IICA (2008). Guía de exportación del frijol rojo a El Salvador. Red SICTA. Proyecto red de innovación agrícola. Managua, 2008.

INCAE (2010). Índice de Competitividad Global 2010-2011. Resultados para El Salvador. Comunicado de Prensa. INCAE Business School.

INSAFORP (2010). Informe de Rendición de cuentas de la Gestión 2009-2010. Instituto Salvadoreño de Formación Profesional. www.presidencia.gob.sv/

ITCA-FEPADE (2010). Memoria de Labores 2009. Escuela especializada en Ingeniería. ITCA - FEBADE.

ITIGES (2010). Gobierno como facilitadores del avance tecnológico. Presentación de Norwin Herrera, Julio 2010.

ITU (2010). Measuring the Information Society 2010. Version 1.01. International Telecommunications Union. Geneva.

Katz (2009). El papel de las TIC en el Desarrollo. Propuesta de América Latina a los Retos Económicos Actuales, Editorial Ariel, Barcelona.

Kirat, T. and Lung, Y. (1999). Innovation and proximity: territories as loci of collective learning processes, European Urban and Regional Studies 6(1): 27-38.

Luhmann, N. (1995). Social systems. Stanford, Calif., Stanford University Press.

Lundvall, B.A. and Borrás, S. (2005). "Science, technology and innovation policy", in: Fagerberg, J. and Mowery, D. and Nelson, R., Eds., The Oxford handbook of innovation. Oxford. Oxford University Press. 2005, pp. 599-631.

Lundvall, B.-Å. Ed. (1992a). National systems of innovation : towards a theory of innovation and interactive learning, Pinter, London ; New York.

Lundvall, B.A., Johnson, B., Andersen, E.S., and Dalum, B. (2002). National systems of production, innovation and competence building, Research Policy 31(2): 213-31.

MAG (2009). IV Censo Agropecuario 2007-2008. Diciembre 2009.

MAG (2010). Plan Estratégico Sectorial. 2010-2014. Documento de trabajo interno MAG. 31 enero 2010.

Malmberg, A. and Maskell, P. (1997). Towards an explanation of regional specialization and industrial agglomeration, European Planning Studies 5(1): 25-41.

McKelvey, M. (1991). "How do national systems of innovation differ? A critical analysis of Porter, Freeman, Lundvall and Nelson", in: Hodgson, G.M. and Screpanti, E., Eds., Rethinking economics : markets, technology and economic evolution. Aldershot and Brookfield. Edward Elgar. 1991, pp. 117-37.

Metcalfe (1995). The economic foundations of technology policy. Handbook of the Economics of Innovation and Technical Change, P. Stoneman (ed.), Oxford, Blackwell.

Metcalfe (1995). The economic foundations of technology policy. Handbook of the Economics of Innovation and Technical Change, P. Stoneman (ed.), Oxford, Blackwell.

MINEC (2010). "Estrategia integral de fomento a las exportaciones," Ministerio de Economía, San Salvador.

MINEC (2011). La animación digital busca abrirse paso. Artículo en www.pixelsawards.com.

MINED (2009). Resultados de la Información estadística de instituciones de educación superior 2008. San Salvador, Dirección Nacional de Educación Superior, Ministerio de Educación.

MINED (2010a). Memoria de labores 2009-2010. Ministerio de Educación, San Salvador.

MINED (2010b). Plan Nacional de Desarrollo Científico y Tecnológico. Marco de ejecución de la Agenda Nacional de Investigación. Viceministerio de Ciencia y Tecnología (Ed.).

MINED (2010c). Resultados de la Información Estadística de Instituciones de Educación Superior 2009. Dirección Nacional de Educación Superior. Ministerio de Educación. San Salvador, noviembre 2010.

Ministerio de Relaciones Exteriores (2010). Ministerio de Relaciones Exteriores. Memoria de Labores 2009-2010, El Salvador.

Monge-González R., Alfaro-Azofeifa C. y Alfaro-Chamberlain José I. (2005). TICs en las PYMES de Centroamérica. Impacto de la adopción de las Tecnologías de la Información y la Comunicación en el desempeño de las empresas. CAATEC.

Nelson, R.R. (1993). National innovation systems : a comparative analysis. New York ; Oxford, Oxford University Press.

Nelson, R.R. and Nelson, K. (2002). Technology, institutions, and innovation systems, Research Policy 31(2): 265-72.

Nordhaus, W.D. (1969). Invention, growth, and welfare : a theoretical treatment of technological change. Cambridge, Mass, M.I.T. Press [1969].

OECD (1992). Technology and the economy : the key relationships. Paris, Organisation for Economic Co-operation and Development.

OECD (1994). The OECD jobs study. Facts, analysis, strategies. Paris, OECD.

OECD (1999). Managing National Innovation Systems. Paris, OECD.

OECD (2002a). Dynamising national innovation systems. Paris, Organisation for Economic Co-operation and Development.

OECD (2002b). Frascati Manual 2002. Proposed Standard Practice for Surveys on Research and Experimental Development.

OECD (2009). Guide to measuring the information society, 2009.

OECD (2010). Science, Technology and Industry Outlook 2010.

OECD and Eurostat (2005). The measurement of scientific and technological activities. Oslo Manual. Guidelines for collecting and interpreting innovation data, (Third Edition ed.). Paris, Organisation for Economic Co-operation and Development and European Commission, Statistical Office of the European Communities.

OSILAC (2010). Compendio de prácticas sobre implementación de preguntas de TIC en encuestas de hogares y en encuestas de empresas en América Latina y el Caribe revisión 2010 Observatorio para la Sociedad de la información en Latinoamérica y el Caribe (OSILAC). CEPAL.

Pavitt, K. (1984). Sectoral patterns of technical change: Towards a taxonomy and a theory, Research Policy 13(6): 343-73.

PNUD (2010a). Informe sobre Desarrollo Humano 2010. La verdadera riqueza de las naciones: Caminos al desarrollo humano.

PNUD (2010b). Informe de Desarrollo Humano El Salvador, 2010. De la pobreza y el consumismo al bienestar de la gente. Propuestas para un nuevo modelo de desarrollo.

PROCAFÉ (2010). Boletín estadístico de la caficultura 2010. Fundación Procafé.

Ricyt (2007). Manual de Indicadores de internacionalización de la ciencia y la tecnología. Manual de Santiago.

Riveros H., Baquero M., García M., and Alarcón E. (2008). Linking small-scale farmers with markets. An analysis of successful initiatives in Latin America. COMUNIICA. Fourth Year Second Phase, May - August 2008.

Rothwell, R. and Zegveld, W. (1981). Industrial innovation and public policy : preparing for the 1980s and the 1990s. London, Frances Pinter.

Schumpeter, J. (1934). The Theory of Economic Development. Cambridge: Harvard University Press.

Schwab, K. Ed. (2010). The Global Competitiveness Report 2010–2011, World Economic Forum, Geneva.

SIGET (2011). Boletín estadístico de telecomunicaciones. 2010. Superintendencia General de Electricidad y Telecomunicaciones.

Soete, L. and STRATA-ETAN Expert Group (2002). Benchmarking national research policies: The impact of RTD on competitiveness and employment (IRCE). Brussels, European Commission, DG Research.

Solleiro J. L. Saad I. Hernández M. y Castillo J. (sin fecha). Informe El Salvador.

Tidd, J., Bessant, J., and Pavitt, K. (2001). Managing Innovation, John Wiley and Sons.

UNCTAD (2007). The Least Developed Countries Report 2007. Knowledge, Technological Learning and Innovation for Development. (UNCTAD/LDC/2007). New York and Geneva.

UNCTAD (2009). Information Economy Report 2009. Trends and Outlook in Turbulent Times.

UNCTAD (2010a). Estudio sobre las perspectivas de la armonización de la ciberlegislación en Centroamérica y el Caribe. Nueva York y Ginebra, 2010.

UNCTAD (2010b). Information Economy Report 2010. ICTs, Enterprises and Poverty Alleviation, 2010.

UNCTAD (2010c). Investment Policy Review. El Salvador. United Nations, 2010.

UNESCO (1978) Recommendations concerning the International Standardization of Statistics on Science and Technology.

UNESCO (2007). Segundo Estudio Regional Comparativo y Explicativo. Los aprendizajes de los estudiantes de América Latina y el Caribe. Resumen ejecutivo.

Universidad de Cantabria (sin fecha). Estudio del sector acuícola. Informe El Salvador. Universidad de Cantabria. Cátedra de cooperación internacional y con Iberoamérica.

Vicens A. y Stark C. (2009). Mejores prácticas de apoyo a la MIPYME para la innovación y el desarrollo exportador. El Salvador: Caso FOEX-FONDEPRO. Marzo de 2009.

von Bertalanffy, L. (1968). General system theory : foundations, development, applications. New York, Braziller.

WITSA (2010). Digital Planet 2010. Executive Summary. October 2010.

Annexes

ANNEX A. NATIONAL SCIENCE, TECHNOLOGY AND INNOVATION POLICIES

Table A.1. National STI policy of El Salvador, 2006. Areas of knowledge for scientific and technological development and innovation[2]

Area of knowledge	Detailed description
Biotechnology	Management of regulatory and legislative framework / Elaboration of policy lines / Scientific and technological research management / Financial resources management and project monitoring / management of mechanisms for identifying, monitoring and assessment of risks / Technical expertise in risk analysis of the scientific aspects / Exchange of information and data management including participation in BCH/Technology transfer relating to biosafety / Physiological studies of in vitro cultivation / Propagation and improvement of species / Molecular biology / Biochemistry / Genetics / Biotechnology used to generate foods / Food technology and food security.
Materials science	Characterization of materials / Identification of materials / Corrosion studies / Properties of materials / Application to the manufacture of new materials.
Education	Equality in education / Teacher training / Repetition and abandonment of classes / Quality of education / Distance learning.
Energy	Biofuels and renewable sources / Geothermal / Small hydro-electric power stations / Unconventional energy sources.
Aerospace engineering and technology	Aircraft assembly / Aircraft maintenance / Aerospace materials / Aerospace engineering.
Manufacturing	Design and manufacture of integrated circuits and devices / Computer Assisted Design / Technology transfer for SME sectors / Metrology services / Waste treatment / Information management / Automation and electronics / Metallic and non-metallic materials technology / Materials recycling / Characterization of materials / Chemical synthesis and modification of materials / Marketing and packaging / Textiles and clothing / Electronic commerce.
Environment and natural resources	Preservation of the environment, forests and water / Biodiversity and biobusiness / Cleaner production technologies / Environmental pollution / Solid waste management / Waste water treatment plants / Drinking water processing / Extraction, maintenance, use and distribution of water resources.
Nanotechnology	Nanostructured materials / Nanomedicine (release of drugs and DNA) / Nanobiotechnology / Nanoparticle processes / Nanomanufacturing processes / Nanoengineering (nanoprobes, power and energy, clean water) / Nano health and biosafety.
Land management and town planning	Urban environment / Land planning / Participatory municipal government / Urban landscape / Town planning / Human settlement, housing and services / Mobility and urban transport / Urban poverty / Urban projects.
Fisheries and agriculture	Fish-farming / Marine biology / Cultivation of molluscs / Cultivation of crustaceans / Coastal management / Sustainable development / Marine resources / Tropical mushrooms / Honey and derivatives / Integrated disease management / Integrated farming for sustainable rural development / Sugar cane cultivation and processing / Coffee cultivation and processing / Sustainable agriculture and agro-industry / Ecotourism.
Geological hazards	Seismology / Earthquake resistant construction / Housing / Landslides / Floods.
Health	Health technologies (bioengineering and biotechnology / Health promotion / New emergent and re-emergent diseases / Environmental rehabilitation.
Information and communication technologies	Software development / Simulation / Geographical information / Design and development of interactive systems / Management of computer and communications resources / Database management / Management of computer networks and peripherals / Systems integration / Remote design and development of applications and services / Wireless communication technologies / Multimedia integration / Development of software for devices (firmware) / Artificial intelligence.

[2] *CONACYT, 2006.*

Box A.1. Principal lines of the Five-Year Development Plan relating to STI

The goals of the five-year plan, directly or indirectly associated with science, technology and innovation include:

- Achieve an average real rate of growth of Gross Domestic Product of 4.0 per cent by the end of the period;
- Generate at least 250,000 new decent, temporary and permanent, jobs, by implementing public investment projects;
- Increase exports of goods and services by at least 20 per cent by the end of the fiver-year period; and,
- The strategic policies, which comprise the following:

1) Strategic social policies

a) Education.

i) Eight strategic action lines have been identified: a) fair access to and remaining in the education system; b) relevant curriculum and significant learning; c) raising the status and professional development of teachers and head teachers; d) strengthening institutional and curriculum management of education centres; e) permanent training for the young and adult population; f) research, science and technology integrated in education; g) strengthening of higher education; and (h) training for work.

2) Financial system to promote development

a) The Financial system to promote development will be formed from the Agricultural Development Bank, the Mortgage Bank and the Multisectoral Investment Bank. The latter will become the National Development Bank of El Salvador.

3) Productive Development Strategy

a) Coordination of government resources and creation of financing models suited to innovation, strengthening business management (according to the individual characteristics of producers and entrepreneurs) and differentiated productive targets (depending on local aims and potential).

4) Macro-economic and sectoral strategies

a) Fiscal.

b) Export promotion.

i) Key processes: a) strengthening state institutional support for export sectors; b) incorporation of innovation and technology transfer processes in the export sector; c) generation of decent jobs in the export sector; d) stimulation of micro, small and medium-sized export companies by the creation of productive chains, business partnerships and associative activities; e) taking advantage of free trade agreements, strengthening of the Central American Common Market and establishment of new trade relations with emerging countries; and f) establishing the foundations for applying a systemic approach to the promotion and internationalization of strategic sectors in countries and niche markets in which there are shown to be comparative advantages.

c) Energy.

d) Environment.

e) Agriculture.

i) Programmes: a) creation of a supply system to ensure food security; b) articulation of the system of technological innovation with public-private participation for research, adaptation, validation and transfer of new processes and products which will increase agricultural productivity and profitability; c) strengthening of the system of market information and intelligence; d) recovery of national livestock farming and fishing; e) encouraging the formation of new centres of intensive fruit and vegetable production; f) renovation of the coffee stock; g) commercial and sustainable forestry management; h) revitalization of leadership and organization of agricultural production (including diversification) and decentralization of the educational provision of the National School of Agriculture to train new local technical agents; i) land registration; j) modernization and decentralization of Ministry of Agriculture and Livestock services; k) expansion and modernization of the area of irrigable land; l) reduction of environmental hazards in agriculture; m) systems to ensure healthy, safe and traceable agri-food products; n) reactivation and modernization of fishing and fish-farming.

f) Tourism.

