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The Innovation System in Bolivia:
Overall Perspectives

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Contents

Abbreviations and Acronyms

ANCB	Academia Nacional de Ciencias (National Academy of Sciences)
CEUB	Comité Ejecutivo de la Universidad Boliviana (Executive Committee of the Bolivian University)
CONACYT	Consejo Nacional de Ciencia y Tecnología (National Council for S&T)
GERD	Gross Expenditure in Research and Development
MPD	Ministerio de Planificación para el Desarrollo (Ministry of Planning for Development)
MSD	Ministerio de Salud (Ministry of Health)
NDP	National Development Plan
RTI	Research, Technology and Innovation
S&T	Science and Technology
SBI	Sistema Boliviano de Innovación (Bolivian System of Innovation)
STI	Science, Technology and Innovation
UMSA	Universidad Mayor de San Andres (the public University of La Paz)
UMSS	Universidad Mayor de San Simon (the public University of Cochabamba)
VMCyT	Vice Ministerio de Ciencia y Tecnología (Vice Ministry of Science and Technology)

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Abstract

"Closing the Loop" is a project that focuses on the expectations that are linked not only to *the role of science, technology and innovation* (STI) in development but *also to its results.* Its goals are *to increase the relevance and utilization of research outputs*, thereby enhancing the influence of researchers, organizations and institutions on the development process. The project looks, through case studies, at the research landscape and national and sector innovation system in four countries: Bolivia, Mozambique, Tanzania and Vietnam. This contribution analyses the case of Bolivia.

After 30 years of exercising a free-market economy, the socio-economic-political situation was drastically modified in 2006 into a scenario of transformation and institutional re-design, based on the conception that the co-existence of different economic paths have made indigenous local communities recognize that their past non capitalist economic relations was being substituted by a market logic, thus threatening their material and socio cultural bases.

Mainly due to favourable international conditions and increased government spending, the country has experienced a high rate of economic growth and it is observed some improvement of social conditions. It is a matter of debate however whether or not the observed growth is sustainable. In spite of the positive changes the country remains one of the poorest in Latin American.

The National Development Plan 2006-2011 adopted by the new Government, considered that education and STI are fundamental instruments of change and defined that their role will become operational through the organization of the national innovation system which should develop technological based solutions to social and productive demands combining modern technological advances with ancestral, local and popular "***knowledges***" and wisdom, with due respect of the environment.

The national innovation system is weak as shown by several indicators. The causes for this situation are well known, lack of financial inputs, limited efforts of the business sector, weak human resource base, weak technology management, etc. There exists however research outputs of value, even if limited, in public and private research centres which are diffused by the way of scientific publications in indexed and refereed journals and technical reports and also outputs applied to specific economic and social developments, and in particular specific products. In recent years some private sector associations have become more active in promoting technology and innovation within their associates and are joining efforts with public and private universities.

To face existing challenges, the Vice Ministry of Science and Technology has defined in 2014, after an ample debate with stakeholders, a "National Science, Technology and Innovation Plan and is conducting several activities leading to its objectives. At the same time the Executive Committee of the Bolivian University has made an in-depth analysis of the situation of STI in public universities and also defined a strategy towards 2015.

The sector systems of innovation are operating with varying degrees of efficiency. In agriculture it is observed that the traditional agriculture production model has produced innovations, but it is criticized as not having valued the local "knowledges" and the wisdom of indigenous people, or the wealth of the existing biodiversity. The new policy approach taken at present takes distance with a view of innovation oriented towards competitiveness, value chains and productive specialization and tries to construct sustainable management of natural

resources and the promotion and use of biodiversity based on an endogenous development vision and model.

Health (and education) has always been considered a priority in Bolivia and consequently much effort has been placed on research, in particular within the university system, falling short of innovations however. The health sector innovation system is today composed of a large number of public and private organizations and an extensive research Agenda have recently been defined.

Research in renewable energies has also been conducted for several years and there are already research outputs that have permitted “closing the loop” and serve as benchmarks in the sector, for both active and passive systems.

Research, technology and innovation in the informal sector have not been analyzed in detail, although characterizations have been made in the studies on SMEs, and training and innovation requirements have been identified. This sector is of particular importance in the country as it is the largest creator of employment at present.

In a global sector analyses, it is found that “closing the loop” has been possible when dealing on a product-by-product basis. Considering existing experiences, it is clear that selective interventions must be sought focusing on strategic areas that can help accumulate the know-how and capabilities for further sophistication. Alternative approaches are important but cannot be the sole approach as it is suggested by the proponents of the endogenous development model. An overemphasis on such model will leave out conventional approaches that have already proven to work.

Science, technology and innovation policies are only effective when governments can formulate and support their implementation. In Bolivia it is clear that the main reason for the difficulty in building-up an adequate capacity for STI has been insufficient government capabilities and effectiveness, and today, as in the recent past, there is inconsistency in the political discourse and credibility problems in the national innovation system, that pose a great challenge for obtaining quality research outputs that impact on policy making or become an input to economic or social innovations. It is thus needed a stronger compromise of the Government with the national innovation system in the way of increased financial resources, better infrastructure, clearer and non-contradictory implicit policies, incentives and other suc policy instruments in this area.

Research that is well conducted and of adequate quality is essential to inform and influence policy, reduce inequalities and boost social and economic development, thus leadership, funding, researchers and institutions, and the capacity to utilize research findings are as important as new discoveries and these must be enhanced. The new STI policy must be able to support the co evolution of all elements and functions of the national innovation system, should “closing the loop” becomes a practice and not the exception, as can be resumed from the extensive analyses and survey conducted under this project.

Key words: *Bolivia, agriculture, health, informal sector, innovation, national innovation system, renewable energy, research outputs*

Introduction

For several years, a large number of research projects have been executed in developing countries with the view of utilizing their results for ***informing and influencing policy*** or to obtain ***social and economic innovations*** that could lead to economic growth and the improvement of the quality of life of their societies. A large number of studies have also been dedicated to study socio-economic processes, including science, technology and innovation (STI) to evaluate the effects of policy interventions. Recent evaluations (Aguirre - Bastos et al, 2010 and Aguirre and Gupta, 2009) show the difficulties that developing countries have to use research outputs for policy making.

There are many reasons that explain why outcomes are not influencing policy; it is found that what lacks is an explicit strategy for achieving influence, embedded across all projects as a standard consideration in research design. It is also verified that when policy analysis is carried out, it is typically concentrated on policies related only to the research's core interest, with little attention paid to the fact that the fundamentally important policies are spread across sectors, and rest on implicit rather than explicit assumptions about what promotes research, technology and innovation. It is also evident today that quality research outputs are needed for social and economic innovation as the former are the basic inputs for any inclusive development strategy (Carden, 2009; Sunkel and Infante, 2009; Cozzens and Sutz, 2012).

"Closing the Loop" seeks to ensure the awareness, understanding, and ownership of research outputs by decision-makers and the economic and social actors at large. Its goals are to increase the relevance and utilization of research outputs, thereby enhancing the influence of researchers, organizations and institutions on the development process. The project is expected to contribute to a better understanding of how the process of knowledge creation and innovation can be made more conducive to the development efforts being pursued in Bolivia, Mozambique, Tanzania and Vietnam.

This contribution describes the results of the project in Bolivia. Part A provides an overview of the present national and social and economic context with emphasis in the changes that have taken place since 2006, when the present Government took office. Part B deals with the development of STI and discusses the evolution of policy and governance, the new concept of the Bolivian System of Innovation, the recently adopted STI Development Plan and assesses the performance of the national innovation system from existing indicators; this Part discusses as well the role of universities in the national innovation system.

Part C deals with policies and research outputs of the agricultural sector innovation system and Part D those of the health sector innovation system. In both Parts a discussion on "closing the loop" is brought out by analyzing specific cases. Because of the importance of energy and of the informal economy in the country, Part E provides an overview of the renewable energy sector innovation system and Part F highlights some characteristics of the informal sector of the economy, as viewed from an innovation perspective.

Part G provides the results of a survey conducted in the research community addressed to better understand the process of "closing the loop" as seen by the national innovation system stakeholders.

The discussion and conclusions provide some elements that can contribute to complement and better implement the present on-going National STI Plan. The Reference section includes additional bibliography that represents the large "gray literature" that exists in the country on STI issues.

Part A

The Social and Economic Context

Bolivia is a country of 10.3 million inhabitants (2012) with a growth rate of 1.45% (2010 – 2015), 1.31% (2015 – 2020) and 1.19% (2020 – 2025), with a large young population, 36.4% less than 14 years of age and 34.8% in the age group 15 - 34, in 2012. Life expectancy in the period 2010 - 2015 is 67 years and should increase to 69.9 between 2020 - 2025, below the regional average of 74.7 and 77 years respectively. The urban population in 2010 was 66.3% of the total and should reach 71.4% by 2025, thus the country holds today and will do so for quite some time a very large rural population that provides the former a very specific sign to its social character (CEPAL, 2013)/[1].

Since the mid-1980's Bolivia continues to uphold a free market economic model which has provided the basis of high growth. In 2006 the development policy, while keeping the model, moved towards a conception based on the belief that the co- existence of different economic forms made indigenous local communities recognize that their past non capitalist economic relations were being substituted by a market logic, thus threatening their material and socio cultural bases (Orozco et al 2006). This vision has become the driving force for change since 2006 and led to the adoption of a new Constitution in 2007 and an extensive normative reform.

The National Human Development Report (PNUD, 2011) recognizes that one of the most relevant changes that have taken place in the past years is in the territorial reorganization of ethnic identities, a phenomena that has allowed indigenous groups to realize that their territory, understood as a system of actors and social relations, defines common features and social distinctions that generate both inequity and possibilities for social mobility.

Investment in education has risen from 5.5% in 2000 to 6.9% of GDP in 2011, while the investment in health has fallen from 6.1% in 2000 to 4.9% in 2011; poverty has fallen from 38.3% in 2006 to 18.7% in 2011; the GINI Index has improved from 0.643 in 2000 to 0.472 in 2011. In the midst of inequalities, society finds concrete forms of mobility: internal and external migration, education and entrepreneurship in the informal market are common.

In health, the mortality rate/1000 inhabitants is 7.1% (2010-2011), above the regional average of 5.9% and it is projected to 6.8% for 2015 – 2020 and 6.6% for 2020 – 2025, compared to the regional averages of 6.0% and 6.2% respectively. In education, the net enrolment rate for the primary level has fallen from 92.2% in 2000 to 83.4% in 2011; the secondary enrolment rate was 68.3% in 2010 and for the tertiary level 37.7% in 2007. In terms of social context, the Human Development Index increased from 0.498 in 1980 to 0.620 in 2000 and 0.675 in 2012.

In spite of such improvements, the country is facing difficulties for reaching the Millennium Development Goals. Hailu and Tsukada (2011) measured the efforts made by countries in achieving the latter by comparing the rate of progress on MDG indicators in the periods before and after these were adopted. They found that rate of progress is non-linear across time and that natural constraints hinder countries from achieving the targets as they approach their upper or lower bound limits; when correcting for this situation it is possible to measure progress in achieving MDG goals, despite their failure in achieving them by 2015. Of the four countries in the project (up to 2008) shown in *Table 1*, Bolivia occupies the last place and a low position worldwide. An update of this ranking is a pending task.

/[1] These figures from.

Table 1: Improvement in the Rate of Progress of the MDG by Country (by 2008)

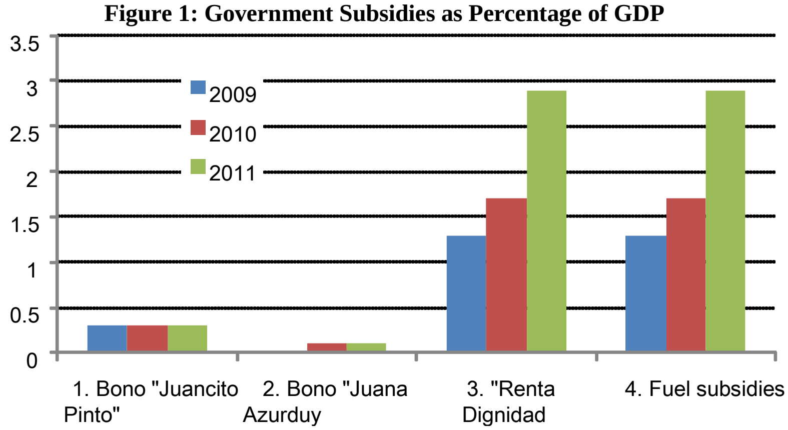
Country	World Rank	Improved		Maintained		Decreased		Indicators by country
		Indicators	%	Indicators	%	Indicators	%	
Vietnam	24	13	72.2	0	0.0	5	27.8	18
Mozambique	41	16	66.7	1	4.2	7	29.2	24
Tanzania	41	16	66.7	1	4.2	7	29.2	24
Bolivia	88	13	50.0	0.	0.0	13	50.0	26

Source: Hailu and Tsukada 2011

Since 2005 the country experienced a high economic growth rate: from 4.4% of GDP (9.55 billion US$ at market prices) to 5.2% of GDP in 2012 (27.04 billion US$), 6.78% in 2013 and 6.49% in the first quarter of 2014. Per capita GDP of 2.5% growth was kept fairly constant in the period 2005 – 2012, and passed to 3.6% in 2013. This growth is due to increasing prices of its export commodities, a phenomenon that is not sustainable. The exports of primary products increased from 89.4% in 2005 to 95.1% in 2012, with the corresponding decrease of manufacture goods, well below the regional average of 49.8% and 55.6% respectively.

Growth has also been due to greater public spending in programmes such as: “Bono Juancito Pinto” (promotion the increase of elementary school attendance); “Bono Juana Azurduy” (reduction of children mortality rates); “Renta Dignidad” (supporting people over 60 years of age not covered by retirement plans; and the fuel subsidy. *Figure 1* shows the behavior of these subsidies in the period 2009 - 2011.

Figure 1: Government Subsidies as Percentage of GDP



Source: Authors based on United Nations Development Program Data

PIEB (2011) pointed out different factors impacting the slow performance of the economy since 1989: a) low factor productivity resulting from institutional inefficiencies and a weak political development; b) high dependence on natural resources impacting all social actors causing significant political conflict; c) little attention paid at linkages in the productive texture; d) absence of mechanisms for productivity growth, education and professional training, technology centres, or university-productive linkages, as well as the existence of weak clusters, value chains and lack of innovation. Most of the above factors are still present today.

Part B

Science, Technology and Innovation in Bolivia

1. Policy and Governance: Evolution

In 1960, the National Academy of Sciences was established, as an autonomous public institution in charge of the definition of science policy. Considering the need of creating a framework that would respond to broader social and economic demands, Government established in 1977 the National System for S&T Development and a Directorship in the Ministry of Planning as its main executive organ. Due to the severe economic crisis that affected the country after 1982, the Directorship was isolated from the Ministry's decisional processes and could no longer lead the S&T system (Aguirre Bastos, 2001).

The situation led in 1991 to reorganize the institutional framework by the establishment of the National Council for S&T, under the chairmanship of the Vice President of the Republic and its Executive Secretariat. In 1997 the S&T system was taken over by the Vice Ministry of Higher Education, S&T in the Ministry of Education. In 2006, under the National Development Plan, the Vice Ministry of S&T (VMCyT) in the Ministry of Development Planning was created and in 2010 it was transferred to the Ministry of Education.

The first S&T policy guidelines were approved by Government in September 1981, leading to the design of a first national plan by 1982, that was never adopted. In 1993 a national conference requested a plan, which was prepared by the National Academy of Sciences and the Executive Committee of the Bolivian University, but again never formally adopted.

In 1996, a Short Term Policy and Action Plan were adopted by the National Council for S&T. This was the first policy to be implemented and also the first to included innovation. The policy led to the definition of a new strategy for the period 1997 – 2002 under the then existing economic context: "Innovation for Competitiveness and Sustainable Development". The strategy was approved by the National Council but never executed.

With the support of the InterAmerican Development Bank the Directorate of S&T under the Ministry of Education, prepared the *National Plan for Science, Technology and Innovation 2004-2009*, which was approved by the six ministries with tuition over the S&T area, but also never executed. In 2002 the Ministry of Economic Development defined on the basis of 34 sector studies, a policy and strategy for competitiveness (Velazco, 2002) that included a chapter on STI (Aguirre Bastos, 2002). The competitiveness agenda was only implemented in its early phase up to January 2006.

In June 2001, Government adopted Law 2209 "Promotion of STI", which constitutes the first legal framework at that level. The National STI Plan 2014 – 2025 calls for its revision under the present social, economic and political context. The new Constitution of 2007 explicitly recognizes in Article 103 the importance of research, science and technology (RTI), for supporting the development of the productive base and the implementation of strategies for incorporating knowledge and application of new information technologies.

2. Science, Technology and Innovation in the National Development Plan 2006 - 2011 and Vision 2025

The NDP 2006 – 2011 emphasizes a social vision and set a full-fledged development agenda. It considers that STI are fundamental instruments to change the primary export productive pattern, both through the transformation processes of natural resources, as well as through the incorporation of new products in the market. Under such vision, the new policy assigns technology and innovation a key role for the increase of productivity and competitiveness and incorporates RTI as key factors for attainment of social objectives

The Plan defines that the role of STI will become operational through the organization of the Bolivian System of Innovation (SBI), which should develop technological based solutions to productive demands with the incorporation of knowledge to the product generation processes to satisfy quality, novelty, diversity levels and will also be assigned an ecological and social certification. The latter implies that technology will not be applied indiscriminately but rather combining modern advances with ancestral, local and popular "***knowledges***" /[2] and wisdom.

The NDP states that besides traditional obstacles to the development of STI, the limited results of the efforts to generate a workable policy and governance, were due to the lack of definition of linkages mechanisms between the productive and scientific spaces and the lack of recognition of other spaces for the generation of knowledge besides the traditional scientific centres. It indicates that policies did not establish the possibility of utilizing S&T for the solution of national, regional or local problems, within a comprehensive participatory mechanism involving all of society (Carvajal and Albarracin, 2007, and Carvajal, 2009). In line with this vision, the NDP emphasizes that local and popular knowledges must be re-valued and validated as mechanisms to strengthen the existence of a national scientific culture that permit to initiate a sustained development process.

In 2013, Government adopted a "Patriotic Agenda" for reaching a set of specific goals by 2025, the country's 200th anniversary of independence. The Agenda contains 13 points, of which # 4 "Scientific and Technological Sovereignty with National Identity" sets guidelines and goals for the national innovation system, as follows:

a. Ownership and development of technology on the basis of the convergence of knowledge in dialogue between science and local ancestral and community practices and knowledges for a given set of products (food, lithium, gas and hydrocarbons, agriculture, manufacture, transformation of minerals and metals, high technology goods and biotechnology, renewable energy), in the framework of respect to mother earth.
b. To become a centre for technology innovation in nutritive and medicinal foods and innovation centres in areas of production of high value native agricultural goods.
c. Develop and strengthen knowledge and technologies for organic and conventional production of high yield products on the basis of the fusion of local, ancestral and modern knowledge guaranteeing an abundant production of food and medicines.
d. Recovery, development and strengthening of local medical ancestral knowledge and practices in convergence with modern knowledge and practices and training and accreditation of professionals and highly specialized medical centres as well as the basis for developing a natural, ecological and spiritual pharmaceutical industry.