5) Public investment

a) Investment is grouped in the priority programmes and projects shown in Figure 3 in Chapter II. The total costs of these and the financing gap is shown in Table 2 in Chapter II.

Table A.2. The National Research Agenda and its links to the Five-Year Development Plan (FDP)

Strategic areas of the FDP and its priority programmes	Strategic research areas corresponding to the FDP	Research subjects in which there are strengths	Possible members of scientific and technological development centres
EQUITY, SOCIAL INCLUSION AND POVERTY REDUCTION			
National Integrated Health System	Health	- Health technologies - New and re-emergent diseases - Environmental rehabilitation - Health systems and policies - Economy and health - Food and nutrition - Social health problems	USAM, MSPAS, CENSALUD, UES, UJMD, UEES, UCA, UNSSA, UNASA, UAB, IEPROES Santa Ana, IEPROPES San Miguel, Santa Ana National Hospital, Rosales National Hospital.
Education	Equity in education	- Education of women for the development of micro-enterprises - Learning without fear - Inclusive education - Infant education - Education in rural areas - Education in citizens' participation - Migration, family and education - Education in human rights	UES, C.E. Rep de Guatemala, National Sarvelio Navarrete Institute, UTLA, UMA, USO, UCA, UPAN, Plan International
	Quality of education	- Repetition and school abandonment - Relevance (education and development) - Education for the acquisition of knowledge, capacities, skills and attitudes for life. - Scientific and technological research - Educational research - Teacher training - Learning problems - Education indicators - Development of critical thought in higher education - Education for prevention of natural or manmade disasters from a risk management perspective	UMA, USO, C.E Rep Guatemala, UTEC, Salvadorian Cultural Centre, UES, National Sarvelio Navarrete Institute, UTLA, UEES, UPAN, UCA, Plan International, USAM, UGB, UFG
	External education	- Distance learning - On-line learning - Implementation of information and communication technologies for access in rural areas	USO, C.E. Rep. Guatemala, UES, UFG, National Sarvelio Navarrete Institute, UGB, UCA, UPAN
Housing	Housing and urban development	- Social housing - Development of new construction technologies - Anti-seismic engineering - Geotechnical engineering - Climatic housing - Building standards - Corrosion - New building materials - Sanitary infrastructure - Urban environment - Bioclimatic construction	UES, UTEC, UCA, FUNSALPRODESE, UNICAES, UTLA, Usulután Technological Institute, UDB, CICES, ITCHA

Table A.2. The National Research Agenda and its links to the Five-Year Development Plan (FDP) (cont.)

Strategic areas of the FDP and its priority programmes	Strategic research areas corresponding to the FDP	Research subjects in which there are strengths	Possible members of scientific and technological development centres
ECONOMIC REACTIVATION			
Reactivation of agriculture	Agro-industry	- Agro-industrial development - Manufacturing - Productive chains - Fruit industry - Industrialization of medicinal plants	CENTA, ENA, UES, UJMD, UNICAES, FUNSAL, UCA, USAM
	Saltpans	- Productive process for sea slt	UJMD
	Food security	- Agricultural diversification	Plan International, CENTA, ENA, UJMD, UES, UNICAES, UTLA, Intermunicipal Technical Unit, SNET, LABOTEX-UES
	Food safety	- Products of animal origin - Analysis of toxins in fish products	UES, UCA, UES-ICMARES , LABOTOX-UES
	Sustainable agriculture	- Environmentally friendly practices - Conservation of phyto-genetic resources - Soil management - Non-transgenic genetic improvement - Domestic kitchen gardens - Industrialized production and use of organic fertilizer - Biological pest control - Agro-climatological studies	CENTA, UES, ENA, UNICAES, UEES, UTLA, FUNDADESCA
	Cultivation of aquatic species	- Experimental cultivation of pargo in small volumes of water - Cultivation of molluscs - Cultivation of native species	UES- ICMARES
	Animal health	- New and re-emergent diseases - Diseases which affect fish-farming	UNICAES, UES- ICMARES
Basic social infrastructure	Land planning	- Urban settlements - Geological research - Regional development - Local development - Urban development - Mobility and transport	UTLA, ASIA, UES- Institute Earth Sciences, Geologists of the World, UTEC, UCA
Micro, small and medium-sized enterprises (MSMEs)	Industry	- Metal industry - Construction - Tourism - Photovoltaic systems - Improvement of processes for manufacture of electrical components - Logistical supply chain - Control of gas emissions - Manufacturing industry - Production of biodiesel - Software development	UCA, AVX Industria, ESEN, UTLA, ITCHA, ITCA, UGB, FEPADE
Innovation and technology	National System of Innovation	- Technology parks	Government institutions, research centres

Table A.2. The National Research Agenda and its links to the Five-Year Development Plan (FDP) (cont.)

Strategic areas of the FDP and its priority programmes	Strategic research areas corresponding to the FDP	Research subjects in which there are strengths	Possible members of scientific and technological development centres
SUSTAINABLE DEVELOPMENT			
Energy sector	Renewable energy	- Photovoltaic energy - Wind power - Tidal energy - Geothermal energy - Biomass energy - Biofuels (biodiesel) - Development of devices - New forms of energy use (nuclear and dark)	UES, UTLA, CIC-UES, UJMD, UTEC-FUCITEC, Interdisciplinary Modular Faculty of UES Oriente, UCA
	Energy efficiency	- Technical standards - Power generation - Service quality of electricity systems	Specialize Franciscan E.S, UES, CIC-UES, UDB, FUNDADESCA, SIGET, ITCA-FEPADE, UCA
	Electricity	- High tension cables - Electrical quality indicators	CIC-UES
	Energy industry	- Innovation in energy production	CIC-UES
	Energy quality	- Quality of imported fuels	UES, MINEC
Environmental and risk management	Prevention and management of natural hazards	- Characterization of movement of slopes - Characterization of floods - Monitoring of seismic activity - Monitoring of volcanic activity - Effect of natural events - Social perception of risks - Risk mapping - Integration of energy plans	UES, Intermunicipal Technical Unit, Geologists of the World, MARN, USAM, UCA
	Integral solid waste management	- Integral waste management	UTLA, UES, UCA
	Environment	- Water quality - Environmental rehabilitation - Degradation of the shore and coastal ecosystem - Study of inland waters - Protection of turtles - Legal aspects of territorial waters and continental waters - Evaluation of the impact of tourism projects - Ecology of the seabed and mangroves. - Animal, fungal and vegetal biodiversity - Inventory of vegetal germplasm - Management of protected areas - Management of social and environmental conflicts - Studies of acoustic, electro-magnetic and chemical pollution - Solid wastes - Sedimentary processes, water treatment	UES, UTLA, Plan International, UCA, Intermunicipal Technical Unit, UNICAES, MARN, ICMARES-UES, Santiago de la frontera Education Centre, USAM, UGB, UES-Química, SNET, ESFE, UDB, UES-FMO, UFG
	Climate change	- Effects on health - Biophysical study of drought - El Niño phenomenon - Incidence of atmospheric systems - Climate characterization - Impact of hurricanes - Rain events - Air quality	CIC- UES, UCA, UGB, LABOTEX UES, MARN, SNET, USAM, UFG, UES Oriente

Table A.2. The National Research Agenda and its links to the Five-Year Development Plan (FDP) (cont.)

Strategic areas of the FDP and its priority programmes	Strategic research areas corresponding to the FDP	Research subjects in which there are strengths	Possible members of scientific and technological development centres
		- Climate change models - Effects of climate change - Prevention and mitigation of the effects of climate change - Seasonal forecast	
	Hydro-geochemistry of waters	- Subterranean rivers - Lakes - Seas	UES, UTLA
	Natural resources	- Germplasm banks - Water resources	MAG, UES, SNET, UCA, ICMARES
CIVIL SECURITY			
Prevention of violence and crime	Violence	- School - Migration and family - Childhood and communication media - Drugs - Violence in the home	Plan International, UEES, UPAN, UGB
SPECIAL ASPECTS OF DEVELOPMENT			
Culture	History	- Cultural heritage - Cultural assets - Revival of the Náhuatl language - Indian law	Plan International, UES, UTLA, UDB, UFG, UTEC, CENICSH, ESFE/AGAPE, UCA, National Library, UEES
Tourism	Tourism	- Tourist accommodation - Local development - Centres of tourist development - Development of tourism products - Ecotourism: design of productive development models and plans - Development of self-sustaining rural tourism	UTEC, UTLA, UJMD, UAB, UPAN, UFG, ITCHA, UAE, UCA

Table A.3. Contents of the National Scientific and Technological Development Plan

Component	Programmes	Projects
Education and training	National programme of training in science, technology and innovation	- Education abroad of persons in the higher education system with master's degree or doctorate in science and technology through scholarships - Development and strengthening of master's degree and doctorate studies in science and technology in the country - Promotion of university-enterprise-government cooperation in research - Development of young researchers - Mobilization of professionals qualified in science and technology at national and international level
	Promotion, dissemination and popularization of science and technology	- Science and technology for all (creation of museums, science and technology prizes, science fairs, congresses, etc.) - Strengthening of the infrastructure of science and technology laboratories in primary and secondary schools
	Continuing training of the population in science and technology	- Studies of the labour force and public (social) perception of science and technology. - Training in knowledge management - Development of an entrepreneurial culture at all levels of the national education system
Scientific and technological information	Establish a system of basic indicators and statistics for science, technology and innovation	- Creation of a science, technology and innovation studies division. - Development of three surveys on science, technology and innovation: human resources in science and technology; determination of scientific and technological capacities; and social perception of science and technology - Articulation of natural networks of scientific and technological information - Consultative forum
Transfer, innovation and technological development	Development and strengthening of university-enterprise-government links	- Development of technology parks, technology-based enterprise incubators - Management of technology and technological innovation in MSMEs - Strengthening and monitoring of the National System of Innovation
Information and communication technologies (ICT)	Building a knowledge-based society	- Strengthening of ICT at all levels of the education system, e-economy and e-government - Strengthening of distance learning programmes - Massive incorporation of ICT in homes and the business sector - Studies of the impact of ICT on Salvadorian society
	Development of MSMEs in the ICT sector	- Support for the creation and development of companies in the ICT sector. - Support for ICT companies through their integration under the International Services Act - Incentivize the use of ICT in distance learning, electronic commerce, multimedia production, telemedicine, etc.
Science and technology for the development of zones or regions of the country	Science and technology as an instrument to strengthen the processes of decentralization and local development	- Strengthen the innovative entrepreneurial fabric in the various regions of the country - Define strategic plans for scientific and technological development of the various regions of the country - Define academic education programmes adapted to the development needs of geographical units
Infrastructure of science and technology	Upgrading and modernization of the country's science and technology infrastructure	- Articulation and modernization of the network of science and technology laboratories in the country. Strengthen joint university-company-government working groups - Upgrade the stock of science and technology infrastructure in the country. - Use of public and private science and technology infrastructure by the country's business sector
Financing of scientific and technological development and innovation	Financing of science, technology and innovation	- Creation and organization of a scientific and technological development and innovation fund - Strategy for the financing of scientific and technological development

Source: MINED, 2010b.

Table A.4. Integral Export Promotion Strategy

Strategic objectives	Strategic areas	Lines of action
Diversify and consolidate destination markets, prioritizing and taking advantage of opening of markets	Taking advantage of priority markets/countries	- Identify priority markets
	Identifying strategic sectors/products to be developed	- Collaboration between public and private bodies in identifying and selecting strategic sectors and products - Stimulate the development of 5 strategic sectors: i) Food agro-industry; ii) Information and communication technologies; iii) Chemical pharmaceuticals; iv) High-tech services; and v) Tourism
	Negotiation, administration and protection of trade agreements	- Identification and proposal of new trade agreements - Negotiation, administration and implementation of trade agreements - Protection of commercial interests in accordance with agreements signed - Strengthening of technical managers
	Management of export promotion	- Stimulate and consolidate the role of EXPORTA and its coordination with the public and private sector. - Establish continuing education and training programmes - Intensive dissemination of services available to exporters through EXPORTA **- Establish mentoring and coaching programmes**
	International marketing: country image	**- Design a single country image strategy** - Strengthen coordination between EXPORTA, PROESA, MINEC, RREE, MITUR and the private sector
Institutionalize export promotion mechanisms: focused, accessible, integrated, measurable over time and share with the private sector	Competitiveness in the local market as a pre-export phase	**- Development of productive chains** - Establish programmes for the strengthening or development of suppliers - Creation and publication of standards to encourage quality, innovation and technology - Work in a coordinated way with national systems of quality and innovation
	Special financing for SMEs	- Strengthen the various existing financial support instruments (FOEX/ FONDEPRO, among others) and/or create new support options - Provide through the BMI a set of instruments or products which allow exporters access to pre- and post-export guarantees and financing
	Support for foreign trade procedures	**- Establish a Centre for Foreign Trade Procedures (CENTRACE)** - Create and inter-institutional team for the development of new procedures and functioning of CENTRACE
Strategic diversification of provision, with significant added value, which allows a competitive presence in the global market	**National System of Innovation (NSI)**	**- Creation of Sectoral Innovation Centres (5)** **- Strengthen the INVENTA gateway** **- Promote the culture of innovation** **- Identify and strengthen resources or factors for innovation** **- Platform to attract Salvadorian science professionals living abroad** **- Define and make available long-term financing mechanisms** **- Establishment of partnerships**
	National Quality System (NQS)	**- Integrate the work and progress in various public and private bodies in relation to quality** **- Create a national centre for productivity and quality** **- Strengthen and/or develop the institutional basis** **- Creation of 4 executing institutes relating to standards, technical regulations, accreditation and metrology**
	Foreign Direct Investment	- Strengthen the operative role of PROESA - Define strategic sectors and countries - Redefine and promote a country image **- Update laws, regulations and incentives for Foreign Direct Investment**
	"Salvadorian Bridge" Platform	**- Identify and contact Salvadorians abroad who work in companies involved in the strategic sectors** **- Draw up an inventory of Salvadorians abroad (PROESA)**

Table A.4. Integral Export Promotion Strategy (cont.)