/[2] The term is used in plural following the Plan, signifying the existence of many streams of knowledge, each coming from the different existing cultural identities in the country.

e. Increase and substantially improve the country's technology high level professionals, technicians, academicians, scientists and experts in different areas of knowledge, trained with support of the state, contributing with knowledge to the development and "living well" (*Box 1*) in harmony with mother earth.

Box 1: "Living Well"

Several instruments adopted in the past years are centred around the concept of "living well" defined as: "Living well" is the civilization and cultural horizon alternative to capitalism and modernism that is borne out of the cosmo-visions of the "originary indigenous peasant nations and peoples and of the intercultural and afro Bolivian communities, and is conceived in the context of interculturality", …, "it means living in complementarity, harmony and equilibrium with Mother Earth and societies, in equity and solidarity and eliminating inequities and dominance mechanisms. It is Living Well amongst us, Living Well with that around us, and Living Well with oneself." (Law on Mother Earth, 15 – 10 - 2012)

3. The Bolivian System of Innovation and the National STI Development Plan 2014 - 2025

For a complex process such as defining, implementing and evaluating STI policies, involving a broad range of actors, stakeholders and experts, a systems approach is certainly needed. The conceptual approach to NIS originates in developed countries, where there exist distinct capabilities to create innovations and the skills needed to bring about technological change, which is not the case of developing countries. Thus, it is argued that policies should consider actions that will not mimic innovation systems of more advanced countries, but to design their own, according to their capacities and social, economic and cultural characteristics.

The proposal for the formal establishment of the Bolivian System of Innovation (SBI) (Carvajal, 2009) as an instrument within the country's own characteristics is derived from the NDP, and it follows a definition of innovation as:

> "*The incorporation of knowledge to productive or social systems that generate new or better products, processes, and uses for the solution of local, regional and national problems, as an instrument that leads by itself to live well*"

This definition can be understood as the collective construction of knowledge and to a social learning process of producers, manufacturers, technicians and scientists in innovation. It is considered that this construct is also part of the complementary process existing between scientific knowledge and the local and ancestral knowledges, which contribute in a different way to the conventional education systems of western society.

The concept of the SBI is based on the need to articulate public sector led demand and is defined as:

> *"The set of interrelated and complementary actors that utilize science, technology and innovation in a coordinated and constructive way in the generation of integral solutions to productive, social and environmental problems with an approach of participative, socially balanced and sustainable development".*

With the mandate to generate and appropriate S&T knowledge and revalue local and ancestral knowledge to solve problems and face demands and needs in a transversal and integral manner transforming the productive matrix and supporting the socio – community matrix.

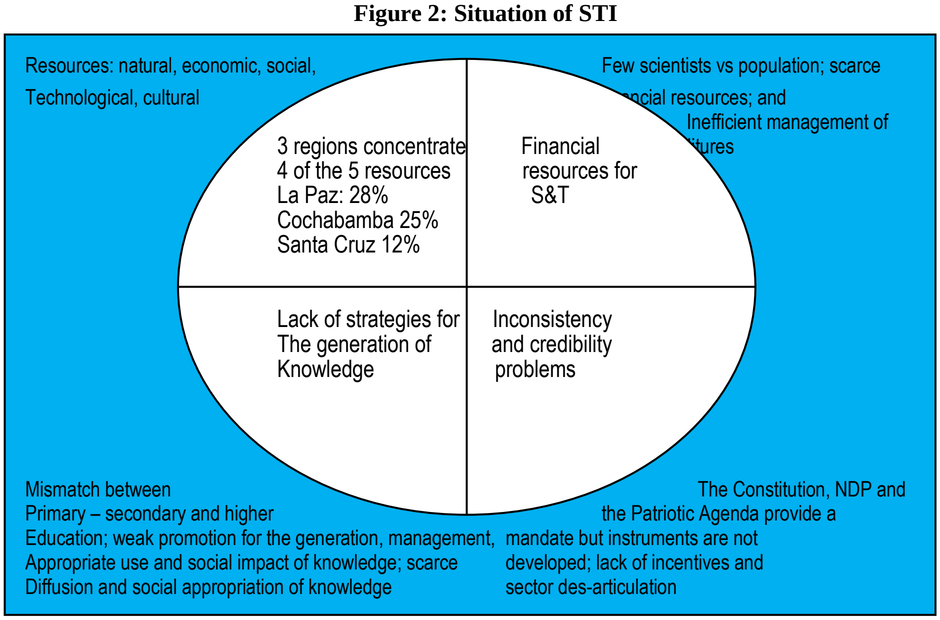
There are lines of work being implemented by the VMCyT to reach the established the development objectives. The first is composed of activities as the production of indicators, science fairs, facilitation of access to scientific publications and support to information services, and the coordination of established networks: a) Food; b) Forests; c) Renewable Energies; d) Biodiversity; e) Hydro resources; f) Nuclear Energy; g) Environmental Remediation; h) Ancestral Knowledges; i) ITC´s; j) Technology Based Incubators.

A second line of work is the implementation of the National STI System through the development of specific structures and instruments: a) the Pluri National Centre of Excellence for Productivity; b) the National Information System; c) the National Digital Inclusion Plan; d) the Programme for the Popularization of S&T; e) the Programme for Local Wisdoms and Ancestral Knowledges and f) the use of foresight techniques.

In order to implement the National Development Plan and reach the objectives set forth in the "Patriotic Agenda", the VMCyT adopted in 2013 a National Plan for the Development of STI 2014 – 2025, after extensive consultations with stakeholders. The Plan is defined within the fundamental framework and vision contained in the Constitution, the Law of Education (Law 70) and the Patriotic Agenda, namely: a) inclusive science and technology; b) education and training of talent; c) scientific and technological sovereignty.

The Plan correctly recognizes the previous efforts to build up a science and technology system and identifies that the deficiencies encountered in these efforts stem from the historical perspective of the absence of effective State policies. The Plan identifies the research work being undertaken by nearly 2,000 researchers in 251 research centres, a large majority of which are located in the public university system, and recognizes also the little research activities being undertaken in the private firm sector.

Figure 2: Situation of STI



Source: National STI Plan, VMCT, 2014

The Plan reinforces the concept of "National STI System" and envisions it as a structured mechanism composed of normative instruments, a financial and information system, a set of government units, universities, productive system, organizations for the transfer of knowledge, linkage instruments, networks and scientific-technological platforms.

The present situation of the national STI system constitutes the starting point for the implementation of the Plan and such situation is depicted in *figure 2*. Further on in this document a more detailed indicator-based analysis of the system will be discussed.

The Plan recognizes the role of universities and the need to strengthen post graduate education and democratization of knowledge through diffusion programmes and projects. It is recognized that the present post graduate supply of professionalizing master level courses (a modality invading doctoral courses) is insufficient to generate STI capacities able to respond to social and economic demands. More amply the Plan considers that five problems must be dealt with priority:

a) Formulation and implementation of normative instruments, including a new Law
b) Inject in a sustained manner the necessary financial resources into the system
c) Diffuse information at all levels so that research outputs reaches decision makers, researchers, follow national policy guidelines, and the demand for technology is satisfied
d) Develop and apply with due frequency the evaluation and monitoring instruments to assess and provide guidelines
e) Generate human talent able to respond to societal demands.

It is expected that the Plan will be applied in two stages, the first between 2014 and 2020 and the second between 2021 and 2025. In the process of consultation of the Plan with the social and economic actors, priority has been set on the human capital, particularly post graduate education as a horizontal priority, and a set of strategic lines and programmes defined in 8 key sectors, as illustrated in *Table 2.*

Table 2: Sectors, Strategic Lines and Programmes under the National Plan for STI

Sector	Strategic Lines	Programmes
Health	1. Health Determinants	1. Social determinants
		2. Economic determinants
		3. Inter-sector health policies
		4. Health and nutrition
		5. Environmental health and environmental determinants
		6. Health and labour
	1. Dominant health problems	7. Infectious – contagious diseases
		8. Non transmissible diseases
	2. Health Anthropology	9. Development of STI on the basis of medicinal plants
		10. Traditional medicine
Agriculture development	1. Conservation and use of productive bases for agriculture development	1. Management and sustained use of hydro resources and agro-climatology
		2. Productive capacity, management, conservation and recovery of soils
		3. Climate change in agro-ecosystems
		4. Conservation and use of agro-biodiversity
	2. Primary agriculture, livestock and non-wood forest production	5. Conventional production
		6. Ecological production
		7. Production for agro industry
	3. Added value and markets for agricultural and non wood forest products	8. Harvest and post harvest management
		9. Quality and innocuousness
		10. Transformation and industrialization
		11. Commercialization and new markets
Industry transformation and manufacture	1. Promotion of industrial transformation and manufacture activities	1. Capital goods
		2. Industrial transformation and manufacture of non traditional strategic products
	2. Biotechnologies	3. Biotechnology for industry
		4. Development of new materials
	3. Technology management	5. Cleaner production and energy efficiency
		6. Innovation and technology transfer
		7. Intellectual property
		8. Metrology, accreditation and quality assurance

Sector	Strategic Lines	Programmes
Local wisdom and ancestral knowledge of the originary indigenous and peasant peoples	1. Social learning in the management of local wisdom and ancestral knowledge through its revalorization and systematization	1. Innovation of knowledge for sustainable production
		2. Innovation of knowledge for the sustainable management of natural resources, environment and biodiversity
		3. Innovation in the procedures for primary health care
		4. Incorporation of innovation methodologies of local knowledge in the national educational system
	2. Revalorization and promotion of best practices and traditional technologies, through its conservation and diffusion	5. Information system knowledges and ancestral knowledge
		6. National network of knowledges and ancestral knowledge
		7. Observatory of knowledges and ancestral knowledge
		8. Studies and research in knowledges and ancestral knowledge
	3. Policies for strengthening, regulatory framework and local capacities for the conservation and promotion of local and ancestral knowledges	9. Strengthening of the regulatory framework and local capacities
		10. Strengthening of planning instruments
		11. Strengthening policies for the management of local and ancestral knowledges
Natural resources, environment and biodiversity	1. Generation of basic knowledge	1. Dynamics of species, ecosystems and climate change
		2. Monitoring of environmental quality
		3. Deterioration and pollution processes
		4. Diffusion of environmental information
	2. Value of environmental components	5. Goods and services of bio diversity
		6. Social and organizational component
		7. Production – tecno-structure – energy
	3. Conservation of biodiversity and environment	8. Priority spaces for conservation
		9. Best practices for management and utilization
		10. Man-nature relation (etnobiology)
Energies	1. Scientific and technological research in renewable and non conventional energies	1. Energy efficiency in poli generation systems of renewable energies for their application in isolated zones
		2. Storage systems for their application in the field of renewable energies
		3. Alternative hybrid energy systems for use in productive complexes
		4. Development of nucleo-energy
	2. Scientific and technological research in conventional energies	5. Development of hydroelectric plants
		6. Development of thermoelectric plants
		7. Generation of geothermic energy
Mining	1. Basic research for the identification of the geological-mining and metallurgy potential	1. Geology, mining and metallurgy of non-traditional deposits (rare earths, uranium and trans-uranium)
		2. Clean technologies
		3. Capacity development of chemical analysis and mineralogical characterization for the sector
	2. Applied research in geology, mining and metallurgy for obtaining high value added products with industrial interest	4. Exploitation and transformation of evaporitic (non ferrous) resources
		5. Exploitation and transformation of ferrous minerals (Mutun, Iron, Manganese and others)
		6. Clean technologies for the sector
Information and Communication Technologies	1. Technological productive development	1. Embedded systems for the transformation of industrial productivity and SME's
		2. Development of intelligent systems for monitoring natural resources and biodiversity
	2. Technology and social development	3. Base technologies for equitative and excellence learning
		4. Development of hardware and software for telemedicine, diagnosis and continuous monitoring of patients
		5. Applied robotics (disabled persons, industrial control, non manned vehicles for border control)
		6. National security and citizenship
		7. Development of intelligent systems for the optimization and monitoring of energy systems
		8. Development of hardware and software for archaeological studies and ancestral knowledges
	3. Digital development	9. Communication and monitoring systems
		10. Mobile technologies
		11. Electronic government
		12. E-commerce
		13. Security of the information society
		14. New satellite applications
		15. E-science

Source: VMCYT, 2014

4. Higher Education in Bolivia

The production of highly skilled human capital is certainly the main contribution that universities can make to the STI system. It is well established that efforts to upgrade the technological infrastructure and stimulate innovation will not yield a high return if it is not completed with and adequate stock of advanced human capital.

In recognizing the role of universities in the STI system, it is important to understand the dramatic transitions that has taken place in university research characterized by the evolution of the role and value of knowledge; the changes in the methods for the production of knowledge; the transition from individual research to partnerships - collaboration and to networking; the articulation of the national S&T systems and the internationalization of research.

The channels of diffusion of research outputs have also changed from the traditional academic channel to the management of results: transfer and commercialization. Funding is no longer centred in the public source and quality control is exercised not only by peers, scientific excellence and ex-ante examination but also by other factors, quality, pertinence, transferability, ex-post analysis and social value.

Besides teaching and research, universities are increasingly expected to make a direct contribution to economic growth and wellbeing of society. This role requires universities not only to produce but also commercialize knowledge. Universities must face this challenge by transforming incentive structures, engaging in public-private partnerships, establishing spin-off companies and patenting research results. More recently the notion of developmental university is being discussed (Arocena, Görensson and Sutz, 2012) and conceived as those higher education institutions committed in diverse ways to social inclusion through knowledge and, more generally, to the democratization of knowledge.

The NDP identifies two aspects that the educational system must confront, the first, lack of equal opportunities, relative to access and permanence and quality and the second lack of linkages between the scientific, technological, cultural and political environments. Regarding the former aspect, the country is characterized by its young population, in the 19–25 age range the universe is comprised by about 1,300,000 individuals (out of 10 million). In the past years more than 50% has been outside the educational system, 25% registered in universities, 4% in technical schools, 3% in teachers colleges, 8% in primary and secondary adult schools, and 2% in other courses of less than one year duration.

Governance of the university system is determined by the new Constitution and a new Educational Law (2010). These instruments recognize: a) autonomous public universities, congregated around the Executive Committee of the Bolivian University (CEUB); b) private universities, supervised by the Ministry of Education, making up the National Association of Private Universities; c) indigenous universities as public organizations, under the tuition of Community Boards; d) special regime universities as public bodies whose operation are under the tuition of their specific boards and supervised by the Ministry of Education.

Expenditure of the university system represents around 2% of GDP. *Table 3* shows the main financial resources made available to the public university system. An important point to be made here is that support of the system is contingent to tax collection and the indirect tax on hydrocarbons. In 2012 public universities received an additional 31 million US $ because of higher tax collection and higher international oil prices.

Table 3: Evolution of Financial Resources in the Public University System

Year	2005	2006	2007	2008	2009	2010	2011	2012
Amount million US$	171.9	228	252.4	296	290	314.6	385.4	444.6

Source: Ministry of Economy and Finance, 2012 (comunicacion@economiayfinanzas.gob.bo)

The number of higher education institutions has observed an important growth after 2005 as shown in *Tables 4 and 5*. The creation of three universities to facilitate the access to indigenous peoples marks a departure from the traditional method of creation of higher education institutions. The main objectives of these universities is reconstructing native identities, develop scientific knowledge, "knowledge's" and technology, oriented by community criteria under the principles of complementarity, cooperative work, individual and collective responsibility, and equilibrium with nature.

Table 4: The Higher Education System: Number of Institutions (2005-2010)

Higher Education Institutions	2005	2006	2007	2008	2009	2010
Universities	67	71	77	84	85	85
Non university institutions	129	152	187	254	302	313
Total	388	443	524	679	788	816

Source: Arauco and Gallardo, 2011

Table 5: Number of Public and Private Universities (2005 – 2010)

Universities	2005	2006	2007	2008	2009	2010
Public Autonomous Universities	11	11	11	11	11	11
Universities under special regime	2	3	3	3	3	4/1
Universities for indigenous groups				3	3	3
Total Number of Public Universities	13	14	14	17	17	17
Private Universities	40	41	42	42	42	42
Sub seats of Private universities	14	16	21	25	26	26
Total private universities	54	57	63	67	68	68
Total Number of Universities	67	71	77	84	85	85

Source: Arauco and Gallardo, 2011 and CEUB, 2012; 1. Note: According to CEUB, 2011, there are 4 (not 3 as noted by these authors) universities under special regime: The Police University, the Andean University, the Catholic University and the Military School of Engineering.

Table 6 provides the number of post graduate level course offered by the universities in 2011 and *Figure 3* shows the distribution of these courses by scientific area.

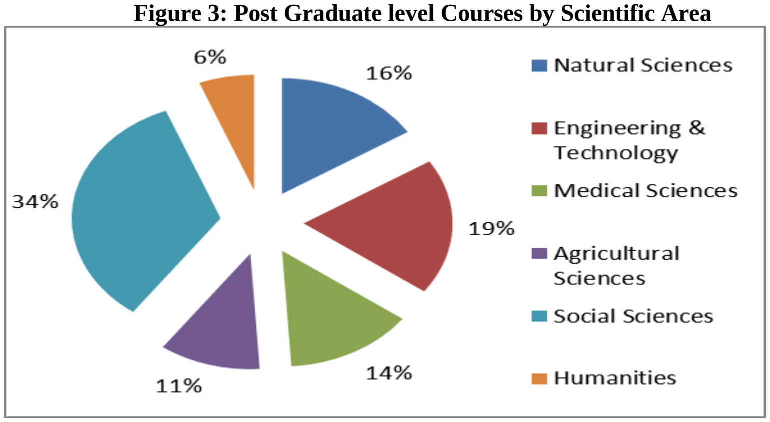
Table 6: Number of Post graduate Courses Offered by Universities (2011)

Doctoral	Master	Specialty	Diploma	Other	Total
9	61	12	115	29	226

Source: VMCyT data base (www.cienciaytecnologia.gob.bo)

By 2010 there were 339,571 registered under graduate students and 9,539 post graduate students, of which only a small percentage complete their studies, as shown in *Table 7*. Many post graduate courses are supported by international cooperation, for example SAREC/Sweden, supporting the two largest universities UMSA and UMSS. Around 100 programmes in private and public universities have been accredited by different regional and national mechanisms. The Pluri National Agency for Evaluation and Accreditation is yet to become operational as the quality assurance mechanism.

Figure 3: Post Graduate level Courses by Scientific Area



Source: VMCyT data base (www.cienciaytecnologia.gob.bo)

Table 7: Number of Under-graduate and Postgraduate Students in the Public University System (2005 – 2010)

Year	Undergraduate	Postgraduate	Postgraduate/ Undergraduate	Number of Post Graduate Titles granted	
				Number	%
2005	257,296	7,929	3.1%	2,559	32.3%
2006	267,011	8,055	3.0%	2,124	26.4%
2007	280,043	8,475	3.0%	1,958	23.1%
2008	297,269	10,256	3.5%	2,470	24.1%
2009	319,953	10,661	3.3%	2,598	24.4%
2010	339,571	9,539	2.8%	1,586	16.6%

Source: Arauco and Gallardo, 2011

CEUB has made an in-depth analysis of the situation of public universities as part of the national STI system (CEUB, 2012) as a necessary step for adopting its National Strategy for S&T 2012 – 2015 /[3]. The analysis shows that the university structures that support the management of S&T, excluding the two largest universities, UMSA (La Paz) and UMSS (Cochabamba) are weak and unarticulated, with reduced personnel. Several universities have drawn strategic plans for R&D, which have yet to be internally approved. The present management structures in the universities have not been able to overcome the weak linkages between the generators of knowledge and the demand side and there is a set of constraints that need to be overcome, as identified in the SWOT analysis further on.

The financing of S&T activities and research in the university system represents only 7% of the total university budget. As discussed further on, funds from abroad constitute the key component for R&D expenditure. For the case of UMSA and UMSS it represents an annual 6 million US $. The direct tax on hydrocarbon has represented a growing support for R&D on average since 2005 of little less than 7.0 million US $ per year for all the system. UMSA has destined 2 million US $ for research activities alone. The excessive bureaucratic procedures for using these funds discourage researchers to apply.

/[3] CEUB recognizes that the public university system is yet to establish a reliable statistical system.

Table 8: Research Projects in the Public University System (2006 – 2010)

Year	Number of projects	Number of participants		Status of projects	
		Academics	Students	In progress	Concluded
2006	371	672	1,116	93	183
2007	533	847	1,618	119	314
2008	684	1,095	1,909	146	440
2009	737	976	2,184	240	308
2010	820	1,078	2,488	306	443

Source: CEUB, 2012

As will be seen further on public universities are by large the main actors in R&D in Bolivia, and in spite of limitations affecting the research system several centres have received international recognition for their contributions to knowledge. *Table 8* shows the number of existing projects between 2006 and 2010 and *Table 9* the number of transferred projects.

Table 9: Research Projects Transferred to Social and Economic Sector /1

Year	Projects transferred to productive sector	Projects transferred to social sector	Total
2006	25	37	62
2007	43	42	85
2008	54	66	120
2009	180	162	342
2010	194	186	380

Source: CEUB, 2012. /1 It is understood by the authors that research projects mean research outputs

When research projects are individually analyzed, it is seen that public universities have been working on issues that deal with the main social and economic problems of the country, and several achievements can be singled out in areas of biotechnology, genetics, energy and others. In some cases university research has provided assistance to vulnerable groups by carrying out research for improving health practices or environmental management. However, a radical cultural change is urgently needed at the universities if they shall be able to effectively support sustained development. Especially, the priority and incentives given to quality research and research-based education must be increased relative to the present dominant emphasis on traditional teaching.

Scientific research projects have as their main outputs publications. A full bibliometric analysis of university research outputs is still to be made. In the section related to the indicator based analysis of the national STI system that follows it must be considered the very large input of university publications to the total number of publications of Bolivia.

Thulstrup et al (2006) have made an in-depth evaluation of the SAREC/SIDA funded research activities in the two largest public universities (UMSS and UMSA) that permits to have an overview of the situation in the whole system. Their main conclusions are:

- ***Relevance*****:** In theory, the relevance of the S&T project themes is generally good, either in the form of a potential, direct impact on social, environmental or economic problems.
- ***Feasibility*****:** All projects have realistic opportunities for successful outcomes, both in terms of research training, academic research results, and within a wide range of real applications, and development contributions.
- ***Effectiveness*****:** Effectiveness is generally quite good with respect to research and research training, but low with regard to academic communication (including publishing) and practical applications of the research results and skills.

- ***Impact:*** The impact is mainly of a less practical nature but formal, academic qualifications of the staff are improving considerably. Societal impacts are so far quite limited, although it seems likely that several of the projects may increase their impact on development and poverty reduction considerably, both directly and indirectly.

Other advances recognized in the evaluation are: a) projects have attracted a large number of bright undergraduate students, b) large number of new PhDs and Masters are returning to Bolivia; c) laboratories have been upgraded significantly and generally successfully; d) often low-cost and local solutions have been cleverly used; e) research funds are changing the culture through their demand for well-documented proposals; f) extensive cooperation with foreign advisers of graduate students exists.

a. In spite of these positive signs, the study of Thulstrup et al also point out to existing problems along four lines:
b. ***Problems in policy and management***. Policies are not institutionalized; academic structures are weak; policy does not have continuity; no policy for training researchers exist; lack of linkages between national and university policies; application and dissemination of knowledge is insufficient.
c. ***Problems in dissemination of research***. Absence of a publications culture; very few Bolivian publications are international or are indexed; little quality control of most local publications; not sufficient diffusion inside the academic community or outside to the general public.
d. ***Problems in the future of research***. Absence of research training; absence of knowledge of policies and national plans; university plans produced without the participation of active researchers; absence of adequate infrastructure; insufficient administrative and financial structures.
e. ***Problems of research as inputs to the quality of education***. Absence of an academic model centred on research; absence of a research administration culture; insufficient contribution of research to development; low priority of STI.

5. Evaluation of University Research Strategy

CEUB has made an in-depth evaluation of the previous S&T University Development Strategy 2007 – 2010 that is worth quoting. *Table 10* reproduces the main results, it is noted that many objectives are those needed to be fulfilled to “close the loop”. The result of the evaluation is interpreted as showing the difficulties in managing research inside the university environment.

On the basis of the results of the evaluation a SWOT analysis was produced (*Table 11)* that shows the conditions under which RTI takes place in the public university system.

Table 10: Evaluation of the 2007 – 2010 University S&T Strategic Development Plan

Objectives	Mean value *
1.Make tangible the contribution of the university to the social and economic sustainable development of regions and the country, conducting research and innovation activities that contribute to improve the quality of life of peoples, increase productivity and competitiveness of the economy, generate employment, and improve the quality of higher education.	2.57
2.Make compatible the productive, prefecture and municipalities and other sector's needs with the interests and academic values of the Bolivian University, so that their resources and infrastructure are added and complemented to attain sustained scientific and technological development.	3.06
3.To develop a normative framework and an institutional operational environment to increase the production of science, technology and innovation, coherent with the demands of productive, prefectures, municipalities sectors and other development organizations.	2.34
Mean Valuation of the Strategy	**2.66**

Source: CEUB, 2012: * Scale: 1 objectives not accomplished; 5 excellent accomplishment

Based on the evaluation of the previous Plan and the SWOT a new Strategy towards 2015 has been defined and adopted by the university system, whose vision is defined as:

"The National University Science and Technology System is a reference at the national and international level that satisfies the economic, social and productive demands of rural and urban communities by the contribution of relevant research and innovation outputs directed to solve problems, providing modern scientific and technological information, managed by highly qualified people and financial resources and infrastructure that permits the successful accomplishments of its activities"

The adopted Strategy defines a set of 12 policy objectives under three broad strategic objectives, which are similar to those in the previous Plan; it defines specific goals and actions to reach the set objectives. It also provides the guideline to evaluate the Plan during its execution and conclusion. No financial resources are estimated for the Plan's execution.

a) Promote the contribution of the university to the social and economic development of the country and regions, through research and innovation.
b) Attain a sustained scientific and technological development making compatible the needs of productive sectors, departmental governments, municipalities and other institutions, with the academic interests and values of the Bolivian University, so that resources and infrastructure in their fields of action are complemented and added.
c) Increase the production of STI in the university, through a convenient normative framework and institutional environment.

Table 11: SWOT Analysis of the R&D University System

Strengths	Weaknesses
1. The SUB groups the largest and most qualified group of researchers in the country 2. The SUB has the largest infrastructure in the country 3. Growing use of ICTs 4. Presence of authorities engaged in improving the environment for research and innovation 5. Growing use of the direct hydrocarbon tax for research 6. Established curricular development policy 7. Human resources trained in management and transfer of research outputs	1. Simple and burocratic organizational structures for managing S&T 2. Insufficient financial resources 3. Inexistent or poor critical masses in certain areas 4. Centres with deficient infrastructure and equipment 5. Weak linkage with socio economic sectors 6. Insufficient diffusion of existing services 7. Lack of knowledge of the S&T demand of productive sectors 8. Incipient information and communication system for STI 9. The largest human resources and material infrastructure is concentrated in three cities 10.

Opportunities	Threats
1. Possibilities to participate in regional and national plans 2. Possibilities to commercialize services and advisory tasks 3. Demand and expectation for university services 4. Possibilities of agreements at national and international levels 5. Possibilities to obtain financial resources for research 6. Possibilities to integrate national and international information networks 7. Generate a change in attitude in the context of the national innovation process 8. Possibilities to initiate a process of certification and accreditation at national and international level of existing laboratories in the SUB	1. Postponement in the generation of laws and decrees that favour development of STI 2. Decrease of direct tax on hydrocarbons income 3. Brain drain at the postgraduate level

Source: CEUB, 2012

6. Indicator-based Analysis of the National STI System

The importance of indicators for defining and evaluating policies has been highlighted extensively. In effect the growing complexity of research and innovation require a profound knowledge of the national innovation system, a credible knowledge that exploits national and international sources, allowing analysis on a temporal, evolutionary and comparable basis. Indicators are precisely such type of knowledge (Barré, 1997).

Bolivia has produced S&T indicators since the early 90's following UNESCO's statistical procedures as well as the Frascati Manual (Telleria, 1993). Between 2010 and mid-2012 VMCyT conducted the first two national R&D surveys). In the first, 344 R&D organizations were recognized and 189 responded, in the second 317 R&D organizations were identified of which 251 responded both on-line and physical questionnaires, thus greatly improving the response rate. The main integrated results of both surveys are presented here /[4]

6.1. Number of R&D Centres and Personnel

Table 12 provides the number of existing research centres by type of administration and scientific disciplines. Of the total, 75% are public and 25% private and 65% of these concentrate in three of the nine departments of the country (La Paz, Cochabamba and Santa Cruz). Of this total 180 belong to public universities while 45 belong to private universities. In three departments (Potosi, Beni and Pando), 100% of the research centres belong to public universities. *Table 13* provides the number of staff in the existing centres and institutes, and *Table 14* this same number by scientific discipline

Table 12: Number of Existing Research Centres (2011)

Scientific Discipline	Public		Private		Total
	Universities	Government	NGO's & Foundations	Private University	
Natural Sciences	41	2	2	8	53
Engineering & Technology	65	1	-	13	79
Medical Sciences	22	1	2	9	34
Agricultural Sciences	40	4	5	3	52
Social Sciences	36	1	3	15	55
Humanities	6	-	-	5	11

Source: VMCyT data base (www.cienciaytecnologia.gob.bo)

/[4] The authors have made a selection of those indicators in each survey that in their perception best represent the situation.

Table 13: Number of Staff in Research Centres (2011)

Personnel	Public		Private		Total
	Universities	Government	NGO's & Foundations	Private University	
Researchers	1,181	93	265	450	1,989
Fellowship holders	351	6	26	135	518
Technicians	239	8	68	127	442
Other support personnel	319	12	68	41	440
Other services personnel	104	3	28	37	172

Source: VMCyT data base (www.cienciaytecnologia.gob.bo)

Table 14: Number of Staff by Scientific Area

Scientific Discipline	Type of Staff		Total
	Researchers	Fellowship	
Natural Sciences	439	111	550
Engineering & Technology	489	151	640
Medical Sciences	229	85	314
Agricultural Sciences	307	58	365
Social Sciences	426	91	517
Humanities	99	22	121
Total	1,989	518	2,507

Source: VMCyT data base (www.cienciaytecnologia.gob.bo)

Table 15 provides information on the time dedicated by staff to research. It is noted the large number of academic staff and fellowship holders that are only dedicated to research part time. This phenomenon is particular of the university system (both public and private, but largely stressed in private universities). *Table 16* provides the same numbers by scientific area and *Table 17* the number by academic degree.

Table 15: Number of Staff by Time Dedicated to Research (2011)

Personnel	Time destined to research	Public		Private	
		University	Government	NGO's & Foundations	University
Researchers	Physical Persons	1,181	93	265	450
	Full Time	740	70	144	147
	Part Time	441	23	121	303
Fellowship holders	Physical Persons	351	6	26	135
	Full Time	115	6	12	24
	Part Time	236	-	14	111
Technicians	Physical Persons	239	8	68	127
	Full Time	120	8	61	13
	Part Time	119	-	7	114

Source: VMCyT data base (www.cienciaytecnologia.gob.bo)

Table 16: Numbers of Staff by Time dedicated to Research by Scientific Area (2011)

Scientific Discipline	Researchers		Fellowship holders	
	Full time	Part time	Full time	Part time
Natural Sciences	284	155	55	56
Engineering & Technology	206	283	43	108
Medical Sciences	116	113	16	69
Agricultural Sciences	223	84	27	31
Social Sciences	238	188	16	75
Humanities	34	65	-	22
Total	**1,101**	**888**	**157**	**361**

Source: VMCyT data base (www.cienciaytecnologia.gob.bo)

Table 17: Academic Level by Scientific Area in 2011

Research Area	Doctorate	Master	Bachelor	Technician	Others
Natural Sciences	67	137	204	75	67
Engineering / Technology	48	182	254	25	131
Medical sciences	21	107	90	53	43
Agricultural sciences	23	96	169	26	52
Social sciences	64	165	184	51	53
Humanities	30	42	39	3	7
Total	**253**	**728**	**940**	**233**	**353**

Source: VMCyT data base (www.cienciaytecnologia.gob.bo)

Of relevance to this study, OIM/SELA (2009) has taken an in-depth look into brain-drain in the Latin American region, showing a rather dramatic situation. The analysis covered both the OECD and USA. *Table 18* shows the situation in the latter case. On the basis of the indicators above, it is possible to build a ranking of brain drain (by number of title holders per population) that would show that Bolivia is in a more favourable position in the region when compared to many other countries, however it is noted that at least 1,200 Bolivians holding a PhD live in the US, a high number indeed for a country with problems of critical mass.

Table 18: Number of Migrants with a University Degree Resident in the US in 2007

Region/country	Total Number	Level of Studies (%)		
		Bachelor	Master	Doctorate
Mexico	**292,625**	**72.9**	**16.4**	**10.7**
Central America	**147,582**	**73.6**	**18.4**	**8.0**
South America	**111,165**	**56.4**	**26.4**	**17.2**
Andean Countries	**246,072**	**66.4**	**20.3**	**13.3**
Bolivia	12,529	68.8	18.3	12.9
Colombia	99,210	65.2	19.8	15.0
Ecuador	34,818	70.1	16.6	13.4
Peru	63,910	70.2	19.5	10.3
Venezuela	35,605	58.6	27.4	13.9

Source: OIM/SELA, 2009; in the total it is included a number of persons which have not been identified by country or origin but only from region

6.2. Research Projects and Technological Infrastructure

Table 19 provides information on the number of projects in both research and scientific and technological activities being carried out in the country for the years 2009 and 2011. The large difference in the number responds mainly to the number of responses to the two surveys and not necessarily to an increase in the number of actual research projects being undertaken.

Table 19: Number of Projects in R&D and in S&T Activities (2005 – 2009)

Types of projects		2009	2011
R&D Projects	Basic research	137	336
	Applied research	392	515
	Experimental development	71	49
	Total R&D	**600**	**900**
S&T Activities	Technology innovation	40	94
	Transfer of results	115	164
	Local “knowledges”	24	47
	Technology transfer	67	41
	Total S&T Activities	**246**	**346**
Total Number of R&D and S&T Activities Projects		**846**	**1,246**

Source: VMCyT data base (www.cienciaytecnologia.gob.bo)

Technology is essential for competitiveness and a key input is the ability of using information and communication technologies. The present government has given a high priority to the development of ITCs and defined a strategic agenda, which is starting to be implemented. At present however the situation of Bolivia in the use of these technologies is still incipient when compared to other countries in the region.

Table 20 produced by the Global Competitiveness Index provides a comparison of the country's technology preparedness as compared to other countries in the region for 2012.

Table 20: Selected Indicators of Technology Development

No.	Indicator/ Descriptor	Chile		Panama		Brasil		Mexico		Costa Rica		Argentina		Bolivia		Venezuela	
		R	I	R	I	R	I	R	I	R	I	R	I	R	I	R	I
9.01	Availability of latest technologies	32	5.9	30	6.0	50	5.3	52	5.3	57	5.2	109	4.3	134	3.6	103	4.5
9.02	Absorption of technology in the enterprise	44	5.2	25	5.6	47	5.2	63	4.8	50	5.1	106	4.3	138	3.7	117	4.1
9.03	Foreign Direct Investment and Transfer of Technology	25	6.1	3	6.0	24	5.2	15	5.3	5	5.8	132	3.6	134	3.6	129	3.7
9.04	Internet users % *	50	53.9	66	42.7	62	45.0	77	36.2	68	42.1	60	47.7	89	30.0	71	40.2
9.05	Wide band subscribers/ 100 hab. *	48	11.6	65	7.9	63	8.6	55	10.6	61	8.7	56	10.5	107	0.7	103	0.9
9.06	Internet wide band, kb/s/capita *	58	20.4	36	44.1	46	29.0	90	8.7	39	36.2	50	25.7	113	4.2	92	8.1
9.07	Wide band mobile subscribers/100 hab	54	17.1	69	14.5	47	20.9	82	4.6	100	2.0	65	11.7	101	1.9	85	4.2

Source: WEF, 2012; Note: * Hard data; R: Ranking; I Value of Indicator in the scale 1 to 7 or 0 to 100%

6.3. Expenditures in Research, Technology and Innovation

Expenditures in RTI are limited and mainly addressed to cover salaries and operational expenses, those for equipment, libraries, travel, all crucial for maintaining research capacity are growing only slowly and a national fund for research is still to be established. In general, the financial system has not developed adequate instruments for RTI. There are few funds normally accessed by public competitions which have provided important sector funding. This is the case of PIEB for social research, (former) SIBTA for agricultural projects, and funds for environmental research and protected areas. *Table 21* provides the figure for expenditures for research and scientific and technological activities for 2011.