Strategic objectives	Strategic areas	Lines of action
Develop an export, innovation and quality culture which promotes capacities and entrepreneurship, aimed at effective penetration of foreign markets	Inter-institutional coordination and impetus to promote an export culture	- Identify and develop a system which allows better access to training for human resources - Establish programmes tailored to companies - Encourage the creation of a Master's degree in Technology Management
	Dissemination of the export culture	- Encourage the dissemination of success stories and subjects related to foreign trade, innovation and quality - Organize training programmes for journalists - Organize extension activities by public and private entities relating to export processes, innovation and quality
Design structure for high-level management, coordination and inter-institutional control, strengthening links between the government, private and academic sectors	Public institutionalization for monitoring, implementation and taking of decisions on exports, investment, innovation and quality	- Create and implement a Ministerial Committee of Exports, Innovation and Quality (CMEIIC) - Elaborate mechanisms for the functioning of the CEMEIIC - The CMEIIC will be responsible for stimulating actions to strengthen the country's business climate
	Strengthening the links between government and the private sector	- Incorporation of members of the private sector in committees and/or boards of relevant programmes or instruments **- Joint management of training programmes for representatives of the private sector on trade negotiations and other disciplines which strengthen their capacity as a trade association** - Jointly disseminate the programmes/instruments contemplated in the export strategy

Note: The strategic areas and lines of action most relevant to STI are shown in bold.
Source: UNCTAD, based on MINEC (2010).

ANNEX B. DEVELOPMENT AND LIMITATIONS OF THE NATIONAL SYSTEMS OF INNOVATION APPROACH. THE CONCEPT OF SYSTEMS IN THE TECHNOLOGICAL INNOVATION LITERATURE

The origin of the use of the concept of systems associated with innovation studies can be found in the evolution of the concept of innovation itself. These early associations between concepts of systems and innovation, which began during the seventies in works by various academics around Christopher Freeman and the Science Policy Research Unit (SPRU)[3], implied the conceptualization of this phenomenon as a non-linear process which involves the coordinated participation of a wide range of actors.

The subsequent use of these concepts, up to the late eighties and early nineties, appeared in three seminal works which introduced the idea of national systems of innovation[4]. It involved extending the idea of networks of agents in the innovation process to include the role played by institutions[5]. These original interpretations did not lead to a unified concept of national system of innovation,[6] probably because the main proponents belonged to different research traditions, in which the common denominator was affinity with the ideas of the economist Joseph Schumpeter.

The main objective of these original interpretations of nationals innovation systems was to explain national economic development patterns through the analysis of the interactions between the actors and institutions involved in innovation networks. Linked to this primary objective, there was also an implicit, and sometimes explicit, orientation towards the design of innovation policies.[7]

Despite their leaning towards policies, none of the original interpretations included an operative version of the systems of innovation approach. This was essentially developed by the OECD, which adopted the concept in the early nineties (David and Foray, 1994; OECD, 1992). From that stemmed what we may call the general interpretation of the approach, which means that specific national systems can be sufficiently described by listing the principal components (agents and institutions) involved in the processes of innovation and the study of their most significant interactions. The analysis of how these interactions give form to successful systems of innovation is the basis for identifying "best practices" and the fundamental components. These then serve as a guide to institutional and organizational learning in the international environment. This general interpretation, refined in various reports and studies[8], is the one usually used in studies of systems of innovation.

The current interpretation of systems of innovation is not entirely consistent with the systems approach. For example, the objectives of the approaches vary. The original interpretation of national systems of innovation leaned towards the identification of differences in the innovative performance of different countries. In particular, how different national institutions influenced the success of systems of innovation. In contrast, systems theory is based on the identification of elements, functions, behaviours, etc. which are similar[9] across different areas. This means that systems of any kind operate according to the same basic principles. Ideally, therefore, it should be possible to deduce the principles applicable to particular systems from the more general[10].

Moreover, the systems of innovation approach was fundamentally based on a traditional definition of systems as entities composed of elements and interactions, and does not address aspects concerning the hierarchical structure of systems, treatment of the environment and analysis of the processes which occur within the system.[11] Open systems theory replaced this traditional concept with one in which the system is distinguished from its environment (Checkland 1981; Luhmann 1995; von Bertalanffy 1968). It introduced two pairs of ideas which constitute the basis of systems thinking: emergence and hierarchy and communication and control. In other words, new systems emerge from the interaction between subsystems, while the various hierarchies between the whole and its components allow differentiation with respect to the environment. These interactions require diverse communication mechanisms whose function is to control the system in its tendency to stabilization.

The application of the systems of innovation framework also presents certain paradoxes. One of them is the dual perspective of the concept of system of innovation. On the one hand, it is a reference framework to explain the reality. On the other, it is also adopted as regulatory posture and

the framework becomes a model of how the reality should be organized. Thus, instead of being a faithful representation of observed reality, it becomes one which is filtered through a predetermined structure. For example, undertaking innovation processes is a desirable state for a company to be successful, but in no way does it represent the only way in which that company grows nor could it represent the state of all companies.

In short, the concept of systems of innovation can only be generalized as an analytical framework which assumes the need for articulation (interaction) between economic agents, but does not provide elements to deal systematically with those agents. In other words, it does not explain how those agents organize themselves hierarchically to form emerging systems of growing complexity.

Consequently, studies carried out within this framework frequently describe supposed subsystems whose interactions constitute national systems of innovation, but they do not present details which would allow evaluation of whether the agents actually constitute such subsystems, for example a sufficiently mature and developed industrial or research subsystem. In other words, it is generally assumed that these subsystems are given and it is only necessary to consider the development of institutions, organizations, policy instruments, etc. (through learning or replication of international experience) which encourage the interrelation of those subsystems. Naturally, this perspective works fairly well in countries which, for historical reasons, actually have such subsystems. However, it would be pointless in countries where those subsystems do not exists or are in a maturing or consolidating phase.

ANNEX C. REGIONAL SYSTEMS OF INNOVATION (RSI)

This concept is usually understood as an interacting set of public and private interests and formal organizations and institutions which operate in accordance with organizational and institutional rules as well as relations which lead to the generation, use and dissemination of knowledge (Doloreux 2004; Doloreux and Parto 2005). The fundamental argument is that this set of actors produces systemic effects which stimulate enterprises within regions to develop specific forms of capital derived from social relations, regulations, values and interactions within the community, which themselves strengthen capacities for innovation and competitiveness.

The origin of the concept relies on two main bodies of theory and research. The first of these is found in the literature on innovation systems itself. The second body of research corresponds to regional studies whose approach is aimed at explaining the socio-institutional environments within which innovation emerges (Malmberg and Maskell 1997). From a regional perspective, innovation is a localized phenomenon in a local setting, and not a universal process. Consequently, this literature deals both with the role played by proximity (the benefits derived from the advantages of localization and geographical concentration) and the set of regional rules, standards and conventions through which the process of generation and dissemination of knowledge occurs (Kirat and Lung, 1999). In other words, a regional system of innovation is characterized by collaboration in innovation activities between companies, knowledge-generating organizations and the culture and institutions which promote innovation, thus allowing the system to evolve over time.

The concept of RSI has emerged in various countries at times when public policies seek to focus on the promotion of truly localized processes for generating knowledge which ensure the competitiveness of the regions. The main justification for conceiving specific policies targeted within regional systems is based on their greater capacity to concentrate on the development of the capacities of companies in terms of performance, as well as improving their business environment. From this point of view, it is of considerable importance to promote interactions between the various actors who should have good reasons for interacting, such as those between companies, universities and research centres, or between emerging companies and other more developed ones (Cooke, 2001). On this basis, policy strategies can also be directed to the development of local comparative advantages, linked to the specific resources of the regions concerned.

ANNEX D. PATENT ANALYSIS

1. Note on methodology

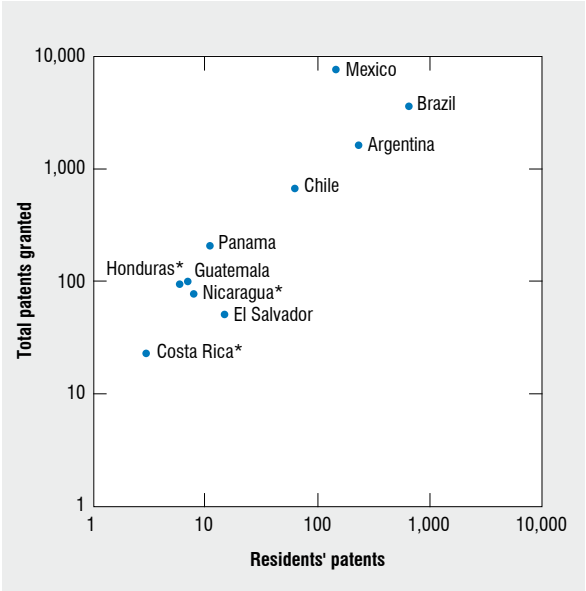
Two sources of information on patents are used: initially, for purposes of comparison, data from the Ibero-American Network of Science and Technology Indicators (RICYT) were used,[12] corresponding to aggregate patenting patterns in Central America and certain Latin American economies, from 2002 to 2008. Secondly, to have additional information to that provided by aggregate indicators which are limited to the number of patents by resident and non-resident, a search was made of the Espacenet database of Latin American patents,[13] of all patents registered in which one of the inventors was resident in El Salvador.[14] 132 patents between 1993 and 2010 were located. The results of the analysis are presented below.

2. Results

Very few patents were registered by residents in El Salvador in the period studies, with an average of less than 8 patents per year in the Espacenet records and 15 in those of RICYT. Despite an upward trend, there was a decline between 2005 and 2009 (Figures D.3 and D.4). Using the RICYT data as a basis for comparison, this pattern of patenting intensity is very similar in the Central American region, where, in fact, El Salvador is the best placed, with a higher annual average of patents granted to residents and a better ratio in this respect to the total (Figure D.1) and in relation to non-resident patents (Figure D.2). It also shows a coefficient of invention (patents applied for by residents in relation to the population) only below that of Costa Rica (Figure D.3).

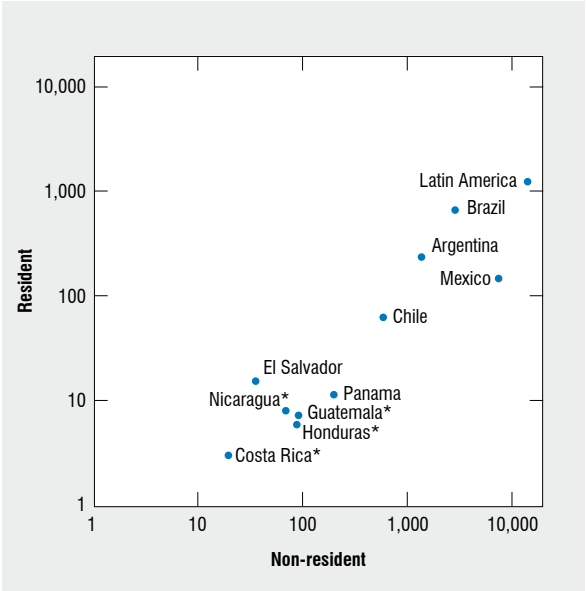
Figure D.1 shows an indicator close to what RICYT calls the self-sufficiency rate (resident patent applications to total patents applied for) and El Salvador's position is the best of the countries shown (because it is closer to the diagonal line which starts from the origin of the graph). Similarly, Figure D.2 shows an indicator close to that indicated by RICYT, dependency rate (non-resident patent applications to applications by residents) and, again, El Salvador's position is the best among the Central American countries.

Figure D.1. Ratio of the annual average patents granted to residents and total patents granted in Central American countries and selected Latin American countries, 2000-2008 (logarithmic scale)



Note: the asterisks indicate that the data series are incomplete.
Source: UNCTAD, based on RICYT data.

Figure D.2. Ratio of the average patents granted annually to non-residents and residents in Central American countries and selected Latin American countries, 2000-2008 (logarithmic scale)

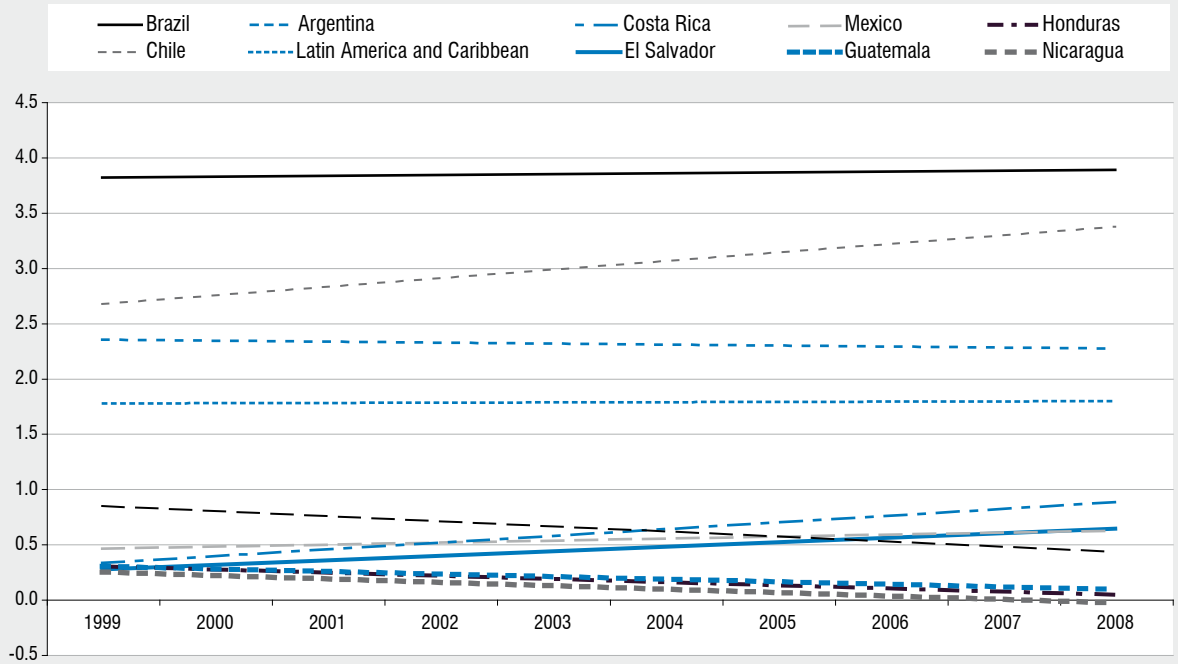


Note: the asterisks indicate that the data series are incomplete.
Source: UNCTAD, based on RICYT data.

Although this comparative information is encouraging, it should not be forgotten that the intensity of patenting in a country is multifactorial and reflects, among other things, the size of the economy, patterns of industrial specialization, the size of the domestic market, its international trade, exports, etc. When we take all these factors into account, we see that although El Salvador's indicators are balanced and positive, they also show a small economy, with a small domestic market and little export capacity for high-technology products (see also Figure 7 in Chapter II).