Table 21: Expenditures in Research and Scientific and Technological Activities for 2011

Source of Financing	Amount (in US$ of 2011)		Totals /2
	Research	S&T Activities	
Own resources 1/	2,422,136	2,364,244	4,786,380
Enterprises	106,298	56,434	162,732
Government	2,266,758	59,388	2,326,147
Foreign Credit	78,571	-	78,571
Foreign	124,152,032	202,473	124,354,505
Total 2/	129,025,796	2,682,539	131,708,335

Notes: /1 Mainly by university funds; /2 may not sum up due to rounding

Source: VMCyT data base (www.cienciaytecnologia.gob.bo)

From the above GERD it can be determined that the expenditure per GDP for 2011 in R&D has been 0.41%, a figure higher that the previously estimated 0.3% (in the decade of 1990's). It is to be noted from the table the extreme dependence of financing from foreign sources (cooperation by donors), were it not for this cooperation the expenditure of Bolivia per GDP would only reach 0.018%.

Bolivia does not have a venture capital system for technology and innovation, but holds a high potential in its microfinance system. In fact the Global Competitiveness Index places the country in the 30th rank worldwide (2012-2013) in the financial market development thanks to this system. The growth of microfinance institutionally, methodologically and normative, has allowed Bolivia to become a model for other countries. It is yet to be analyzed how to utilize this developed financed system for technology and innovation.

6.4. Diffusion of Research Outputs

"Closing the loop" depends strongly on how the scientific community transmits the result of its work. Ideally research results must be made available for:

a. The international scientific community
b. The local users such as industry, local communities etc.
c. Policy makers, interest groups and organizations that require scientific opinion in respect to specific issues for the definition of policies.

In Bolivia, dissemination of research results fail in all categories in spite of existing talent, the value of research results and the efforts to publish local journals.

Many scientific publications are made in local journals, but few of them are indexed in international data bases, due to (Moraes, 2009) the lack of criteria to define the level of advancement and development of published journals, the lack of procedures, norms and national criteria to define the publication index, and lack of editorial committees.

The Vice Ministry's surveys identified scientific and technological publications (books and journals), independent of indexation, periodicity or refereeing criteria). It found that in 2011 there were 390 books and 468 journals published. Of the large number of existing journals, only 7 in the social sciences, 3 in science and technology and 3 in the medical sciences comply with international standards as in form and content. It has been noted that some countries are managing to merge a large number of more or less useless local journals into a small number of strong, international journals. "There is little doubt that Bolivian research would benefit greatly from stronger national journals" (Thulstrup, 2006).

The Scielo Platform was recently created and today comprises 15 journals that conforms defined quality criteria. Of these 10 journals belong to the public university system (of which four are from the Catholic University, four from UMSA, and two from UMSS). One journal (Ecology in Bolivia) is indexed in Latindex, Dialnet, Periodica and LILACS. At the same time there are 19 publications on-line, of which 9 belong to the public university system (2 of the Catholic University, 4 by UMSA, 1 by UMSS, 1 by UMSFX, 1 by UAGRM, and 3 by UNIVALLE (private).

Lemarchand (2012) has conducted a bibliometric analysis for Ibero American publications between 1973 and 2012 in the SCI, SSCI & A&HCI data bases. *Table 22* shows the total number of publications. It should be noted that although Bolivia has in effect produced a small number of publications, it ranks better than many other countries in the region when considering specific criteria, as shown in *Table 23*.

SCImago Lab has also conducted a bibliometric analysis that compares the number of published scientific results in Bolivia with those in other countries of the region. Figure 4 shows the ranking of a selected group of countries by the "H" Index that provides a measure of the impact of research. It can be observed that Brazil leads the group with an "H" Index of 305, while Bolivia is placed in the last position of the ranking in this group with an "H" Index of 61.

Table 22: Number of Publications in the Web of Science (1973 – 2012)

Ranking	Country	Number of Publications	Ranking	Country	Number of Publications
1	Spain	703,031	10	Peru	9,897
2	Brazil	363,581	11	Uruguay	8,915
3	Mexico	145,800	12	Costa Rica	8,011
4	Argentina	136,369	13	Jamaica	6,512
5	Portugal	102,444	14	Panama	5,820
6	Chile	74,470	15	Ecuador	3,903
7	Venezuela	32,679	16	Trinidad &Tobago	3,815
8	Colombia	22,207	***17***	***Bolivia***	***2,806***
9	Cuba	14,817	18	Guatemala	2,769

Fuente: Lemarchand, 2012

Table 23: Growth of Citable Publications as a Function of Time (G), per inhabitant (E) and by GDP (2005 in Billion US $)

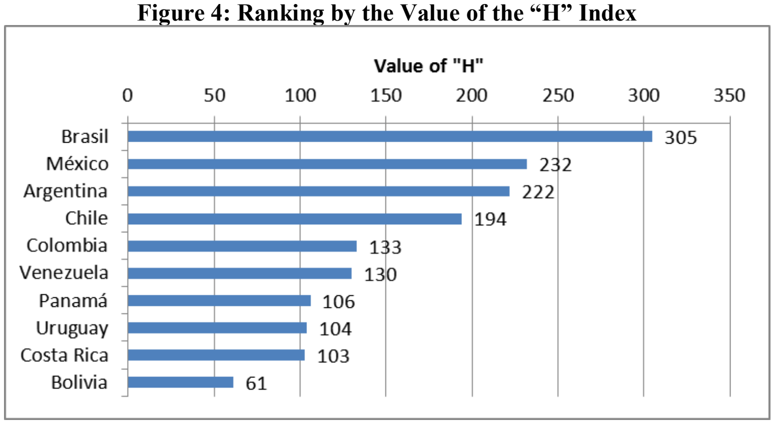
Ranking	País	G	Ranking	País	E	Ranking	País	D
1	Portugal	0.1250	1	Portugal	0.1215	1	Portugal	0.0973
2	Colombia	0.1104	2	Colombia	0.0925	2	Cuba	0.0723
3	España	0.0983	3	España	0.0918	3	España	0.0718
4	Brazil	0.0952	4	Cuba	0.0809	4	Brazil	0.0670
5	Ecuador	0.0901	5	Uruguay	0.0794	5	Ecuador	0.0661
6	Cuba	0.0867	6	Brazil	0.0776	6	Uruguay	0.0624
7	Uruguay	0.0837	7	Ecuador	0.0740	7	Colombia	0.0547
8	México	0.0788	8	Trinidad & Tobago	0.0656	***8***	***Bolivia***	***0.0525***
9	***Bolivia***	***0.0760***	9	México	0.0608	9	México	0.0503
10	Chile	0.0573	***10***	***Bolivia***	***0.0554***	10	Trinidad & Tobago	0.0456
11	Peru	0.0568	11	Chile	0.0426	11	Argentina	0.0349
12	Argentina	0.0541	12	Argentina	0.0408	12	Peru	0.0337
13	Costa Rica	0.0516	13	Peru	0.0377	13	Venezuela	0.0179
14	Trinidad & Tobago	0.0420	14	Costa Rica	0.0272	14	Costa Rica	0.0112
15	Panamá	0.0419	15	Panamá	0.0226	15	Chile	0.0084
16	Venezuela	0.0420	16	Venezuela	0.0140	16	Panamá	0.0004
17	Guatemala	0.0760	17	Jamaica	0.0043	17	Jamaica	-0.0020
18	Jamaica	0.0203	18	Guatemala	-0.0040	18	Guatemala	-0.0110

Source: Lemarchand, 2012

Figure 5 shows the limited capacity for publication of the region in general, when compared to developed countries whose "H" index is well over 500. Coincident with the previous measure, Cornell et al (2013) in measuring the Global Innovation Index provides a world ranking of citable documents measured by the "H" index, as shown in figure 6. Again Brazil is the highest ranked country of the region, 22nd in the world, while Bolivia occupies the 94th place among 142 countries.

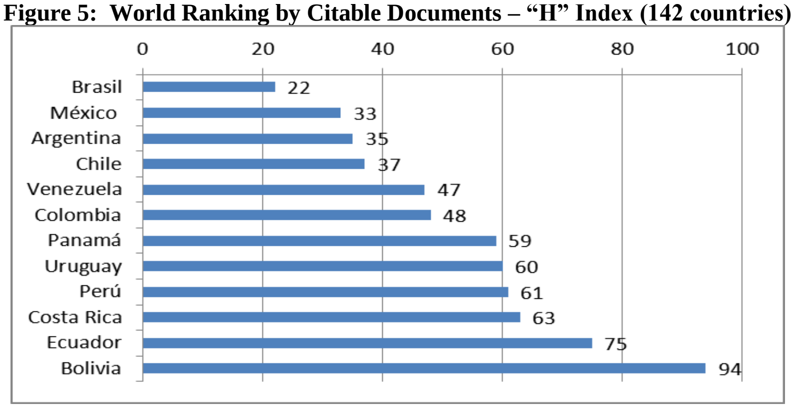
This low ranking of the country and as noted further the small impact of research not only in scientific publications but also on policy and innovation can be explained in part by the fact that only a small percentage of academics, 8%, dedicate more than 90% of their time to research, while 66% dedicate less than 50% of their time to this activity, as already shown above.

Figure 4: Ranking by the Value of the "H" Index



Fuente: ScimagoLab (accessed so el 14.03.2014)

Figure 5: World Ranking by Citable Documents – "H" Index (142 countries)



Source: Cornell et al 2013 with data from SCImago of 7 April 2013

6.5. Research and Development in the Business Sector

The efforts of the business sector to develop research and innovation in Bolivia are still quite limited and have not been measured formally as the country has not conducted innovation surveys. There are specific case studies that provide a vision of the innovation activities that take place in this sector. The study of Aguirre Bastos (1997) conducted on SMEs showed the lack of conscience and sensibility of managers towards research and innovation and also showed the little value given to human capital. In spite of this situation it is also observed that several SMEs have an organizational dynamics showing a tendency towards using quality control and programmes for continuous improvement.

Alänge et al (2004) analyzed local innovation and cluster activities that show many weaknesses, but also showed examples of innovation in communities (f.e. ecotourism), entrepreneurial companies, and there exist relationships with suppliers. In the more recent years, private sector associations have been more active in promoting technology and innovation development within their associates. Some larger enterprises have attained technology development and innovations of value, for example the textile sector, oils and fats, and leather industries have become exporters to international markets.

As an example of the level of RTI efforts in the business sector, the number of local patents continues to be very low. *Table 25* shows the indicators for 2010 and 2011.

Table 25: Patents Requested and Granted at the National Patent Office (2011)

	Patent Requests		**Patents Granted**	
	Residents	**Non residents**	**Residents**	**Non residents**
2010	80	333	5	67
2011	118	322	48	66

Source: VMCYT data base (visited 12 August, 2013) (www.cienciaytecnologia.gob.bo)

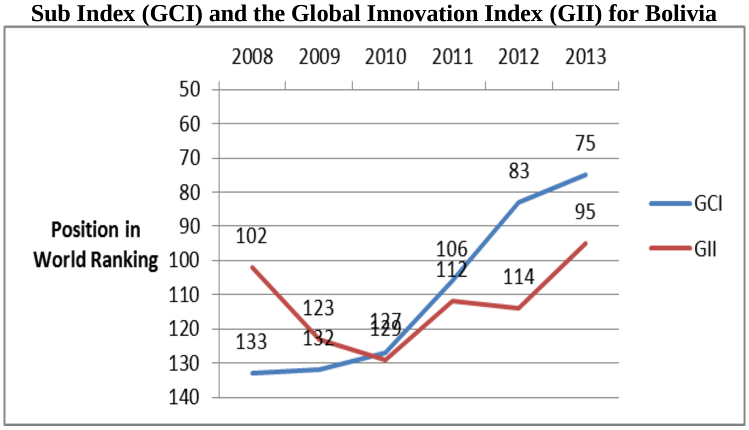
Today's emphasis on traditional knowledge, as a basis for entrepreneurial development, comes from fact that Bolivia more than other countries in the region, still conserves an almost intact indigenous social life, so restoring traditional knowledge is considered not simply an anthropologic task rather it is a way to rediscover more efficient techniques of production and management. There is a development vision based on the belief that a dialogue between local and traditional knowledge, academy and enterprises, is possible.

In the business context, a number of institutions and organizations in Bolivia have been created or strengthened to service production. Examples in the 1990's are in the Bolivian Institute for Standards and Quality and the National System for Quality, Metrology, Accreditation and Certification. Also in this period the Bolivian Office for Accreditation and the National Service for Intellectual Property were reorganized.

6.6. Other innovation indicators

Figure 5 shows the evolution of the ranking of Bolivia between 2005 – 2013 in the Global Competitiveness Innovation Sub Index and the Global Innovation Index, noting the improvement in the ranking of the country in the last 5 years. Between both sets of indicators that of Cornell is considered a much more reliable one due to the source of information on which they are built (Aguirre Bastos, 2014).

Figure 5: The Global Competitiveness Innovation Sub Index (GCI) and the Global Innovation Index (GII) for Bolivia



Source: Cornell U et al (2013) and WEF (2013)

Part C

The Agriculture Sector Innovation System

1. Overview

Between 1949 and 1966, at the impulse of the Inter-American Agricultural Service (established in 1948) eleven agricultural and three demonstrative livestock experimental stations were created. It is recognized that this is the period when research and innovation reaches high standards. Efforts in this period were strongly influenced by the green revolution concepts, and were dedicated to study the most appropriate conditions for the production of a large number of products. Research results were (linearly) transmitted by an able extension service established also at the time (Flores, 2003; Cardozo, 2001).

With the creation in 1975 of the Bolivian Institute for Agricultural Technology (IBTA), research and extension was taken over principally by the State and the traditional model of research institutes was consolidated following the green revolution model and the industrialization of agriculture. It has been amply recognized that the intensive agricultural model adopted was not adequate to the (dry) western or mountainous production zones, as it required irrigation but was more successful in the more resource rich eastern lands.

In 1990 a process of institutional reform was undertaken, as part of the structural adjustment, modernization and reduction of the State process. In this period the role of international cooperation was fundamental to continue with research, but the extension services were completely dismantled. The process of institutional reform was completed only in 2000 with the creation of the Bolivian Agriculture Technology System (SIBTA), whose main task was to articulate, from the State, the private and public sectors and promote and develop technology, forestry and agro-industrial innovation, as a function of the demand of actors in agro-productive value chains. SIBTA operated through four foundations in the main national macro-regions, and defined two sets of projects: Projects for Applied Technological Innovation and National Strategic Innovation Projects.

According to an impact evaluation of 24 of the former projects (Lema *et. al.* 2006 cited by Delgado and Escobar, 2009) there has been found positive effects in income and the mean return rate. It has also been noted that there was an induced demand by the suppliers (62%), weak participation of demand in project design (66%) and weak benefit for vulnerable groups (40%). Public universities were excluded from projects as potential suppliers and priority was given to consulting firms. In 2004 an assessment of the R&D capacities of the existing 69 agricultural centres (9 private, 1 mixed and 59 public, including university centres) showed that only eight had adequate capacity, 41 moderate capacity and 20 severe limitations to undertake R&D.

One important example of private innovation efforts in agriculture is being undertaken since 2000 by Fundación Valles (2010), whose membership is composed of 21 private and public institutions. The technology innovation programme is the main axis of work and it is strongly based on a participative approach and has played attention to value chains, based on long-term programmes. This approach has been determinant in the attention of critical factors that limit the development of agri-business and that limit the adequate economic development of the small producers.

Until December 2011, the Foundation had executed 12 programmes, which include 136 projects (finished) and 14 on-going, benefiting more than 58,184 families grouped in 122 based organizations and small enterprises. The interventions are mainly centred in the diffusion of existing technology based innovations. Through its projects, it has been possible to develop suppliers of inputs and services, and the access of small producers to export markets.

Of importance in the private sector is the presence of the research and extension services of the Patiño Foundation (www.fundacionpatino.org) established in 1958 which contributed to the development of education, culture, research, health, hygiene, nutrition, agriculture and ecology. The Foundation operates through various centres, owned by the Patiño University Foundation created in 1931. The latter operates in Europe, diffusing the richness and diversity of Latin American cultures and in Geneva maintains a university centre that provides scholarships to deserving Bolivian students.

In the area of agriculture, the Foundation operates three organizations: The Centre for Phytoecogenetic Research; the Model Farm; and the Seed Centre. The research and innovation effort concentrates on specific plant varieties (and livestock), and in collaboration with the Seed Centre it diffuses its products and information on use through training courses, demonstrative plots, preparation of technical manuals.

The production of high quality genetic and phytosanitary seeds is done through contracts with farmers and the Model Farm, to whom basic seeds are provided and maintains technical assistance provided through the production cycle. The Seed Centre produces over 200,000 kg of certified seed of improved varieties for sale to small producers. Nearly 40,000 of the latter cultivate these seeds. The increase of income of small farmers that use the Centre's varieties is estimated at 10 million USD per year.

One of the most important and evident impact of the model pursued before 2006 is that of the Andean grain quinoa; the present commercial varieties have been obtained through extensive research efforts on behalf of IBTA and other actors of the sector innovation system. In 2011, the FAUTAPO (2011) Foundation prepared full documentation to back and register the "denomination of origin" of the Quinoa Real specie, which is today amply commercialized worldwide.

The research efforts allowed "closing the loop" in this specific case. Antonio (2011) has analyzed both the potentials and the existing policy challenges for the development of a sustained quinoa-based agro-industry as described in *Box 2*.

Several other research efforts by both public and private non university agents with positive, although limited results, can be identified in the period prior to 2006. Examples are those of the PROINPA which makes part of the system of natural genetic resources, using molecular markers to evaluate diversity in their culture collections, and working in programmes to improve corn, quinoa and other species.

Universities have also contributed extensively to the development of the sector system, for example the University of Santa Cruz (UAGRM) has worked on commercial fruits, the Military University on micro propagation of flowers; UMSS in micro propagation of fruits.

Hartwich and Jansen (2007) have extensively analyzed the role of government in agricultural innovation in Bolivia. The authors have pointed out that governments in developing countries when trying to manage complex innovation processes involving many and different actors, find it difficult to design effective interventions and therefore end up supporting and managing only the public research and extension organizations that directly depend upon them. This has not been the case of Bolivia, however. The study found that despite a number of weaknesses related to the design of the system and the government's limited commitment, the regional foundations were able to effectively identify the demands of small farmers, set priorities, and provide transparency and accountability with regard to funding and decision making.

Box 2: Success and Challenges of a Sustainable Quinoa-based Agro-industry

The value of Bolivian quinoa exports has risen from a total of US $ 2 million in 1999, representing 1,500 tons to more than US $ 46 million in 2010, or about 15,400 tons. Exports have attracted international customers and exporters willing to buy the grain at higher prices. In 2010 there were 23 major quinoa exporters, all part of the National Association of Quinoa Producers (ANAPQUI) whose combined revenue that year was about US $ 42 million. The analysis made shows that if production and exports are to be sustainable, the agricultural practices must be both ecologically and socially sound. Producers face technical difficulties and environmental risks of importance, and there are impacts on the social and environmental capital of the regional economy, that need very special attention.

The policy problem in the long term is that the expanded growth of the industry represents both a great opportunity and potentially a serious threat to the environment and local nutritional levels among the poorer communities. The high prices and worldwide demand have put tremendous pressure on production, and this pressure has encouraged poor environmental practices as well as illegal trafficking.

To face the challenge, ANAPQUI should promote and assist farmers to implement sound environmental management practices, focusing on how to increase production by increasing the yield instead of expanding the agricultural surface; government should solve trade issues and making the industry more competitive, one step in this direction has been the quinoa law approved in March 2011, that establishes property rights over the variety *Royal Quinoa*, and provides for other means of support. But government needs to improve the business environment, as well as trade conditions and infrastructure. The study also recommends that stronger partnerships are required between ANAPQUI and the government, for example the latter promoting local nutrition programmes by providing quinoa to the most vulnerable groups, incorporating the grain into the school feeding program run by the Zero Malnutrition Programme.

Source: Antonio, 2011

The study collected an extensive data base by means of an expert consultation and interviews with a wide range of key actors and stakeholders from various organizations involved in agricultural innovation. The empirical findings of the study suggest:

a) A research and technology transfer program such as SIBTA constitutes only part of an innovation system and there are other complementary functions with which the government has to comply to foster innovation. Rather than aiming to carry out research and extension, governments should focus on overall planning on the macro level and on policy analysis, the setting of consultation platforms, supporting the building of innovation networks, and setting up specific funding mechanisms.

b) Setting up decentralized semiautonomous agencies that administer funds and design innovation projects do not automatically lead to sufficient participation of local producer organizations and technology providers. More participation requires special rules and incentives to collaborate and the special efforts of all involved, and eventually further decentralization on the regional level.

c) Weak leadership and limited commitment, rather than a decentralized structure or the delegation of too much power, have prevented governments from taking a more active role in governing their innovation systems. Decentralization, however, should not stand in the way of a national strategic vision, and mechanisms need to be put in place to discuss and harmonize national- and local-level priorities.

d) Being responsive to the demands of farmers does not necessarily imply that one is generating the best technical solutions. Generating adequate innovations requires the participation of all agents of the innovation system. It also requires analysis and identification of technological and market opportunities.

e) Policymakers should foster in-depth analysis of farmers' demands on the local level through decentralized organizations, which simultaneously help to orient these demands to where technological and market opportunities lie. This requires improved analytical and planning capacities as well as intensive communication with the farmers and agents who benefit from new and promising technologies.

2. Research Policy in the Agriculture Sector

Recognizing that the existing agriculture production model had limited impacts, several authors (Delgado and Escobar, 2009) have considered that the model did not value the local "knowledges" and the wisdom of indigenous people, neither the wealth of the existing biodiversity, as the model introduced modern technologies replacing ancestral systems.

Under the above premise, in 2006 the new government established the National Institute for Innovation in Agricultural and Forestry Innovation (INIAF), whose mission is defined as "*the sole research instance accredited in scientific exchange activities at the national and international levels, related to agriculture and forestry issues*". At the same time, it is expected "to promote and articulate national, departmental, municipal and local policies in the realm of agriculture – forestry research and innovation". The Decree creating the INIAF points out that "research must be undertaken from the State (in association with universities and the private sector) for all rural producers".

Table 26: Comparative Analysis of the Traditional and Alternative Innovation Approaches

Category	Conventional	Alternative
Approach	Neoliberal approach that emphasizes the market and reduces the role of the state giving emphasis to enterprise development and industrialized agriculture for exports. Does not recognize the local "knowledges" and the wisdom of local communities that have had a fundamental role in food security in the country	Approach for a sustained endogenous development triggered by a dialogue among "knowledges" (modern scientific western knowledge, local "knowledges" and wisdom of local communities) emphasizing the complementarily of industrialized agriculture and that of small producers.
For what?	Greater competitiveness in the market in front of the opening of new markets, climate risks and diminishing soil productivity	Guarantee food security and autonomy with larger competitiveness in the local and external markets, in front of climate changes and the diminishing soil productivity
How	Disciplinary and inter-disciplinary development in the framework of western modern science and technology, through conventional methodologies and vertical trends. Prioritization of vertical technology transfer.	Trans-disciplinary, revalue of local "knowledges" and wisdom of local original communities, as opening of an inter-scientific dialogue. Participatory research is re-valued and participatory technology development are usual methodologies in a perspective of a multi and inter-methodological perspective
Where	Efforts are prioritized in experimental stations with some efforts of participatory research of instrumental character and the transfer of technology	Research and innovation are prioritized as part of a dialogue of "knowledges" between local actors and professional technicians. It is carried out in the field (producers lots, communities, production centres, etc.) with the participation of local actors

Source: Delgado and Escobar (2009)

From their analysis, Delgado and Escobar have proposed to define the agriculture sector innovation as:

In the view of Delgado and Escobar, the innovation vision taken by INIAF is an adequate alternative as it orients to the prioritization of food security and autonomy, and to incorporate local "knowledges" sustaining an integral development vision. As it takes distance with a view of innovation oriented principally to competitiveness in the market, value chains and productive specialization, it does form the basis for the construction for the sustainable management of natural resources and the promotion of biodiversity allowing an endogenous sustainable development. *Table 26* provides a comparative analysis of the traditional and alternative innovation approaches.

> *"... the participative generation or re-creation of a knowledge, technology, product or process, in the framework of sustained management of the whole of the productive system, through the re-value of the local "knowledges" and the wisdom of the original indigenous groups, the inter-cultural and inter-scientific dialogue and the trans-disciplinarity, to guarantee the food autonomy and security, as well as greater competitiveness in the local and external markets to live well"*

To analyse the issue of endogenous development, it is important to look at the experience of the Project for Capacity and Theory Building for Universities and Research Centres in Endogenous Development (CAPTURED), under the auspices of the Ministry of Foreign Affairs of the Netherlands, aiming to develop capacities for research and use of local knowledge. The Project in Bolivia was conducted by AGRUCO (2008) a research and development centre of the Universidad de San Simon in Cochabamba. *Box 3* resumes the evaluation of the Project.

Box 3: Experience in the Creation of Capacities for Endogenous Development

After five years of support by CAPTURED in Bolivia AGRUCO was able to establish a learning community interested in subjects like inter- and intra-culturality, inter-scientific dialogue, inter-civilizational dialogue, participatory research methodologies that recognise the wisdom of indigenous peoples, decolonization, integrative logical understanding of history and culture, and transdisciplinarity. AGRUCO achieved a shift in the main concepts it is working with: from agro-ecology, biodiversity, sustainable endogenous development, and reciprocity towards indigenous economies, legal and political issues like pluralnationality, autonomy, plural legal systems, communitarian socialism, wellbeing, and other concepts.

In the current political reality of Bolivia it is important to take the "Living Well" discourse and ideology to a next level and AGRUCO contributed with a support to the NDP, the framework of Intercultural Governance, and other policies, programs and projects. The plural-national education system should future strengthen this process and AGRUCO provided an example that has the potential to be expanded in Bolivia and Latin America.

The Evaluation has identified the following challenges that AGRUCO faces:

- The process of qualification at postgraduate level, especially in the Masters has improved since 2010 but it needs a strategy to achieve a higher percentage of students' qualifications
- The PhD program needs co-funding in order for students to complete their research projects
- AGRUCO could increase its presence in the international scientific community by making a clear strategy in identifying partners who can contribute to the dissemination of scientific and other achievements
- There is a potential for AGRUCO to work in new areas of knowledge and topics in coordination and complementarity with other partners in the health sector, technology, migration and urbanism, the multinational state, religion, and energy.

The Evaluation concluded that AGRUCO is well positioned in the socio-political context, has contributed to a mayor institutional impact, has develop a set of innovative education programs at different levels, and also has contributed in development efforts.

Source: Orellana and Brouwers, 2012

Part D

The Health Sector Innovation System

1. Overview

The development and strengthening of the health system has always been considered a priority in Bolivia. Administrative decentralization initiated in the second half of the 1990s, brought benefits to the sector as it allowed the presence of the State and, along with it, resources for areas of the country where access to health services was virtually non-existent. Popular participation and administrative decentralization processes revealed deficiencies particular to the different regions of the country, including cultural, social and economic obstacles and provided local solutions (Aramayo, 2009).

The health innovation system is composed of a large number of public and private organizations and functions. In the public sector the Ministry of Health and Sports (MSD) leads the system, not only in policy definition but also conducting research and services through its dependent institutes. Two key vice ministries support the policy and implementation tasks of MSD: the Vice-Ministry of Health and the Vice-Ministry of Traditional Medicine and Intercultural Affairs. The presence of the MSD at the sub national level is represented by departmental health services, which are decentralized entities that function within the prefectures of the departments. Government has also established, within MSD a National Advisory Unit for Project Planning and Coordination. This unit has a research and technology sub-unit and is currently setting priorities for research.

Within the MSD, the programmes that carry out research are: National Control of Tuberculosis, Fight against Great Endemic Diseases, National System of Health Information, Epidemiologic Shield Programme (EE), Integral Health Project and the National Institute of Health Laboratories (INLASA). It should be highlighted however that no programme of the ministry carries out clinical research.

The greatest concentration of MSD resources assigned to R&D goes to INSALA (5%), which focuses its activities in the biomedical area (almost 80%); the rest of its activities are dedicated to public health. Although quite far from INSALA, EE comes in second place (2.8%) in the share of resources assigned to research. The Health Information System had the lowest share of expenditure in 2006. The ministry concentrates a great part of its energy and resources in epidemiological control.

A key actor of the health innovation system is the University of la Paz –UMSA- that operates 6 large research centres with different focuses: 1) Research Institute in Health and Development (INSAD); 2) the Institute of Genetics; 3) the Bolivian Institute of High Altitude Biology (IBBA); 4) the Institute of Laboratories Services for Diagnosis and Health Research (SELADIS); 5) the Institute of Research in Pharmacology and Biochemistry; and the 6) Centre for Information and Documentation of Medicine.

The greatest concentration of projects is found at IBBA, where clinical and public health research has high priority; these two research methodologies, when added, represent 73% of the total number of projects. Within the IBBA clinical research, “non communicable diseases and addictions” are the focus of the most research. In public health research SELADIS focuses on “nutrition and the environment”.

In the private sector operates an important coordinating network PROCOSI composed of 36 NGO’s, several working in isolated communities, where tasks range from data collection to analyzing information and developing community action. PROCOSI supports capacity development in NGOs to assist communities with prioritizing and supporting their own research and has been able to contribute to knowledge generation, developing methodologies, for example in supporting the intercultural-communitary family health policy, participative methodologies, and proposals for communication of social change.

Some key questions and challenges to enhance community engagement in health research revolve around issues of how to accomplish the following: strengthen the capacity of community members to play an active role in health; research, and determine the capacity needed in NGOs to facilitate this process; extract and build on existing experiences within NGOs, and determine capacity needs; strengthen the link between academia and the NGO sector. Present research results in such a way that they facilitate decision making (Mc Farren, 2006).

Advances in health research and related areas have been amply documented, although much remains to be done in diffusion as explained by de Pardo (2012) when dealing with the publication of the Bolivian Medical Gazette. Both at the level of public and private research organizations such advances have included the development of vaccines, better knowledge of the relationship health-anthropology, when dealing with native populations (see f.e. Mc Farren, 2006).

At the university level, one result of the SIDA/SAREC financed project at UMSA was to introduce biogas production in small villages and new medication against parasitic diseases. In this particular cooperation project contributed to the development of a research culture that did not exist before, in particular the use of funding mechanisms.

An interesting example of a multidisciplinary project which has yielded and extensive number of international publications is that of the Tsimane Health and Life History Project (Kaplan and Gurvey, 2013) a joint health and anthropology project aimed at understanding the impacts of ecology and evolution on the shaping of the human life course.

2. Research Policy in the Health Sector

Disconnect of the health sector research with policy definition and implementation in the attempt to achieve health sector goals has been a common problem in many countries in Latin America. Policy-makers often lack proper knowledge on what works and what does not, either because relevant research does not exist or because it is not well diffused.

In an attempt to understand and measure the extent of this phenomenon in 10 countries in the region, Urcullo et al (2008) has made an important survey-study to list and to analyse the principal themes in terms of priorities for health policy and research in the following areas: health financing, human resources for health and role of the non-governmental sector in health. The research used three methods of inquiry: (1) Quantitative analysis of closed-end questions restricted to predefined priority listings; (2) Qualitative analysis of open-end questions about country specific policy and research priorities in each thematic area; and (3) Review of the existing scientific and grey literature.

Some of the results of the survey-study provide the answers needed to analyse how near is the health innovation system in “closing the loop” in Bolivia. *Table 27* shows the specific questions that were asked and the responses in the case of Bolivia. In the table, the figure R represents the coherence indicator as the coefficient of determination (or R-2), between two different rankings of priorities. When analysing responses to the different questions the study of Urcullo et al show a high coherence in the country’s research agenda with policy decisions in the academic sector. The study also analyzed the scientific and grey literature showing the aforementioned coherence with mainly university oriented efforts.

Table 27: Opinion of Experts in Respect to "Closing the Loop" in the Health Sector

Question in the survey	Response and R2 coefficient
➢ Does government respond to the needs of population?	Perhaps to some extent (R2 = 0.40)
➢ Is scientific evidence being generated to assess, change or improve current policies?	Yes very much (R2 = 0.83)
➢ Should scientific evidence aimed at assessing, changing or improving current policies be generated?	Not much (R2 = 0.28)
➢ Is scientific evidence being generated to support policies that respond to the needs of the population?	Perhaps to some extent (R2 = 0.35)
➢ Do respondents value scientific evidence to support policies that respond to the needs of the population?	Yes, very much (R2 = 0.85)
➢ Is research moving in the right direction?	Difficult to say (R2 = 0.23)

Source: Urcullo et al 2008. Note: R2 values range from 0 to 1, where 0 represents no coherence at all and 1 represents full coherence).

Since 2006, government has followed the priority concerns of the past and revamped its policy vision in several ways, for example, traditional medicine has been revaluated and social policy has been defined as a high priority by the government, which has also requested that there are specific diseases that require mandatory reporting and are part of the epidemiologic profile of the country.

Present policy includes research and technology management that would incorporate high technology for the diagnosis, treatment and rehabilitation according to the population needs, guaranteeing the preservation of intellectual property rights of the traditional knowledge of indigenous and originary communities. Policy calls to develop and implement progressively and sustainably national technology to substitute imported technology, with the possibilities of marketing alternative products and procedures.

Although there is no integrated legislation applied to health research, there is legislation that applies to specific cases. One such case is the traditional medicine sector (with Law 0928 that dates back to 1987) destined to promote research, identify active principles, and contribute to the application and diffusion of traditional medicine into the medical practice.

There are regulations that apply to medical ethics, patents and medical products. INLASA has a laboratory in charge of quality control and dealing with patents is a responsibility of MSD, which is now working to make compatible the national legislation (and statistics) with the Andean Decision 486 (Common Law on Industrial Property)

The private sector has been normally absent from health research, although the national pharmaceutics industry has been growing steadily having exported some products to neighboring countries. The sector however has not made part of the definition of research agendas and linkages with universities have also been limited.

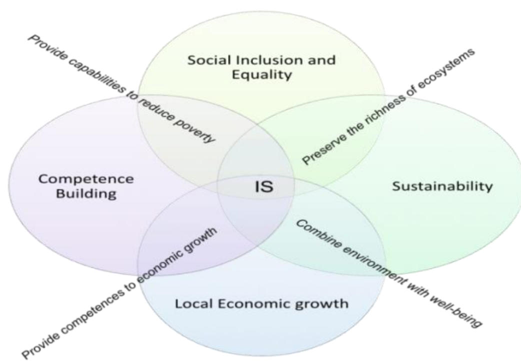
In March 2008, after a period of intense preparation, the Ministry of Health invited institutions involved in the sector to design a National Agenda of Research Priorities. After an analysis and following the recommendations of the meeting, the Ministry adopted an Agenda for Research (MSD, 2009), containing priority themes and research areas and 216 lines of research to implement them. It is noted at the onset that the Agenda lacks time as a key element for the definition of actions for the adequate functioning of the innovation system as discussed in Section 1, the number of prioritized research lines is too large and further no financial resources are quantified to implement the research lines.

Part E

The Renewable Energy Sector Innovation System

Pansera et al (2011) have discussed the importance of a systemic view of innovation to support a change towards a sustainable economic system, and maintain that sustainable development is possible by exploiting local potential and traditional knowledge to achieve economic growth, social equality and environmental sustainability. To back the hypothesis, a model for an innovation system applicable to developing countries is proposed as shown in *Figure 6*. The model advocates eight dimensions: 4 basic: *Local economic growth, Social inclusion and equality, Sustainability and Competence Building;* and 4 derived from the intersections: *Provide capabilities to reduce poverty Preserve the richness of ecosystems, Combine environment with well-being, Provide competences to economic growth*.

Figure 6: Innovation System Approach for Developing Countries



Source: Pansera et al 2010

The model has been tested in Bolivia where in its vision to fight poverty by the use of technology developments, and thanks to the adoption of an innovative *off-the-grid* model, the country has been carrying out the largest program of rural electrification in the Latin American region. The program *"Electricidad para Vivir con Dignidad"* (Electricity to live with dignity) is addressed to increase extension of electricity networks to rural populations. The project implemented renewable and alternative energy sources: photovoltaic systems, wind, micro-hydroelectric and the efficient use of biomass. Such dynamic is interesting as the development of local infrastructures and productive potential related to territory is a pillar of an endogenous development framework. *Table 28* provides the findings in the renewable energy system under the model.

Some of the highlights of the Programme show the intense efforts being made in this sector.

Table 28: Eco-Innovation System Dimensions

Score	Dimension	Description
3	Inclusion and Equality	The case showed clearly that in Bolivia an innovative approach to energy has been adopted. This approach is particularly interesting because it is focused on the social use of energy in rural zones and degraded urban areas. Consequently energy also becomes a tool for social inclusion, which has been proved by the installation of electricity in schools, rural health posts and public infrastructures.
0	Ecosystem preservation	Although in all the projects analyzed in the case study there are several vague allusions to the preservation of the local ecosystems, no particular details deserve to be mentioned
2	Sustainability	The level of sustainability has improved. In several rural areas people replaced the production of energy with biomass with that of PVS or Hydroelectric. However it seems hard to evaluate the impact of the sector on a large scale.
2	Environmental well-being	As it has been shown in the case, the quality of life of several thousand of families has improved due to the use of clean energy. However, there are many other factors that still affect the life of Bolivian people such as scarcity of fresh water, malnutrition, low levels of education and inefficient health infrastructures.
3	Local Economic growth	The renewable energy sector, especially in the case of PVS, has been strongly increasing in the last two decades. The birth of many local firms in the sector led to growth in employment related to the installation and maintenance of electrical infrastructures.
2	Competitiveness	The accumulation of knowledge and capability in the sector is creating, step by step, a group of small enterprises that are already able to compete at national level. However, this entrepreneurial environment is still too dependent on government and international funding
4	Capabilities building	The process of accumulation of knowledge and capability building has had a great impact on the sector. Nowadays there are several organizations in Bolivia able to design a plan for rural electrification and carry out it efficiently. Furthermore, over time, the local actors were able to create a network of international contact that was crucial for technological transfer.
1	Poverty reduction	Although electrical energy in rural areas considerably improves the potential productivity, it is quite difficult to assess its impact on poverty. A specific study is needed to find out if the massive installation of PVS yielded to an increment of the income of the users

Source: Pansera et al 2010, Scores: 0 (No specific effects found); 1 (Slight effects found, but not possible to quantify); 2 (Slight effects found and possible to quantify); 3 (Important effects found and possible to quantify); 4 (Great impact easily verifiable).