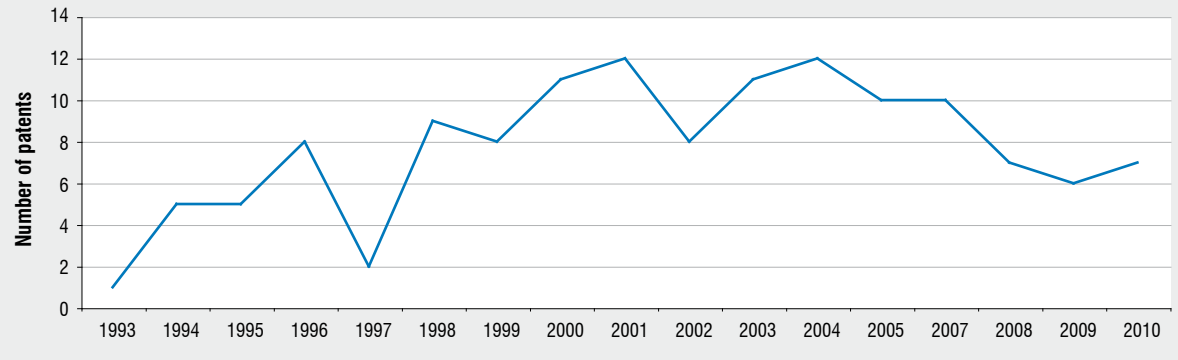
For more detailed information, Figures D.5 and D.6 show that although inventors who apply for patents live in El Salvador, the owners of the rights are essentially foreign companies. In addition, to provide some useful information on the productive specialisation of the country, Tables D.1 to D.5 show the principal areas in which patents are obtained, the companies which hold the greatest number of patents and the countries to which they belong (two periods have also been distinguished: a general one, from 1993 to 2010, and another covering only the last ten years).

Figure D.3. Trends in coefficients of invention of Central American countries and certain Latin American economies, 1999-2008



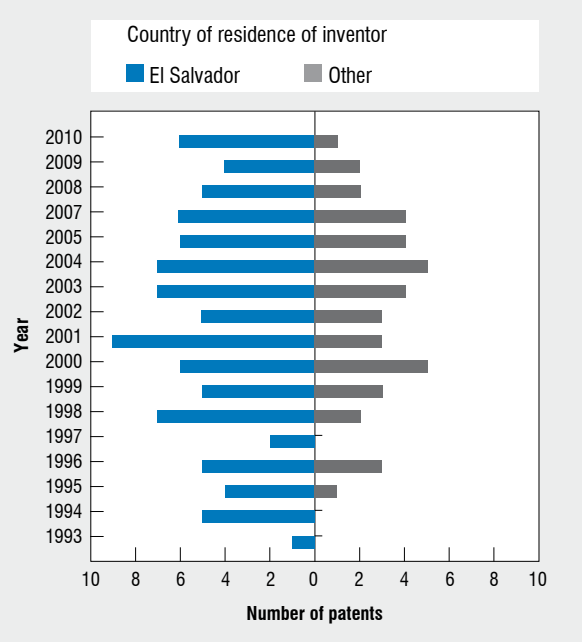
Note: The coefficient of invention is the number of patents applied for by residents per 100,000 inhabitants.
Source: UNCTAD, based on RICYT data.

Figure D.4. Number of patents with at least one inventor resident in El Salvador, 1993-2010



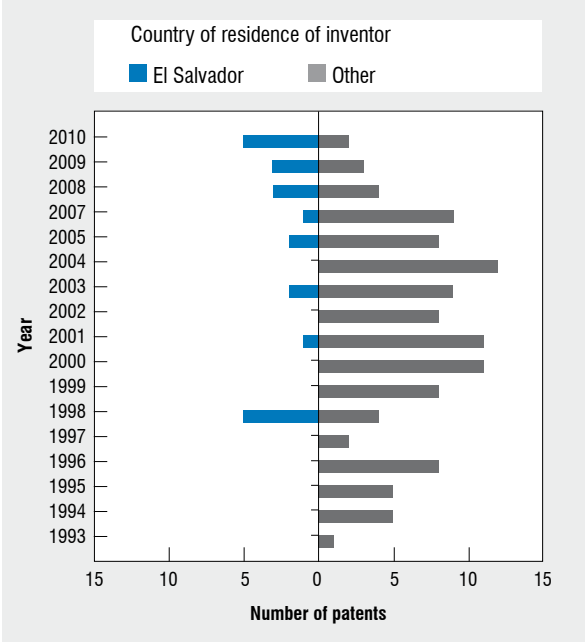
Source: UNCTAD, based on Espacenet data.

Figure D.5. Distribution of patents by country of residence of primary inventor, 1993-2010



Source: UNCTAD, based on Espacenet data.

Figure D.6. Distribution of patents by country of residence of primary owner, 1993-2010



Source: UNCTAD, based on Espacenet data.

Table D.1. Principal classes of patents registered (international classification), 1993–2010

Class	N° of patents	Percentage of total
Medical or veterinary science	18	13.64
Basic electric elements	6	4.55
Combustion engines	6	4.55
Electric communication technique	6	4.55
Foods or foodstuffs	6	4.55
Agriculture	5	3.79
Combustion apparatus	5	3.79
Conveying	5	3.79
Furniture	5	3.79
Building	4	3.03
Computing	4	3.03
Generation, conversion, or distribution of electric power	4	3.03
Organic chemistry	4	3.03
Engineering elements or units	3	2.27
Information storage	3	2.27
Organic macromolecular compounds	3	2.27
Vehicles in general	3	2.27
Animal or vegetable oils	2	1.52
Biochemistry	2	1.52
Hand cutting tools	2	1.52
Hand or travelling articles	2	1.52
Hoisting	2	1.52
Machine tools	2	1.52
Machines or engines in general	2	1.52
Physical or chemical processes	2	1.52
Working of plastics	2	1.52

Source: UNCTAD, based on Espacenet data.

Table D.2. Principal countries of origin of holders of patents registered, 1993–2010

Country of patent holder	N° of patents	Percentage of total
Sweden	38	28.79
United States of América	26	19.70
El Salvador	22	16.67
Switzerland	6	4.55
Germany	5	3.79
Finland	4	3.03
Japan	2	1.52
The Netherlands	2	1.52

Source: UNCTAD, based on Espacenet data.

Table D.3. Principal holders of patents registered, 1993–2010

Patent holder (company or person)	N° of patents	Percentage of total
Asea Brown Boveri	4	3.03
Ericsson Telefon ab l m	4	3.03
IBM	4	3.03
Nestlé SA	3	2.27
ABB ab	2	1.52
Borealis Tech oy	2	1.52
Campos Marcia José Luis Arturo	2	1.52
Distribuidora Shell de El Salvador	2	1.52
Electrolux res & innovation	2	1.52
Ford Global Tech Inc	2	1.52
Manufacturas Humberto Bukele e	2	1.52
Motorola Inc	2	1.52
Químicas Lasser de El Salvador	2	1.52
Texas Instruments Inc	2	1.52
Vásquez Valiente Maria Eugenia	2	1.52
Volvo Car Corp	2	1.52

Source: UNCTAD, based on Espacenet data.

Table D.4. Principal* classes of patents and principal* patent holders, 2001–2010

	Total	Ericsson Telefon Ab L M	IBM	Nestlé SA	ABB ab	Borealis Tech Oy	Campos Marcia Jose Luis	Ford Global Tech Inc	Manufacturas Humberto Bukele E	Nunez Suarez Rene Mauric	Oestreich Gerd	Texas Instruments Inc	Underphone Ab	Vasquez Valiente Maria E	Volvo Car Corp
Total	**79**	**5**	**3**	**3**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**2**
Medical or veterinary science	8										1				
Combustion engines	6						1	2							
Electric communication technique	5	3													
Foods or foodstuffs	5			3											
Agriculture	4														
Conveying	4												2		
Organic chemistry	4								2						
Basic electric elements	3		1		1							1			
Computing	3	2													
Furniture	3													1	
Biochemistry	2														
Building	2														
Combustion apparatus	2									2					
Information storage	2		2												
Machines or engines in general	2						1								1
Organic macromolecular compounds	2					2									

**Note: the thresholds for classes and patent holders were set at two patents.*

Source: UNCTAD, based on Espacenet data.

Table D.5. Principal* classes of patents and patent holders, 2001–2010

	Ericsson Telefon Ab L M	IBM	Nestlé SA	ABB Ab	Borealis Tech Oy	Campos Marcia Jose Luis	Ford Global Tech Inc	Manufacturas Humberto Bukele E	Nunez Suarez Rene Mauric	Oestreich Gerd	Texas Instruments Inc	Underphone Ab	Vasquez Valiente Maria E	Volvo Car Corp	Basf Se	Ct De Cooperation Intern	Currency Venture Sweden	Dsm Nv	Fitness Conection SA De	Ford Global Tech Llc	Inclan Robredo Margarita	Invacare Internat Sarl	Jean Charles Inc	Lopez S A De C V Lab	Manufacturas Humberto To	Mazariego Pena Eustaquio	Meardi Guevara Angel	Monterrosa Amaya Saul An	Mygarb Inc	Nokia Corp	Nokia Mobile Phones Ltd	P & B Res Ab	Pharmacia Ab	Posada Pedro	Ruffatti Paz Salvador Ro	Sca Hygiene Products Hol	Syngenta Participations	Tapachulteca Ii	Univ Liege	Ventura Hernandez Jose D	Vertex Pharma	Volvo Penta Ab	Wolff Walsrode Ag
Medical or veterinary science										1												1		1			1					1	1				1			1		
Combustion engines						1	2										1			1																				1	
Electric communication techs	3																												1	1											
Foods or foodstuffs			3																1																				1			
Agriculture															1	1					1													1								
Conveying												2																							1							1
Organic chemistry								2																	1											1						
Basic electric elements		1		1							1																														
Computing	2																											1													
Furniture													1										1				1														
Biochemistry																		1																			1				
Building																									1								1								
Combustion apparatus									2																																
Information storage		2																																							
Machines or engines in general						1								1																											
Organic macromolecular comp					2																																				

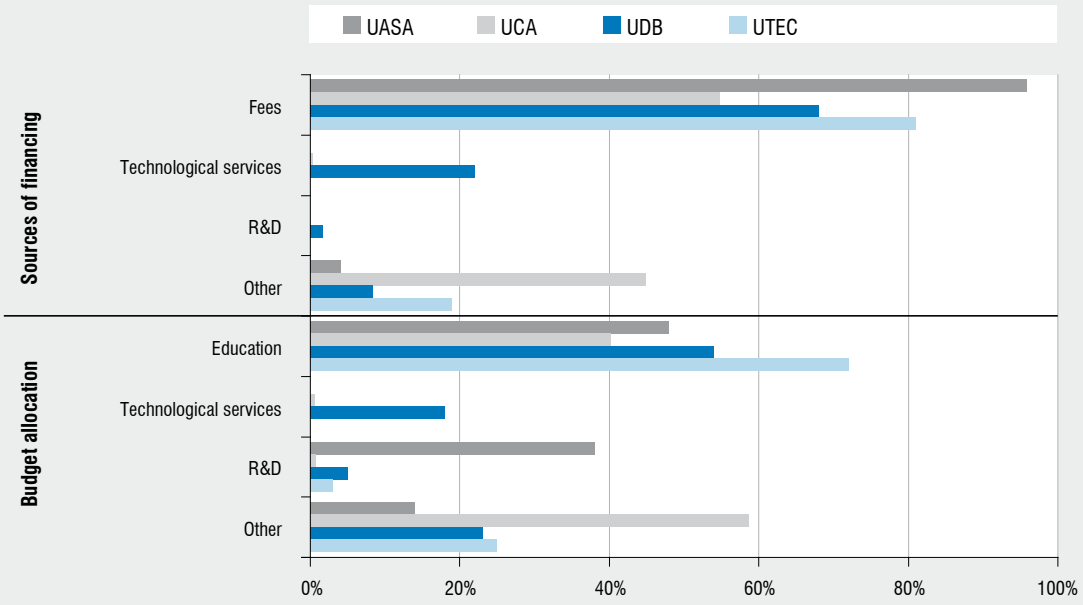
**Note: the thresholds for classes were set at two patents and the holders of each patent are shown in the corresponding classes.*

Source: UNCTAD, based on Espacenet data.

ANNEX E. INFORMATION ON HIGHER EDUCATION INSTITUTIONS

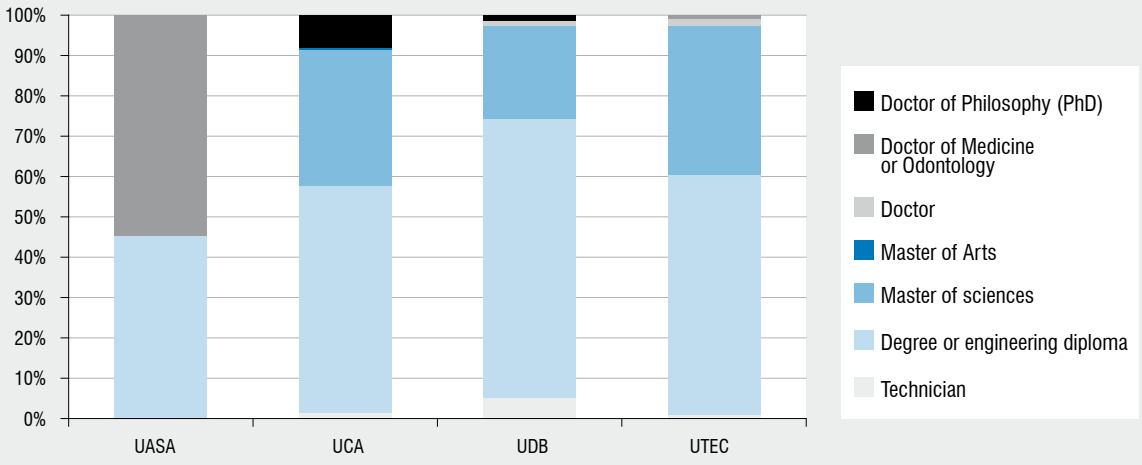
Selected data from a brief survey carried out by the Directorate of Innovation and Technological Development (DIDT) of MINEC, which provide some evidence (although not statistically significant) of aspects of higher education and research in El Salvador. The institutions which replied to the questionnaire were the Autonomous University of Santa Ana (UASA), the Central American University (UCA), Don Bosco University (UDB) and the Technological University (UTEC).