Rural Areas

In 2007, it was estimated that around 3 million people living in rural areas (495,000 households) did not have access to electric energy. Around 40% of that people lived close to existing grids while the other 60% lived in smaller villages far away from them, and was estimated that 70% of the total could be covered with alternative - decentralized renewable energy sources such as photovoltaic or turbine systems.

The interest in rural electricity, especially for PVS, dates back to the ‘80s. During the last two decades that interest has been clearly increasing to such an extent that it is currently estimated that in rural areas there are about 20,000 installed PVS. That achievement was possible thanks to two main factors: i) the development of local technological and organizational capability and ii) the international cooperation aid. It is recognized (Aliaga et al , 2011) that rural areas could potentially hold 150,000 PV systems to meet the growing demand. More innovation and cheaper adaptation are needed to reach that goal.

In some communities located away from the main grids and where water resources at different elevations are available, micro hydroelectric systems were installed. There are around 60 systems working around the country that produce close to 3 MW of power together, and the country has the potential to install up to around 300 more systems to meet the demand.

Other systems can also be introduced to rural areas, for example, 500,000 efficient stoves could be implemented to reduce the growing energy demand and energy looses; 1,100 pumping photovoltaic systems could also be implemented. These areas could also benefit from the energy provided by 2,500 wind turbines, or 4,000 thermo-solar systems.

Urban Areas

In urban areas, a different energy phenomenon is observed. PV and thermal-solar systems would be the most efficient. In the case of PV systems, urban areas would need around 30 MW. The systems could be installed in urban ceilings and connected to the main grids to insert energy ranging from 1 kW to 300 kW. In the case of thermal-solar systems, these are the systems with the largest potential. Even though they provide a cheaper way to warm up water, they only have a 7% adoption and diffusion. The country has potential to carry around 150,000 to 200,000 thermal-solar systems; however, the country only installs 400 units per year and there are currently only 3,000 working units, showing a large gap as investments are not enough to provide incentives to meet the energy demand utilizing renewable energy sources.

Human Resources for Renewable and Alternative Energy

Even though the Bolivian government has been prioritizing the work on the project "Electricidad para Vivir con Dignidad," there is very little reliable data, qualified human resources and research about the Bolivian energy sector which has significantly limited the implementation of the Programme (Aliaga et al 2011). In the case of PV and pumping systems there is a significant and stable demand for engineers and maintenance technicians. The main bottleneck of the process is the formation of installers and is estimated that around 600 to 1,600 of these are needed, while 300 to 820 engineers are needed.

For efficient stoves, there is evidence that shows that there is also a stable demand for engineers and maintenance technicians. The required number of installers is high similarly to the case of photovoltaic systems; this number represents more than 4000 technicians needed by the year 2025. Since these stoves should be mainly implemented in rural areas, most of these technicians should be people permanently living in these areas; therefore, their formation should enable them to adapt to their local context. Hydroelectric micro-central units exhibit the same behavior efficient stoves do

The study performed by Aliaga et al recognizes the requirements for renewable energy systems for the next twelve years. This requirement is mainly focused on photovoltaic and pumping systems (90,000 units), efficient stoves (up to 200,000), and hydroelectric units (up to 190,000 units). It was also estimated that around 72% of all the human resources needed for renewable energy systems by the year 2025 corresponds to technicians, installers and maintenance technicians globally; around 21% will be engineers and 7% administrators. In Bolivia, around 800 engineers and 3,300 technicians are needed if thermal-solar and wind systems are not taken into account. A clear and strong energy policy and investment is needed to promote the renewable and alternative energy market.

Part F

The Informal Sector "Innovation System"

1. Overview

The importance of the informal sector is paramount in Bolivia, as it contains a large number of micro enterprises and as it contributes greatly to employment generation and family savings, although scarcely contributing to GNP due to its low productivity. This sector has been characterized by several studies under two different approaches. The first (Evia, Pacheco and Quispe, 2010) considers that the informal sector contains workers who by their own decision belong to it, those family or apprenticeship workers that do not receive a salary, and to patrons and workers that undertake their activities in organizations with less than five employees. A second approach is that of Collao, (2011), that considers that micro and small enterprises constitute the bulk of the informal sector and thus stress the study on the characteristics and behavior of this type of organizations.

Considering a multiple set of factors that constraint the operation of enterprises in the informal sector, government has manifested its interest in the informal sector through the creation of the Ministry of Productive Development and Plural Economy, in charge of policy design to stimulate productivity and coordination with SMEs and the Bank for Productive Development.

Government has also established other support organizations. Among the most important:

a) Pro-Bolivia to provide entrepreneurial development services to enterprises; small urban and rural producer associations; peasant economic organizations; through programmes of training; technical assistance; identification, formulation and evaluation of business plans and projects, and the respective financial assistance. During 2010 it operated with a small fund of 1.4 million USD and in 2011 this was raised to 2.5 million USD. In 2010 training reached 1,185 productive units. This organization also registers and provides accreditation so that enterprises can access preferential treatment in State bids. By 2010 514 units were registered and 209 accredited. Of these 38% were microenterprises, 30% small, 15% medium and 17% large enterprises.

b) Promueve-Bolivia to manage internal and external markets, through information, organization of national and international fairs, entrepreneurial missions, register of potential exporters, opening of markets and product promotion. It advices producers and exporters on external trade issues through documents and specialized statistics, as well as training and technical assistance services. In 2010 in its foreign trade training it has reached around 700 micro and small enterprises, and in generic exports issues reached 1,800 enterprises

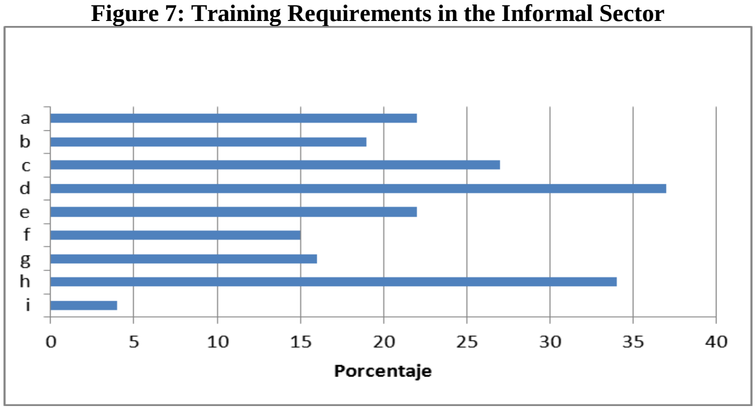
c) Insumos-Bolivia to acquire raw materials and strategic inputs for direct support of productive units; provide added value to exports; commercialize and distribute products and inputs in the internal market. Some of its main users are small producer organization.

The private institutional support to the development of the informal sector is not exactly quantified but it is extensive. Of the total number of 2,000 registered non profit institutions, it is assumed that at least 500 are involved with this sector, several providing micro credit. There are international and national support programmes which can be identified, for example initiatives by the European Commission and the National Chamber of Industries.

2. Research, Technology and Innovation in the Informal Sector

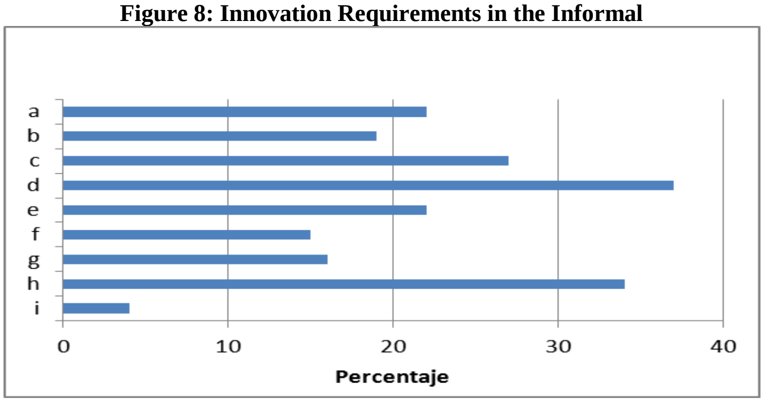
RTI activities in the sector have not been analyzed in much detail. In general, 88% of activities do not produce innovation-based products or market diversification; 95% do not introduce new technologies; 78% do not export their products; 23% received entrepreneurship training. Many of these limitations could be overcome by a more focused and coherent set of policies. Collao has analyzed the requirements of training and requirements of innovation as shown in *Figure 7* and *Figure 8* respectively.

Figure 7: Training Requirements in the Informal Sector



Source: Collao (2011). Notes: a) Financing issues; b) Industrial safety; c) Quality; d) Environment; e) Technology and processes; f) Commercialization and marketing; g) Leadership and development; h) Partnerships; i) Others

Figure 8: Innovation Requirements in the Informal



Source: Collao (2011). Notes: a) Capacity to access last technology; b) New technology to improve quality; c) Improvement of production processes; d) Improvement of commercialization processes; e) New product development; f) New or improved raw materials; g) Product presentation and design; h) Quality of product; i) Others.

Part G

Surveying "Closing the Loop"

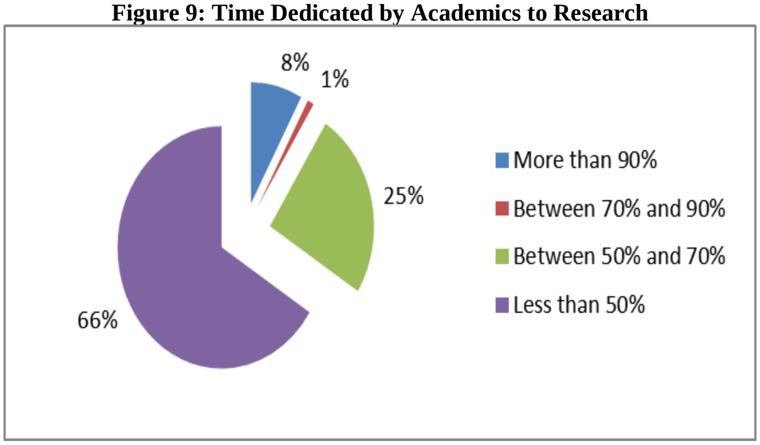
1. The Survey and the Respondents

During the course of the Project in Bolivia a survey was conducted in two periods randomly approaching members of the academic community to test how far "closing the loop" was actually occurring. For this purpose 250 (bi-lingual) questionnaires were sent of which a total of 75 (30.0%) were responded. The questionnaire supported the assessment using two methods: i) closed questions for the overall assessment of the research and innovation system in Bolivia; and ii) open questions, in order to capture those missing elements that are not contemplated in the first part.

Although the percentage of responses was relatively high, a larger number was not obtained due to the fact that not all academics are (or ever did) undertake research activities; also, there remains a culture in developing environments of not responding to surveys; and the little incentives that the research community has to test its outputs.

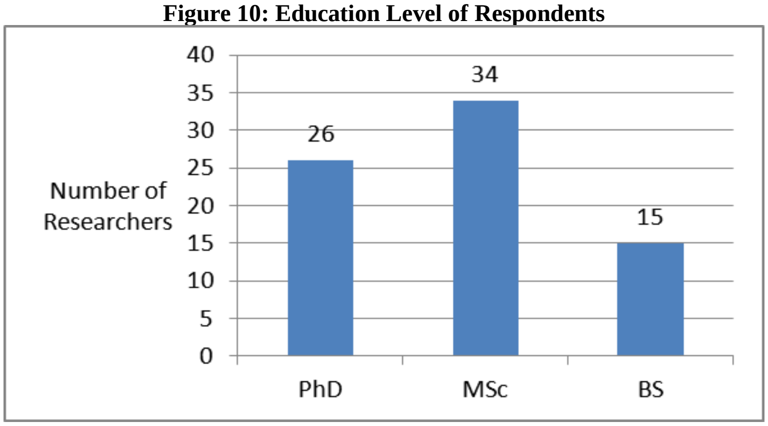
Figure 9 shows the percentage of time dedicated to research of those academics that responded the survey. The small percentage fully dedicated to R&D is consistent with the findings of surveys made by the VMCyT and CEUB of the small research community of Bolivia and the recommended need to promote research activities among all academics particularly in universities.

Figure 9: Time Dedicated by Academics to Research



It is considered that the result of the survey is highly representative of the qualified opinion of the research community because of the level of those that have responded and their engagement in important on-going and past research projects. *Figure 10* shows the level of education of respondents, 35% having a PhD, 45% a MSc and 20% a BSc degree, of these 54 were males and 21 females, and 60% between the ages of 31 and 45 years. The respondents belong to different sectors such as agriculture (9), health (3), and the rest to economics, technology transfer, climate change, energy, among others. Of the total, 25 researchers indicated having less than five years of experience in research while 50 had more than five years.

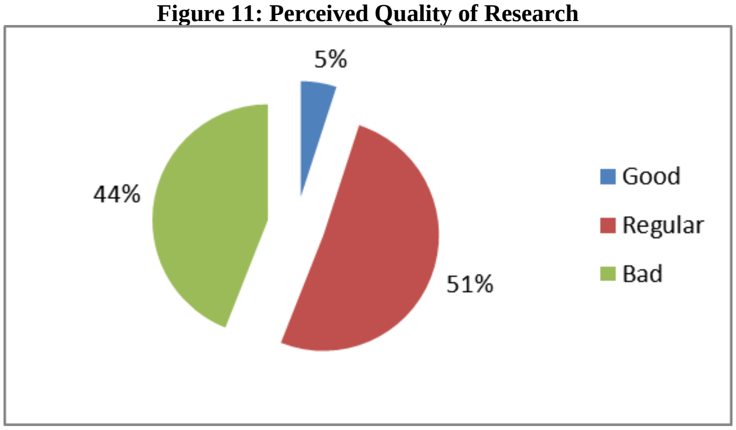
Figure 10: Education Level of Respondents



2. Quality of Research

Figure 11 illustrates the assessment made by the respondents of the quality of research that is taking place in the country. It is noted that 44% of responses indicate the bad quality of research. From the results of the survey and the bibliometric analyses referred to previously it can be said that research output in quantitative terms is modest, but quality is highly variable. A handful of outputs are outstanding and significant, several are useful and relevant at the project level but contribute modestly to the STI domain, others are methodologically sound but add little to STI.

Figure 11: Perceived Quality of Research



3. Relevance of Research

A first consideration of relevance in the survey is made by the opinion of whether the balance between basic and applied research is appropriate. The results show that only 15 out of 75 responses consider that the balance is appropriate, a large number of research projects being basic research. This response is interpreted here in the sense that respondents consider that basic research does not necessarily lead to an application of results, which of course is debatable.

Figure 12 shows the relevance of projects towards perceived national development problems or problems identified in public policies as claimed by respondents. When researchers were asked about the important factors that they considered when they formulated their research projects the most important factors ranked were: compliance with national development goals (29%) and academic impact (23%), while the least ranked were other (21%), compliance with priorities set by funding agencies (15%) and compliance with faculty/department research priorities (12%), as shown in *Figure 13*.

Figure 12: Relevance of Projects

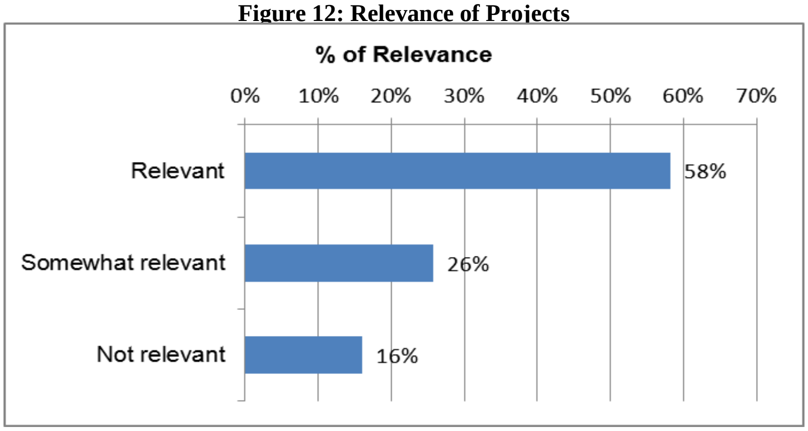
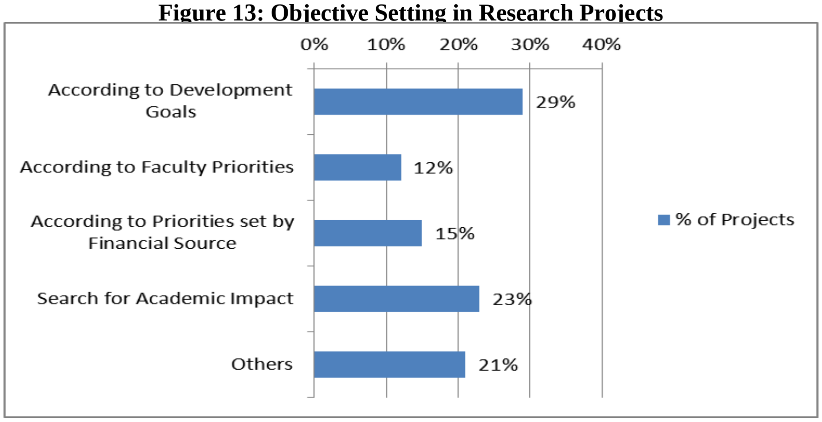


Figure 13: Objective Setting in Research Projects



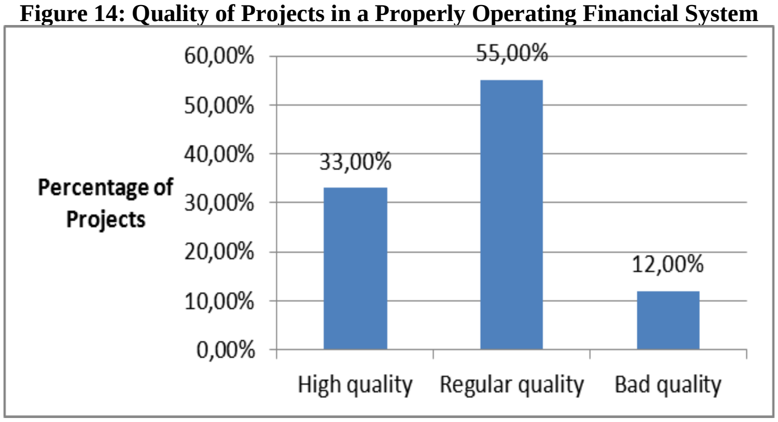
A note needs to be made here to compare the above results with those obtained in the case of the health sector, where the study of Urcullo et al (2008) shows that there is a high degree of coherence between the scientific evidence being generated in projects to assess, change or improve current policies and that scientific evidence is being generated to support policies that respond to the needs of the population to some extent.