Figure E.1. Sources of financing and budget allocation



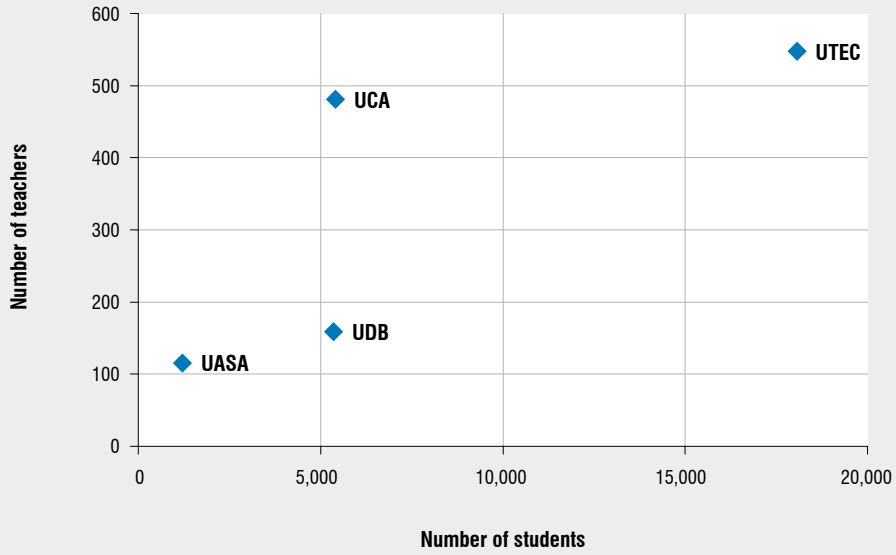
Source: UNCTAD, based on data collected by DIDT.

Figure E.2. Proportion of academic grades among teaching staff



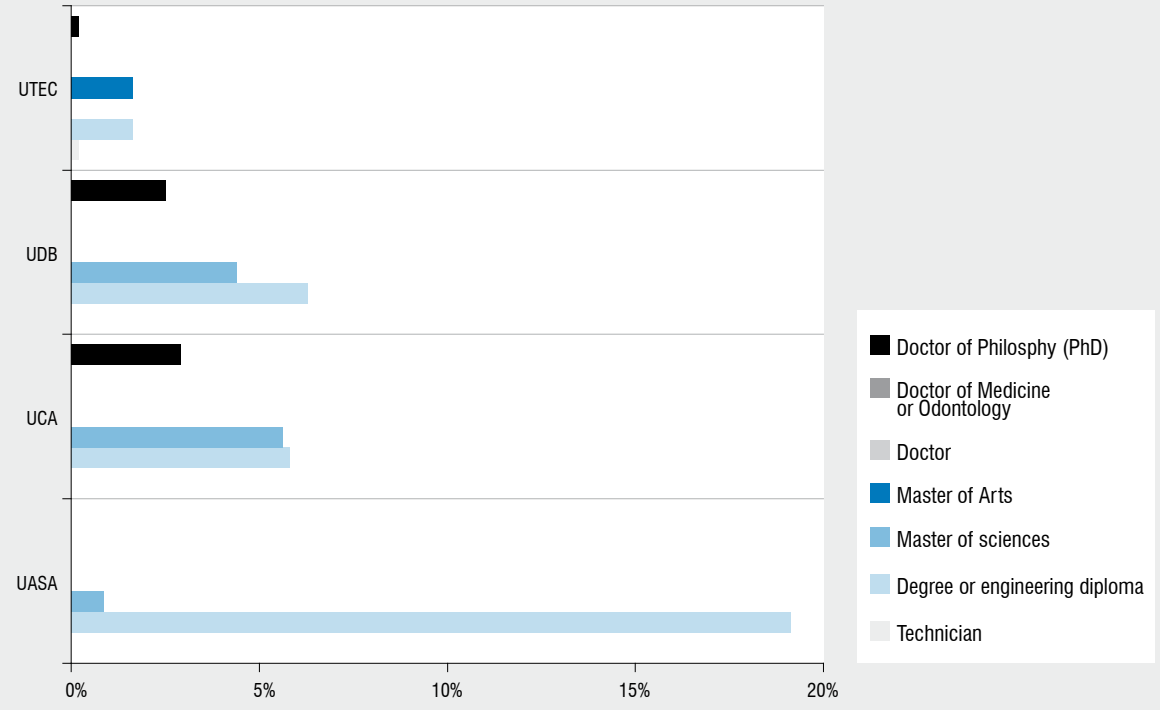
Source: UNCTAD, based on data collected by DIDT.

Figure E.3. Student-teacher ratio



Source: UNCTAD, based on data collected by DIDT.

Figure E.4. Ratio of research staff, by adademic level, to total teaching staff



Source: UNCTAD, based on data collected by DIDT.

ANNEX F. BIBLIOMETRIC STUDY OF SALVADORIAN SCIENTIFIC OUTPUT

1. Note on methodology

This brief bibliometric study is intended to assist in identifying the strongest areas of research in El Salvador, in order to guide decision making with regard to setting STI priorities. In general terms, the study measures the "international visibility" and other attributes of publications in which Salvadorian researchers participated during a specific period. In this case, it was decided to include all recorded output. This international visibility is determined, in this type of study, on the basis of the publication in indexed journals, i.e. journals whose bibliographies and references cited in each of its articles are automatically recorded in databases of recognized prestige.[15] In this study, the ISI[16] Web of Knowledge database of Thomson Reuters, the most widely recognized internationally, was used.

For the study, all articles published in journals were collected,[17] up to the first fortnight of September 2010, in which an author registered as resident in El Salvador participated. Once the bibliographic records had been extracted, the following database fields were used: name of author, title of article, authors' addresses, address of principal author, institution in which the research was carried out, subject category (according to the ISI), key words assigned by the authors, key words assigned by the ISI and number of citations of the article (at the date of collection of the data). For comparative purposes, publications of the Central American countries and some of the most important economies in Latin America were collected, in this case limited to the period 2000 to 2010 (Figures F.3 and F.4).

By using spread sheets, statistical programmes and specialized bibliometric analysis programmes, the various fields were processed to obtain graphs and tables which show indicators such as: the number of articles by subject category, differentiating between the institution and country of residence of the principal author; the impact of articles by subject category and by institutions, differentiating the country of residence of the principal author; the research subjects in which there is the greatest scientific output; the collaboration networks established with other countries for research purposes, etc.

With regard to the subjects and patterns of research, various analytical methods were used: construction of networks and statistical processes. The first type of method was used to identify the most frequently recurring groups of research headings and their relationships, taking into account the total number of articles, and also the subject groups in which the greatest amount of research was carried out and their relationships. On the other hand, the statistical methods were used to make comparisons between articles in which the primary author was based in El Salvador and those where the primary author was based abroad. The following variables were used for this analysis: number of publications and their impact by subject group; number of publications and their impact by country; and number of publications and their impact by Salvadorian institution.

The impact, which is an indicator used on various occasions in this study, is generally defined as the number of citations divided by the number of publications. In this case, it is the number of citations received by articles in each subject category and each country, divided by the total number of publications in that category and country during the period determined by the study. It is an indicator which provides an approximation of the level of quality of the articles, by relating the articles which the scientific community considers useful for its work (by means of citations) to the total volume of published articles.

Interpretation of the networks

Some of the graphs used in bibliometrics are networks which refer to different types of relationships. The networks are formed of nodes and connectors (relations). In the example of Figure F.1, the countries are the nodes and the lines which connect them, the relations. Depending on the type of analysis which is being carried out, it is important to distinguish between three aspects of the networks: the frequency of appearance of each node (number in the rectangle next to the name of the country); the frequency with which each node is paired with another (frequency of pairs, represented by the number enclosed in a circle on the connector); and the number of relations which each node has with the rest, or connectivity (number of lines issuing from each node).

Thus, in the example, the El Salvador node has a

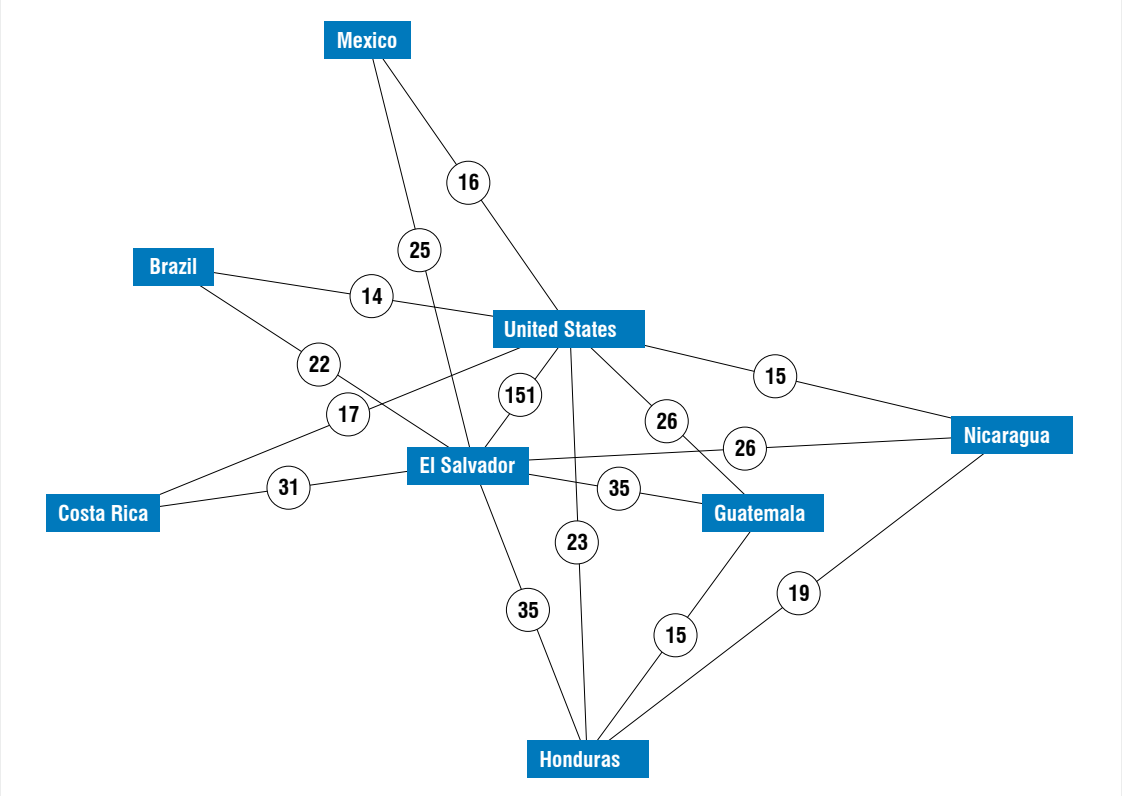
frequency of pairs of 151 with the United States, representing the number of times a Salvadorian and American appear as co-authors of an article. It has a connectivity of seven, indicating co-authorship relations with seven countries. The example in Figure F.1 is a highly simplified network, as it uses thresholds of these factors to eliminate their complexity, improve understanding and extract more significant conclusions.

2. Results

420 publications were identified in indexed journals in which authors resident in El Salvador had participated.[18] Of this total, in 186 cases, they appears as the primary authors, which means in recent years an average of 4 articles per year in this type of medium (see Figure F.2). In absolute terms, the number of articles is low. If historic information on investment in R&D and human resources involved in scientific and technological activities were available, real productivity could be estimated with greater precisions. Nevertheless, Figure F.3 shows that El Salvador has the lowest scientific output in Central America, despite having a better economic position than Guatemala, Honduras and Nicaragua.

Also for comparative purposes, Figure F.4 shows that Guatemala, El Salvador, Honduras and Nicaragua have a greater research output in the social sciences and humanities than the other countries (although the difference is small and the proportion with respect to natural sciences is less than 20 per cent). However, in the case of El Salvador, Figure F.4 is highly significant when taking into account the data on expenditure on scientific and technological activities such as R&D. As can be seen from Figure F.5, total expenditure on the social sciences and humanities in 2008 was approximately 45 and 55 per cent for each of these headings. In other words, there is a great disparity

Figure F.1. Example of a network



Source: UNCTAD.

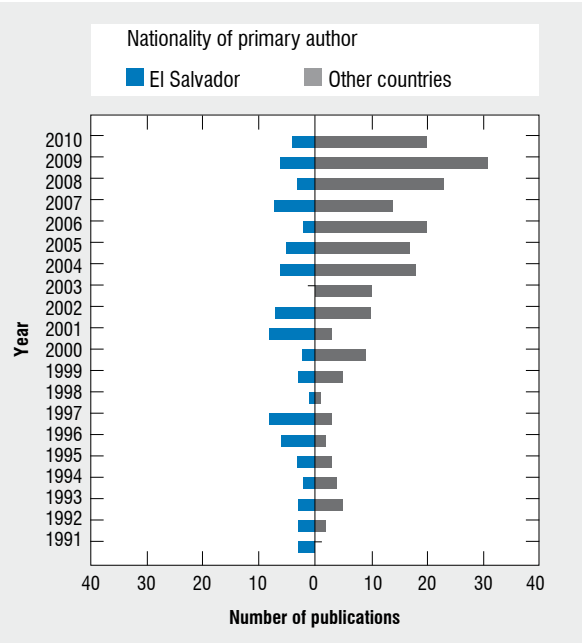
between research output by areas of knowledge, in that the areas which receive less than 50 per cent of the budget produce over 80 per cent of the scientific output with international visibility.

The joint research relations take place essentially with the United States and, to a lesser extent, with Spain and the neighbouring countries of Central America – Honduras, Guatemala and Costa Rica (see Figure F.7). Figure F.6 shows the pattern of joint publications where the principal authors are in El Salvador and the United States, observing that output of the latter has been growing since 2000, as well as the general greater impact of works where the primary author is resident in the United States.

The research subjects where intensity of publication is greatest are public, environmental and occupational health, especially tropical medicine, dermatology, infectious diseases and oncology. There is also considerable output in plant sciences, their pharmacological applications and biochemical supports. Other areas which stand out are ecology, zoology, entomology, veterinary sciences and earth sciences (Figure F.8). Figures F.9 and F.10 show, respectively, the comparison between subject areas with the most publications and those with the greatest impact on the scientific community. With respect to the latter, the areas which stand out, taking into account the totality of the articles, are immunology, research into the respiratory system, meteorology and atmospheric sciences, and food science and technology.