4. Funding of Research

A key element influencing on the performance of the national STI system is of course funding, and as already discussed, the government and private expenditures in R&D and innovation in Bolivia is still very low. The survey allowed examining the perception of researchers around the issues of funding, 91% of whom consider that the funding system does not function adequately. Such situation constitutes the major lack of incentives for research and is responsible for the large number of academics that do not dedicate full time to research and thus limit a better quality of research outcomes.

For the small percentage of researchers that believe the funding system operates well, the quality of projects being financed is of varied nature as shown in Figure 14.

Figure 14: Quality of Projects in a Properly Operating Financial System



For those researchers that believe there is a poorly operating financial system the perception of quality of projects is shown in *Figure 15*. Further, only 52% of respondents feel that the financing organizations take measures to secure the alignment of their funding towards established development objectives.

Figure 15: Quality of Projects in a Poorly Operating Financial System

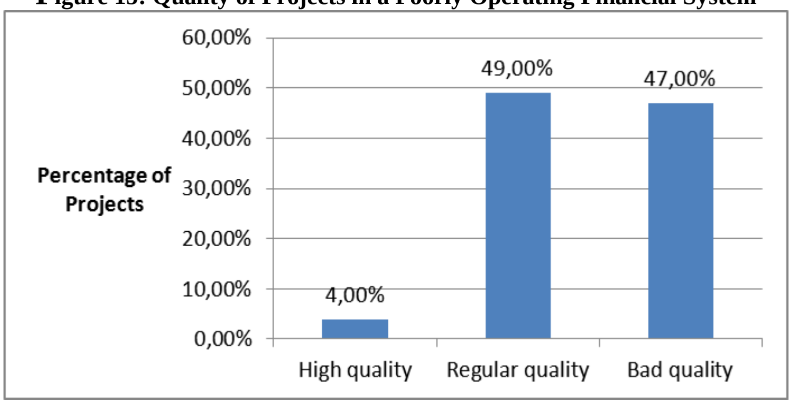


Figure 16 shows the distribution of the sources of funding for research projects and this result is coincident with the indicators produced by the VMCyT as discussed in the description of the national STI system. It is noted that not only donor funding is high, but also that researchers prefer it as they are not attached to government policies (and politics), even though research results might not be readily utilized by public decision makers. This preference to donor funding comes both from young and also experienced researchers.

It is also possible to measure quality of projects by considering the priorities that are followed in the design of projects as is shown in *Figure 17*. It is noted that independent of the guiding priority, 44% of the respondents to the survey consider the outputs of bad quality, while 51% consider outputs of regular quality and only 5% consider them of high quality. It is noted in particular the high percentage of regular or bad quality project outputs when national development goals define the objectives.

This is a hindrance to policy makers at the moment to take a decision and leads to a phenomenon by which bad quality research replaces high quality. On the other hand, a large number of researchers consider that the measures taken by funding agencies to align research objectives with national development goals are insufficient and these agencies are not functioning adequately.

Figure 16: Sources of Funding

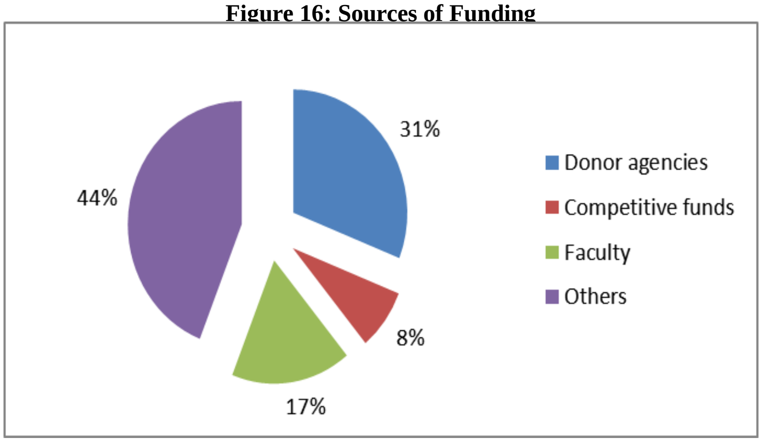
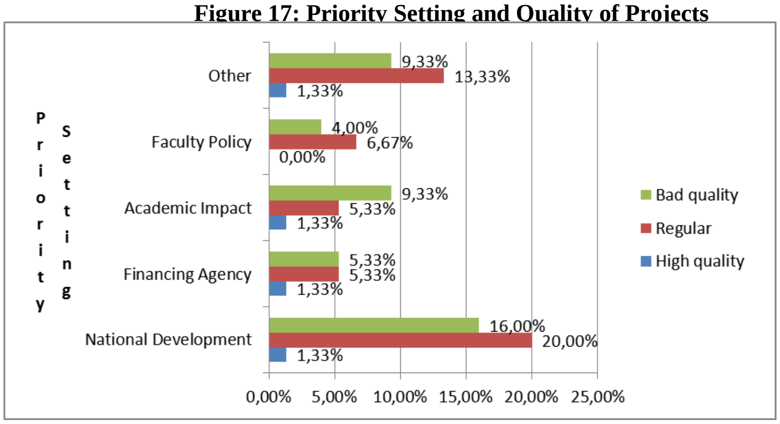
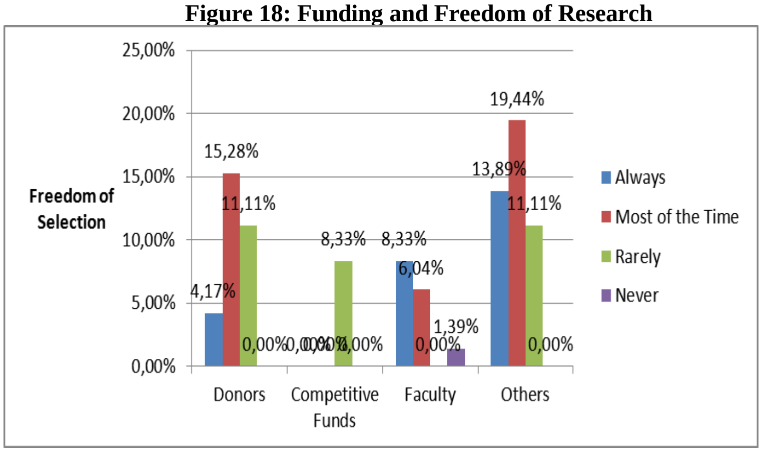


Figure 17: Priority Setting and Quality of Projects



On the other hand, in spite of the preference of researchers for donor funding, it is one which allows the least academic freedom for project design, as shown in *Figure 18.*

Figure 18: Funding and Freedom of Research



5. Use and Impact of Research Results

The survey determined that 75% of the researchers consider that their projects output had impact at local level while only 25% had impact on the national level. This distribution can be in part responsible for the more limited use of research outputs by decision makers who normally look at the national picture rather than more restricted local situations.

At the same time, researchers considered that their outputs should have impact on policy, social development and economic development as shown in *Figure 19*. In spite of the claim that that only 15% of project outputs had impact on policy, in the survey 56% of respondents claimed that their projects contained policy oriented problems, while 44% did not. *Figure 20* shows however the actual degree of use that is made by policy makers of project outputs. It is seen that only 3% of outputs are actually used much.

Figure 19: Expected Impact of Project Outputs

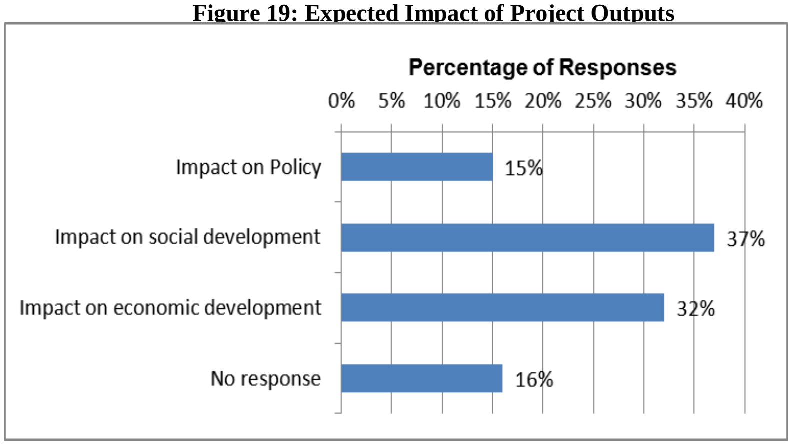
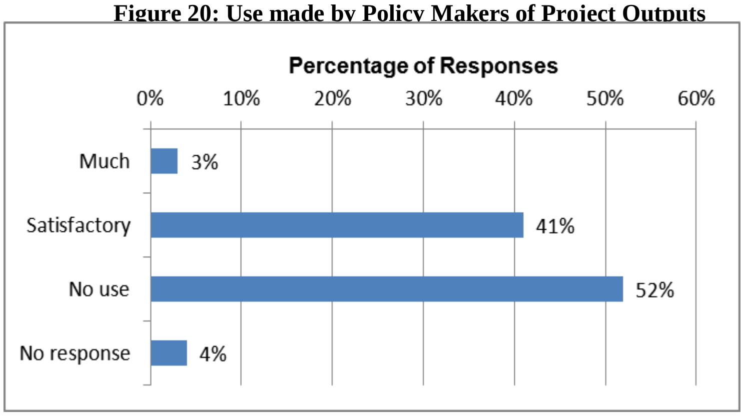


Figure 20: Use made by Policy Makers of Project Outputs



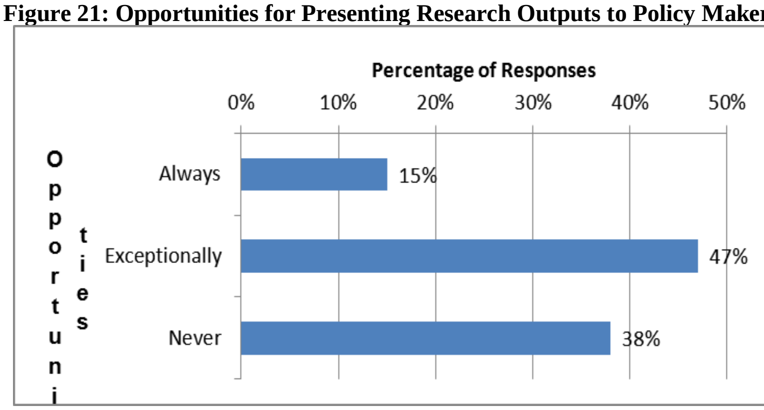
One way to improve quality of research and particularly the use of research outputs for policy making is to engage policy makers themselves during the time of project execution, in this case only 9% of research projects included a policy maker.

At the same time, the survey asked researchers to indicate whether or not policy makers were aware of the on-going projects and their outputs, and in this case it is found that 37% of projects were known while 63% were not.

On the other hand, researchers were asked whether they had the opportunity to present their outputs to policy makers as shown in *Figure 21*.

On the other hand, the presence of policy makers in the projects themselves was not necessarily responsible for an improvement in the quality of the research. In the case where decision makers participated, it was considered that not more than 10% of the outputs were of high quality, a figure that is comparable to the perceived quality of outputs in projects where policy makers did not participate. To this result, it should be added that there are few officers of high level that understand S&T and these rotate frequently in government offices due to policy changes, and many leave due to brain drain.

Figure 21: Opportunities for Presenting Research Outputs to Policy Makers



The result of the survey show the need that researchers choose topics that have both theoretical and practical / policy implications, to ensure mutual interest and benefits in project collaboration and it is important to involve many stakeholders (including policy makers) in both the design and development of the project.

In terms of the relevance of the research as a policy informing, 87% of researchers consider that there is a large communication gap between the scientific community and decision makers. It is claimed by several researchers that the gap occurs as the former are not well aware of the new legal and economic framework existing in the country, while at the same time public officers lack the understanding of what technical or scientific contributions can do for development.

Other studies (e.g. Aguirre Bastos et al, 2010) show several reasons and difficulties being faced by the scientific community and policy makers to close the gap, amongst these, that the latter think in a more practical and broad way, while the scientific community thinks more specific. It is also important to note that policy makers are not inclined to read lengthy research reports, so provision for policy briefs, highlighting the major finding are helpful and should be made part of the outputs of projects.

Further, closing the gap demands regular communication and good networking practices between the two groups and involvement of other actors in and outside respective sectors. Networking would contribute closing the gap by a continuous engagement and feeding of research outputs results into the variety of civil-society and governmental processes. The present activities of the VMCyT have the creation of networks one of its important priorities and to deepen their effectiveness as channels towards decision makers it will be necessary to financially support their activities.

It is also found that the extent of the gap depends on the sector. It is very small within the agriculture sector, where the scientific community and policy makers have agreement on most issues, while the gap is larger in sectors where there is a dynamic and more critical S&T community.

In general to close the observed gap it is necessary to review the process by which research agendas are set in order to satisfy policy maker's demands as well as concrete problem of enterprises. It is also necessary to strengthen the dissemination of research results, reviewing polices for access and diffusion; strengthen the capacity of statistical analysis of STI policy organizations; and develop strategies to build bridges that favou contacts.

Conclusions

➢ ***Who sets policy and the research agendas?***

It is important at the onset of the conclusions that follow to separate as much as it is possible the research outputs that are addressed to the enrichment of culture, social and economic innovations from those addressed directly to policy definitions, recognizing of course that it is normal for the former to also contain important elements of policy that need to be identified by policy makers.

It is also important to separate the discussion on what was done in Bolivia before and after 2006 to define and implement STI policies. Before 2006 the development agenda was set by government bureaucracy with the support of outside expertise, both national and international, accompanied by a rather limited dialogue with social and economic actors. After 2006 the development agenda is set by government following the dictates and pressures of social movements, and in fact it is an explicit policy decision that the latter be the leading force in policy definitions.

Independent of the period, STI policies and research agendas has been set rather independently by different agents of the national STI system, such as sector government organizations, universities, private agents, etc. causing a permanent disconnect in policy and strategy. The different efforts taken to define and implement a national STI plan, with limited exceptions, have always ended in failure.

Today the VMCyT is making a new attempt to integrate efforts under the National STI Plan under the endogenous-led vision set by "Patriotic Agenda" 2014 – 2025. Whether this attempt succeeds or not will depend on several factors. Of particular importance is to consider that as with many other national or sector STI plans and strategies, the present one is evidently large, cutting many economic sectors, technology fields and policy domains and concerns, but at the same time it has limited (undefined at present) resources.

Further, there is no analysis on the impact of implicit policies affecting the national STI system. Unless there is a better understanding on how such policies affect the system and what could be done to better complement explicit with implicit policies, any policy or research agenda will not be strong enough to face the present development challenges and the former may be subject to permanent changes depending on the will and understanding of individual policy makers.

STI policies are only effective when government can formulate and implement them for which is needed a more secure politico-institutional foundation and the capacity to enforce regulations, thus it is clear that the main reason for the difficulty in building-up an adequate capacity in STI was and still is insufficient government capabilities and effectiveness. Moreover inconsistencies and credibility problems exist at present as the 2007 Constitution and the National Development Plan and government declarations provide mandates that are not implemented. Such inconsistencies are clear also when government demands an endogenous-based development but has as its main source of funding external cooperation.

For Bolivia to benefit from the existing pool of knowledge and that which will be generated in the future, and develop new knowledge in favour of economic and inclusive growth there needs to be interest not only in the scientific communities but also in the policy and political establishment that sets priorities and provide incentives to the national innovation system.

- ***How do innovations come about?***

From the analyses of existing documents it is recognized the persisting difficulty to understand the concept and practice of innovation by all agents of the national STI system. In the on-going discussion on the national STI system, there is recognition of innovation as a key resource for market penetration and competition, as well as the recognition of examples of incremental innovations; also it is correctly recognized past innovations in large infrastructure works or in the domestication of products of biodiversity.

However, the existing understanding of innovation and the definition of the national STI system (as well as the conceptual approach to STI development) miss a key element in the production of innovations which is the recognition of the enterprise as the main actor of the innovation process. Communities at large, social cooperatives and similar organizations, and universities are not and cannot be the sole responsible for the production of innovations. Unless enterprises of any size are present, the innovation process cannot be easily completed.

- ***What is the character of the adopted policy and research agendas?***

Bolivia has adopted an "endogenous-led" STI policy and strategy that relies strongly on the potential capacities of traditional knowledge and local wisdoms and their combination with "western knowledge". This approach lies on a set of assumptions stemming from a diagnosis that is too strongly ideologically oriented and does not recognize the full extent of both the strengths and weaknesses of previous STI policies or the intensive learning processes that have taken place in the country, the region and worldwide. The diagnosis identifies correctly that scarce financial support to research and the dependence on foreign technology hampered development.

It is also quite evident, contrary to the diagnosis, that past policies were addressed to develop local potentials and in fact the latter has been the guiding vision in Bolivia, as well as in Latin America, that was developed by the Latin American School (Martinez and Mari, 2002). Further, past policies were addressed to strengthen the structural functions of the national innovation system.

Several assessments made under the ideologically oriented vision of the research and innovation efforts show a picture of weakness and slow improvement, but such assessments underestimate the dedicated efforts of several public or private institutions and researchers, in particular public universities, and private research centres whose role has been fundamental in creating and utilizing knowledge for social and economic development and are key actors in the national innovation system.

It is also not clearly recognized, the existence of enterprises with assimilation capabilities that constitute important potential for future development and the existence of support mechanisms and services to production, and existing elements in past and even present policies whose application will favour the creation of new opportunities for innovation.

When lack of funds and lack of more solid governance meet, such has been the case of Bolivia, the situation is dramatic. In the country there is still need to effectively improve STI governance understood as the capacity of the country's institutions to define and implement policies. It must be understood that an effective governance structure for STI policy-making needs more than a competent and relatively independent public administration, while remaining autonomous it must also be sufficiently embedded in the economy to have access to the decentralized sector specific and local information that is needed for policy making.