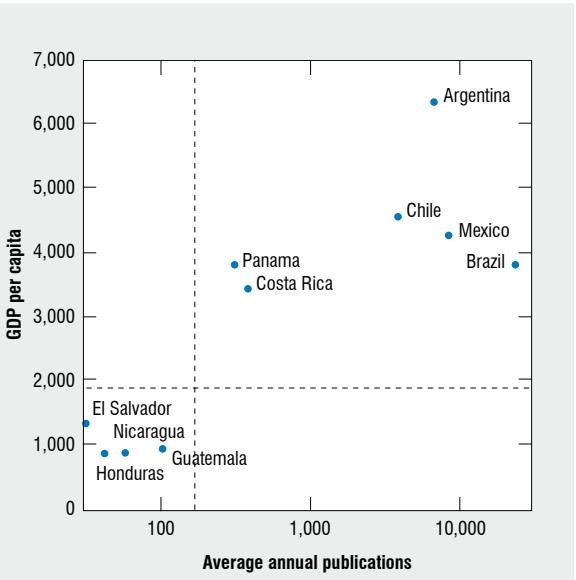
On the other hand, taking into account only articles in which the primary author is resident in El Salvador (Figures F.11 and F.12), the publications with the greatest impact relate to oncology, orthopaedics, health policy and services, paediatrics, andrology, nutrition and ophthalmology. Finally, the research bodies with the greatest output are, in first place, the University of El Salvador, followed a long way behind by the Central American University, the Center for Disease Control and Prevention, CENTA and the US Department of Health and Human Services (Figure F.13). However, considering the impact of publications, research by Salvadorian bodies appears to have little impact (less than 5 citations per article) with the exception of Rosales Hospital (Figure F.14).

Figure F.2. Total number of publications by nationality of primary author, 1991-2010



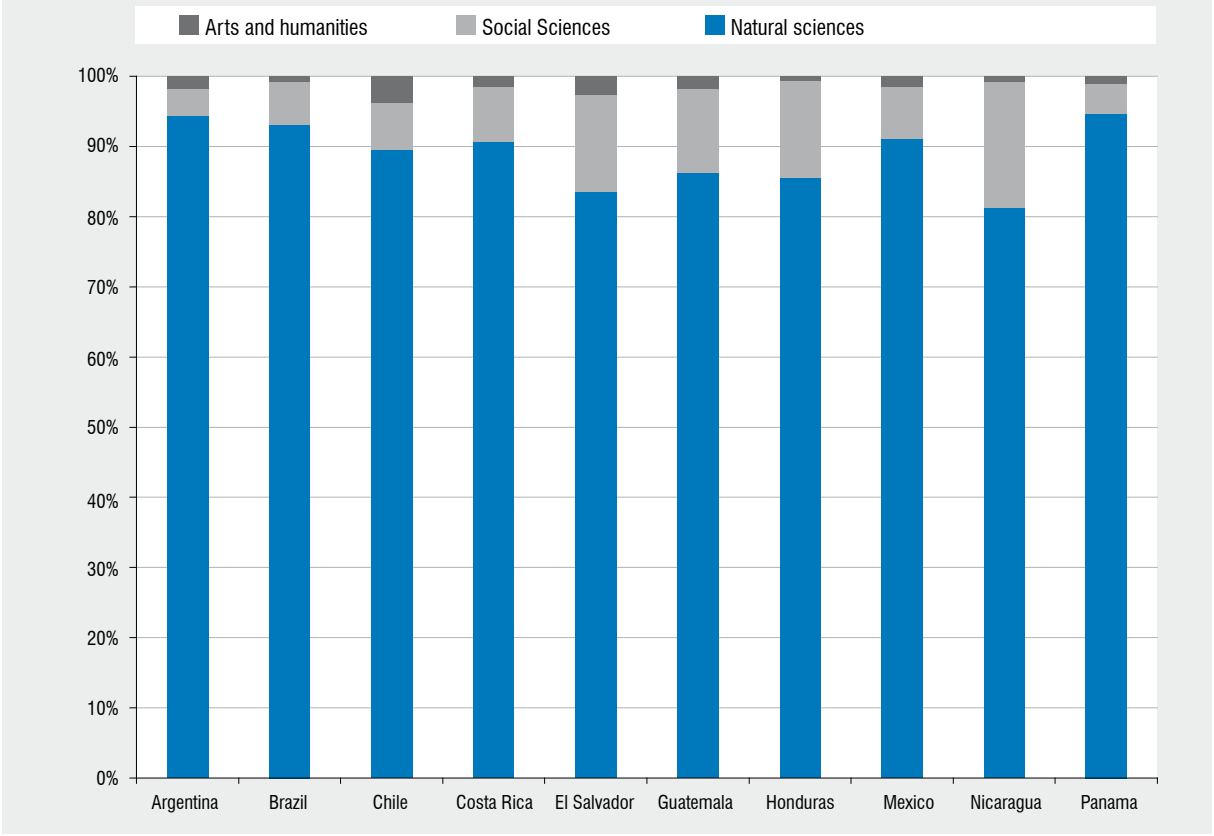
Source: UNCTAD, based on ISI Web of Knowledge data.

Figure F.3. Comparison of scientific output in Central America and certain Latin American countries, 2000-2010 (x-axis on logarithmic scale)



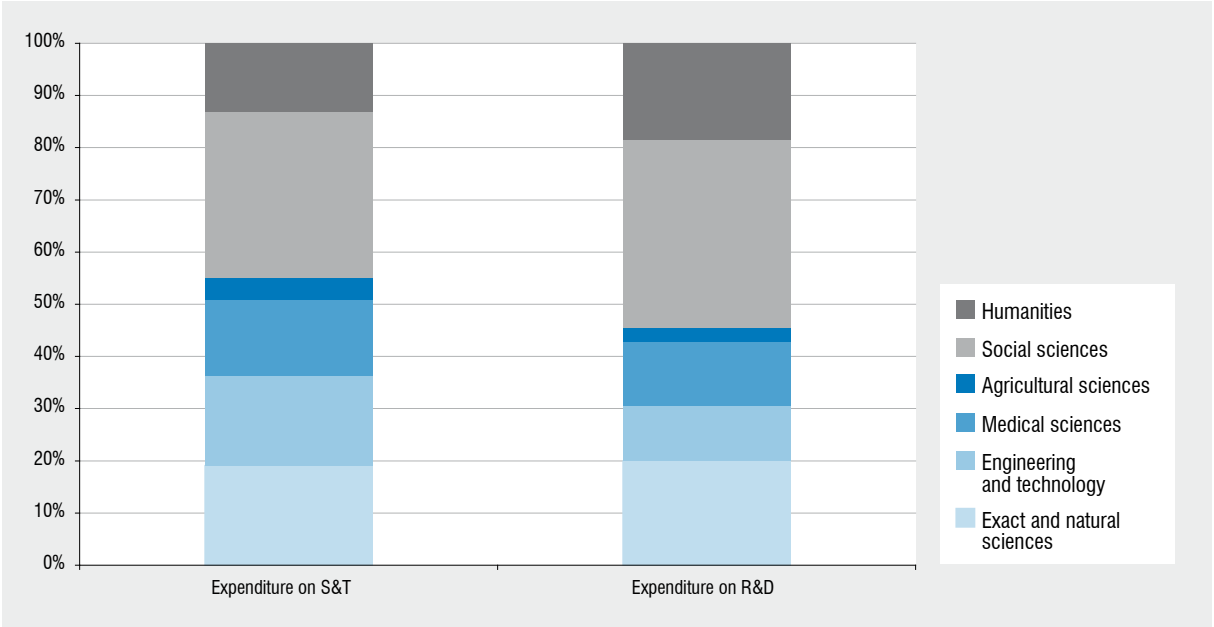
Source: UNCTAD, based on ISI Web of Knowledge data.

Figure F.4. Distribution of scientific and humanist output in Central America and certain Latin American countries, 2000-2010



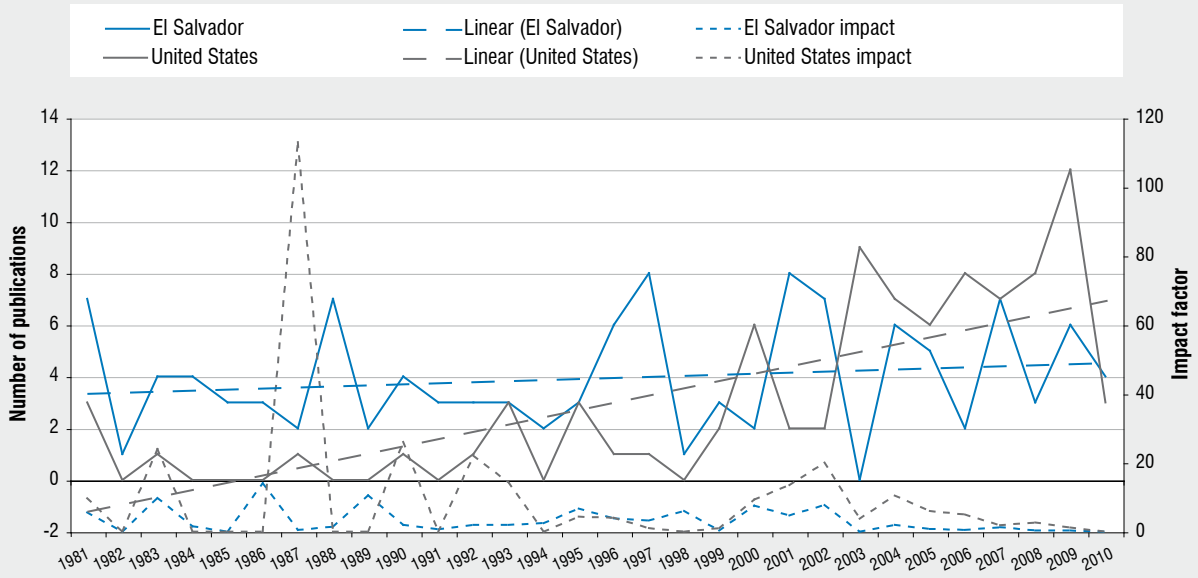
Source: UNCTAD, based on ISI Web of Knowledge data.

Figure F.5. Expenditure on scientific and techological research and development by area of knowledge, 2009



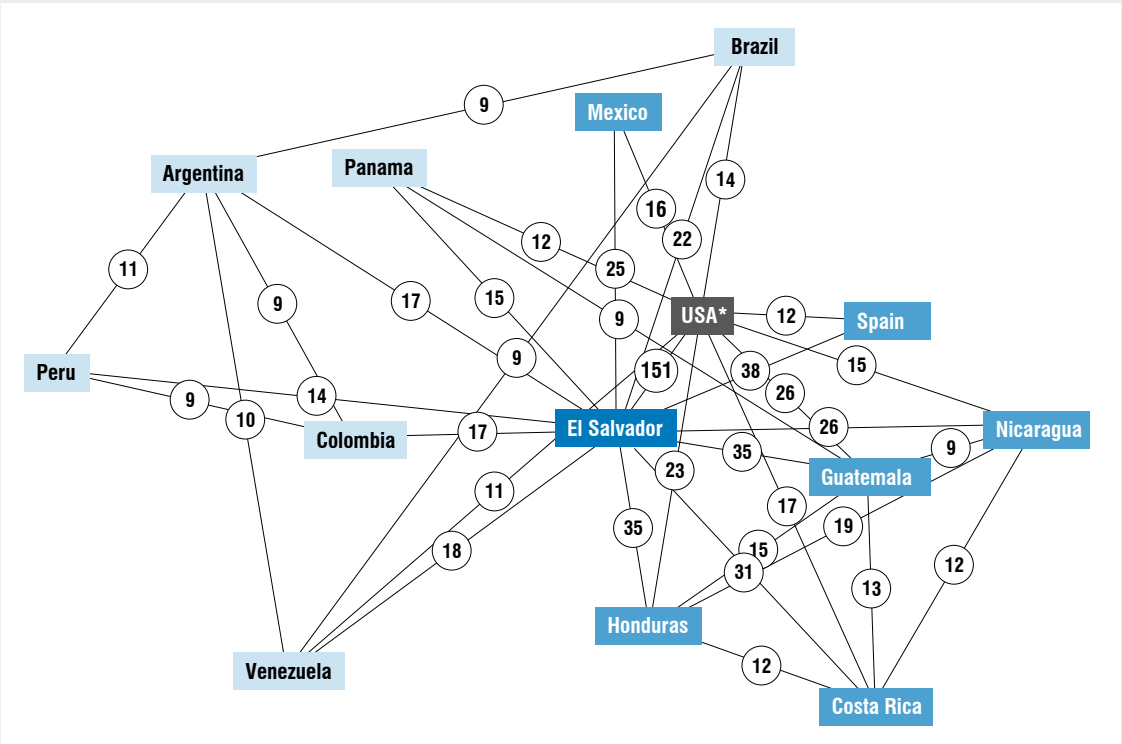
Source: CONACYT 2010.

Figure F.6. Patterns of publications of articles whose primary author resides in El Salvador and the United States and annual impact factor, 1981-2010



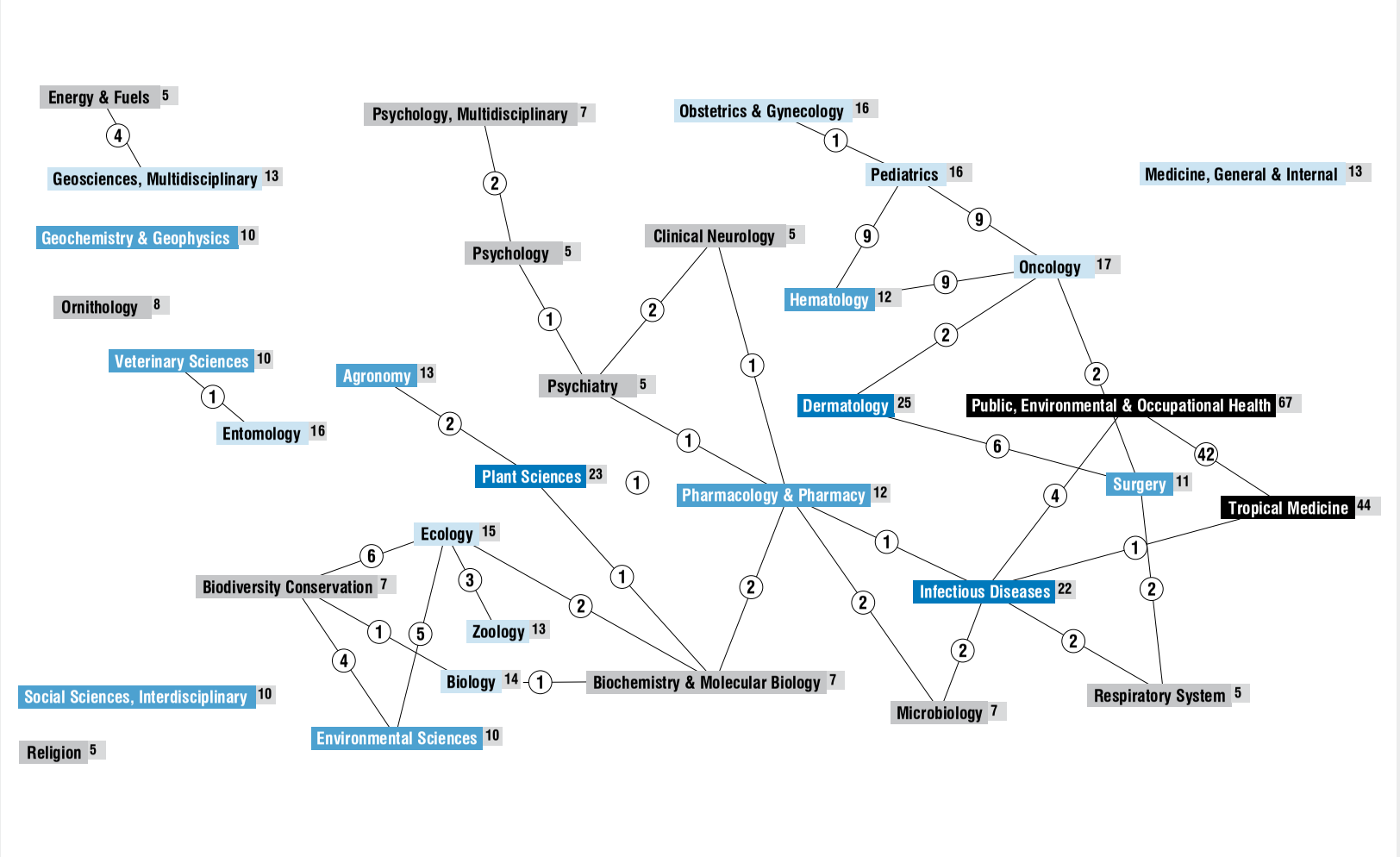
Source: UNCTAD, based on ISI Web of Knowledge data.

Figure F.7. Network of collaboration between authors by country of residence



** United States of America.*
Source: UNCTAD, based on ISI Web of Knowledge data.

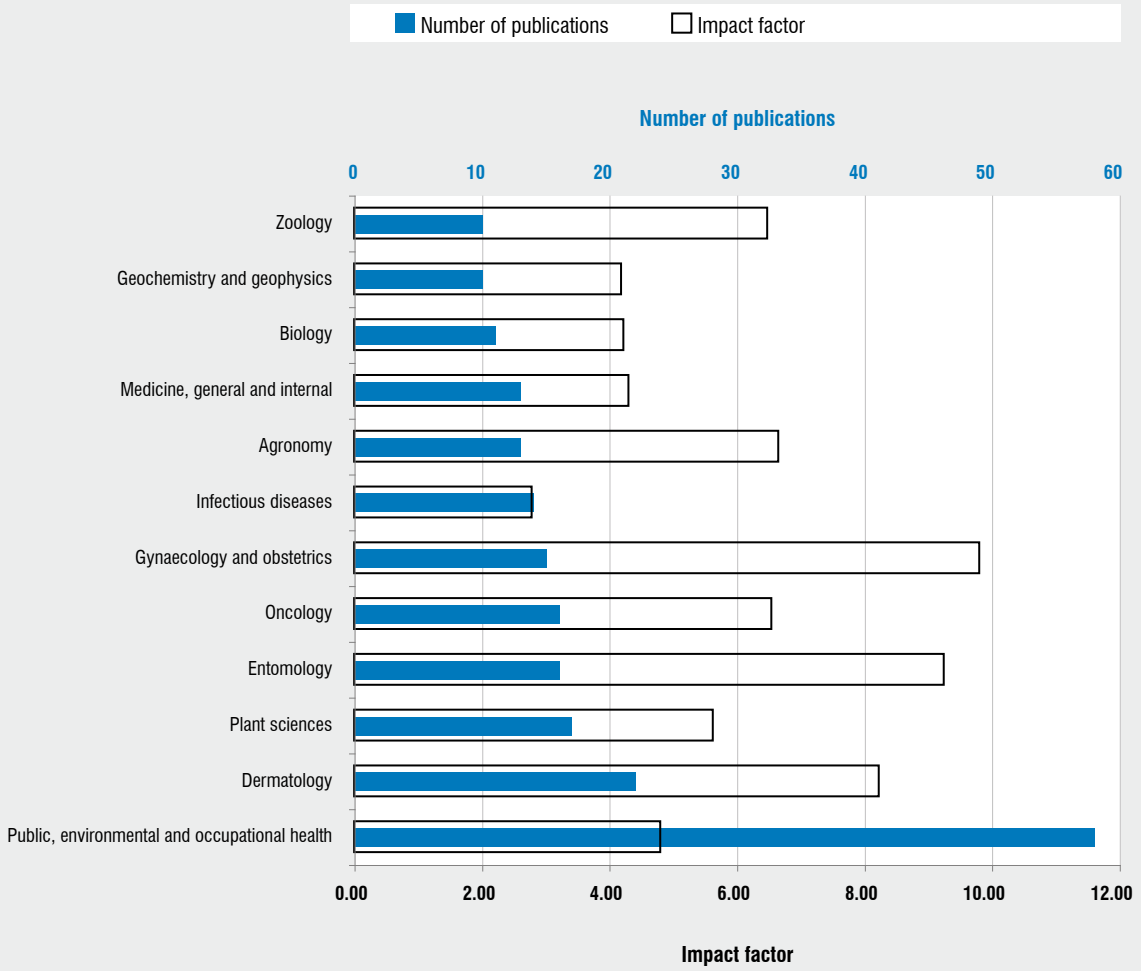
Figure F.8. Research patterns based on co-occurrence of subject categories*, considering totality of articles



** Subject categories assigned by ISI.*

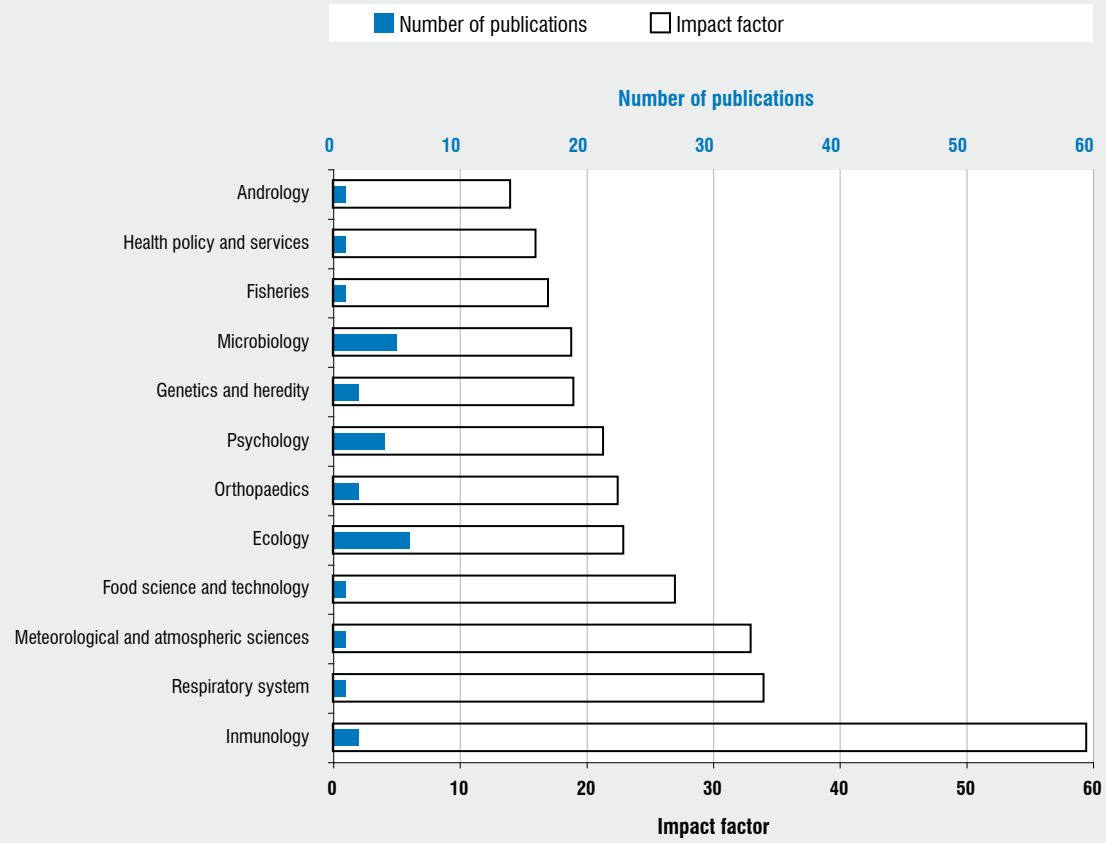
Source: UNCTAD, based on ISI Web of Knowledge data.

Figure F.9. Principal subject categories ranked by number of publications (including impact factor)



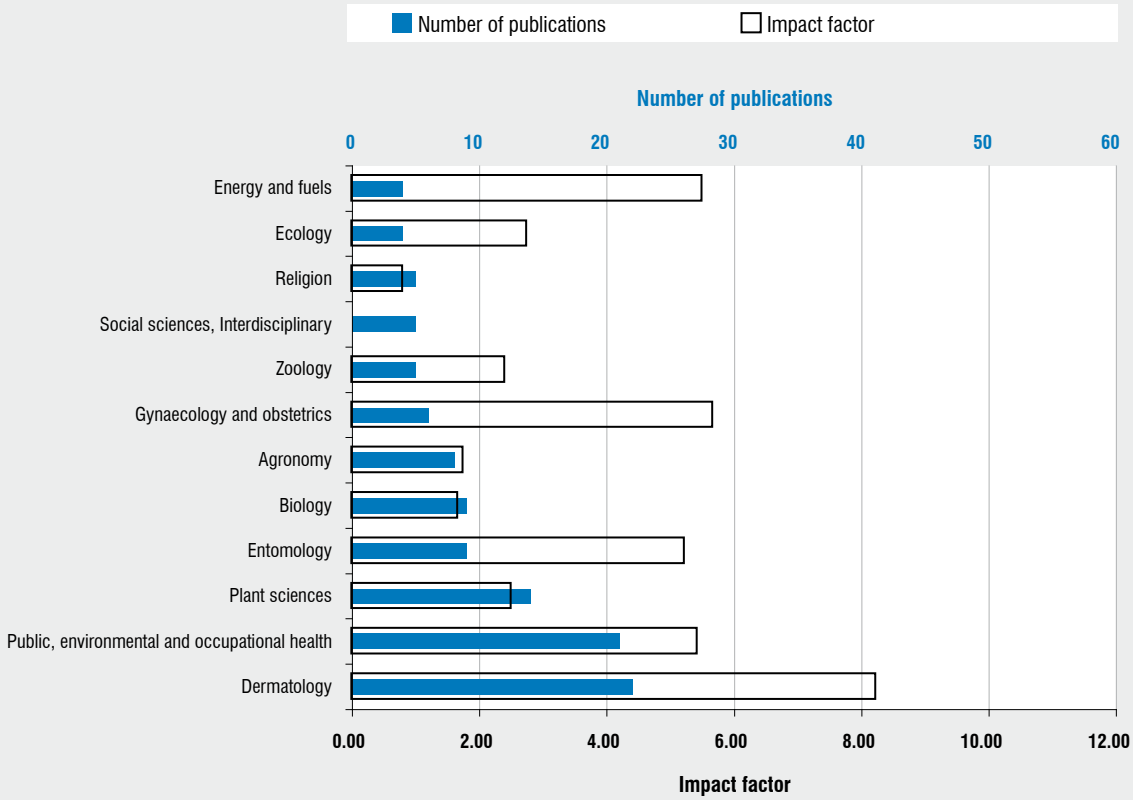
Source: UNCTAD, based on ISI Web of Knowledge data.

Figure F.10. Principal subject categories ranked by impact factor (including number of publications)



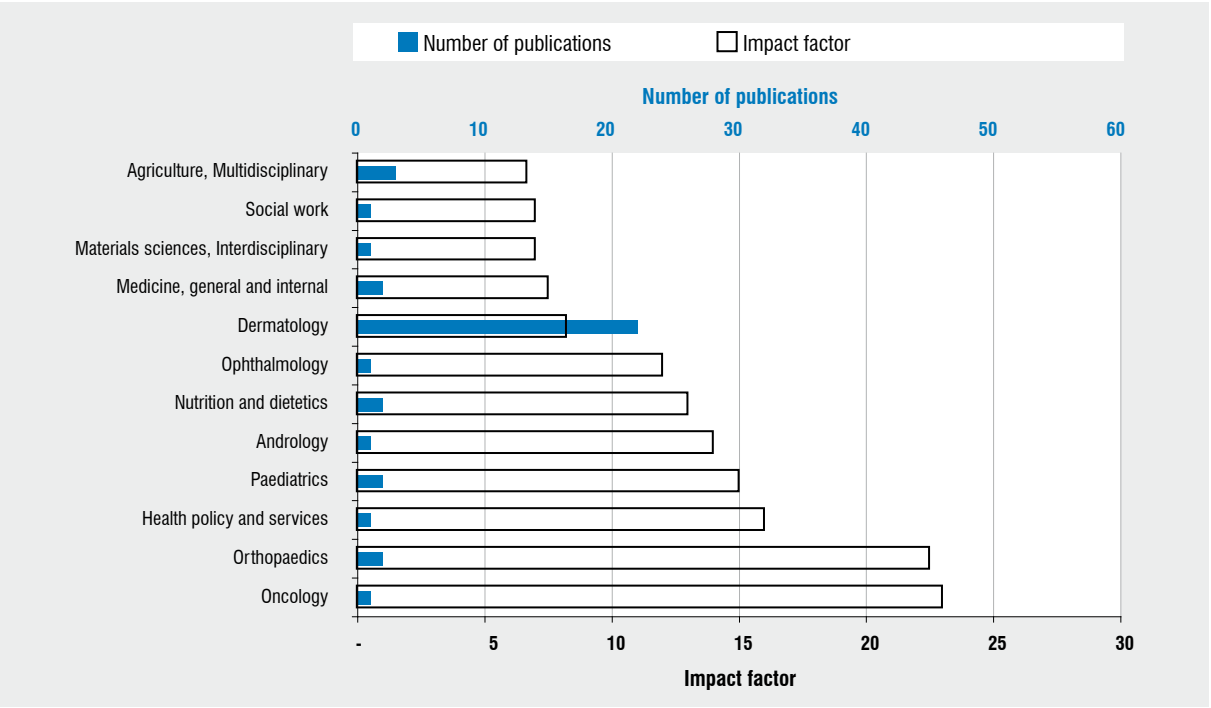
Source: UNCTAD, based on ISI Web of Knowledge data.