- ***Which actors are involved in the innovation system and what roles do they play?***

The national STI system is still weak and not well articulated but actors can be identified. A key actor is evidently the State which today does not act only as a facilitator but also as an operator from public enterprises, R&D centres and financing mechanisms. At the same time the public university system is the main actor for R&D, while the private system is very weak in this task; private and public enterprises continue to lag behind in the generation of innovations. Important new actors have become several local communities and regional governments, which are in effect innovating in the commercialization of specific products and also generating social innovations.

- ***What are the rules that guide the behavior and practices of actors?***

Attitudes and practices are a major obstacle to innovation in Bolivia. Strong incentives to innovate, arising from exposure to highly competitive markets, have rarely been sufficient to induce new patterns of collaboration.

The lack of interaction inside the STI system results in limited access to new knowledge, weak articulation of demand for research and training, weak or absent technological learning, weak or absent organizational learning at the company/farmer/entrepreneur level and at the sector level, weak sector upgrading, weak integration of social and environmental concerns into sector planning and development, and weak connections to sources of financing for innovation.

In considering “closing the loop” in the agricultural innovation system for example, it must be understood that the context for agriculture is changing rapidly and radically, and among the challenges to be met is that markets, not production, increasingly drive agricultural development. This situation contrasts with present government priorities for this sector.

- ***How are small stakeholders engaged in and affected by a process of institutional learning?***

Small stakeholders are yet to be fully engaged in the definition and operation of the national STI system. When considering inclusive development, it must be borne in mind that Bolivia holds a millenary tradition in dialogue, as a strong cultural trait, that can be utilized by developmental universities and other actors, to introduce and create alternative research and innovation visions permitting to close the loop.

- ***What are the economics of investments?***

Investments in research, technology and innovation have paid well in specific cases. In others, insufficient funding has been the key obstacle for “closing the loop”. Research projects were well defined, but lacked, because of financial constraints, the better identification of diffusion mechanisms, other than publications or oral presentations.

Research agendas should be set-up to succeed. This means adequate sustained and transparent funding, professional research managers, ethical standards and accountability in the use of public funds.

In general, for the STI system to operate efficiently, a culture of evaluation needs to be introduced at all levels so that research agents will be backed by scientifically conducted process of measuring outputs and impacts.

- ***Are they the priorities of the funding agencies?***

In Bolivia, researchers must find resources from any available source, as there is no specific funding agency. In this case research projects are those which are prioritized by funding agencies. This is not a general rule as funding is open for projects under calls from few sector funds, such as in the areas of economy or agriculture. But these are small funds in front of existing requirements.

- ***Is the loop being closed in Bolivia?***

In the sector analyses, it is found that agriculture has always been given a high priority and consequently, agricultural research and innovation has been on the different government's agendas for several years. Closing the loop has been possible when dealing on a product-by-product basis, one evident example is that of the Andean grain quinoa, which is today successfully commercialized nationally and internationally, after scientific research in the 60's and 70's provided the basis for improving commercial varieties.

Considering the past experience in the centralization of the state management of research activities (through IBTA), it may be possible that the difficulties that were encountered could be overcome by the alternative approach taken by INIAF. But, a strictly state managed research and innovation agenda is destined to fail if it does not consider the enterprise (or a similar type of organization) which is the central player in innovation, which should follow more traditional entrepreneurial approaches.

The debate now centres on the extent of the introduction (or re-introduction) of local, ancestral knowledge into production and commercialization. Although projects such as CAPTURED by AGRUCO have effectively created better capacities in endogenous development processes, there remains the task of showing how such processes can actually work to "close the loop."

Considering this example and at the early stage of the operation of the agricultural sector innovation system, selective interventions should be limited in number focusing on strategic areas, those that can help the country to accumulate the know-how and capabilities for pursuing more sophisticated policies. The Global Conference on Agricultural research for development held in November 2012, has made a set of recommendations for an improved performance of the sector system on three fronts: foresight, capacity development and partnerships. In the first case overarching emphasis is placed on improved stakeholder engagement.

- ***Is it possible to improve and deepen the "close the loop" process and under which conditions?***

"Closing the loop" in Bolivia is possible, as there exists, although in limited quantity and quality, infrastructure and human potentials for obtaining research outputs for social and economic innovations. There is however a set of conditions that must necessarily be met in order to complete the process:

a) Expenditures for research, technology and innovation, and for higher education, must be increased, Government declarations are not a substitute for resources.
b) A structural analysis on productivity and competitiveness shows that in spite of institutional achievements, there is absence of both adequate explicit and implicit policies that affect the behavior of research, technology and innovation processes.
c) What is clearly needed is demand driven innovation policy; the country continues to apply supply side policies.
d) It is absolutely necessary that existing implicit policies be examined and modified or re defined should the national STI system be expected to operate efficiently. Further, it is necessary that STI policies be closely connected with other sector policies, and firmly embedded in the national development policy and strategy. Among the implicit policies, those addressed to promote and strengthen the productive sector are of high priority for research, technology and innovation.
e) For policies to be successfully applied it is necessary to develop and use policy instruments that have already shown their value: technology transfer mechanisms, foresight, incubators and many others need to be fully developed.

In the specific case of universities, a contributing element to the lack of innovation is that they are still below that which is necessary to face a globalized economy and even local challenges. It is satisfactory to find that many university projects deal with subjects of direct development relevance. But often these research interests have not been fully implemented in the form of extensive operation with research users, such as industries and authorities, as well as other parts of society, especially poor and indigenous communities. Certainly it is needed that university research environments should be more competitive and globalized, a culture of innovation must be generated, new opportunities for career must be created, the best talented should be attracted, a creative and open but rigorous, demanding and empowering environment should be generated.

The lack of linkages between research and production is one of the most evident signals of the low degree of efficiency of the national innovation system. Fast technology change, globalization, and other international developments make it necessary for universities to upgrade their activities from those of more or less advanced teaching institutions to modern universities. In particular, the Bolivian universities must become able to support national development through research-based solutions to development problems and, in particular, production of university graduates with a relevant research background. A renewed higher education system destined to attend the development of positive attitudes in front of creativity, entrepreneurship and technology and non-technology based innovations is absolutely necessary to face future challenges.

In spite of the efforts placed by the government and multilateral, international, regional and in occasion’s non-governmental and private agents, and successful experiences, the rate of progress towards inclusive growth remains slow. It is becoming increasingly evident that a focus on innovation, structural transformation and productive capabilities, need to be mainstreamed into development policies if growth is to be inclusive and resilient and its pace accelerated. In this context it is important an in-depth analysis on how prepared is the national STI system to support inclusive development objectives under the “closing the loop” approach.

References and Bibliography

AGRUCO (2008) Aprendiendo el desarrollo endógeno: Construyendo la diversidad bio-cultural, AGRUCO, COMPAS, Plural editores, la Paz, May (www.compasnet.org)

Aguirre Bastos, Carlos (2014) El Ambiente de la Tecnología y la Innovación en Panamá: Una Visión a partir de Indicadores, Secretaría Nacional de Ciencia, Tecnología e Innovación, Marzo 2014 (www.senacyt.gob.pa/gestion)

Aguirre Bastos, Carlos; Violetta Cumberbatch; Lourdes Palma And Ruben Berrocal (2012) Indicators for Policy and Strategy: Any evidence of their use in the developing world? Proceedings of the International Indicator Conference, Montreal, Canada, September, pp 432-433

Aguirre Bastos, Carlos; Andy Hall and Janice Jiggins (2010) Report of the External Review of the Innovation, Technology and Society (ITS) Program, Study commissioned by IDRC' Evaluation Unit, Ottawa, 27 August (www.idrc.ca/programme evaluations)

Aguirre Bastos, Carlos and Mahabir P Gupta (2009) Science, Technology and Innovation Policies in Latin America: Do they work? *Interciencia, Dic. 2009, Vol. 34 No. 12 pp 865 – 872*

Aguirre Bastos, Carlos (2004) Centro Nacional para el Desarrollo y Transferencia de Tecnología e Innovación (CENDETEC) Study commissioned by the Vice Ministry of Industry, Trade and Exports, La Paz, 31 March

Aguirre Bastos, Carlos (2002) Lineamientos para una Política Pública para el Desarrollo de la Ciencia, la Tecnología y la Innovación en Bolivia, Document prepared for the Bolivian System of Productivity and Competitiveness of the Ministry of Economic Development, December, La Paz

Aguirre Bastos, Carlos (2001) El desarrollo del Marco Institucional y de Políticas de la Ciencia y la Tecnología en Bolivia. en: Contribuciones a la Historia de la Ciencia en Bolivia. Academia Nacional de Ciencias e Instituto Panamericano de Geografía e Historia, No 519, México D.F., p.p. 3 - 12

Aguirre-Bastos, Carlos (1997) Las Pequeñas y Medianas Empresas en el Sistema Nacional de Innovación, Academia Nacional de Ciencias de Bolivia y Centro Internacional de Investigaciones para el Desarrollo, Canadá, Publicación de la Academia Nacional de Ciencias, La Paz

Alänge, Sverker; Sari Scheinberg; Carol Arribasplata; Rolando Jimenez (2004) "Cluster Analysis" Results of a survey/study presented at the Innovation Cluster Workshop, held in La Paz, Bolivia on 30 July 2004.

Aliaga, Javier (2014) Study on the Renewable Energy Sector of Bolivia, to be published; Catholkic University of Bolivia

Antonio, Katherine (2011) The Challenges of Developing a Sustainable Agro-industry in Bolivia: the Quinoa Market, MS Thesis in International Development Policy, Duke University, USA.

Aramayo Carrasco, Antonio (2009) Monitoring Financial Flows for Health Research 2009 in: Global Forum for Health Research, Geneva (www.isn.ethz.ch)

Arauco, Eliana and Eliana Gallardo Paz (2011) La Educación Superior en Bolivia,in Educación Superior en América Latina: Informe 2011 (J.J. Brunner, RF Hurtado, editores), CINDA, Santiago, Octubre (www.cinda.cl)

Arocena, Rodrigo; Bo Göransson and Judith Sutz (2012) Developmental Universities and Knowledge Policies, paper prepared for the GLOBELICS 2012 Conference

Barré, Rémi (1997) Production of indicators for research and innovation policy: Organization and institutional context, in El Universo de la Medición: La perspectiva de la ciencia y la tecnología (Thee Universe of Measurement: The perspective of science and technology), H. Jaramillo and M. Albornoz (Compiladores) Editorial Tercer Mundo, Bogotá.

Carden, Fred (2009) Knowledge to Policy: Making the most of development research, IDRC (www.idrc.ca) , SAGE Publications

Cardozo Gonzales, Armando (2001) Evolución de la investigación agropecuaria en Bolivia in: Contribuciones a la Historia de la Ciencia en Bolivia, Academia Nacional de Ciencias e Instituto Panamericano de Geografía e Historia # 519, México, p. 159 - 170

Carvajal, Roger (2009) Fortaleciendo las Instituciones de Innovación: El caso del sistema boliviano de innovación, presentación en el Seminario Regional, Monterrey, México

Carvajal, Roger and Meliza Albarracín (2007) Sistema Boliviano de Innovación, Documento del Ministerio de Planificación para el Desarrollo, La Paz, Febrero

CEPAL (UN Economic Commission for Latin America) Socio Economic Indicators, December 2013 (www.eclac.org)

CEUB (2012) Estrategia Universitaria Nacional de Ciencia, Tecnología e Innovación (2012 – 2015), Comité Ejecutivo de la Universidad Boliviana.

Collao, Franklin Rubén (2011) Políticas e instituciones de apoyo a las micro y pequeñas empresas en Bolivia, en: Apoyando a las pymes: Políticas de fomento en América Latina, (C. Ferraro, compilador) CEPAL y AECID, Santiago (www.eclac.org)

Cornell University, INSEAD, WIPO (2013) The Global Innovation Index: The local dynamics of innovation, Geneva, Ithaca, Fontainebleau

Cozzens, Susana and Judith Sutz (2012) Innovation in Informal Settings: A research agenda, mimeo of July 28

De Pardo Ghetti, Evelyn (2012) Obstáculos al desarrollo de investigación y publicación en salud en Bolivia: el rol de la Gaceta Médica Boliviana, *Gac Med Bol 2012; 35 (2); 53-54*

Delgado Burgoa, Freddy J.M. and Cesar G. Escobar Vásquez (2009) Innovación Tecnológica, Soberanía y Seguridad Alimentaria, AGRUCO / Plural Editors, La Paz, February (www.plural.bo)

Evia, José Luis; Mario Napoleon Pacheco; Saúl Roberto Quispe (2010) Sector Informal y Políticas Públicas en América Latina: Bolivia, Programa SOPLA, Fundación Konrad Adenauer, Rio de Janeiro

FAUTAPO (2011) La Quinua Real en le Altiplano Sur de Bolivia: Documento Técnico para la Denominación de Origen, Fundación FAUTAPO para la Educación para el Desarrollo, Environmental Support Program Certificate.

Flores, Adolfo (2003) El Proceso de la Revolución Verde y su Repercusión en el caso de las Comunidades Campesinas de Capaña y Laguna Pampa, Provincia Linares, Departamento Potosí, MSc Thesis, UMSS

Fundación Valles (2010) Memoria 2010: Innovando el campo, mejorando vidas, Informe Anual 2010, Cochabamba (www.fdta-valles.org)

Hailu, Degol and Raquel Tsukada (2011) Achieving the Millennium Development Goals: A measure of progress, Working Paper No. 78, International Policy Centre for Inclusive Growth (www.ipc-undp.org) February

Hartwich, Frank and Heinz-Gerhard Jansen (2007) The Governmental role in the process of agriculture innovation: The experience of Bolivia, Research Resumes No. 8, IFPRI, Washington (www.ifpri.org)

Kaplan, Hillard and Michael Gurver (2013) The Tsimane Health and Life History Project (www.unm.edu/~tsimane/results.html#pubs)

Lemarchand, Guillermo A. (2012) The long-term dynamics of co-authorship scientific networks: Iberoamerican countries (1973 – 2010), *Research Policy 41 (2012) 291 - 305*

Mc Farren, Wendy (2006) Bolivia – the contribution of NGOs and Communities to health research, in: Supporting health research systems in Latin America: results of Latin America Regional Think Tank, Council on Health Research for Development (COHRED), Antigua, August (www.cohred.org)

Martínez Vidal, Carlos y Manuel Marí (2002) La escuela Latinoamericana de Pensamiento en Ciencia, Tecnología y Desarrollo: Nota de un proyecto de investigación, *Ciencia, Tecnología y Sociedad, Estudios*, No 4 (Septiembre – Diciembre).

Moraes, Mónica (2009) Difusión de la ciencia, indicadores e indexación de revistas científicas, *Propiedad Intelectual en la Investigación y Publicaciones Científicas,* UMSA, La Paz Segunda versión, Mayo, pp 35 - 48, MPD (2006) Plan Nacional de Desarrollo del Estado Plurinacional de Bolivia: Lineamientos Estratégicos 2006 – 2011, Ministerio de Planificación para el Desarrollo, La Paz (www.mpd.org)

MSD (2009) Agenda Nacional de Prioridades de Investigación en Salud, Ministerio de Salud y Deportes, La Paz (www.msd.org)

OIM/SELA (2009) La emigración de recursos humanos calificados desde países de América Latina y el Caribe: Tendencias contemporáneas y perspectivas, Organización Internacional para las Migraciones y Sistema Económico Latinoamericano, Caracas, June.

Orellana Halkyer, Rene and Jan Brouwers (2012) CAPTURED: Bolivia Country Evaluation: Report (www.captured.org)

Orozco Ramírez, S., Álvaro Garcia Linera, P. Stefanini (2006) No somos juguete de nadie: Análisis de la relación de movimientos sociales, recursos naturales, estado y descentralización, NCCR North – South, AGRUCO, Plural editores

Pansera, Mario; Angel Francisco Agudo and Felix José Pascual (2011) Eco-entrepreneurship in developing countries: the case of renewable energy sector in Bolivia, paper delivered at the 2011 ICBS World Conference, Stockholm, June

PIEB (2011) Factores que incidieron en el escaso desarrollo de Bolivia, Temas de Debate, Programa de Investigación Estratégica de Bolivia (JA Morales, editor) Número 18, Año 7, Diciembre

PNUD (2011) Informe Nacional sobre Desarrollo Humano en Bolivia: Los cambios detrás del cambio; desigualdades y movilidad social en Bolivia, La Paz (http://idh.pnud.bo)

SIR (2014) SCIMAGO Institutions Ranking (Ibero-America) (http://www.scimagolab.com; http://www.scimagoir.com)

Sunkel, Osvaldo y Ricardo Infante (editores) (2009) Hacia un Desarrollo Inclusivo: El caso de Chile, Comisión Económica para América Latina, Fundación Chile y Organización Internacional del Trabajo, Santiago (www.eclac.org/publicaciones)

Sutz, J. and R. Arosena (2005) Comparing Systems of Innovation through a “Constructive Approach”, Preprint for the 2nd GLOBELICS Conference (www.globelics.org)

Tellería, José Luis (Coordinador) (1993) Levantamiento del Potencial Científico y Tecnológico de Bolivia, Consejo Nacional de Ciencia y Tecnología. La Paz.

Thulstrup, Erik W.; Manuel Muñoz and Jean-Jacques Decoster (2006) Building Research Capacity in Bolivian Universities, Evaluation of SAREC/SIDA Financed Project in Bolivia, January

UNDP (2011) Human Development Report 2011, UNDP, New York (www.undp.org)

Urcullo, Gonzalo; Rodrigo Muñoz, Ricardo Bitrán (2008) Identification of Priority Research Questions in LAC within the Areas of Health Financing, Human resources for Health and the Role of the Non-State Sector, Final report, Bitrán & Asociados, Santiago, February

Velazco Reckling, Enrique (2002) Valoración Sistémica de la Problemática de Productividad y Competitividad en Bolivia, Informe al Sistema Boliviano de Productividad y Competitividad, La Paz, Octubre.

VMCyT (2013) Plan Nacional de Ciencia, Tecnología e Innovación, La Paz, Octubre (www.cienciaytecnologia.gob.bo)

VMCyT (2012) Potencial Científico y Tecnológico Boliviano 2009 - 2001, Vice Ministerio de Ciencia y Tecnología, La Paz (www.cienciaytecnologia.gob.bo/indicadores)

VMCyT y ADSIB (2007) Plan Nacional de Inclusión Digital 2007 – 2010, Viceministerio de Ciencia y Tecnología del Ministerio de Planificación del Desarrollo y Agencia de Desarrollo de la Sociedad de la Información en Bolivia, La Paz, febrero, 2007

Weber, Matthias (2010) Inception Report, Project Support to the Definition of STI Policy and Long Term Plan of Vietnam, UNIDO, Vienna

WEF (2013) Global Competitiveness Index 2013 – 2014, World Economic Forum, Geneva, 2013 (www.wef.org)

WEF/INSEAD (2013) The Global Information Technology Report 2013: Living in a Hyperconnected World (S. Dutta and B. Bilbao-Osorio, editors), Geneva, 2013 (www.insead.org)