Figure F.11. Subject categories ranked by number of publications when the primary author resides in El Salvador (including impact factor)



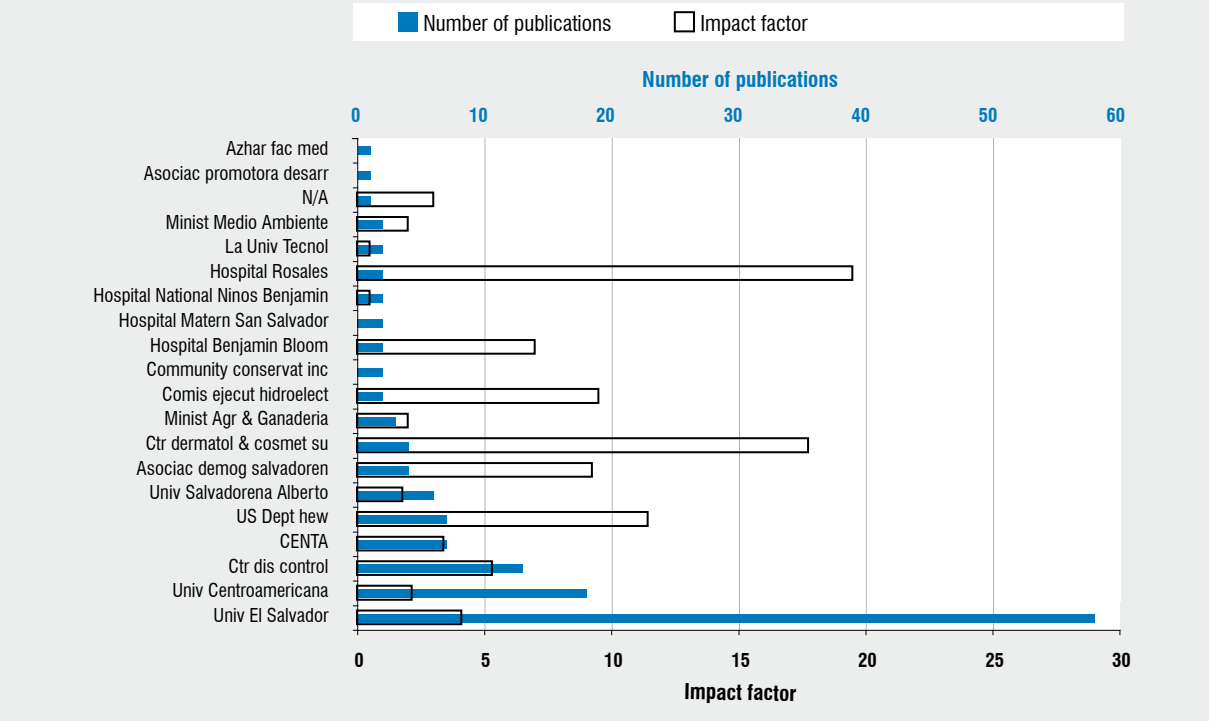
Source: UNCTAD, based on ISI Web of Knowledge data.

Figure F.12. Subject categories ranked impact factor when the primary author resides in El Salvador (including number of publications)



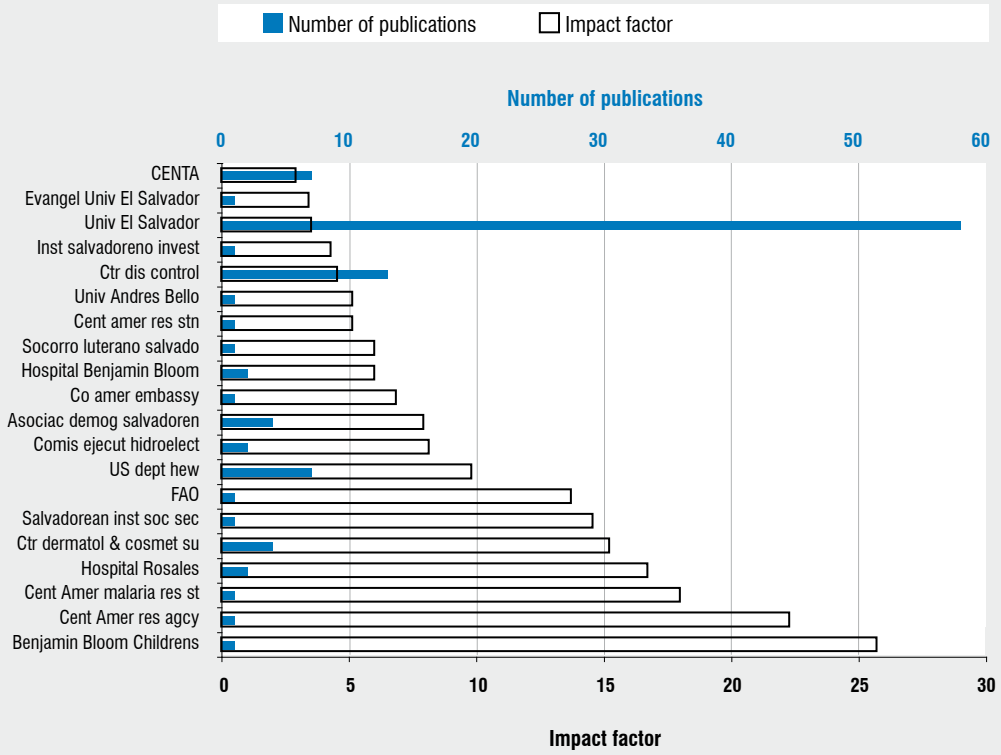
Source: UNCTAD, based on ISI Web of Knowledge data.

Figure F.13. Research bodies with the greatest number of publications (including impact factor)



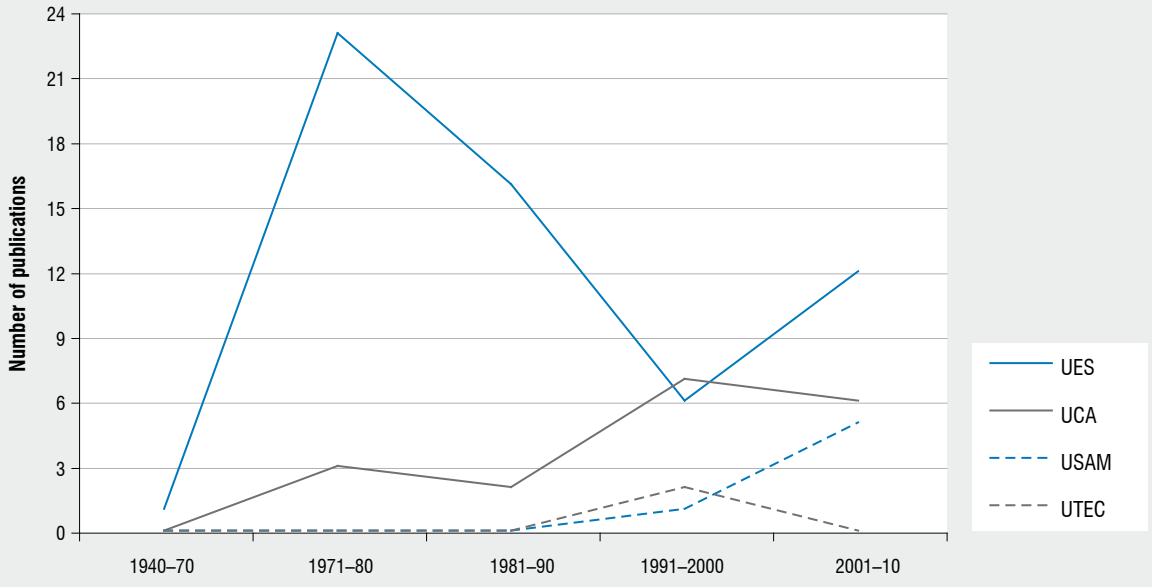
Source: UNCTAD, based on ISI Web of Knowledge data.

Figure F.14. Research bodies with the greatest impact factor (including number of publications)



Source: UNCTAD, based on ISI Web of Knowledge data.

Figure F.15. Output of scientific articles with international visibility, 1940-2010



Source: UNCTAD, based on ISI Web of Knowledge data.

Annex G. Provision of education at technical, higher education and postgraduate level and R&D activities in ICT in educational institutions, El Salvador, 2011 (cont.)

	Institution	Technical studies	University courses (engineering/degree)	Postgraduate studies	Other studies	R&D activities
1	University of El Salvador		- Degree in computer sciences - Computer systems engineer			
2	Don Bosco University	- Computer engineering technician - Call centre technician	- Computer sciences engineer - Electronics engineer - Telecommunications engineer	- Master of software architecture - Master of new technologies applied to education	- CISCO Academy Continuing education technical courses (30-50 classroom hours): - Infrastructure for VoIP - E-Marketing - Foundations of Internetworking - Routing protocols - LAN switching and wireless networks - Asterisk and VoIP - WAN technologies	- Development and implementation of supercomputer models - Development of fourth generation technologies in mobile applications - Development of a didactic computer for teaching basic programming - Research in protocols and wireless broadband communication - Technological principles of wireless communities and feasibility of installing them in schools in close geographical proximity to Don Bosco University - Research into the technical viability of implementing Terrestrial Digital radio in El Salvador
3	Francisco Gavidia University	- Computer systems technician - Computer maintenance and repair technician - Telecommunication engineering technician	- Computer sciences engineer - Telecommunications engineer - Electronics engineer	- Master of business management with specialization in electronic commerce - Master of applied information technology in networks - Master of educational technology	Continuing education technical courses (30-50 classroom hours): - AutoCAD - Telephone exchanges - Electronic commerce - Graphic design and Web pages - Fibre optic cable and installation - Computer maintenance - JAVA programming	Graduation studies: - Incubator of ICT companies - University-company links and provision of technological services
4	José Simeón Cañas Central American University (UCA)		- Degree in computer sciences			
5	Technological University	- Network engineering technician - Software engineering technician - Hardware engineering technician	- Computing and systems engineer - Degree in information technology. - Degree in business management with emphasis on computing			- Knowledge society with gender perspective in El Salvador

Anexo G. Oferta de formación a nivel técnico, de educación superior, y postgrado y actividades de I+D en TIC en instituciones educativas, El Salvador, 2011 (cont.)

	Institution	Technical studies	University courses (engineering/degree)	Postgraduate studies	Other studies	R&D activities
6	Capitán General Gerardo Barrios University	- Computer programming technician - Hardware engineering technician - Systems and computer network technician	- Systems and computer networks engineer - Degree in computing			
7	Pedagogic University of El Salvador	- Computer systems technician	- Degree in computer management			
8	Polytechnical University	- Computer systems technician	- Computer sciences engineer			
9	Dr. José Matías Delgado University		- Degree in computer management. - Electronics and communications engineer	- Master of virtual education		
10	Sonsonate University		- Computer systems engineer			
11	Evangelical University of El Salvador	- Computer networks and technology technician	- Computer systems engineer		- CISCO Academy	
12	Monseñor Oscar Arnulfo Romero University		- Degree in computer sciences			
13	Albert Einstein University		- Computing engineer		- Computer operator - Software executive - Webpage design - Computer assisted drawing - Systems analyst-developer - Computer maintenance and repair	Graduation work: - Design of intranet for Hotel Royal Decameron Salinitas - Computer security, theory, management and practice - Didactic guide to digital methods with application in c++ - Linux operating manual for didactic applications - Object oriented programming using didactic examples in java, using jgrasp - Design and implementation of a multifibre synchronized server for business mobile applications

Anexo G. Oferta de formación a nivel técnico, de educación superior, y postgrado y actividades de I+D en TIC en instituciones educativas, El Salvador, 2011

	Institución	Estudios técnicos	Carreras universitarias (Ingeniería / licenciatura)	Estudios de postgrado	Otros estudios	Actividades en I+D
						- Computer system for information management in the elective surgery area of the Rosales National Hospital - Application of geographical information systems for institutional management and decision-making - Toad and dbartisan tools for management and integration of relational databases.
14	Occidente Catholic University		- Computer systems engineer - Degree in management information systems			
15	Cristiana de Las Asambleas de Dios University		- Computer sciences engineer			
16	Dr. Andrés Bello University	- Computer technician - Information networks technician - Computer maintenance technician	- Degree in computing			Research areas: - Design and management of information tools and promotion of tourist products on the Internet - Design of tools for recoding, process and analysis of health information
17	Salvadorian Lutheran University		- Degree in computer sciences			
18	Salvadorian Alberto Masferrer University		- Degree in computer sciences			
19	ITCA-FEPADE Specialized Engineering School	- Computer maintenance technician - Telecommunications technician - Information systems technician - Computer networks technician			- CISCO Academy	- Development of software applying artificial intelligence technology

Source: UNCTAD, based on information available on websites of the various higher education institutions, May 2011.

NOTES

[1] Included in the Integral Export Development Strategy 2010-2014.

[2] CONACYT, 2006.

[3] Andersen 1994.

[4] See: Freeman, 1987; Lundvall, 1992a; Nelson, 1993.

[5] It should be emphasized that the concept of institutions refers to "rules of the game" in the context of nations, such as legislation, regulations, usages and customs, etc., and should not be confused with organizations.

[6] The classic reference in this sense is Edquist, 1997; see also McKelvey, 1991. In addition, recent works by the original proponents of the concept usually make reference to the differences between the different approaches (Freeman 1995, 2002; Lundvall et al., 2002; Nelson and Nelson, 2002).

[7] Dalum et al. 1992.

[8] OECD 1994, 1999, 2002; Edquist et al. 1998; Soete and STRATA-ETAN Expert Group 2002.

[9] It is a process which goes from perception to analogy and subsequently to isomorphism (Beer 1984).

[10] General Systems Theory (von Bertalanffy 1968).

[11] This is chiefly reflected in the debate (which may be insoluble) concerning appropriate limits or boundaries for the analysis of systems of innovation.

[12] The RICYT databases are prepared from information provided by bodies responsible for science and technology statistics in each country. A degree of caution is required in making comparisons, as the information is frequently incomplete.

[13] http://lp.espacenet.com/advancedSearch?locale=es_LP.

[14] Which means that they do not necessarily have Salvadorian nationality.

[15] Journals (of any country) which wish to be indexed must satisfy various criteria which guarantee their quality and value to the scientific community. It should be mentioned that there will always be a slight bias and limitations in using these databases, as there is a predominance of publications in English. Nevertheless, they largely reflect the visibility in the most relevant media used by the scientific community to disseminate its research.

[16] Institute of Scientific Information.

[17] All the databases were included: sciences, social sciences, arts and humanities.

[18] The period covered by the research includes from 1941, although there were only three publications before 1972, the year when they began to increase in number and regularity.

[19] Subject categories assigned by ISI.